4.—SUMMARY OF THE FISHERY INVESTIGATIONS CONDUCTED IN THE NORTH PACIFIC OCEAN AND BERING SEA FROM JULY 1, 1888, TO JULY 1, 1892, BY THE U. S. FISH COMMISSION STEAMER ALBATROSS.

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INTRODUCTION.

The building, in 1882, of a staunch sea-going steamer, thoroughly equipped for the purposes of the U. S. Fish Commission, afforded, for the first time, the proper means for studying the extensive ocean fishing-grounds adjacent to the Atlantic seacoast of the United States. During the five years following her completion the steamer *Albatross* was actively employed, and with marked success, in this special field of work, the region covered by her operations extending from off Newfoundland to the northern shores of South America. The interest aroused by these investigations, the utility of which had been fully demonstrated, led to a demand for the transfer of the *Albatross* to the North Pacific Ocean, a proposition which met the approval of the late Commissioner of Fisheries, Prof. Spencer F. Baird, and was later sanctioned by Congress. Extensive arrangements were necessary in preparation for so long a cruise, but they were satisfactorily completed in the fall of 1887, and on November 21 of that year the ship left Norfolk, Va., for San Francisco.

The first systematic researches bearing upon the economic marine fishes of the western coast of North America were conducted in 1879 and 1880, by Dr. David S. Jordan and Prof. Charles H. Gilbert, for Washington, Oregon, and California, and by Dr. Tarleton H. Bean, for Alaska. Not having suitable facilities for investigating the fishing-grounds, the work of these naturalists was chiefly limited to collecting and studying the fishes obtainable along the shores and from the fishermen, but, nevertheless, exceedingly important results were accomplished by them. These have been published in the reports of the Fish Commission and in the Proceedings of the U. S. National Museum, the series of volumes entitled the Fisheries and Fishery Industries of the United States containing full accounts of their observations relative to fishery matters, as well as a complete review of this entire subject down to 1882. The same information has also been summarized in the Bulletin of the Fish Commission for 1888, in connection with the first report upon the explorations of the *Albatross* in the North Pacific Ocean. A reference to these papers shows that, while a few cod-fishing vessels were accustomed to resort to certain places in Bering Sea and off the south side of the Alaska Peninsula, very little was then known regarding the extent and characteristics of the Alaskan fishing-grounds, only a comparatively few soundings had been made to ascertain the depths of water at any distance from the land, and the limits of the continental platform were almost wholly undetermined. Respecting the coasts

of Washington, Oregon, and California even less information was at hand, Dr. Jordan stating that—

> Except the salmon fisheries of the Sacramento and the Columbia and the ocean fisheries in the immediate vicinity of San Francisco, the fisheries of the Pacific coast exist only as possibilities. For the most part only shore fishing on the smallest scale is done, and no attempt is made to discover offshore banks, or to develop them when discovered.

Being specially equipped for hydrographic as well as fishery inquiries, the *Albatross* was well adapted to undertake the investigation of this practically new region, in which, at the outset, the delineation of the bottom was fully as important as the determination of its food resources. She is an iron, twin-screw propeller of 1,000 tons displacement, measures 234 feet in total length, and is rigged as a brigantine. The hull is modeled with reference to the peculiar character of her movements, and she is provided throughout with the most approved appliances for the different branches of research in which she is expected to engage, many of them being a direct outgrowth of the Fish Commission work. Sounding is carried on by means of fine piano wire, operated by a Sigsbee steam and a Tanner hand machine, both working on the principle first demonstrated by Sir William Thomson. Iron rope is employed for dredging, the machinery used in connection with it consisting of a heavy hoisting engine on the spar deck forward, and a reeling engine on the berth deck underneath, together with all the necessary auxiliary apparatus to insure its smooth running. The outfit supplied for physical and fishery observations comprises the means of studying the temperature, density, etc., and of collecting animals in all depths of water, the latter including a large assortment of dredges, beam trawls, and tangles, as well as all the ordinary forms of fishing gear.

The program arranged for the steamer *Albatross* contemplated, in the beginning, a somewhat rapid survey or reconnoissance along the entire western coast line, with the object of ascertaining the contour and condition of the bottom wherever the depths were suitable for fishing, the positions and outlines of all distinctive fishing-grounds, and the character and abundance of the food resources. Such an investigation could not fail to yield immediate results, by supplying early information to the fishermen to guide them in seeking favorable localities for the prosecution of their work, and it would also serve as the basis for the more complete development of important regions or of special branches of fishing. The *Albatross* reached San Francisco in May, 1888, and within three years from that time she had completed these preliminary surveys from San Diego to the Strait of Juan de Fuca; along the southern side of the Alaska Peninsula, from Middleton Island to Unalaska; and in the southeastern part of Bering Sea, from Unalaska to the head of Bristol Bay and Cape Newenham. Since June, 1891, she has been detailed to study certain problems respecting the habits of the fur seals in the North Pacific Ocean and Bering Sea, and to make the survey for a cable route between California and the Hawaiian Islands, neither of which subjects, however, is discussed in this paper.

The width of the area covered by the fishery explorations of the *Albatross* has been regulated mainly by the depth of water, having extended from the shallow soundings close along the shore to the abrupt outer margin of the continental platform. The object has been to carry the examinations over the entire surface of this platform, into depths of 100 and 200 fathoms, but in order to locate these curves with accuracy it has been necessary to extend the lines of soundings into somewhat deeper water, with the result of contributing very important data of general hydro-

graphic interest. Bottom fishing is rarely carried on beyond a depth of 200 fathoms, and in a new region it will be limited for many years to much shallower water. The sounding work, as indicating the general contour of the bottom, has, therefore, been sufficiently extensive for this purpose over the area so far explored, but more detailed surveys will be required in some localities, especially where the bottom is irregular and the fishery resources are rich enough to call for additional information of that character.

The summary of the operations of the *Albatross* herewith presented gives, in geographical sequence, the principal information of interest to the fishermen, which has been gathered during the several cruises in the North Pacific Ocean and to Bering Sea. It is based mainly upon the narrative reports of the commanding officer and his civilian assistants, but is necessarily very incomplete, as only a comparatively small part of the extensive natural-history collections obtained has yet been studied and described. It is considered, however, that the more essential practical results of the explorations have been sufficiently well worked out to warrant placing them before the public in this preliminary paper. The fishes, which comprise the most important group of animals from an economic standpoint, have been placed in the hands of Prof. Charles H. Gilbert, of the Leland Stanford Junior University, who also accompanied the *Albatross* on several trips, and while a number of papers descriptive of the new species secured have been published by him, a discussion of the ichthyological results must be deferred until the completion of his final reports. Much progress has also been made in the working up of the crustaceans and mollusks, which next to the fishes offer the most forms of commercial value.

It has been the practice of the Fish Commission to transmit to the U. S. Coast and Geodetic Survey and the Hydrographic Office of the Navy all of the hydrographic data obtained by the *Albatross* at the end of each cruise. This information has been incorporated from time to time in the charts issued by those bureaus, and, as their publications can readily be obtained at all of the principal ports of the United States, it has not been considered expedient for the Fish Commission to duplicate this work. A few charts have, however, been published by the Commission for early distribution among the fishermen, and those relating to the Alaskan fishing-grounds are still the most desirable for the regions covered, being upon a larger scale and containing more details than any others. The five small maps which accompany this paper are intended mainly to show the positions of the principal fishing-grounds; they illustrate only a very small proportion of the work accomplished.

At the end of the paper is given a list of the publications of the Fish Commission, the U. S. Coast and Geodetic Survey, and the Hydrographic Office of the Navy, which relate directly to the investigations of the *Albatross*, or contain data derived from them, and may be regarded as supplementing the information given in this summary. The titles of a few earlier papers by the Fish Commission are also cited because of their important bearing upon the questions here discussed. The charts of the Coast Survey and Fish Commission will be found most useful by the fishermen, those of the Hydrographic Office covering the coasts of the United States being usually upon a small scale. Where referred to in the body of the paper they are designated by the numbers which accompany them. It should be understood, however, that this list is very far from complete as regards the literature which now exists relative to the fishes of the North Pacific Ocean, and many published papers respecting the scientific results of the *Albatross* are here omitted, as they do not immediately concern the question of the practical fisheries.

The explorations which the *Albatross* has been conducting on the Pacific coast, and which it is intended shall be continued to the extent of making known at least all the more important fishery resources of that region within the limits of the United States, are especially noteworthy from the fact that they constitute an innovation in the support given by government to the development of this particular industry. No foreign nation has ever attempted, on more than a very limited scale, to enlighten the fishermen respecting the character, distribution, and abundance along its coasts of the aquatic forms of life which are the objects of their pursuit. The United States was the first to institute systematic inquiries of this nature, in connection with the work of the Fish Commission along the Atlantic coast, and, although the fisheries had been carried on there assiduously for several centuries, the value of scientific research in extending the areas of productive fishing-grounds was conclusively established. In the new field presented by the North Pacific Ocean, however, so little information had previously been collected that it was necessary to begin at the very rudiments of the problem, as explained before, and the investigations have been of the most searching and comprehensive character.

The conduct of these inquiries have been in charge of Commander Z. L. Tanner, U. S. N., the commanding officer of the *Albatross*, whose long connection with the Fish Commission especially qualified him for this important task. Having been closely identified with all of the oceanic work since 1879, and thoroughly appreciating the objects to be attained, his services have been invaluable. In the hydrographic and physical observations he has had the assistance of the naval officers detailed to the ship. On the voyage from Norfolk to San Francisco, the civilian scientific staff consisted of Prof. Leslie A. Lee, of Bowdoin College (in charge), Mr. Charles H. Townsend, Mr. Thomas Lee, and Mr. Dennis M. Cole. Since that time, however, Mr. Charles H. Townsend has acted as resident naturalist, Mr. A. B. Alexander as fishery expert, and Mr. N. B. Miller as assistant naturalist. Prof. Charles H. Gilbert, now of the Leland Stanford Junior University, also accompanied the *Albatross*, as ichthyologist and chief naturalist, from January to August, 1889, and during the Bering Sea cruise of 1890.

The movements of the Albatross.—Leaving Norfolk, Va., on November 21, 1887, the *Albatross* began the voyage to San Francisco, which terminated on May 11, 1888. Agreeably to the plans proposed by Prof. Baird before his death, the commanding officer was directed to make occasional dredgings and hydrographic examinations on the way, and to afford such opportunities as time permitted for studying the local fisheries and other matters of scientific interest at each port of call, as well as at the Galapagos Islands off the coast of Ecuador. On the Atlantic side stops were made at Santa Lucia, one of the West Indies, Bahia, Brazil, and Montevideo, Uruguay. Scientific observations were conducted at frequent intervals during the passage through the Strait of Magellan, and the ship proceeded thence to Lota, Chile, and Panama. From the latter place the Galapagos Islands were visited, and subsequently Guaymas and La Paz, Mexico.

Having perfected the arrangements for a northern cruise, the *Albatross* sailed from San Francisco on July 4, 1888, for the Alaskan coast, where, during two months, the fishing-banks south of the Alaska Peninsula and adjacent islands, between Unalaska and Middleton Island, were made the subject of careful study. The balance of this season was spent on the coasts of Washington and Oregon. The local fisheries in the neighborhood of Seattle were investigated during the early part of

September, after which the survey was carried down the outer coast from Barclay Sound, Vancouver Island, and the halibut bank off Cape Flattery, to the vicinity of Tillamook Rock, just south of the Columbia River. The ship reached San Francisco from this cruise on October 21.

After refitting at this place, the months of January and February, 1889, were spent on the coast of California between Point Conception and the Mexican boundary line, the investigations being carried seaward to include all of the outlying islands, as well as Cortes and Tanner banks, the latter bank having been discovered by the *Albatross* during this trip. A line of hydrographic stations was then run to Guadeloupe Island, the Alijos Rocks, and the Revillagigedo Islands, after which a series of examinations was conducted through the Gulf of California as far as the mouth of the Colorado River at its upper end. This last inquiry was undertaken for the purpose of ascertaining the relations of the Colorado River to the waters of the Gulf, and observations were also made upon the oyster deposits of the region, which, it was conjectured, might afford a source of seed in the event of oyster-cultural operations being started in southern California. Starting from La Paz on April 7, several stops were made along the outer coast of Lower California, the *Albatross* returning to San Francisco on the 27th of the same month, but leaving there again on May 21 to resume the work off Washington and Oregon, which was continued until July 1, 1889.

From July 8 until July 28, 1889, the ship was used by the U. S. Senate Committee on Indian Affairs for the purpose of visiting the Indian settlements in southeastern Alaska. Subsequently the investigations were again taken up on the coast of Oregon and were carried southward, terminating October 14 at Cape Mendocino, California. The coast of California, between Point Arena and the Santa Barbara Islands, was examined during March and April, 1890, and on May 5 following the *Albatross* left San Francisco for Alaska, where the summer was occupied in developing the fishing-grounds in the southeastern part of Bering Sea, and determining the western extension of the continental platform on which the Pribilof Islands are located. The hydrographic results obtained on this cruise were of more than usual interest. During the trip south in the fall, some additional observations were made on the fishing-banks off the southern side of the Alaska Peninsula, a line of deep-sea soundings was run in the direction of the Queen Charlotte Islands, and the survey of the continental platform was completed from Cape Mendocino to Point Arena, California.

On January 30, 1891, the *Albatross* sailed from San Francisco on a special expedition, authorized by the President of the United States, to investigate the hydrographic and biological features over an extensive area off the western coast of Mexico, Central and South America, between Lower California and the latitude of the Galapagos Islands. Mr. Alexander Agassiz, director of the Museum of Comparative Zoölogy of Harvard University, was in charge of the scientific work, which yielded results of great importance. The cruise terminated the last of April.

During the summer of 1891, the *Albatross* was employed to convey the United States seal commissioners, Dr. T. C. Mendenhall and Dr. C. Hart Merriam, to Bering Sea. During the following fall and winter she was engaged in surveying for the cable route between California and the Hawaiian Islands, under the direction of the Secretary of the Navy. Again during the late spring and summer of 1892 she was detailed to participate in the sealing investigations in the North Pacific Ocean and Bering Sea, taking an active part in the extensive inquiries directed from the State Department.

BERING SEA.

PRELIMINARY REMARKS.

Itinerary of the investigations.—The general survey of Bering Sea by the *Albatross* was conducted during the summer of 1890, but in 1888, while engaged in a study of the fishing-grounds south of the Alaska Peninsula, a few observations were made in Iliuliuk Harbor and in the passes between Unalaska Island and Unimak Island, and during the summers of 1891 and 1892 some additional inquiries were also prosecuted in connection with the sealing investigations.

The principal object of the cruise of 1890 was to determine the positions and characteristics of the more important cod-fishing grounds, but the examinations were extended over the entire southeastern part of Bering Sea to a line some distance beyond the submerged continental border. The *Albatross* entered Bering Sea by way of Unimak Pass in the latter part of May, and carried a line of soundings in a northerly and easterly direction, a distance of about 80 miles, when stormy weather made it necessary to proceed to Unalaska, the soundings and dredgings being continued on the way. Leaving the latter place on May 28, the ship began a reconnoissance of the shore line of Bristol Bay, which was extended first along the north side of the Alaska Peninsula to Kvichak River, and thence to Kuskokwim River. From Cape Newenham a line of stations was run in the direction of the Northwest Cape of Unimak.

On June 23 investigations were commenced on Slime Bank, and were carried thence over Baird Bank to the head of Bristol Bay and the Kulukak ground. Two visits were paid to Port Moller and Herendeen Bay, where a coal mine had recently been opened, and partial surveys of both of those inlets were made, which define their entrance and the channel leading to Coal Harbor. During the first part of August a line of soundings was run from off Cape Cheerful, Unalaska, to Bogosloff Island, from the latter place in a westerly and northerly direction, and subsequently in a southerly direction, for the purpose of developing the 100-fathom curve along the western edge of the broad plateau occupying the eastern part of Bering Sea. The remainder of the season was spent in the vicinity of Unalaska, mainly in determining the resources of the fishing-grounds lying off the northern side of that island. The *Albatross* left Bering Sea for the south on August 25.

General features of the region examined.—The entire eastern and northern part of Bering Sea is occupied by a broad extension of the continental platform, which, for convenience of definition, may be said to terminate abruptly at a depth of about 100 fathoms. On the Siberian side the position of the 100-fathom curve is still undetermined, and previous to 1890 no observations had been made respecting the topography of the intervening deeper area, except in the immediate vicinity of the Aleutian chain of islands, where an important line of soundings was run by the U. S. S. *Tuscarora* in 1874.

On the eastern side of Bering Sea the 100-fathom curve extends from off the northern entrance to Unimak Pass in the direction of Cape Navarin, Siberia, forming a sinuous line approximately parallel with the coast line of the Alaskan mainland to the east, from which it is distant from 260 to 325 miles. The location of this curve, and therefore of the western border of the platform (as yet only approximately defined in most places), was largely established through the investigations of the *Albatross* in

NOTE.—All bearings are true unless otherwise stated.

1890, the observations being carried by that vessel to 58° 43′ N. latitude, or about 168 miles northwesterly from St. Paul Island of the Pribilof group. From this point, in 144 fathoms, a line of soundings was run southward in the direction of Atka Island, developing a least depth of 977 fathoms and a maximum depth of 2,147 fathoms. A second line, farther to the eastward, extending from latitude 56° 12′ N., longitude 172° 07′ W., toward Uliaga Island, immediately to the west of Umnak Island, shows depths of 1,033 to 1,818 fathoms. Additional deep-sea soundings were made by the *Albatross* to the north of Unalaska Island, and several dredging stations were also occupied in depths between 100 and 1,625 fathoms. In the deeper waters the bottom was composed principally of green ooze, the absence of foraminifera, according to Capt. Tanner, being a marked feature of this region.

The location of the Pribilof Islands near the outer edge of this platform, with the interesting problems respecting the habits of the fur seals suggested by the controversy now in progress, makes it very important that the physical and biological features of the surrounding area should be thoroughly studied; but, although some progress in this direction has already been made, it is not intended to touch upon the subject in this connection, the remarks which follow having reference chiefly to the fishing-grounds for cod and halibut.

The fishing-banks investigated by the *Albatross* in 1890 are mostly situated to the eastward of a line connecting Cape Newenham with the northwest cape of Unimak and off the northern side of Unalaska Island, no extensive cod banks having yet been recorded from outside of these limits in the eastern part of Bering Sea. Capt. Tanner has extended the application of the name Bristol Bay so as to cover all of that region first defined above, but, as generally accepted by geographers, it is restricted to the much smaller area bounded on the north, east, and south by the mainland of Alaska, and not extending farther westward than an imaginary line drawn from Cape Newenham to Cape Seniavin on the peninsula, or to the neighborhood of Port Moller.

In the region occupied by these fishing-grounds the depths seldom exceed 50 fathoms, and the bottom is, for the most part, quite uniform in character, consisting mainly of fine sand, occasionally of coarse sand, and often having an admixture of gravel or pebbles. Cod were found to be quite generally distributed over this area, but the examinations were not sufficiently complete to define the outlines of the individual grounds in all particulars. Three separate banks have been recognized by Capt. Tanner—Slime Bank and Baird Bank, skirting the northern side of Unimak Island and the Alaska Peninsula, and Kulukak ground in the northern part of Bristol Bay; but from the information now at hand it can not be affirmed that these banks are entirely distinct and separate from one another. Slime Bank begins at the northern entrance to Unimak Pass. Its western end is more or less defined by the adjacent deep water which occurs in that locality, and its northern margin is limited to some extent by a muddy bottom. The somewhat barren ground which surrounds Amak Island also serves to break its continuity with Baird Bank, which, however, possesses the same character of bottom, and may be connected with it to the north of Amak Island. The latter bank extends northward as far as Cape Chichagof, and while the practical fishing operations which have been conducted upon it have been chiefly limited to within a comparatively short distance of the land, it is apparently connected with the Kulukak ground off the Walrus Islands, the intermediate bottom not differing essentially in its characteristics and being rich in cod.

All of Bristol Bay, except near the mouths of rivers and in certain other localities to be defined hereafter, is, therefore, practically a continuous fishing-ground, but further investigations are required to determine its extension westward, the area of good fishing being probably larger than is indicated by the present surveys. The combined length of Slime and Baird banks, from the Northwest Cape of Unimak to Cape Chichagof, is about 340 miles, and their total extent within the limits by which they have so far been defined is about 10,645 square miles. These banks, therefore, together with the remaining area within the boundaries of Bristol Bay, where cod and halibut occur, constitute one of the very largest fishing-grounds in either the Atlantic or Pacific Ocean, being exceeded, in fact, only by the Grand Bank of Newfoundland.

On this Bering Sea ground, however, the halibut seem to be mostly of small size, and it is chiefly important for its cod. It has been resorted to during a number of years past by one or more fishing vessels every season, but it remains for the future to fully appreciate and utilize its resources.

The weather in this part of Bering Sea, according to Capt. Tanner, is usually pleasanter than to the south of the peninsula. The principal grounds, moreover, have a weather shore with the prevailing summer winds, and a well-found vessel may anchor anywhere and ride out the usual gales at that season without much risk or discomfort.

Preliminary to the fishery investigations, and as a basis for the hydrographic work, a partial reconnoissance of the coast was made from Unimak Island to the head of Bristol Bay, and thence to Cape Newenham. This survey was rendered necessary by the fact that little dependence could be placed upon the existing charts with respect to the shore features, which have thus been referred to by Capt. Tanner:

> The shore lines are usually low and without distinctive features, but high mountain ranges and volcanic cones extend along the central parts of Unimak and the Alaskan Peninsula. These rugged, snow-covered mountains and lofty peaks would serve as unmistakable landmarks were they not obscured by the almost constant fogs which prevail in that region during the summer months. In fact, they were so seldom visible during the season of 1890 that the officers of the *Albatross* made no pretense of using them as landmarks. The shore line and objects near the sea level were often seen beneath the fog when the higher lands were obscured, and, therefore, most of the available landmarks were found on or near the beach.

Partial surveys were also made of Port Moller and Herendeen Bay, and of the lower part of Nushagak River.

FISHING-GROUNDS NORTHEAST OF UNIMAK PASS.

Slime Bank.—Slime Bank is the first of the larger fishing-grounds to be reached after entering Bering Sea through Unimak Pass. As delineated by the steamer *Albatross*, it begins directly off the Northwest Cape of Unimak Island, is elongate in shape, and follows approximately the trend of the adjacent coast to within a few miles of Amak Island, its inner margin lying only a short distance off the land. It is about 85 miles in length and 17 miles in average width, broadening somewhat at the eastern end; its total area is estimated at about 1,445 square miles. The depths range from 20 to 50 fathoms, while the bottom consists generally of black sand and gravel, frequently intermingled with pebbles, and sometimes of gray and yellow sand, rocks also occurring near the shore.

At its western end the bank is bordered by the deeper water lying off the northern entrance to Unimak Pass, 70 fathoms being found near the margin of the bank, and depths exceeding 100 fathoms a short distance farther away. Off its northern

edge the depths determined by four soundings range from 53 to 62 fathoms, with muddy bottom at three of them. Toward the eastern end, however, on the northern side, sand and gravel occur, and in this locality the precise limits of the bank are still undefined.

This bank derives its name from the presence of immense numbers of a large jelly-fish, brownish or rusty in color, measuring from 6 to 18 inches across the disk, and provided with long, slender tentacles, having great stinging powers. These animals, it is said, have never been observed upon the surface of the sea, but seem to occupy an intermediate zone toward the bottom, where they occasion much annoyance to the fishermen by becoming entangled about their fishing gear, and in this way often being hauled up. It is also claimed that they sometimes interfere with the hooks reaching bottom, and by covering the bait and lines they render the former unattractive to the cod and the latter very uncomfortable to handle. Mr. Alexander states that up to the middle or latter part of June this so-called slime is not sufficiently abundant to give much trouble, but by July 1 it becomes so thick as to render it almost useless to remain upon the bank, and other localities, farther north, are then resorted to. Should the fishing be continued late, however, the fishermen profess to keep their hooks above the layer of slime, not allowing them to reach bottom.

After leaving the Akutan and Unimak grounds the fishermen anchor next on the western part of Slime Bank, gradually working to the eastward. The advantages for fishing on this bank, except for the unusual prevalence of jelly-fishes, are described as excellent, and cod are plentiful enough to supply all immediate demands. The largest and best cod taken by the *Albatross* were obtained some 6 or 8 miles from shore, those captured nearer land having been inferior in size and quality. From the results of this investigation and from information derived from other sources it would appear, however, that cod of fair size are pretty generally distributed over the bank, and are almost everywhere abundant.

The examinations by the *Albatross* were begun on June 24, 1890. Five beam-trawl stations (Nos. 3259–3262, 3264) were made on the western end of the bank, and three (Nos. 3265–3267) on the eastern end. The bottom fauna was found to be very rich, affording good feeding-ground for fishes.

Hand-line fishing was carried on at each of the dredging stations and also in connection with some of the soundings. Seven trials were made on the western part of the bank, from off the Northwest Cape to off Cape Lapin, in depths of 13 to 43 fathoms. The trials occupied from 10 to 15 minutes each and aggregated 96 minutes, from 9 to 12 lines being employed. The total number of fish taken was 132, ranging in length from 23 to 37 inches, the average size for each catch ranging from $26\frac{2}{3}$ to $32\frac{1}{2}$ inches. The combined weight of all the fish was 1,528 pounds, making their average weight about $11\frac{1}{2}$ pounds apiece. One halibut, weighing 5 pounds, was also taken in this region, and in 62 fathoms, muddy bottom, just outside the bank, 7 cod were captured averaging 12 pounds in weight and $30\frac{3}{4}$ inches in length. Nineteen cod, averaging 27 inches in length, were secured in Shaw Bay, in a depth of 6 fathoms, sandy bottom, the trial lasting one hour.

Five trials, with 8 to 10 hand lines and aggregating 79 minutes, were made at the eastern end of the bank in depths of 26 to 44 fathoms. The catch amounted to 53 cod, ranging in size from $20\frac{1}{2}$ to 36 inches, and in average size for each trial from $24\frac{2}{3}$ to $31\frac{1}{2}$ inches. Their aggregate weight was 574 pounds, an average of about $10\frac{4}{5}$ pounds each. One halibut, weighing 8 pounds, was also taken in 32 fathoms.

A few attempts have been made to employ cod trawls on Slime Bank, but they were not attended with satisfactory results, as the jelly-fishes interpose too great an obstacle to this kind of fishing. This bank, moreover, is otherwise better suited to the use of hand lines, on account of the shallow water and the abundant supply of fish. There are no available harbors along the adjacent coast, although excellent protection may be found in Shaw Bay during southeast to southwest winds. Winter fishing would, therefore, be attended with much danger from the heavy storms which then prevail, and the season is chiefly limited to the summer months, when only occasional moderate blows occur. It is the opinion of Captain Tanner that a well-found fishing schooner could anchor anywhere on Slime Bank between May and September, with an even chance of being able to ride out any gale she would encounter.

Amak Island.—Amak Island lies about 11 miles off Izenbek Bay, and, as indicated by the dredging work, seems to be surrounded by a comparatively barren region, some 18 to 20 miles in width, which may be regarded as separating Slime Bank from Baird Bank. How far seaward these conditions hold was not determined, as all of the dredging and fishing stations were within a short distance of the island. Beam trawling was carried on in five different positions (stations Nos. 3269–3272), but with poor results, the bottom fauna being far from rich.

Nine trials were made with hand lines in depths of 10 to 35 fathoms. Two of these proved entirely unsuccessful, while at the remainder the total catch amounted to 33 cod, weighing only 260 pounds, an average weight of about 7.9 pounds apiece. The average length for the several trials ranged from 23 to 29⅜ inches. So far as the evidence goes, therefore, fish are less abundant and of smaller size in this region than on the adjacent banks. This may be due in part to the presence of numerous sea lions, which haul out upon Amak Island, Sea Lion Rocks, and the neighboring coast, but it is probable that some other cause must also be held accountable for this condition of affairs, especially as regards the scarcity of invertebrates and the relatively smaller size of the cod. Walruses are likewise plentiful in this region, but they are not fish-feeders.

Amak Island affords fairly good protection on its southeast and southwest sides, and can easily be reached from the contiguous parts of both Slime and Baird banks.

Baird Bank.—Baird Bank, generally known to the fishermen, in part at least, as Port Moller bank or ground, was named by Capt. Tanner in honor of the late Prof. Spencer F. Baird, the first U. S. Commissioner of Fish and Fisheries. It is the largest of the fishing-grounds yet discovered on the Alaskan coast. As described and charted by Capt. Tanner, it commences a few miles east of Amak Island and extends northeastward, off the northern side of the Alaska Peninsula, to the vicinity of Cape Chichagof, at the mouth of the Ugaguk River, a distance of about 230 miles. It has an average width of about 40 miles and an extreme width of 58 miles, its total area being estimated at about 9,200 square miles, which is 2,400 miles more than that of Portlock Bank, off Kadiak Island, and some 800 miles more than that of Georges Bank, in the North Atlantic Ocean.

It is doubtful, however, if the limits of this bank should be so restricted, as several lines of stations connecting it with Kulukak ground and the region off Cape Peirce show the extension in that direction of essentially the same depths of water and character of bottom, good fishing also having been obtained at nearly every trial. This would make of Bristol Bay in its restricted sense (inside of a line drawn from Cape Newenham to Cape Seniavin) a practically continuous fishing-ground, except at the

mouths of the larger rivers and in some other places as explained below. Outside of Bristol Bay the observations were not carried beyond the limits of the bank as defined by Capt. Tanner, and the entire width of its western portion still remains to be determined. It is not impossible that some connection may be found to exist between Baird and Slime banks to the north of Amak Island. A line of stations from Cape Newenham to the Northwest Cape of Unimak Island, however, showed good fishing only in the vicinity of land.

The examination of Baird Bank was begun at the western or southern end of the bank on June 27. The soundings were generally conducted along regular lines, approximately at right angles to the coast, but to the west of Cape Seniavin they were not carried beyond a maximum distance of about 48 miles from land. Inside of this point, however, they were run practically from shore to shore. Thirty-two dredging stations (Nos. 3235–3238, 3273–3299, and 3303) were occupied within the limits of Baird Bank as originally defined; 4 stations (Nos. 3288–3290, 3295) between the bank and the shores of the peninsula; 7 stations (Nos. 3228–3234) at the extreme head of the bay, in the broad mouth of the Kvichak River; and 14 stations (Nos. 3239–3246, 3300–3302, 3304–3306) between the bank and the northern shores of Bristol Bay. Fishing trials with hand lines were made at all dredging stations and at the majority of sounding stations.

The inner margin of Baird Bank has been made to correspond approximately with the 15-fathom line. A maximum depth of 53 fathoms was discovered about 37 miles off Lagoon Point, to the westward of Port Moller. West of Cape Seniavin, however, the depths range mostly from 30 to 45 fathoms, while to the eastward of that point they gradually diminish toward the head of Bristol Bay, the soundings at the extreme end of the bank in that direction indicating depths of 11 to 20 fathoms. In the direction of Kulukak Bay and Cape Peirce the depths also decrease gradually, becoming reduced to 15 and 17 fathoms on the Kulukak ground. The bottom consists mainly of fine gray sand, with areas of black sand, black sand and gravel, and occasionally rocky patches near the shores. The bottom fauna over the main part of the bank was discovered to be rich and varied, in most places corresponding with that of Slime Bank.

According to Capt. Tanner, the conditions improved with each line of stations until off Port Moller, where the most productive fishing-ground was found. Cod were taken on nearly every trial with the hand lines, but their abundance and quality varied in different localities. They were smaller and in poorer condition near the land, the best results having been obtained some 15 to 20 miles offshore, in depths of 25 to 40 fathoms. In shallow water the bottom was often covered with sponges, mussels, and large clustered barnacles adhering to the rocks, the cutting edges of the latter soon tearing the nets to pieces.

The results of hand-line fishing may be summarized as follows, with respect to the general grouping of the stations on the bank:

Two trials only were made at the extreme southwestern end of the bank, in depths of 26 and 39 fathoms, respectively, the catch consisting of 9 cod, having an average weight of about 10 pounds and an average length of about 27 inches. A few pollock and sculpins were also taken at the same time.

Off Lagoon Point, in an area covering a length of about 25 miles and extending 48 miles from land, 13 trials were made in depths of 18 to 53 fathoms. The total catch amounted to 56 cod, an average of 4⅓ to each trial, the average length of the

trials having been 14 minutes. The average weight of the fish was 9¼ pounds and their average length 27⅛ inches. In some places, however, a large proportion of the fish ranged from 28 to 35 inches in length.

Three trials were located directly off Port Moller, at distances of 16 to 33 miles from land, in depths of 25 to 39 fathoms. At these stations 65 cod were obtained during an aggregate period of 60 minutes, the average weight of the fish being 13 pounds and their average length about 30¾ inches; the range in length was from 19 to 39 inches.

Off Cape Seniavin, within an area 23 miles long, extending 44 miles from shore, 9 trials, averaging about 30 minutes each, yielded 102 cod, or an average of 11⅓ to a trial. The average weight of the fish was 10⅖ pounds, their average length 29⅕ inches, and their range in length from 20 to 36 inches. The average length of the trials was much increased in this region by the fact that at one of the stations, about 12 miles off the cape, fishing was continued for 2½ hours. Forty-one cod were taken at this station in a depth of 20 fathoms, and 33 cod about 23 miles farther to the eastward, in 30 fathoms.

Another important group of stations occurs off Port Haiden and between there and Cape Menchikof, covering a length of 28 miles and a width of 67 miles from shore. Eleven trials were made, averaging 14½ minutes in length, the total catch amounting to 210 fish, an average of about 19½ fish to a trial. The average weight was 10⅘ pounds, the range in length from 18 to 36 inches, and the average length 29⅜ inches.

From off Cape Menchikof to the northern extremity of the bank, a distance of some 40 miles, seven trials were made in depths of 11 to 24 fathoms, the average duration of each trial having been about 13½ minutes. The total catch was 75 cod, an average of about 10⅔ to each trial. The average weight of the fish was 12 pounds, their range in length from 26 to 34 inches, and their average length 30⅖ inches.

A comparison of the results obtained at each of the groups of stations above discussed furnishes some interesting facts respecting the value as fishing-grounds of different parts of Baird Bank, but they are not to be considered as entirely conclusive, owing to the relatively short duration of the fishing trials. For many reasons, however, such a comparison is important, especially as directing the attention of the fishermen to localities which they have not visited.

The relative abundance of the cod in the different areas may be expressed by the proportion of fish to the length of time occupied in making the trials, which, reduced to minutes, shows that the best results in this respect were obtained off Port Haiden, the remaining areas coming in the following order: North of Cape Menchikof, off Port Moller, off Cape Seniavin, and off Lagoon Point. A comparison of the groups of stations with reference to the average weight and the average length of the cod necessitates a somewhat different arrangement from that above given, the area off Port Moller (13 pounds, 30¾ inches) taking precedence, followed by "north of Cape Menchikof" (12 pounds, 30⅖ inches), "off Port Haiden" (10⅔ pounds, 29⅜ inches), "off Cape Seniavin" (10⅖ pounds, 29⅕ inches), "off Lagoon Point" (9¼ pounds, 27⅛ inches).

Many additional observations are required, however, before passing finally upon the relative values of the different parts of the bank, and this is all the more evident when it is considered that the examinations by the *Albatross* were restricted to a very brief period during one summer. The distribution of cod, moreover, is greatly influenced during some seasons by the movements of certain migratory fishes which they seek as food, such as the capelin, herring, and sand lance, but at present scarcely

anything is known regarding the habits of these species on the Alaskan coast. The fishermen consider that good fares are most certain to be obtained off Port Moller, although successful trips have been made farther north.

During the progress of the investigations, the schooner *Vanderbilt*, of San Francisco, Capt. A. W. Smith, was observed at anchor on the Port Moller ground, about 20 miles offshore, where she had been a little over a month. Owing to the excellent fishing obtained, only a single berth had been made. About 43,000 cod had been taken up to the time of the visit of the *Albatross*, and the trip was subsequently completed with a fare of about 48,500 count fish, each measuring 28 inches and over, and several thousand small fish. Capt. Smith regards the Port Moller ground as superior to any other in Bering Sea, not that the fish are larger or of better quality than on Slime Bank, but the bottom is cleaner and jelly-fishes are not troublesome. He states that halibut weighing about 25 pounds are seldom taken, but individuals of smaller size are abundant during some seasons, and when obtained are used as bait. During the past season they had been scarce. From June 11 to 21, 1890, heavy winds prevailed and prevented fishing. Stormy weather seems to scatter or drive the cod from the fishing-spots, and at such times it is thought they seek deeper water.

Between the inner edge of Baird Bank and the adjacent mainland eight trials were made with hand lines in depths of 8½ to 16 fathoms, but cod were taken at only three of them. The total number so captured was 19; 4 near Nelson Lagoon, measuring from 28 to 32 inches; 10 off Port Moller, measuring from 26 to 32 inches; and 5 near Port Haiden, measuring from 28 to 33 inches.

The good fishing-spots found at the extreme northern end of Baird Bank are located a short distance outside of the extensive shoals surrounding Cape Constantine, but the head of Bristol Bay, to the northward of a line drawn from the mouth of the Ugaguk River to Cape Constantine, has no value as a codfishing-ground, and only a few fish, in poor condition, were captured here and there. The water is not only too fresh for this species, but, owing to the strong currents produced by the immense discharge from several rivers and by the tides, an unusual amount of sand and mud is constantly held in suspension. An examination of the stomachs of those captured showed that they had been feeding upon salmon, and they had evidently been attracted to these unsuitable waters by the presence of the latter fish. Farther south, on the same bank, their food embraced a great variety of bottom life, such as crustaceans of several species, holothurians, starfishes, ophiurans, sea-anemones, and other forms of invertebrates, as well as fishes. Small pebbles and even stones of relatively large size were not infrequently found in their stomachs, as has so often been recorded in connection with the fishing-banks of the North Atlantic, but their presence may readily be explained by the fact that the sea-anemones and some other animals used as food by the cod grow firmly attached to such objects, which would naturally be swallowed with them.

The conditions of weather on Baird Bank are practically the same as on Slime Bank. The adjacent peninsula affords a weather shore during southeast winds. Port Moller and Herendeen Bay will be resorted to when they are better known, and Port Haiden may also become available for shelter after it has been surveyed. According to Mr. Alexander, southerly and westerly winds cause no inconvenience on the bank, but a strong breeze from the northwest or southwest is immediately followed by a disagreeable choppy sea.

Four lines of stations were run from the outer margin of Baird Bank as defined by Capt. Tanner, in the direction of the northern coast of Bristol Bay, which show that the bank should probably be extended as far as the shoaler water of Kulukak Bay and off Cape Peirce. On the westernmost line, reaching a distance of about 70 miles, 5 trials were made in depths of 23 to 33 fathoms, the catch consisting of 25 cod, measuring from 23 to 33 inches. On the second line, extending about 58 miles, with depths of 22 to 31 fathoms, the number of trials was 4, the total number of cod 30, measuring from 26 to 36 inches. The two eastern lines were both much shorter and connected Baird Bank with Kulukak ground, as described farther on. Five trials were made in depths of 15 to 30 fathoms, resulting in the capture of 46 cod, measuring from 21 to 34 inches. The better portions of Kulukak ground are included in this area. The size of the fish varied considerably in different parts of the region, but without reference to the depth of water or character of bottom. The general results may be summarized as follows: Aggregate time consumed in making the trials 230 minutes, total number of cod taken 101, average weight of the cod $10\frac{3}{5}$ pounds, average length $29\frac{1}{3}$ inches. These results correspond approximately with those obtained off Cape Seniavin and off Port Haiden, but the extent of the area is too great to make such general deductions and comparisons of much value. Good and profitable fishing could, however, undoubtedly be found in some places.

Kulukak Bay.—Kulukak Bay occupies a large part of the region included between Cape Constantine and Cape Newenham, and contains Hagemeister Island and the Walrus group. Within this area codfish are found in isolated spots, scarcely entitled to the name of banks, but for convenience sake the title of Kulukak ground has been used by Capt. Tanner to designate them. Extensive shoals occur off Hagemeister and the Walrus islands, 6 fathoms being found about 15 miles to the southward of the latter. The principal fishing-spots are outside of these shoals, as well as to the eastward and westward of them, in depths of 12 to 25 fathoms, the bottom consisting generally of sand, with some mud and gravel, and the fauna being essentially the same as on Baird and Slime banks. These outer grounds have already been referred to under the heading of Baird Bank. They were formerly resorted to at times by fishing vessels, but they are said not to be at present.

The fishermen have called attention to a small ground, called Gravel Bank, situated about 16 miles SSW. from the southern end of Hagemeister Island, where large cod are reported to be abundant. It has depths of 16 to 20 fathoms, but its size is inconsiderable. It is stated that small fish predominate among the islands of the Walrus group, but that larger ones may be taken in some of the indentations and on some of the rocky patches, although such places are not numerous. Between these islands and the mainland the bottom was found by the *Albatross* to be exceedingly barren, black mud being frequently encountered.

Out of 7 trials made near the shore between Cape Constantine and Cape Peirce, cod were captured only twice. One specimen, weighing 17 pounds, was secured in $11\frac{1}{4}$ fathoms about 18 miles west of Cape Constantine, while 8 specimens, averaging 13 pounds in weight and $33\frac{1}{4}$ inches in length, were taken off the east side of Walrus Island.

Cod are said to be abundant in the neighborhood of Cape Peirce, but none were taken by the *Albatross* in the immediate vicinity of either Cape Peirce or Cape Newenham. Eleven miles southwesterly from the latter cape 2 specimens were obtained, measuring 29 and 32 inches respectively, and 22 miles farther in the same

direction a total catch of 15 cod was made, but their average size was only 27⅜ inches.

The examinations of the *Albatross* were not carried north of Cape Newenham, but cod are reported to occur in greater or less numbers as far north as the ice line; but how extensive the banks or how profitable the fishing may be in this region can only be ascertained by a detailed and careful examination.

Condition of the cod in Bering Sea.—Attempts have been made to compare the abundance, size, and condition of the cod inhabiting Bering Sea with those taken on the fishing-grounds in the North Atlantic Ocean, but up to the present time sufficient data have not been obtained to justify conclusions in this respect. The trials made by the *Albatross* have all been of short duration, very rarely exceeding 20 minutes, and in the majority of cases not more than 15 minutes. At the same time, moreover, the ship was generally drifting with the wind and current, the hooks being thereby dragged along over the bottom. The fishermen consider that a berth has usually to be occupied for some time before the best fishing begins or the larger fish appear in the greatest numbers. It is recorded as the experience of fishing vessels on Baird Bank that better results are obtained after the lapse of two or three days than when first anchoring, and the supply has tended to increase rather than diminish by the end of a week. The bait which falls from the hooks or otherwise reaches the bottom probably serves to tole the fish about the spot, and thus contributes to their greater abundance.

The total number of trials made by the *Albatross* with hand lines in Bristol Bay was 110, and the aggregate amount of time spent in this work was 1,907 minutes, an average of about 17 minutes to each trial. Two of the trials, however, were long ones, occupying 2½ and 3 hours, respectively. If these be deducted it reduces the aggregate time to 1,540 minutes, and the average time to between 13 and 14 minutes. The total number of cod taken during these trials was 922, an average of 8⅓ fish to a trial. From 8 to 12 lines were generally employed.

Limiting the calculations to what have been designated above as the banks proper in Bristol Bay, we find that the total number of trials was 74, the aggregate time 1,374 minutes (including one trial of 2½ hours), and the average time 18½ minutes. A total of 832 cod were captured on these trials, being an average of 11 fish to each trial.

All of the cod secured were weighed and measured, and the average of weight and length was calculated for each trial. The smallest fish measured 9 inches, the largest 39 inches. In a number of trials, as before mentioned, nothing was obtained, and in some others only a few fish of small size were taken. At 75 stations, however, the average size ranged from 24 inches to 32½ inches, distributed as follows: 3 stations, 24 to 26 inches; 19 stations, 26 to 28 inches; 25 stations, 28 to 30 inches; 28 stations, 30 to 32½ inches. Considering all the circumstances attendant upon the trials, the results obtained by the *Albatross* must therefore be regarded as exceedingly favorable and indicative of an abundant supply of good, marketable fish.

The range in weight of the cod taken in Bristol Bay was from 2½ to 27½ pounds, the average weight about 10½ pounds. The highest average obtained at any one station was 15½ pounds, on Slime Bank; and the next highest 15⅓ pounds, on the Port Moller ground of Baird Bank. The average of several catches on these two banks reached 15 pounds, and it must therefore be considered that the run of fish is about the same on both.

A marked difference exists in the size and quality of the fish in different localities, as elsewhere explained, but after sufficient experience has been acquired a judicious discrimination in the choice of grounds will be possible, and the few fishing vessels which resort to this region already have their favorite spots, where they find no trouble in securing full fares. In any consideration of this general subject, however, it should be borne in mind that the only information on which to base conclusions has been obtained during a few summer months of each year, while the great banks on the Atlantic coast have been visited by multitudes of fishing vessels for several centuries.

Mr. Alexander reports a large proportion of diseased fish in the shallow water along the coasts, due in part at least to parasitism, but the proportion decreases as the water deepens, and at 8 or 10 miles from shore the average is very good. Capt. Tanner also refers to the occurrence of many wounded cod, particularly in the spring and fall, after the passage of the seals into and out of Bering Sea. They have been chiefly observed near the passes between the Aleutian Islands.

Halibut and flounders in Bristol Bay.—Only three specimens of halibut were taken by the *Albatross* within the limits of Bristol Bay, and they were all small, their combined weight amounting to only 42 pounds. As mentioned elsewhere, Capt. A. W. Smith, of the schooner *Vanderbilt*, informed Mr. Alexander that, according to his experience, halibut weighing above 25 pounds are seldom captured in this region, although individuals of smaller size are abundant during some seasons. He had also found them scarce during the season of 1890. The specimens taken by the fishing vessels are generally used as bait for the cod. Flounders of several species, some of which were of excellent food quality, were captured in the beam trawl at nearly every station.

Port Moller and Herendeen Bay.—From their proximity to the better fishing-grounds on Baird Bank, these two bays may be regarded as affording convenient shelter for fishing vessels during stormy weather. Hitherto they have seldom, if ever, been used for this purpose, owing to the lack of information respecting their hydrography, but this desideratum has been in part supplied through the agency of the *Albatross*. Their channels, however, have not yet been buoyed, nor are they likely to be for some time, and access to them must, for the present, be considered as rather difficult. Both bays are shallow and elongate, cutting more than halfway through the Alaska Peninsula and opening close together on its northern side, the principal passage into Herendeen Bay leading through Port Moller entrance. A detailed account of the survey made in 1890, together with sailing directions, will be found in Commander Tanner's reports (F. C. 9, pp. 281–283, and F. C. 10). The former contains a chart suitable for navigation purposes. It shows the entrance to Port Moller, the channel from Entrance Point to Point Divide, called Hague Channel, the narrow and intricate passageway from the latter point to Marble Point, named Johnston Channel, after the officer who surveyed it, and the general contour of the upper part of Herendeen Bay, including Mine Harbor, the headquarters and shipping station of the coal company.

According to Capt. Tanner, "the entrance to Port Moller is guarded by banks and shoals over which the tide sweeps with great force, making the channel difficult and dangerous, its ill repute having, in fact, caused the great bay and its tributaries to remain almost a *terra incognita* to the navigator." The survey of the *Albatross* will render these harbors available hereafter, but the chart should be used with caution

until it is ascertained whether the banks about the entrance are permanent or shifting. There is an excellent beach at Mine Harbor for hauling a schooner out, if necessary. The rise and fall exceeds 15 feet, and would give several hours each tide to examine or make repairs on a vessel's bottom. Should the coal mine be developed, as seems probable, the place would afford some facilities for repairing and refitting; water is easily procured and fuel can be had in any quantity. There is no settlement at present on either bay.

The coal mine above referred to is situated about 1¼ miles from the water front, to the eastward of Mine Harbor, transportation to the landing being effected by means of a tramway operated by a small steam motor. The mine was opened just previous to the visit of the *Albatross*, which took the first output of coal. The latter was used with satisfactory results, but owing to the lack of proper screening facilities much fine material and dirt was delivered with it, and it was found necessary to burn from 20 to 25 per cent more in quantity to obtain the same results as with a fair quality of Wellington coal. For a full account of its steaming qualities, see report of Passed Assistant Engineer C. R. Roelker, U. S. Navy (F. C. 10, pp. 282, 283). Capt. Tanner states, however, that, "considering that it was taken from a vein near the surface, the extra amount required to furnish the same quantity of steam will not seem excessive. It was shown that the coal possesses merit, and it will doubtless improve with the development of the deeper veins."

Salmon fishery on the Nushagak River.—While the *Albatross* was anchored in the Nushagak River, at the head of Bristol Bay, many important facts respecting the salmon fishery and canning industry which has recently sprung up in that locality were obtained by Mr. Alexander, whose discussion of the subject is contained in the appendix to the report of the Fish Commission for 1889–1891. The following statements from this source relate mainly to matters of scientific interest:

The first salmon cannery on the Nushagak was built in 1884 by the Arctic Canning Company. Three similar establishments have been added since that time, all being located between the mouth of Wood River and Clark Point. The salmon first make their appearance about June 1, and remain from forty-five to sixty days. As the season is short, full preparations are made in advance and great activity prevails during the continuance of the run. The king salmon appear earliest and are present about a fortnight, being first sought for off Coffee Point, a high promontory situated on the west side of the river. They are followed by the red salmon, and the latter closely by the silver salmon. During the season of 1890 the first salmon were taken on the morning of June 3, after which several days elapsed before other fish were seen.

The presence of ice retards their movements; they will not enter the river until it has disappeared and the temperature of the water has moderated to some extent. When the salmon are late in arriving, they proceed immediately upstream to Lakes Nushagak and Aleknagik, where they spawn; but if the season is an open one, they move more leisurely, and furnish better opportunities for fishing. In the spring of 1890 the river was blockaded with ice until May 20, and the run was late in consequence. The fishermen believe that the salmon spawn about a month after entering the river, and the superintendent of the Bristol Bay Canning Company, who has had much experience in this region, states that from the first of August until October the young are passing down the river and into the sea in immense numbers.

It takes on an average six of the red salmon, and the same number of silver

salmon, to make a case of the canned goods. Two and one-half of the king salmon are equivalent to the same amount.

Each cannery has hitherto maintained from one to five traps for capturing salmon, but the yield by this means has not warranted the expense of keeping them in repair. The main body of the trap is made of twine, but the leaders are constructed of galvanized wire netting, which is better adapted to withstand the pressure of drift material brought down by the current. Notwithstanding every precaution, however, they are frequently swept away. Gill nets have now been adopted by all the canneries, as affording the best results. Two sizes are in use. The one for king salmon measures 100 fathoms long by 23¾ feet deep, and has a 9½-inch mesh; the other, for red and silver salmon, is 70 fathoms long by 13 feet deep, and has a 6½-inch mesh. They seldom last more than a single season, as they are subject to very hard usage.

The salmon are sometimes most abundant a considerable distance above the canneries, or from 40 to 50 miles from the mouth of the river. At such times the fishermen are carried to the fishing-grounds, where they live on board of the scow lighters ordinarily employed for discharging and loading vessels, a steam launch being used to tow the latter.

Under instructions received from the Secretary of the Treasury, Capt. Tanner inspected the site of a proposed large fish-trap on Wood River, a tributary of the Nushagak River, which, it had been reported, would prove an obstruction to the movements of salmon within the intent of the law of Congress approved March 2, 1889. He found that a double trap was being built about 20 miles above the mouth of the river and 40 miles from the Nushagak cannery. The Wood River at this point is a swift running stream of clear, cold water, between 700 and 800 feet wide, and 10 to 14 feet deep. Operations had not progressed sufficiently to indicate the character and extent of the work, but the plans contemplated an opening in midstream 100 feet wide, flanked on each side by a trap 40 feet square, with wings extending from the traps to the shores. The Secretary of the Treasury has decided that such a construction would be illegal.

UNALASKA ISLAND AND VICINITY.

This island has been visited several times by the *Albatross* in the course of the Alaskan investigations, from 1888 to 1892, principally for the purpose of coaling or repairing, but much valuable information has been secured regarding the fishery resources of the contiguous waters and the hydrography of the neighboring region. On approaching the Aleutian Chain, at the beginning of the season of 1888, a line of soundings was carried inshore to a depth of 28 fathoms, off Kiliuliuk Bay, on the southern side of the island. Subsequently the *Albatross* proceeded into Bering Sea through Unimak Pass and entered Unalaska Harbor from the north, the return trip to the Pacific Ocean being made by way of Unalga Pass. The hydrographic observations obtained during these two passages, sailing directions, and a general account of the fishery resources and native industries of Unalaska Harbor have been published in the Bulletin for 1888 (F. C. 8, pp. 19–22) and in the appendix to the Commissioner's report for the same year (F. C. 7, pp. 397–400).

During the summer of 1890 a general reconnoissance was made of the submerged platform off the entire northern and western sides of the island. Akutan Pass was

used by the *Albatross* on leaving Bering Sea, in August of the same year, the trip through being referred to by Capt. Tanner as follows:

> The atmosphere was usually clear, and as we had never used Akutan Pass we availed ourselves of the favorable opportunity of passing through and examining it. There is a clear channel two miles or more in width between Cape Morgan and four small islets lying off Unalga Island, free from dangers except near the shores, with 26 fathoms, rocky bottom, in the narrowest part of the pass.

Unalaska Harbor and adjacent waters.—During the summer of 1888 collecting was extensively carried on in this harbor and in the waters adjacent to it. Seining proved everywhere successful within the limits of the harbor, but the few hauls made at or near its mouth were unproductive, owing probably to the fact that the water there deepens rapidly from the shore outwards. The natives, however, take cod in these exposed positions. The *Oncorhynchus gorbuscha* (humpback salmon), *O. keta* (dog salmon), and *O. nerka* were seined abundantly both in the main harbor and in Captain Harbor at its head. The red-spotted trout (*Salvelinus malma*) was also plentiful in the harbor and in the fresh-water lake. Other common species obtained were the *Pleuronectes stellatus* (starry flounder), *Lepidopsetta bilineata*, *Hemilepidotus jordani*, and *Clupea mirabilis* (herring). The advantages offered by Unalaska for the establishment of fishing stations and the preparation of dried salmon or *ukali* by the natives have been discussed in the Fish Commission reports last referred to above.

The investigations were continued in Unalaska Harbor at intervals during the summer of 1890, and late in the season they were carried along the Bering Sea side of the island from Priest Rock, in the east, to Umnak Island, in the west. Regarding the vicinity of Unalaska Harbor, Mr. Alexander states that the fishing-grounds extend only a short distance from the shore, the width of bottom over which cod may be expected to occur ranging from 3 to 6 miles. The fishing-spots consist of rocky and muddy patches of variable extent, on which sand, gravel, and shells also occur in small quantities. The rocks are generally sharp and would prove destructive to fishing gear. Cod are frequently caught from the wharf and beach in Unalaska Harbor, and there are certain places in Captain Harbor where this species is sufficiently abundant to supply the local demands during the entire year. The fish taken in such localities, however, are inferior in quality to those captured farther off shore, but as salmon form the principal diet of the natives a large stock of cod is never secured at one time. The latter species is almost invariably eaten fresh, but small quantities may be dried in the same manner as the salmon.

According to Capt. Tanner:

> Rumor placed valuable cod banks in the outer bay, but no one seemed to know their exact locality or extent. Such a resource at the doors of a populous settlement would be of inestimable value. Availing ourselves of the opportunity offered by a clear day, we ran several lines of soundings across the bay, making frequent hauls of the trawl and trials with the fishing lines, extending the examination to the 100-fathom line outside of Cape Kalekhta, or Priest Point, and Cape Cheerful, without finding indications of even ordinarily good fishing-ground. In fact, nearly every sounding inside of the capes gave muddy bottom. Spots were discovered, however, near the shore line where cod were plentiful.

At a subsequent time "the search for cod banks in Unalaska Bay was resumed. The region from Ulakta Head to Elder Point was carefully examined, and the examination was extended to Broad and Nateekin Bays, without developing anything that could be called a fishing-bank. Near the shores, however, particularly on the west side of the bay, cod were plentiful and halibut were fairly abundant."

Mr. Alexander reports that the trials made in close proximity to Cape Cheerful indicated the presence of cod in considerable numbers, those captured having an average weight of about 11 pounds. In the vicinity of Priest Point the fishing was less successful, but a diligent search might disclose good bottom here and there, which had been overlooked in the hurried investigations of the *Albatross*. Although halibut have never been found here in abundance, they have not at any time been specially sought for, and it is therefore possible that they may be plentiful in some places.

The bays, harbors, and streams in all parts of the island are well filled with salmon during the proper season, but the run is not sufficiently large to induce the establishment of canneries, as on Kadiak Island and in some other parts of the territory.

Cape Cheerful to Makushin Bay.—The 100-fathom curve lies about 4 miles from shore at Cape Cheerful, but it draws in abruptly to about a mile or less until up with Cape Makushin, where the platform again widens out. From the latter cape a line of soundings was run to Makushin Bay, a large and secure harbor, containing a village of the same name, which consists, however, of only a small frame church, a store belonging to the Alaska Commercial Company, and a dozen barabaras, or native earth huts. As a rule, very poor success attended the trials for fish along this section of the coast, but this may have been due in part to the unfavorable weather which prevailed. In some places cod were fairly abundant, the largest catches being made near shore, although the fish were smaller in such positions than in deeper water. Excellent results were obtained at the entrance to a small indentation or bay, 11 miles east of Cape Makushin, both cod and halibut being secured, three specimens of the latter weighing 6½, 8, and 15 pounds, respectively.

By means of the drag seine, large numbers of humpback salmon, trout, young cod, and flounders were captured in Makushin Bay. The beaches are smooth and well adapted to this method of fishing. Two small streams enter the bay near the settlement. The larger of these brings down considerable quantities of sediment, but this, apparently, does not prevent the salmon from ascending it to the same extent that they do the clear stream.

Makushin Bay to Umnak Island.—At Cape Makushin the coast falls away abruptly toward the south, the entire western part of Unalaska being very narrow, and, together with the adjacent shores of Umnak Island and the coast between Makushin cape and bay, encircling a bay some 32 miles in greatest width. Within these limits the 100-fathom line lies from 12 to 23 miles offshore, furnishing an area of considerable extent, over which the bottom seemed favorable for cod and halibut, the fauna generally resembling that on Baird and Slime banks. Very few fish were obtained, however, until the ship had reached the neighborhood of Chernoffsky, although a more thorough search might show them to be equally abundant to the eastward. The beam trawl was used successfully in the vicinity of Makushin Bay and Cape Hague, but only 5 cod were secured in as many trials with hand lines. Halibut are also reported from these localities, but nothing was learned respecting their abundance.

Excellent cod-fishing was obtained at nearly every station made directly off Chernoffsky Bay, but less success was met with toward and to the west of Umnak Pass, although practically the same character of bottom was observed throughout the entire area. These differences in the abundance of fish were probably only temporary, due to the state of the tide or to other conditions changing from time to time. In one trial off Chernoffsky, in 42 fathoms, 53 cod and 5 halibut were taken on the hand lines

in half an hour. Vessels of small tonnage could undoubtedly conduct a profitable business in this region.

But few halibut were secured near the outer edge of the platform, the bottom being, apparently, better adapted to them a short distance farther in. This species occurs near the shores during the summer months, but invariably seeks deeper water on the approach of winter. It is sufficiently abundant to support a small fishery, but in the absence of local markets the catch could not be disposed of. The specimens taken by the *Albatross* were all of the white variety, which is also said to be the more common one throughout the Alaskan waters, as well as on the coasts of British Columbia and Washington. The average weight in this region was about 10 or 12 pounds. Mr. Ranken, the agent of the Alaska Commercial Company, states that the best halibut grounds on this section of the coast are located in a small bay some 6 or 8 miles to the westward of Chernoffsky.

Herring and other fishes suitable for bait school in large numbers about this part of the island. There is a fine smooth beach at Chernoffsky, well suited to the hauling of drag seines, and gill nets could also be employed there to good advantage.

In this region, as elsewhere on the fishing-banks in Bering Sea, hand lines are preferable to trawl lines, for the reasons previously explained. Moreover, the resources are not sufficiently extensive to yield a profitable return to the larger class of vessels, and in the event of the establishment of fishing operations, it would be preferable to employ smacks of rather small size, with local stations where the catch could receive preliminary treatment before shipment to the south.

The total number of trials with hand lines made between Priest Rock, at the entrance to Unalaska Harbor and Umnak Island, was 37, of which 14 gave no results. The remaining 23 trials yielded 177 cod weighing 1,834 pounds, and 21 halibut weighing 292½ pounds. The average weight of the cod was, therefore, about 10⅓ pounds, and of the halibut about 14 pounds. The cod ranged in length from 19½ to 37 inches, the average length for the combined catch having been about 29⅙ inches.

The coast from Cape Makushin to Chernoffsky is broken by a succession of deep bays, some of which almost bisect the island, and this region is, therefore, well supplied with safe and convenient harbors. Chernoffsky Bay is one of the most secure harbors in Bering Sea; it is easy of approach, and in entering it is only necessary to keep a mid-channel course. The village of the same name is situated on a narrow neck of land between the harbor and the sea, and is conspicuous in passing along the coast. The native population consists of 46 persons living in barabaras, in addition to which there is a Greek church and a store and residence of the agent of the Alaska Commercial Company, all frame structures.

MISCELLANEOUS OBSERVATIONS.

Fishing vessels in Bering Sea.—According to Mr. Alexander, from one to four vessels have fished each year on the cod banks in Bering Sea, and, as a rule, with good success. Small vessels are regarded as best suited to the region, owing to the fact that they do not have to change their ground so often as the large ones. The experience of the schooner *Vanderbilt*, described above under Baird Bank, will serve to illustrate this point.

Vessels entering Bering Sea sometimes make trials in the vicinity of Unimak

Pass and off the Northwest Cape of Unimak Island, near the western end of Slime Bank. In the spring they not infrequently obtain moderately good fishing off the islands of Akutan, Akun, Tigaldi, and Avatanak, between Unimak and Unalaska. These places compare favorably with the banks in Bristol Bay as to the size and quality of the cod, but, as the fish are much less abundant, full fares are not taken there. The natives, however, have no trouble in securing, about these islands, all the cod, flounders, etc., needed for their own use.

Trawl lines are not employed in Bering Sea, although they have been tried there, the depth of water and character of the bottom making it more convenient and profitable to resort to dory hand-line fishing.

Additional notes on the vessel fishery in Bering Sea will be found in the U. S. Fish Commission Bulletin for 1888, pages 22, 23.

Bait.—The vessels depend chiefly for their bait upon the fresh fish taken on the hooks during the progress of their fishing operations, and there is seldom any difficulty in obtaining all that is required for that purpose, and even much more. The fishes so employed, according to Mr. Alexander, consist principally of sculpins, flounders, halibut, when they can be secured, and several other small species. The small halibut are said to make an excellent bait, being second only to the squid in that respect. A small quantity of salt salmon and herring is usually taken along to serve for the first baitings.

Meteorological conditions.—Capt. Tanner summarizes as follows the observations made upon the wind and weather in Bering Sea from the last of May to September 1, 1890:

> Southwest winds prevailed, but we had them frequently from southeast to northwest. It was boisterous weather nearly half the time, but seldom rough enough to interfere with our work. We had several summer gales of moderate force, but no severe storms. Fog and mist prevailed, and a clear day was the rare exception. The tidal currents were strongest in the vicinity of Unimak Pass and at the head of the bay; they were greatly affected, however, by the winds. The flood stream set to the northward and slightly inshore along the coasts of Unimak and the peninsula, the ebb to the southward and offshore. The former was invariably the stronger, and probably found an outlet by sweeping past Cape Constantine in the direction of Cape Newenham. There has been no systematic study of the currents of Bering Sea, and the almost constant fogs prevent the navigator from adding much to our meager knowledge concerning them.

The daily meteorological observations for the same period have been published in the Fish Commission Report for 1890–91.

Bogoslof Island and Volcano.—On the afternoon of August 2, 1890, the *Albatross* passed within three-fourths of a mile of Bogoslof island and volcano, of both of which good photographs were obtained. The day was unusually clear, Makushin and the high lands of Umnak being distinctly visible. Regarding the observations made in this interesting locality, Capt. Tanner reports as follows:

> Sail Rock had fallen, its original position being marked by the débris. New Bogoslof was enveloped in smoke so dense that its outline could not be accurately determined, but its altitude was not far from 400 feet. There were no outlying dangers visible, and a couple of soundings, taken 2 miles from the old cone on different bearings, gave 649 and 578 fathoms, the latter being on the reef marked on old charts as extending from Bogoslof to the north end of Umnak. It is needless to say that this reef does not exist. Myriads of guillemots were seen on the island and for 15 miles or more around it, and a portion of the beach was occupied by a rookery of very large sea lions. Old Bogoslof is rapidly crumbling away, and will, like Sail Rock, eventually disappear.

OFF THE SOUTHERN SIDE OF THE ALASKA PENINSULA.

GENERAL CONSIDERATIONS.

The first investigations made by the steamer *Albatross* in the North Pacific Ocean were conducted during the summer of 1888 off the southern side of the Alaska Peninsula and the easternmost of the Aleutian Islands, between Unalaska Island, in the west, and Middleton Island, in the east. The examinations covered the entire width of the submerged continental platform within these limits, including the best-known of the Alaskan fishing-grounds for cod, the greatest amount of time being spent in those localities which promised the most important practical results. A complete review of the work accomplished on this survey has been published in the Bulletin of the Fish Commission for 1888 (pp. 1–92), together with a large chart suitable for navigation purposes, making it unnecessary, in this connection, to give more than a general summary of the observations.

The ship left San Francisco, Cal., on this expedition, July 4, 1888. After coaling at Departure Bay, British Columbia, and making the passage inside of Vancouver Island, a course was laid in the direction of the Shumagin Islands, off which a line of deep-sea soundings was begun on July 19, being carried thence to the vicinity of Kiliuliuk Bay, Unalaska. The fishery investigations were commenced off the latter island, and were continued northeasterly along the coast.

Ten or eleven days were spent in the vicinity of Unalaska and Unimak Islands, including Davidson Bank. Soundings were carried through Unimak Pass and off the northern side of Akun and Akutan Islands to Iliuliuk Harbor, Unalaska, where a supply of coal was obtained, and where opportunity was given to study the fisheries and the inshore fishing-grounds of the region. The reported positions of Lenard Rock and Anderson Rock, south of the Sannak Islands, were examined July 30, and on the following day the steamer arrived at Humboldt Harbor, Popoff, one of the Shumagin Islands. At this place the services of Capt. Paul M. Pavloff, a well-known pilot of the coast, were secured. Subsequently, Eagle Harbor, Nagai Island, and Yukon Harbor, Big Koniushi Island, were visited. About six days were spent in the region between the Sannak Islands and the Shumagins, and on Shumagin Bank, the exploration of which was completed August 6. From the Shumagin Islands soundings were carried to Mitrofania island and bay on the mainland, and thence to Light-house Rocks, Chirikoff Island, and the Trinity Islands, the *Albatross* arriving at Old Harbor, on the southern side of Kadiak Island, August 10. The development of Albatross Bank occupied five days, and on the 14th the harbor of St. Paul, at the eastern end of Kadiak Island was reached. The steamer was detained here until the 20th in coaling and in studying the fisheries and shore fishing-grounds, beginning the investigation of Portlock Bank August 21. On the afternoon of the 24th an anchorage was made off Middleton Island, which was visited the next day for the purpose of determining its precise position and the character of its surroundings. From this point the *Albatross* proceeded to one of the reported positions of Pamplona Rocks, in lat. 59° 03′ N., long. 142° 40′ W., where a thorough search was made for these supposed dangers to navigation, but no trace of them was found within 20 miles of this locality. Having finished this examination a course was laid down the coast for Seattle, Wash.

Although much foggy weather was encountered during the summer, making it difficult at times to locate the sounding stations with accuracy, the work was prosecuted without serious delays, and very successful results were accomplished. The

occasional detentions in port, moreover, afforded excellent opportunities for studying the inshore fishery resources and the fishery methods of the region, respecting both of which subjects important information was obtained.

The five banks whose positions were indicated by older surveys, namely, Davidson, Sannak, Shumagin, Albatross, and Portlock Banks, were more thoroughly examined than were the intervening areas, some of which, however, may, upon further examination, prove to contain fishing-banks of equal value, and not inferior in size to at least the smaller of those mentioned. Good fishing was obtained at nearly all localities where trials were made with hand lines, whether upon defined banks or upon the more level grounds between them, and it is natural to infer that the entire submerged plateau from off Unalaska Island to Fairweather ground is one immense fishing-ground, limited upon the outer side only by the abrupt slope, which may be said to begin about the 100-fathom curve. Equally good fishing can not be expected to exist in all parts of this area, some places being more favorable for the feeding and spawning of the cod and halibut than others, and as a rule the larger fish have to be sought for in deeper waters. This important tract can best be compared with the succession of well-known banks which skirt the southern border of the British Provinces on the eastern coast of North America from the Gulf of Maine to beyond Newfoundland, but its total area is much less. If considered as a single and continuous bank, however, it has more than twice the area of the fishing-grounds of Bering Sea, previously described in this paper.

DESCRIPTIONS OF THE FISHING-GROUNDS.

Vicinity of Unalaska.—One line of soundings was made in approaching Kiliuliuk Bay from the south, and another from the same bay in a southeasterly direction to the 100-fathom curve, which was traced eastward to Davidson Bank. A third line was also carried eastward along the inner edge of the plateau, from the entrance to Akutan Pass. These soundings were not sufficient to demonstrate the existence of a defined bank in this region, but it was estimated that an area of about 2,000 square geographical miles to the westward of Davidson Bank was suitable for fishing. The width of the plateau here varies from 15 to 24 miles inside of the 100-fathom curve. Beyond this line the bottom drops off very suddenly here as elsewhere along this part of the Alaskan coast, a depth of 1,961 fathoms being found within 34 miles of Unalaska.

Davidson Bank.—This bank was discovered over twenty years ago by Prof. George Davidson, of the U. S. Coast and Geodetic Survey, who made a number of soundings upon it in depths of about 50 fathoms, and found cod abundant in some places. Its outline and surface contour were established by the *Albatross* with considerable accuracy. The bank lies south of Unimak Island, and extends westward from the neighborhood of the Sannak Islands to about the longitude of the southern entrance to Unimak Pass (about longitude 164° 40′ W.). Its eastern end is continuous with the shoal water surrounding the Sannak Islands; its area was estimated at about 1,600 square miles. The greatest width of the submerged plateau off Unimak Island is 45 to 50 miles. Depths less than 50 fathoms were found over a large part of the bank, 41 fathoms being the shoalest water discovered. Between the shallow area and the islands to the north and northwest of it, depths of 50 to 72 fathoms occur.

Sannak Bank.—The shoal water at the eastern end of Davidson Bank was traced some distance eastward along the southern edge of the Sannak Islands, and between

those islands and the reported positions of Lenard and Anderson Rocks; but still farther eastward on the same line of soundings (longitude 162° 22′ W.) a depth of 60 fathoms was found. Sannak Bank begins immediately to the northeastward of this position, and covers an estimated area of about 1,300 square miles. It lies to the east and southeast of the islands of the same name, is somewhat elongated in shape, and trends in a general way northeast and southwest. A small area, having depths of 30 to 37 fathoms, occurs near the center of the bank. A depth of 63 fathoms was found between it and the Sannak Islands, and depths of 75 to 82 fathoms exist off the northern edge in the direction of the Sandman Reefs.

Between Sannak Bank and the Shumagin Islands.—In this area about 1,800 square miles, more or less adapted to fishing, were partly surveyed, the depths ranging from 38 to 74 fathoms. This region is free from the hidden dangers which render Sannak Bank unsafe to those not well acquainted with its surroundings.

Shumagin Bank.—This bank lies to the south and southeast of the Shumagin Islands, and its outer margin follows approximately the trend of the coast line formed by the adjacent islands. It has been traced westward to about longitude 159° 52′ W., but probably extends farther in that direction. East of the Shumagin Islands it reaches north to the latitude of Big Koniushi Island. Its width inside of the 100-fathom curve varies from 15 to 35 miles, while its area has been estimated at about 1,800 square miles. The depths over a large part of the bank are less than 50 fathoms, the bank not being separated from the islands by deep water.

Shumagin Islands to Kadiak Island.—Only a single series of soundings was carried across this wide area to the eastward of Shumagin Bank, with a double line extending from the neighborhood of Light-house Rocks to Mitrofania Bay. These soundings were insufficient to demonstrate the full value of this region, but they indicated the existence of several fishing-banks, the outlines and characteristics of which must be left for future investigations. The extent of the area thus partly developed was estimated at about 4,400 square miles.

Albatross Bank.—This bank lies off the southeastern side of Kadiak Island and extends the entire length of that island as well as in front of the Trinity Islands. At the eastern end it is practically continuous with Portlock Bank. Along some portions of the coast, as in the neighborhood of Sitkalidak Island, the bank is separated from the land by comparatively deep water, while in other places shoal water intervenes. The 100-fathom curve is distant 25 to 45 miles from the land, inside of which limit there is an estimated area of 3,700 square miles. The existence of this bank was predicted by Prof. George Davidson upon the evidence of a few isolated soundings, which were the only ones that had been made previous to the investigations of the steamer *Albatross*, from which it has derived its name.

Portlock Bank.—This is the largest single bank south of the Alaska peninsula, its area inside of the 100-fathom curve being about 6,800 square miles, or only 1,600 miles less than that of Georges Bank, the second largest of the great banks of the western Atlantic Ocean. It extends northeastward from Kadiak Island, in the direction of Middleton Island, a distance of about 120 miles, and is irregular in shape. Isolated soundings of 68 to 81 fathoms occur near Kadiak Island, at the western end of the bank, but there are no indications of a marked or extensive depression between the bank and the land.

From Portlock Bank the soundings were carried to Middleton Island, the position of which was ascertained by a careful series of observations on a clear day. The

reported position of Pamplona Rocks in lat. 59° 03′ N., long. 142° 40′ W., was next visited, but only deep water was found within a radius of 20 miles of this locality.

Character of the bottom on the banks.—Sand was the predominant material composing the bottom on these several banks, a gray sand being the most common. This was combined in many places with pebbles, gravel, or broken shells, which were also recorded separately in some localities. Mud rarely occurred upon the banks or anywhere inside of the 100-fathom line. Rocks were not found upon Davidson Bank, but on Sannak Bank they compose a large part of the bottom, even in the deeper soundings. Rocky patches are numerous on Shumagin and Albatross banks, but were observed only at the extreme western end of Portlock Bank near Kadiak Island. In the region between Sannak Bank and the Shumagin Islands the bottom consists of sand, mud, pebbles, gravel, and rocks, but the last-mentioned material occurs only in the neighborhood of the islands and Sannak Bank. In the corresponding area between the Shumagin Islands and Kadiak Island fine sand was most abundant in depths less than 100 fathoms, with the admixture in places of pebbles, gravel, and broken shells, and occasional patches of mud and coarse sand. Green and blue mud usually composed the bottom in depths over 100 fathoms, but sand and rocks were also recorded.

Off Unalaska sand was traced down to a depth of 228 fathoms, with mud at 261 fathoms. Black sand was found in 342 fathoms just off Davidson Bank, while mud occurred in 435 fathoms off Sannak Bank, with rocky patches at depths of 265 and 464 fathoms. Sand and rocks composed the bottom off Shumagin Bank in 105 to 119 fathoms. Off Albatross and Portlock banks gray sand was discovered in 298 fathoms and black sand in 594 fathoms. Muddy bottom occurs, however, in places close to the 100-fathom line, but in the pocket which indents the southwestern end of the latter bank, with depths of 102 to 166 fathoms, the bottom consists entirely of sand. A rocky spot was found off Albatross Bank in a depth of 485 fathoms.

Dredging trials.—The beam trawl and naturalists' dredge were frequently used upon the banks, resulting in the collection of a large amount of natural-history material. As was to be expected, the assemblage of forms strongly recalls the fauna of the great fishing-banks of eastern North America, and many of the species from these two northern regions are closely related to one another, some also probably being identical. The most conspicuous features in the hauls were the fishes, crustaceans, mollusks, and echinoderms. Edible fishes, crabs, and shrimps were frequently taken, the last mentioned often in great numbers. The dredging operations were entirely subordinated to those of sounding, as it was considered most important to determine first the outlines and contours of the banks, but the results were ample to prove the exceeding richness of the grounds with respect to the lower forms of animal life, upon which their value for fishing is mainly dependent.

Trials for fish.—The trials for fish on these banks and other offshore grounds were made entirely with hand lines. Cod and halibut were the principal species taken, and are the only ones to which we need refer in this connection. Six to nine lines were generally used at each trial, which occupied from fifteen minutes to something over an hour each, according to circumstances. Salt clams and salmon were chiefly employed as bait, and pollock, sculpins, and cod occasionally. The depth at which the fishing was done ranged from 27 to 84 fathoms, and every variety of bottom observed upon the banks was tried.

The trials made by the *Albatross*, as before explained, do not furnish conclusive results with respect to the average size of the fish inhabiting the banks. It is said

that the larger cod are least quickly attracted by the bait, but as time was too valuable to permit of long stops at any single position, the records showing the size of fish taken by the *Albatross* are less gratifying than might otherwise have been expected. A length of 28 inches is taken as the standard size for large fish on the Atlantic coast, and all under this size bring a lower price in the markets. Out of 20 captures of cod recorded by the *Albatross*, the average size of the fish attained this standard in only six instances; it was rarely below 24 inches, and generally above 25 inches. The trials were usually made during the progress of or subsequent to a sounding or dredging haul, the steamer often drifting with the tide and changing the ground before the lines had touched bottom. By anchoring, and especially by remaining some time in each position, much better results would undoubtedly have been obtained. Halibut were secured at nearly every station.

In four trials made off Unalaska Island, aggregating eighty-five minutes, 22 cod were taken, averaging for the several trials from 21 to 28¾ inches in length; in one instance, on Davidson Bank, 25 cod averaged 28 inches, and in another, 21 cod, 24½ inches; 18 cod captured on Sannak Bank averaged 23½ to 25 inches in length. The cod taken off Unga, one of the Shumagin Islands, had an average length of 30 inches; on Shumagin Bank of 26½ inches, and near the Chirikof Island of 23¼ inches. Several trials were made on Albatross Bank, two of which were unusually successful. One was off Tugidak, the westernmost of the Trinity Islands, in 37 fathoms, where 47 cod were captured in 38 minutes, and the other off Dangerous Cape, Kadiak, in 39 fathoms, where the capture amounted to 69 cod in 50 minutes. At the former locality the fish averaged 28½ inches in length and at the latter 30¾ inches, in both instances being above the eastern standard. Pair after pair of cod were hauled up in quick succession at each of these localities, and they were seizing the bait as actively at the close of the trials as at the beginning. Only one large catch of cod was made on Portlock Bank, in a depth of 36 fathoms, where 30 individuals, averaging 27 inches in length, were taken in the course of 18 minutes.

Bait.—Bait is as readily obtained in this region as in Bering Sea, and the same custom prevails of fitting out with only a small quantity of salted fish or clams, for which fresh material is substituted as soon as the fishing work actively begins.

Miscellaneous observations.—Besides the fishery investigations summarized above, many other important observations were also made bearing more or less directly on the same subject. These have been discussed in full in the reports previously referred to. They relate to the hydrography and meteorology of the region, the availability of harbors, etc. Corrected positions were obtained for some of the rocks and islands of the Sandman Reefs, which had been inaccurately located on the published charts. An unsuccessful search was made for two reported dangers south of the Sannak Islands, namely, Lenard and Anderson rocks, without, however, disproving their existence. Much valuable information was secured regarding the different islands visited and the mainland at Mitrofania Bay. A partial list of the harbors and anchorages situated between Unalaska and Kadiak was compiled, and sailing directions were also prepared for entering some of the more important ports.

While approaching the Alaskan coast in May, 1890, a second attempt was made to locate the position of Anderson Rock, respecting which Capt. Tanner has reported as follows:

The high land of Sannak Island was sighted on the morning of May 21, and a line of soundings and dredgings, commenced in 483 fathoms, was carried over the position assigned to Anderson Rock,

and thence to the westward of the islands through Unimak Pass into Bering Sea. The weather was squally and misty at times while working in the region of Anderson Rock, but there were frequent intervals when it was quite clear, and from the masthead we commanded a view of the horizon for 10 miles or more in every direction, but without detecting any surface signs of rocks or shoals; neither did the soundings indicate anything of the kind. Our observations do not prove the non-existence of the danger referred to, but simply show that it does not lie in the position indicated. The evidence seems so conclusive as to the existence of rocks somewhere in that vicinity that I am inclined to the belief that they will eventually be found and located properly. Our investigations are gradually narrowing the limits in which they may be searched for.

A few dredging and fishing trials were also made south of the Alaska Peninsula during the summer of 1890, but they add no information of material importance for this brief review.

DEEP-SEA SOUNDINGS AND DREDGINGS IN THE NORTH PACIFIC OCEAN, OFF THE ALASKAN COAST.

On approaching the Alaskan coast in July, 1888, soundings were begun in a depth of 2,550 fathoms, latitude 52° 15′ N., longitude 156° 37′ W. This was the first of a series of ten stations extending N. 88° W., 390 miles, and made to ascertain whether a marked depression in the bottom, observed farther to the eastward by the U. S. S. *Tuscarora* in 1874, was more than local in its character. The soundings of the *Tuscarora* revealed a depression simply, but from them geologists had predicted the existence of a submarine trough, running parallel to the coast of the Alaska Peninsula and the Aleutian Islands, and extending probably along the entire length of the latter islands to the sounding of 4,037 fathoms made by the *Tuscarora* off Attu Island. The *Albatross* soundings, supplementing those of Capt. Belknap, developed this predicted trough a distance of 400 miles. Its direction, where determined, was S. 65° W. and N. 65° E., nearly parallel with the trend of the coast line, the center being 60 miles from the Shumagins and 100 miles from the southwestern extremity of Unalaska. It is about 30 miles in width between the 3,000-fathom lines, with a maximum depth of 3,820 fathoms in latitude 52° 20′ N., longitude 165° W.

In August, 1890, after leaving Bering Sea, another similar line of soundings was run across the same region, but some distance to the eastward of the *Tuscarora* series. The results have been described by Capt. Tanner as follows:

Departure was taken off the Trinity Islands in latitude 56° 02′ N., longitude 153° 52′ W. Running E. 3° S. true, 11 miles, we found 207 fathoms; then east true, with intervals of 20 miles, the following depths were found across the line of the great submarine trough which extends along the Aleutian Islands, viz: 1,152, 2,197, 2,620, 2,935, and 2,925 fathoms. Increasing the interval to 30 miles, we found 2,776 fathoms, and a farther distance of 62 miles gave us 2,414 fathoms. The maximum depth was found in latitude 56° 02′ N., longitude 151° 12′ W. It will be observed that while the depths are less than those found farther west, they are at least 800 fathoms greater than the normal, showing that the easterly extension of the depression reaches that point. The line of soundings was extended to the Queen Charlotte Islands, where a successful haul of the trawl was made in 1,588 fathoms.

This depression has therefore now been traced a distance of nearly 600 miles.

After completing the investigations off Middleton Island and Pamplona Rocks, in August, 1888, a line of ten sounding and dredging stations was carried southward, nearly parallel with the coast line of Alaska and British Columbia, to the north end of Vancouver Island. At the first six stations the depths ranged from 1,433 to 1,815 fathoms, but they subsequently decreased to 876, 204, 83, and 52 fathoms.

The foregoing deep-sea soundings and dredgings, as well as those of lesser depth, made to determine the contour of the bottom along the margin of the continental platform off the coast of the Alaska Peninsula, are represented on U. S. Coast and Geodetic Survey charts S and T.

SOUTHEASTERN ALASKA.

Practically nothing has yet been done toward investigating the fishery resources of southeastern Alaska, all of the time suitable and available for work in northern latitudes since the *Albatross* arrived in the North Pacific Ocean having been spent off the southern coast of the Alaska Peninsula, in Bering Sea, and in the sealing investigations of 1891 and 1892. During July, 1889, however, a trip was made through the inland passages of the southeastern part of the territory as far as Juneau, with several members of the Senate Committee on Indian Affairs, who were desirous of inspecting the principal Indian settlements of that region. The steamer left Tacoma on July 8, and returned on the 28th of the same month. Stops were made at Fort Tongass, Port Chester, Karta Bay, Fort Wrangell, Sitka, Pavloff Harbor, Hoonyah Bay, Portage Bay, Chilkat, and Juneau. Several important fishing stations and canneries were visited, and some investigations were also made by means of the beam trawl and other kinds of fishing apparatus.

BRITISH COLUMBIA.

On the voyages to and from Alaska the *Albatross* has generally made use of the inland passage inside of Vancouver Island; she has also often coaled at Departure Bay, and has made occasional visits to Victoria and to other parts of the same island. Opportunities have therefore been afforded, from time to time, to observe the fishery resources of the British Columbian coast, but comparatively little information has been obtained in regard to them. This subject will be discussed in part in connection with the State of Washington, the following notes referring mainly to the inland passage:

Departure Bay.—The results of collecting work during July 10 and 11, 1888, together with notes upon the fisheries, are recorded in the Bulletin for the same year, pp. 51, 52. According to Mr. Alexander, the white fishermen of Departure Bay are exclusively Italians, whose chief occupation during the winter months is the capture of dogfish for their oil. Herring are also very abundant, but they are taken only in small quantities for the benefit of the local trade. The salmon fishery is likewise very limited, being followed by only a few Indians to supply their own wants and the small market at Nanaimo. Cod sometimes enter the bay, but they are said to be more plentiful in deeper water outside. They are described as small fish, averaging about 5 pounds each in weight, and are not often fished for.

A visit to the same place, beginning May 25, 1889, is thus described by Mr. Alexander:

During the stay in port I was occupied in obtaining additional information respecting the fisheries of the region. A visit was paid to Mr. Vozza, an Italian fisherman, who conducts a small fishing business on one of the islands in the bay. He said that the past winter had been exceptionally mild and consequently the fishing for dogfish much poorer than usual. These fish would visit the bay in large numbers during cold spells, but every time the weather moderated they immediately sought deeper water. It is not probable that the temperature had a direct effect upon the dogfish, but it influenced the presence of the herring on which they feed. The herring usually resort to Departure Bay during the winter in incredible numbers, and the dogfish follow them about from place to place. Several thousand herring were smoked by Mr. Vozza during the preceding winter, but he found no demand for them in Nanaimo or elsewhere. Three thousand gallons of dogfish oil were put up between December 1 and the last of March by two men. The usual yield for the same time is about 5,000 gallons. Mr. Vozza says that the spring run of salmon strikes the Fraser River in March and remains there until the latter part of June. In July the suk-kegh salmon enter the river and continue in it until sometime in August, after which the spring salmon return and are plentiful for three

or four weeks. A form called "cohoes" by the natives predominates during September, and in October there are several species running.

There are now fifteen canneries on the river, three having been built during the present season. The sizes of mesh in the salmon nets are 6, 7½, and 8 inches. The 6-inch mesh is used for the suk-kegh salmon. About 2,000 men are engaged in the fishery this year.

On May 13, 1890, while on the passage to Alaska, Capt. Tanner notes that "schools of herring were seen in the Gulf of Georgia during the evening, pursued by sharks and porpoises. Among the latter several were observed with peculiar markings, the head, back, and sides being black or very dark; belly, tips of fins, and tip of tail, white."

Alert Bay.—Stops were made at this place both going and coming in 1888. There is an Indian village here and also a salmon cannery, where, up to September, 46,000 cases had been put up. Salmon are sometimes very abundant about the bay and neighboring islands, being chiefly fished for by means of seines and gill nets. A large number of suk-kegh salmon (*O. nerka*) were observed at the cannery on July 11. The Indians of the village are mainly occupied in fishing for the cannery.

Fort Rupert.—The *Albatross* stopped at Fort Rupert, or Beaver Harbor, on July 12, 1888, for the purpose of obtaining a supply of clams for use as bait on the Alaskan fishing-grounds. Clams are unusually plentiful in this locality, and with a force of fifteen sailors 10 bushels were secured during a single low tide. Three species are said to occur here in about equal abundance. The large gaper clam (*Schizothærus*) burrows deeply in the bottom at very low tide level, while the *Saxidomus nuttallii* (quahog) and the smaller *Tapes staminea* are usually only 6 or 8 inches below the surface, and may be found anywhere between high and low water mark. During unfavorable seasons for salmon the cannery at Alert Bay has preserved clams, obtaining its supplies from Fort Rupert.

Dredgings.—On the way south through the inland passage, in September, 1888, dredging stations were made in Queen Charlotte Sound, off the southern entrance to Goletas Channel, depth 238 fathoms (No. 2862); and in the Gulf of Georgia, off Fraser River, depth 67 fathoms (No. 2863).

Black-cod.—Much information was obtained at Victoria respecting the black-cod and the attempts made to establish a regular fishery for this highly prized species. References to this subject will be found in the several reports of Capt. Tanner and Mr. Alexander. In October, 1888, the schooner *Theresa*, of Victoria, completed a successful trip, having secured about 3,000 of these fish, many of which weighed from 20 to 25 pounds apiece. They were taken principally in a depth of 210 fathoms, about 5 miles off the Queen Charlotte Islands, trawl lines being used for their capture. A part of the cargo, however, was purchased from the Indians. According to Mr. Alexander, the great depth at which these fish generally live, 150 to 200 fathoms, has undoubtedly had much to do with hindering the establishment of this industry, as the northwestern coast fishermen had never been obliged to go beyond a depth of 50 fathoms for their cod and halibut, and are totally unused to deep-water fishing.

In June, 1889, Mr. Alexander wrote that he had received information of only one trip subsequent to that mentioned above off the coast of the Queen Charlotte Islands. The fish were caught in the vicinity of Gold Harbor, in a depth of 250 fathoms. He takes exception to the customary manner of dressing the fish, by splitting them down the back and leaving the head and backbone attached, which he thinks causes them to rust very quickly, and considers that if prepared like the true cod, or even mess mackerel, they would be in much greater demand.

WASHINGTON AND OREGON.

GENERAL CONSIDERATIONS.

The coasts of Washington and Oregon, from Cape Flattery to the California boundary line, have a total length, due north and south, of about 383 nautical miles, reaching, therefore, through nearly 6½ degrees of latitude. The examination of this region by the steamer *Albatross* was begun in September, 1888, and was continued at intervals until in October, 1889, when it was practically completed. Since that time, however, some additional observations have been made.

As in the Alaskan region, it has been necessary to spend most time in determining the contour and general characteristics of the bottom, as very few soundings had previously been made beyond a depth of 50 fathoms, and only comparatively limited areas in more shallow water had been surveyed. The regular hydrographic work of the *Albatross* consisted in running parallel lines of soundings seaward from the coast, at intervals of 5 to 10 miles, and generally into depths of 200 or more fathoms, thus serving to develop the entire width of the continental platform to its abrupt outer edge. As the bottom fishing-grounds are mostly confined within a depth of 100 fathoms and rarely extend beyond a depth of 200 fathoms, the survey made here by the *Albatross* has been sufficiently comprehensive to meet all the requirements of the fishery interests in that respect, although in some places more detailed examinations would be desirable. Wherever the nature of the bottom or previous information indicated the occurrence of fishing-grounds, the sounding stations were run more closely together, and the amount of time spent in determining their contours and conditions was proportioned to their importance.

The width of the continental platform varies considerably at different places along the coast. At Cape Flattery the 100-fathom line is 40 miles from shore, while at Cape Johnson, 26 miles further south, it is distant only 18 miles. Off Grays Harbor the distance is 30 miles; off Willapa Bay, 20 miles; off Cape Disappointment, at the mouth of the Columbia River, 15 miles; at Tillamook Rock, Oregon, 27 miles, and at Cape Lookout 11 miles. From this point the platform gradually broadens out, attaining a width of 35 miles off the Siuslaw River, in the region of Heceta Bank, immediately south of which it is abruptly constricted to about 14 miles, becoming reduced to 7 miles at Orford Reef and 12 miles at the California State line.

The superficial area of this platform within the 100-fathom line has been estimated at about 3,700 square miles for the coast of Washington and about 4,750 square miles for the coast of Oregon.

The soundings off Cape Flattery were irregular and suggest the existence of submarine ridges lying parallel with the coast. A very elongate crescent-shaped depression, having depths of 100 to 200 fathoms, extends southward from the mouth of the Strait of Fuca a distance of some 20 or more miles, being distant from the coast from 8 to 12 miles. Thence to Yaquina Head, Oregon, the slope is regular, except in the region of the rocky bank off Grays Harbor and Willapa Bay, where elevations of a few fathoms were found. Below Yaquina Head the platform attains its greatest width south of Cape Flattery, the somewhat triangular area which occurs there being occupied at its southwestern extremity by Heceta Bank. Further south the soundings are regular, but the depths increase more rapidly from the shore outward. The bottom consists generally of fine sand in the shallower water, changing

to mud farther offshore, although sand was also found at times in considerable depths. On the fishing-banks its character is variable, as described elsewhere.

Dredging and fishing trials were made at frequent intervals down the coast as far as Orford Reef, Oregon, leaving a distance of about 48 miles between that place and the State line, over which no fishery investigations have yet been made; but the continental platform is there very narrow.

There are very few defined fishing-grounds on the coasts of Washington and Oregon, and those which occur are of small extent. The largest and most important one lies about 11 miles northwesterly from Cape Flattery, and has a total area of about 1,100 square miles. Another, covering only about 110 square miles, is situated off the coast between Grays Harbor and Willapa Bay. A still smaller bank or rocky patch is located about 19 miles southwesterly from Yaquina Head; its area has been estimated at 40 square miles. Heceta Bank, lying off the Siuslaw River, is next in importance to Flattery Bank, having an extent of about 600 square miles.

The small extent of the banks, however, does not indicate a scarcity of fishery resources, as fishes of excellent food quality were found to be pretty generally distributed over the surface of the platform throughout a large part of the region, as described further on. In the immediate vicinity of exposed rocks lying near the coast, which are inhabited by sea lions, fishes were noticed to be rare if not entirely absent in most cases, Orford Reef, however, presenting a notable exception in this respect.

The halibut and the true cod (*Gadus morrhua*) are the species which have been most eagerly sought for by the fishermen along these coasts, but no traces of the latter were discovered by the *Albatross*. The halibut, however, ranges as far south as Monterey, Cal., although it has nowhere been found sufficiently abundant to afford the basis for a special fishery except on Flattery Bank. Scattering specimens were taken by the *Albatross* off Flattery Rocks, off Tillamook Rock, and on Heceta Bank, but the resources of this bank have not yet been fully tested. The species has also been recorded from off Cape Mendocino. The fact that the Indians south of Cape Flattery do not include the halibut among their supplies of food may be regarded as additional evidence that this fish will not be found in any numbers, near the shore at least, within this region.

Several species of rockfish (*Sebastodes*) were abundant upon the banks as well as upon the sandy bottom of the platform. Flounders were taken everywhere, but were most plentiful between depths of 50 and 100 fathoms. A number of species were discovered, some of which are of excellent food quality, and they will offer strong inducements for the introduction of beam-trawl fishing whenever a market has been established for them. Cultus-cod (*Ophiodon elongatus*) were obtained on all the banks and on Orford Reef. Black-cod (*Anoplopoma fimbria*) of good size inhabit the deeper waters, while smaller individuals, together with the ling or Pacific whiting (*Merlucius productus*), occur in moderate depths. Large red edibles hrimps were also frequently captured in the beam trawl; they are distributed through a considerable depth of water.

The principal obstacle at present to the development of extensive sea fisheries on the outer coast of Washington and the coast of Oregon is the lack of markets for disposing of the catch. The scarcity of good harbors is also a very serious inconvenience, and as those which do exist are encumbered with bars, they can be entered in bad weather only with much difficulty. Although gales are of rare occurrence during

the summer, still the coast winds blow constantly from the northward, maintaining a boisterous sea and strong currents. During the winter southeasterly storms are frequent.

List of the more abundant food-fishes taken by the Albatross on the coasts of Washington and Oregon with the beam trawl and hand lines.

[Prepared by Charles H. Townsend.]

Hippoglossus hippoglossus, Halibut.
Atheresthes stomias, Halibut-flounder.
Microstomus pacificus, Deep-sea sole.
Glyptocephalus zachirus, Long-finned sole.
Citharichthys sordidus, Flounder.
Hippoglossoides jordani, Flounder.
Hippoglossoides exilis, Flounder.
Psettichthys melanostictus, Flounder.
Parophrys vetulus, Flounder.
Isopsetta isolepis, Flounder.
Lepidopsetta bilineata, Flounder.
Sebastodes ruber, Red rockfish.
Sebastodes pinniger, Orange rockfish.
Sebastodes flavidus, Yellow-tail rockfish.
Sebastodes rosaceus, Rockfish.
Sebastodes elongatus, Rockfish.
Sebastodes melanops, Rockfish.
Sebastodes paucispinis, Rockfish.
Sebastodes nebulosus, Rockfish, and other smaller species of the same genus.
Anoplopoma fimbria, Black-cod.
Ophiodon elongatus, Cultus-cod.
Merlucius productus, Whiting.
Microgadus proximus, Tomcod.

Large rays and skates, of several edible species, were common. Anchovies and smelts were taken in the beam trawl when used near shore, while in the deeper water beyond the margin of the platform the redfish (*Sebastolobus*) was dredged in abundance. The flesh of the last-named species is rather soft, but edible.

WASHINGTON.

The Straits of Juan de Fuca and Puget Sound.—Only incidental observations have been made in these waters, either while passing through or while in port. Brief accounts of the fisheries in the vicinity of Seattle, Port Townsend, and Victoria will be found in the Fish Commission Report and Bulletin for 1888 (F. C. 7, 8, 16).

The beam trawl has been used at only four stations, two (Nos. 2864, 2865) in the extreme eastern part of the straits, and two (Nos. 3067 and 3068) off Dwamish Head, near the city of Seattle. The former trials were made on September 6, 1888, in depths of 40 and 48 fathoms, but no fishes of economic value were secured. The latter were made on June 8, 1889, in depths of 82 and 135 fathoms, the bottom consisting of green mud. Among the specimens obtained were three species of flounders, hake, skates, several ratfishes (*Chimæra*), shrimps, starfishes, and sea-anemones, but not many of any kind.

In the evening of September 24, 1888, the halibut trawl was set off Kaihsla Point, outside of Neah Bay, the inner end being in 20, the outer in 25 fathoms. It was allowed to remain down until the following morning, but on being hauled 24 dogfish and 2 skates comprised the entire catch. Halibut and black-cod are sometimes taken in close proximity to Neah Bay earlier in the season. The latter species is never abundant there, but during some years it is sufficiently common in the spring to furnish the Indians of the vicinity with a considerable supply of food. On October 19, following, a cod trawl was set for half an hour in a depth of 101 fathoms, off Race Island, at the southeastern end of Vancouver Island, for the purpose of discovering the presence of beshowe, or black-cod, which had been reported to occur there, but only dogfish were captured, about 40 specimens in all.

Mr. Alexander states that—

There are a few fishermen about Port Townsend and Victoria who fish for halibut and dogfish the greater part of the year. One of these, Mr. Isaac Bakman, with whom I conversed, stated that he did not think that halibut were ever abundant enough in the Straits of Fuca to warrant vessels of large size engaging in the business. In April, 1888, Mr. Bakman secured in different parts of the straits 4,500 pounds of halibut, for which he received from 2 to 3 cents per pound. These spring fish have been very scarce, and not enough have been caught to pay expenses.

During the winter of 1888–89, three men were fishing for cod in Puget Sound with gill nets and trawl lines. No large quantities of these fish were caught, but many flounders and a few halibut were taken on the trawls. The cod are obtained in all depths from 5 fathoms downwards, the deepest water in which gill nets have been set being 150 fathoms, off Quartermaster Harbor, near the head of Puget Sound. In this region both the *Gadus morrhua* and the cultus-cod (*Ophiodon elongatus*) are known under the name of cod.

Flattery Bank.—This bank, which constitutes one of the most important fishing-grounds on the Pacific coast south of British Columbia, is located to the northwestward of Cape Flattery, on the northern side of the deep-water area (from 100 to 200 fathoms) at the entrance to the Strait of Juan de Fuca. It is mostly confined within the 50-fathom curve adjacent to the coast of Vancouver Island, and lies directly off the entrance to Nitinat Lake, but it is also continuous with that part of the continental platform inside of the 100-fathom curve which skirts the outer coast of Washington, although depths of nearly 100 fathoms intervene. Flattery Bank has long been resorted to by the Indians, but, while large quantities of halibut and of other fishes have been taken from it in times past, the first extensive commercial fishery there was attempted about 1888.

As the hydrography of the bank had previously been determined with sufficient accuracy for fishery purposes, the investigations of the *Albatross* were limited for the most part to dredging and fishing trials. The first visit was paid to it in September, 1888, the inquiries being begun on the southeastern part of the bank, nearest Cape Flattery, and being carried thence to the neighborhood of Barclay Sound, Vancouver Island. The second and last examination was made in June, 1889. The entire area of the bank has not yet been surveyed and its extreme limits are, therefore, still unknown. The depths may be said to range from 27 to about 75 fathoms. The bottom varies exceedingly in character, consisting of rocks, sand, mud, and shells, and in some places being very rough and irregular. It supports a very rich fauna, which fits it especially as a feeding-ground for fishes.

Capt. Tanner assigns to this bank a total area of about 1,100 square miles. The least depth of water, 27 fathoms, was found at its southeastern extremity, 11 miles W. by N. (magnetic) from Cape Flattery light-house. Halibut occur most abundantly on the same part of the bank, over an exceedingly rough, rocky bottom, having an area of about 35 square miles. From early in the spring until the middle of June this species can be obtained on Flattery Bank in paying quantities, but later in the season dogfish and sharks strike in, driving a majority of the edible fishes away.

The dredging and fishing trials by the *Albatross* were as follows:

Three dredging stations (2873 to 2875, inclusive) were made on September 24, 1888, at distances of 10 to 12 miles northwesterly from Cape Flattery, the depths ranging from 27 to 40 fathoms, and all varieties of bottom being found. The first trial was with the beam trawl in 40 fathoms, but it caught upon the bottom and was badly

wrecked. The tangles were then used successively in depths of 27 and 40 fathoms, with good results. A trawl line, baited with salt salmon and red rockfish, was set for three hours in about the same position on rocky bottom, depth 40 fathoms, the catch consisting of 4 halibut, 2 sharks, 4 red rockfish, and 2 starfishes. The average weight of the halibut was 47¾ pounds; three were females and one was a male; they were all white. It is said that gray halibut are seldom found in these waters.

On September 25 work was continued in nearly the same locality as on the previous day. The beam trawl was cast at station No. 2876, 2 or 3 miles northeasterly from stations 2873 to 2875, and the trawl line, baited with salmon, red rockfish, and fresh halibut, was set at the same time. The depth was 59 fathoms, and the bottom consisted of black sand and mud. The beam trawl dragged but a few yards, when it caught on a rocky patch, parted the bridle stops, and came up tail first. It was, however, a successful haul, and many specimens were found in the net. The tangles were subsequently hauled over the same ground (station 2877) with good results, giving evidence of the richness of the bottom. The towing net, which was frequently used in this region, however, gave very little evidence of surface life. The halibut trawl remained on the bottom three hours, and the catch consisted of 2 halibut, 1 red rockfish, and 9 dogfish, the average weight of the halibut being 55 pounds.

On the afternoon of September 25 the trawl line was set and the dredge lowered in 66 fathoms, gravel and pebbles (station 2878), S. 48° W., 16 miles from Cape Beale light-house, on the southern side of the entrance to Barclay Sound, Vancouver Island. The contents of the dredge, consisting for the most part of small mollusks, did not bear evidence of a rich bottom. The same bait was used upon the trawl line as in the previous trial, and the capture after two hours' time consisted of 2 black-cod, 15 dogfish, 2 common sharks, and 2 ground sharks. Only a small quantity of surface organisms was taken in the tow nets.

Early on the following day two dredge hauls were made at stations 2879 and 2880, 27 miles N. 79° W. from Cape Beale, in 34 fathoms, rocky bottom, with about the same results as at station 2878, the bottom not being rich so far as the contents of the dredge indicated. A trial with the halibut trawl in the same locality, lasting about three hours, afforded 1 halibut weighing 25 pounds, 2 sharks, and 3 dogfish.

At station 2881, in the same neighborhood, but much nearer the coast, Cape Beale bearing S. 26° E., distant 26 miles, the dredge was cast in 24 fathoms, on a rough bottom, with fine gray sand in places. The results were not favorable to good fishing. The trawl line set in the same position took 1 halibut weighing 15 pounds, 5 dogfish, 1 shark, and 1 skate. The trawl, when it came up, was covered with "slime," which was contrary to expectations, as the dredging which preceded it indicated clean bottom.

September 27 and 28 were spent in Barclay Sound, and the following day a skate of halibut trawl was set in 60 fathoms of water, sandy and rocky bottom, 22 miles S. 14° E. from Cape Beale. The trawl was kept down about two hours, with the result of capturing 16 dogfish, 1 beshowe or black-cod, 1 cultus-cod, and 3 small halibut. This spot would probably be a good one for halibut earlier in the season, before the dogfish set in, and is convenient to the Straits of Fuca. It requires examination in the spring or winter to determine its merits.

On June 14, 1889, the trawl line was set on Flattery Bank, in a depth of 31 fathoms, Cape Flattery bearing E. by S. ½ S. and Cape Beale NW. by W. The bottom consisted of gravel, broken shells, and rocks. The tide was running ebb, but not

strong, and a dense fog prevailed. The trawl was left down about three hours, at the end of which time the following fish were taken from the hooks: 8 halibut, averaging 35 pounds each; 10 red rockfish, averaging 10 pounds each; 2 orange rockfish; 1 sea trout; 1 cultus-cod, weighing 19 pounds; 1 skate, and 45 dogfish. The bottom was so rough that many of the hooks caught upon it while hauling, and toward the end the ground line parted, but none of the gear was lost. One small halibut and about a dozen dogfish were caught with hand lines from the small boats tending the trawl, and during the same time one halibut weighing 93 pounds and several red rockfish were taken by the same means from the deck of the *Albatross*. A native canoe with four Indians, which came alongside during the day, contained 15 small halibut which had been captured with the primitive wooden hooks.

Barclay Sound, Vancouver Island.—On September 26, 1888, the *Albatross* anchored in Barclay Sound, where she was detained by fog for two days, enabling the naturalists to make some interesting observations upon the natural history of the region. A rich and diversified fauna was discovered, and many specimens were collected. There are not many beaches adapted to seining, but some were found on which a large variety of shore fishes was obtained. Salmon were seen darting about in every direction. They are said to be very plentiful at the head waters of the sound, where they enter the creeks and inlets to spawn. A few large specimens were caught by trolling. A cod trawl, baited with halibut and salmon, was also set one evening in a depth of 17 fathoms, and allowed to remain down over night. The next morning 28 dogfish and 1 red rockfish were found upon the hooks.

Notes on the Halibut Fishery.—The following notes on the halibut fisheries located off the coast of Washington or tributary to its ports are such only as have been furnished through the medium of the *Albatross*, and are here given to illustrate in a practical manner the resources of the grounds. For further information on the same subject reference should be made to the Bulletin for 1888, pp. 62–64, and the Annual Report for 1888, pp. 260–266.

Until within a few years the halibut fisheries of Washington have been almost exclusively the property of the Indians resident upon certain portions of the coast. Beginning in 1888, however, strenuous efforts have been made to establish an extensive commercial fishery, the final outcome of which is still to be decided. The promoters of this enterprise have, unfortunately, encountered many obstacles in the matter of obtaining ice and of shipping their catch to market, which, tending to restrict their operations, has prevented a thorough testing of the grounds; and yet, within certain limits, good results have already been accomplished.

The Indians of Neah Bay visit Flattery Bank daily during the halibut season, whenever the weather permits, and also fish on less important grounds closer at hand; they bring in considerable quantities of halibut, cultus-cod, and red rockfish; herring, smelt, and squid, as well as halibut and red rockfish, are used as bait.

The first vessel fishery appears to have been started in 1888 by two well-equipped schooners, the *Mollie Adams* and the *Oscar and Hattie*, which had recently arrived from Gloucester, Mass. After completing a successful sealing voyage in the spring of that year, the *Mollie Adams* made four trips in quick succession to Flattery Bank, securing, in all, 145,000 pounds of halibut, which were landed at Seattle. The stock amounted to $3,000, the crew receiving shares of $75 each. The expenses were high, however, $15 per ton having been paid for ice on the first trip, although the price was subsequently reduced to $8. During the same season the *Oscar and Hattie* obtained

one fare of 50,000 pounds of halibut on Flattery Bank; the fish were landed at Tacoma. But little or nothing was realized from the trip.

In the fall of 1888, several fishermen, well equipped with dories, trawls, etc., established a camp in the vicinity of Neah Bay, and fished continuously throughout the following winter on Flattery Bank and directly off Cape Flattery. Mr. Moor, one of the members of this party, who came to the Pacific coast in the schooner *Mollie Adams*, has furnished a synopsis of the winter fishing. They first set trawls on November 23, 1888, and from that date up to January 7, 1889, succeeded in landing 2,076 pounds of halibut and 244 pounds of cultus-cod. The average weight of the halibut was 37 pounds, and of the cultus-cod 24 pounds. After January 7 little was done, owing to the scarcity of fish and bait and the prevalence of stormy weather. Mr. Moor does not think it advisable to send vessels to Flattery Bank earlier than the 1st of March nor later than the 1st of September. He thinks that halibut are abundant from March to June, but they do not occur in the incredible numbers which have been reported from time to time.

In November, 1888, Capt. Silas Calder, then of the *Mollie Adams*, made a series of trials for halibut on Flattery Bank, without, however, securing a single specimen. He is of the opinion that vessels could obtain good fares during a few months of each year, and might find the business profitable if there were a market for the catch.

The yacht *C. H. White*, of San Francisco, chartered in the fall of 1888 by Messrs. Louch and Johnson, of Seattle, obtained 100,000 pounds of halibut during three trips to the same bank. About 60,000 pounds were shipped fresh to New York, the remainder being smoked.

Several interesting trips at different seasons of the year have also been made farther north than Flattery Bank. While the results accomplished in that direction are not sufficient to serve as a basis for positive conclusions regarding the abundance of halibut in the places visited, which undoubtedly varies at different times of the year, they are at least suggestive and worthy of notice in this connection.

On July 24, 1888, the *Mollie Adams* left Seattle with the object of testing the bottom along the coast of British Columbia. Trials were made in several localities, but few halibut were captured until the schooner arrived off the southern extremity of the Queen Charlotte Islands, where they were found in greater abundance and of larger size than on Flattery Bank. A few of those obtained were estimated to weigh over 300 pounds apiece. Fishing was carried on in depths of only 30 to 45 fathoms, the fish taking the bait so rapidly that the trawls were left down only during the day time. The work continued until September 8, with slight intermissions on account of stormy weather. About half the halibut secured were large enough for fletching, the remainder being used as bait or thrown away. The total fare carried to Seattle amounted to 150,000 pounds. After deducting all expenses the crew received $175 each, or at the rate of $9 a day for 19 days' fishing.

On January 3, 1889, the schooner *Oscar and Hattie* sailed from Port Townsend on a similar errand, but proceeded directly to Sitka, Alaska, and began fishing on the inshore grounds adjacent to Baranof Island, where halibut had been reported as very abundant. Work was continued, as the weather permitted, until March 1, but not enough fish were taken to keep the hooks baited. The vessel was subsequently shifted to deeper water off shore, but without securing any better success. Early in March she proceeded down the coast, fishing until June 1 in the neighborhood of the Queen Charlotte Islands, Cape Scott, and Hecate Channel. Halibut were more com-

mon in these localities, but nowhere abundant, and it was often necessary to shift position twice a day. A fare of 140,000 pounds was finally secured. The fish averaged about 65 pounds each in weight, and on the British Columbian coast none were captured in greater depths than 45 fathoms. Capt. Calder, of the *Oscar and Hattie*, states that while off Sitka he encountered many heavy gales, which did much damage to the rigging and fishing gear, but there was no snow or ice to contend with, as would have been the case on the North Atlantic coast at the same season.

The schooner *Rose Oleson*, of Astoria, chartered by parties in Port Townsend, made one trip to the vicinity of Cape Scott, at the northern end of Vancouver Island, beginning the cruise during the first part of April. She was gone five weeks, and obtained a fare of 15,000 pounds.

Cape Flattery to Grays Harbor.—The hydrographic examinations along the coast of Washington were begun off Cape Flattery on September 19, 1888, and were completed in the latitude of Columbia River on the 13th of October following. Dredging and fishing trials were made in the same connection and also at subsequent periods. The first line of stations was commenced in 82 fathoms, 10 miles S., 68° W., from Cape Flattery light, and was carried 65 miles S., 68° W., soundings being made at intervals of 5 miles to develop banks reported to exist 60 and 75 miles from the cape. The depths were irregular for 30 miles, then increased uniformly to 768 fathoms at the former and 1,239 fathoms at the latter position. The occurrence of the banks in the places indicated was therefore disproved.

Three dredgings, all with the beam trawl, were made in the vicinity of Flattery Rocks and between there and Cape Flattery on September 20 and 24, 1888. The first was at station No. 2866, 19 miles S., 40° W., from Flattery light-house, 171 fathoms, gray sand; the second at station 2867, 17 miles S., 23° W., from Flattery light, 37 fathoms, fine sand; the third at station 2872, 8 miles S., 40° W., from the same light-house, 38 fathoms, gray sand.

Near station 2867 the halibut trawl, baited with salt salmon, was set at 3 p. m. and hauled at 5 p. m., securing 8 sharks, 2 dogfish, and 1 halibut, the latter weighing 140 pounds and measuring 5 feet 9 inches in length. A few hand lines were also tried in the same locality, 1 red rockfish and several dogfish being taken by that means. A skate of halibut trawl, baited with salt salmon and red rockfish, was likewise set in the position of dredging station 2872, but only 2 sharks and 1 starfish were obtained. In the spring the Indians fish for halibut in this locality, but no satisfactory information regarding their abundance there has yet been obtained.

On September 21, 1888, the beam trawl was used at station No. 2868, off Cape Johnson, and station No. 2869, off Destruction Island, in depths of 31 and 32 fathoms, respectively, the bottom consisting of sand. At the former station tomcod, flounders, red rockfish, and 1 black-cod were taken in the beam trawl. A trawl line, baited with salt salmon and clams, was set in the same position, but very few of the baits were disturbed, only 2 red rockfish, 3 dogfish, and 1 skate being captured. Trial lines from the deck of the steamer afforded no results.

The following June dredging operations were conducted off this part of the coast, to the west and southwest of Destruction Island, in depths of 178 to 877 fathoms. That work has been reported upon by Capt. Tanner as follows:

Passing Cape Flattery we steamed offshore until 7:45 a.m., on June 28, 1889, when the trawl was cast in 760 fathoms (station 3069), green mud. A heavy westerly swell caused the ship to tumble about so much that it was difficult to carry on our work, and finally resulted in parting the bridle

stops, causing the net to come up tail first, and practically empty. There were, however, a few pennatulas, starfish, holothurians, etc., adhering to the net. Four more hauls were made during the day in 636, 685, 584, and 477 fathoms (stations 3070, 3071, 3072, 3073), the bottom being uniformly of green mud. The wind and sea increased with heavy rain squalls, making it necessary to use the small trawl the latter part of the day, the weather being too boisterous to handle the large one with safety. The results were very satisfactory and, it being practically new ground, many unrecognized specimens were taken besides others that were familiar, among them being several species of flounders, deep-sea sole, deep-water redfish (*Sebastolobus*), red rockfish, macruri, chimæras, and hagfish. Among the invertebrates were shrimp, hermit-crabs, annelids, sea-urchins, holothurians, ophiurans, starfish, sea-anemones, crinoids, pennatulas, etc.

The weather was partially overcast on the 29th, with moderate winds and heavy westerly swells. Three hauls of the trawl were made in 877, 859, and 178 fathoms (stations 3074, 3075, 3076), green mud, with excellent results. Among the fishes recognized were the deep-water redfish, flounders, sole, red rockfish, and a single specimen of black-cod taken in 859 fathoms, the greatest depth in which they have been found. Among the invertebrates were holothurians, sea-urchins, starfish, ophiurans, sea-anemones, pennatulas, hermit-crabs, shrimp, annelids, an octopus, etc., the greatest amount of life being found in about 200 fathoms.

The stations occupied on the 28th and 29th extended our explorations from the shore to 877 fathoms, and gave us a very good representation of the marine fauna occupying the various depths. A notable feature in the hauls made during the trip was the absence of mud in the trawl net when it reached the surface, although soft green mud was reported at every station. This would seem to indicate that the bottom was composed largely of very fine sand, rather than mud, or at least the absence of clay. A few whales were seen, but with this exception no surface life was observed. The black-footed albatross or gony and an occasional petrel were the only birds seen, except near the land, where gulls were plentiful.

Beam trawl stations No. 3343 (516 fathoms) and 3344 (831 fathoms) were also made in the same region as the above, on September 21, 1890.

Grays Harbor to the Columbia River.—A report of Indian origin having indicated the existence of a small bank off the coast of Washington between Grays Harbor and Willapa Bay, a careful examination of the region was made during the progress of the hydrographic work in September and October, 1888. Such a bank was discovered and its principal features have been defined; it has been named Willapa Bank. It is about 20 miles long, northeast and southwest, and about 12 miles in extreme width, having a total area of about 110 square miles. Its eastern extremity, on which there is 42 fathoms, rocky bottom, lies 16 miles southwest (magnetic) from Point Chehalis, on the southern side of the entrance to Grays Harbor, and 23 miles W. by S. (magnetic) from Toke Point light-house at the northern end of Willapa Bay. The soundings are quite regular, but the bottom alternates in character between rocks, gray sand, and mud. The dredgings and trials for fish on this bank proved more successful than any previously made south of Cape Flattery, and there is little doubt that at the proper season good fishing would be found in this locality.

On September 23, 1888, the beam trawl was used at station 2870, on the southern edge of the bank, in 58 fathoms, rocky bottom. A very rich fauna was discovered, black-cod, red rockfish, tomcod, and shrimps also being taken by this means. On a trawl line set in the same position 10 red rockfish, 2 black-cod, and 4 sharks were captured. Three red rockfish were likewise caught with hand lines from the ship at the same time. The last-mentioned species was the most abundant one at this season. Hand lines were subsequently tried for 15 minutes about 10½ miles off Cape Shoalwater, but without success. On the same day station 2871, with the beam trawl, was made about 45 miles off the entrance to Grays Harbor, in a depth of 559 fathoms, brown ooze, with the result of obtaining many deep-water forms.

The investigations on this bank were resumed on June 7, 1889, the day being spent in dredging and fishing trials. Stations 3046, 3047, and 3048, in 48 to 52 fathoms, were made with the beam trawl, the bottom consisting of rocks in some places and in others of fine gray sand, and flounders, tomcod, and shrimps being thus secured. A trawl line was set for two hours at the last station, one end being in 52 fathoms, the other extending into 60 fathoms, but on being hauled only 4 red rockfish, 4 dogfish, 2 skates, and several starfish were found upon the hooks. The tide was running too strong to employ hand lines successfully from the small boat, but a few rockfish were taken by that means from the steamer.

Beam-trawl station 3049 was in 43 fathoms, fine sandy bottom, about 13 miles to the southwestward of the entrance to Willapa Bay, the catch comprising flounders, tomcod, and shrimps, as on the bank farther north. On June 13, 1889, the beam trawl (No. 3066) was again used about 7 miles south of the above station in a depth of 55 fathoms, sand and mud, flounders and skates being the only fishes taken.

OREGON.

Columbia River.—The fisheries of the Columbia River have been discussed in the Fish Commission Report and Bulletin for 1888 (F. C. 7, 8, 16).

Off the Columbia River.—The region off the mouth of the Columbia River was examined chiefly in October, 1888. On the 13th of that month three nearly parallel lines of soundings were made between the latitude of Cape Disappointment and that of Tillamook Rock, extending offshore distances of 32 to 36 miles, and into an extreme depth of 601 fathoms. The northernmost line, which was directly off the mouth of the Columbia River, showed depths two or three times greater than in corresponding positions on adjacent lines 7 or 8 miles distant, both to the north and south, the submarine trough thus indicated being probably the ancient bed of the Columbia River. Trials were made with the beam trawl and trawl line at station No. 2882, about 27 miles off the mouth of the river, in a depth of 68 fathoms, gray sandy bottom. By means of the former a number of flounders, red rockfish, and black-cod were secured, but only 1 black-cod and 4 dogfish were taken upon the latter. Southwest of Cape Disappointment station 3065 was occupied on June 13, 1889, the depth being 27 fathoms and the bottom consisting of fine black sand. Flounders, tomcod, and shrimps were captured in the beam trawl, but nothing was obtained by the use of hand lines.

The existence of fishing-banks from 50 to 60 miles off this part of the coast, which had been reported in Astoria, was entirely disproved by the investigations of the *Albatross*, very deep water occurring in the positions indicated. It is possible that this rumor had its origin in Heceta Bank, which, however, is located very much farther south.

According to Capt. Tanner:

> The sea fisheries off the Columbia were commenced a few years since with a small schooner, which operated a 40-foot beam trawl over the ground between Cape Disappointment and Shoalwater Bay. The vessel being found unfit for the purpose, the steamer *Dolphin* was built and made 40 trips between April and October, 1887, but she also proved a failure. Her catch was fairly good, and had she been able to market her fish promptly the venture would have turned out profitably. The various fish taken by the *Dolphin* were classified as sole, flounders, hake, cod, rock-cod, and halibut.

The "cod" mentioned were probably not the *Gadus morrhua.*

Off Tillamook Rock.—This rock is situated off Tillamook Head, about 16 or 17 miles south of the mouth of the Columbia River. As halibut had been reported from the adjacent waters, a careful examination was made of its surroundings, one visit having been paid to the region in October, 1888, and another in June, 1889. On the first visit the bottom was tested in several places off the northern side of the rock, in depths of 29 to 30 fathoms, by means of the dredge. It consisted of hard gray sand, but only a comparatively small amount of life was obtained. At the same time a trawl line was set near the can-buoy off the northern end of the rock, one end lying in 18 fathoms, the other in 25 fathoms, the bottom being rocky. The total catch consisted of only 7 dogfish. This experience, together with the results of subsequent trials during the same season, showed that, in the fall, the coast of Oregon, like that of Washington, is seriously infested with sharks and dogfish, which greatly interfere with successful fishing.

Somewhat better success was met with the following June, when the *Albatross* proceeded to Tillamook Rock in company with the light-house steamer *Manzanita*. Acting upon the advice of the commander of the *Manzanita*, the trawl line was set so as to cover as much as possible of the ground from which the capture of halibut had been reported, one end being placed close to Tillamook Rock and the other near the shore of the mainland. After remaining down two hours, the catch comprised 1 halibut weighing 25 pounds, 1 large skate, and 1 red rockfish. Hundreds of starfishes were also attached to the hooks and proved a great annoyance. In the meantime the *Manzanita*, at her moorings alongside the rock, obtained 3 halibut and 2 ground-sharks by means of hand lines, but with the same appliances only a few red rockfish were taken by the *Albatross*, although trials were made in numerous places.

Four beam-trawl stations (Nos. 3060–3063) were occupied in different positions about the rock, during the same day, in depths of 23 to 44 fathoms. The bottom consisted of mud at one station in 28 fathoms, and of fine sand at the others. Among the specimens secured were 8 species of flounders, hake, tomcod, sculpins, shrimp, smelt, crabs, and an octopus.

The grounds about Tillamook Rock to which halibut are likely to resort appear to cover a very limited area, which may be regarded as suitable for boat fishing with hand lines. Scattering halibut will probably be found there during a large part of the year. The grounds are too small, however, and the fish too scarce to offer any inducements for vessel fishing or the use of trawl lines. Many of the so-called halibut recorded from this region are said to be a very different kind of flatfish, the *Atheresthes stomias*, which also goes by the name of "turbot" in Astoria.

Beam-trawl station No. 3064 was about 9 miles northwest from Tillamook Rock, in 46 fathoms, fine gray sand and gravel. Although the same character of bottom fauna as occurs in corresponding depths about the rock was discovered in this position, trials with hand lines proved entirely unsuccessful.

Off Cape Falcon.—Cape Falcon, or False Tillamook, is about 11 miles south of Tillamook Head. Several soundings were made in the vicinity of Falcon Rock on September 7, 1889, and hand lines were tried in the same connection. A fine salmon and 2 orange rockfish were the only specimens taken. The work was continued at short intervals down the coast, but the ground was not found to be especially productive for hook-and-line fishing. A strong tide was running at the time and it is possible that this circumstance may partly account for the scarcity of fish, as is known to be the case elsewhere. On many of the spots over which the vessel drifted flounders

were captured on the hand lines, indicating that the beam trawl could be used successfully in this region.

At station 3089, about 5 miles south of the cape, in a depth of 20 fathoms, fine gray sand, the beam trawl brought up between 800 and 900 flounders, besides 12 tomcod and a quantity of shrimps. Eleven orange rockfish and 2 flounders were taken with hand lines in the same locality. The beam trawl was also used at station 3090, about 8½ miles southeasterly from the cape, in a depth of 62 fathoms, fine gray sand. The catch included 3 species of flounders, rockfish, whiting, and shrimps. Station 3345 was in a depth of 759 fathoms, a little south of east of Cape Falcon.

Off Cape Meares.—In approaching this cape, which lies about 16½ miles south of Cape Falcon, a cast of the beam trawl was made at station 3091, about 15 miles west of the cape, in a depth of 87 fathoms, green mud. Five red rockfish, 4 species of flounders, represented by about 100 specimens, half a dozen squid, and a peck of prawns were secured. Station 3092, also with the beam trawl, was about 4 miles off the cape, in the same direction, depth 46 fathoms, the bottom consisting of broken shells, 4 species of flounders and several crabs being obtained. By the use of hand lines, 1 red rockfish was taken in the same position; 14 red rockfish were quickly captured nearer the cape in a depth of 25 fathoms; and 24 rockfish of several species, together with 1 cultus-cod, were secured in 18 fathoms in the vicinity of Arched Rock, about 6½ miles north of the cape.

A series of trials with hand lines was made from the dory about Three Arch Rocks, some 2 miles south of Cape Meares, while the *Albatross* was employed farther offshore, but although the work was conducted with as much thoroughness as the time permitted, the fishermen met with no success. The first trials were on the northern side of the rocks, but after shifting to the southern side, the cause of the scarcity of life in the immediate vicinity of the rocks was apparently discovered in the abundance of sea lions, hundreds of which were hauled out in all sheltered places where they could receive the warmth of the sun's rays.

About 1½ miles southwesterly from these rocks, in a depth of 21 fathoms, rocky bottom, 1 red rockfish and 1 cultus-cod were taken on the lines; and again, 3½ miles farther south, or 2⅔ miles north of Cape Lookout, in a depth of 18 fathoms, sandy bottom, 1 flounder was taken by the same means.

Beam-trawl station 3346 was west of Cape Meares, in a depth of 786 fathoms.

Off Cape Lookout—A thorough search of the bottom was made close inshore in the vicinity of Cape Lookout, beginning about 3 miles north of the cape and ending some 3 or 4 miles south of it, but, although the hand lines were tried in 15 different positions, not a single fish was taken. About 2 miles southwest of the cape, however, in a depth of 39 fathoms, 2 orange rockfish, 1 salmon, and 1 flounder were secured. Beam-trawl station 3093 was about 4⅓ miles west of the cape, in a depth of 57 fathoms, fine gray sand, but only negative results were obtained there as regards the capture of fish, either in the net or with the hand lines. The abundance of sea lions along the coast might account for the scarcity of fishes in close proximity to the shore, but not in deeper water.

Nestuggah Bay to Siletz Bay.—Attention having been called to a supposed bank off Nestuggah, Oregon, where the genuine cod was reported to abound, a careful search of the region was made by the *Albatross* in the early part of September, 1889. It was said to be located about 10 miles from land and to have a depth of 12 fathoms. Soundings made at frequent intervals off the bay, and for some distance to the north

and south, showed 15 fathoms about 1 mile from shore, from which point the depths increased regularly to 70 fathoms, at a distance of 8 to 10 miles, or in the position of the alleged bank. The bottom consisted of fine gray sand, from which the customary varieties of coast fishes were obtained, but no specimens of cod. A depth of 12 fathoms will be found nowhere in this region except within a fraction of a mile of the land and well within the sound of the surf.

Thirteen trials with hand lines were made between Cape Lookout and Siletz Bay on September 9, 1889, with the result of finding food-fishes abundant in some localities. The slight depths of water near the shore and the generally smooth bottom render fishing easy, and it may be regarded as comparatively good. The tidal currents are somewhat strong at times, but not sufficiently so as to greatly inconvenience operations. Many black-cod were taken on the hand lines off Nestuggah Bay and off Cascade Head, the other fishes consisting mainly of different varieties of rockfish, with an occasional flounder. The black-cod from these shallow waters are smaller and are also said to have a poorer flavor than those obtained from the deeper waters offshore and farther north.

The beam trawl was used at station 3059 (June 9, 1889), about 8 miles off Siletz Bay, depth 77 fathoms, muddy bottom; and at station 3347 (September 22, 1889), off Nestuggah Bay, in a depth of 345 fathoms, muddy bottom. In the former haul many flounders were secured, and also one herring and several specimens of *Octopus*.

Off Yaquina Head.—Investigations were conducted in the vicinity of Yaquina Head (latitude 44° 40′ N.) in June, August, and September, 1889. Leaving Heceta Bank at dark on June 8, 1889, a line of soundings was run to Yaquina Head, developing a maximum depth of 78 fathoms. Early the next morning the beam trawl was hauled twice (stations 3055, 3056) in a depth of 28 fathoms, fine gray sand, about 3 miles west (magnetic) from Yaquina Head, taking an abundance of several species of flounders, besides crabs and shrimps. Trials with hand lines in the same position gave negative results, but the wind was blowing fresh at the time, causing the small boat to pitch about considerably, and possibly being accountable for the poor fishing.

A station (No. 3057) was then occupied 13 miles from the head in the same direction, depth 43 fathoms, coarse gray sand. Large numbers of flounders, red rockfish and shrimps were taken in the beam trawl, and 20 orange rockfish on the hand lines. Specimens of rockfish weighing 7 and 8 pounds apiece were fairly abundant. The wind and sea having greatly increased during the morning, the *Albatross* ran in and anchored under the head, a boat party being sent out to examine the shore to the leeward of the rocks. They met with no success, however, and fishing from the steamer also proved a failure.

In the afternoon of the same day the beam trawl was used at station No. 3058, 13½ miles northwesterly from Yaquina Head, and 4 miles offshore, in a depth of 38 fathoms, coarse gray sand and shells. Several species of flounders were taken in the beam trawl, but nothing was secured by means of hand lines.

On August 30, 1889, while proceeding down the coast, a trial with hand lines was made in a depth of 28 fathoms, fine gray sand, about 12 miles southwest of Yaquina Head, and 5½ miles in the same general direction from the mouth of Yaquina Bay. The only fishes obtained were one red rockfish and two ling or whiting (*Merlucius productus*). The wind at this time was blowing fresh, however, causing the ship to drift rapidly, and making it difficult to keep the lines on the bottom.

The vessel returned to the same region on September 3, 1889, and continued the investigations to the southwest of Yaquina Head at varying distances from the land. In addition to four hauls made with the beam trawl, hand-line fishing was carried on in very many places. An exception to the customary smooth, sandy bottom was discovered in a small bank or rocky patch lying SSW. ¼ W. (magnetic), 19 miles from the head, and almost directly off the entrance to Alseya Bay, from which it is distant about 14½ miles. It has been designated as Yaquina Bank. The center of the ground, so far as it has been surveyed, is in about latitude 44° 27′ 30″ N., longitude 124° 25′ W. It covers an area of about 40 square miles, the least depth discovered being 42 fathoms, and the bottom being composed of clay and mud, with frequent rocky or stony patches. Several specimens of the rock were brought up in the beam trawl. They consisted of waterworn bowlders of blue limestone, weighing from 50 to 200 pounds apiece, and evidently belonged to a drift deposit. Their surfaces were honeycombed by boring animals, and they were thickly covered with living organisms, including small cup corals, sponges, brachiopods, mollusks, annelids, ophiurans, etc. Dredging stations Nos. 3087 and 3088 were on this bank, and trials with hand lines were also made, resulting in the capture of orange rockfish and flounders, but the prevalence of stormy weather prevented entirely satisfactory results. The various species of rockfish will doubtless be found here in great abundance.

At different positions between the bank and Yaquina Head, the bottom, in depths of 28 to 46 fathoms, consisted generally of fine sand, from which many black-cod and orange rockfish, and a few specimens of whiting, flounders, etc., were secured. Flounders and prawns were taken in the beam trawl at stations 3085 and 3086, in depths of 42 and 46 fathoms, respectively, the former being about 14 the latter about 11 miles southwesterly from the head. Thirty-seven specimens of black-cod were obtained during a single drift, in a depth of 44 fathoms, about 8 miles SW. ½ S. from the head. The best fishing-grounds inside of the bank were found at distances of 6 to 8 miles offshore.

Cape Perpetua to Umpqua River.—On September 2, 1889, the beam trawl was cast in 46 fathoms, fine gray sand, at station 3084 (latitude 44° 12′ 31″ N., longitude 124° 19′ W.), about 15 miles southwesterly from Cape Perpetua, securing many flounders. By means of hand lines, 10 black-cod and 9 whiting were obtained in the same position, in the course of 45 minutes. Between this locality and Cape Perpetua, and to the northward of the cape as far as latitude 44° 20′, the hand lines were frequently employed in depths of 12 to 31 fathoms, and generally with good results, the catch consisting of red rockfish, black-cod, whiting, and flounders. One trial of 45 minutes in a depth of 31 fathoms yielded 24 whiting, 14 rockfish, and 2 flounders Specimens of the whiting were eaten by the mess and they were pronounced to be of as good quality as the red rockfish. The region about Cape Perpetua affords good advantages for small-boat fishing, the depths being slight and the bottom smooth. About 600 pounds of edible fish were obtained by the *Albatross* on the trials made during this day.

A single trial with the hand lines in 29 fathoms, off Heceta Head, on August 31, 1889, was entirely unsuccessful.

On September 10, 1889, several orange rockfish were taken on the hand lines northwesterly from the mouth of the Siuslaw River (latitude 44° N.), at distances of 3 and 11 miles from land, in depths of 30 and 42 fathoms, fine sand bottom. Beam-trawl stations 3081 and 3083 were also made off this river on September 1 and 2, in depths of

61 and 32 fathoms, respectively. An abundance of fishes, including several species of flounders and of rockfish, 2 black-cod, and a quantity of crabs and shrimps, were secured at the former, and many flounders at the latter. Nine red rockfish and 2 whiting were captured with hand lines in the last position.

Two and two-thirds miles off the Siuslaw River, in a depth of 18 fathoms, fine gray sand, 52 black rockfish (*Sebastodes melanops*) were taken with hand lines, on the latter date, in a trial lasting one hour. In 24 fathoms, yellow sand bottom, about 1½ miles farther north, the catch consisted of 5 black-cod and 8 orange rockfish. This locality is very favorable for hand-line fishing, large captures being possible in comparatively shallow water and in close proximity to the shore.

Beam trawl station 3082, on September 2, was located 4 miles from land, directly off the mouth of Ten Mile Creek which drains Tsiltcoos Lake, in latitude 43° 52′ N., 43 fathoms, fine gray sand. Several flounders were taken in the net, but nothing was caught on hand lines used in the same connection.

Several trials were made with hand lines, on September 10, between the latitude of Siuslaw River and that of Umpqua River, with the following results: In 13 fathoms, just to the north of Ten Mile Creek, nothing; in 36 fathoms, about 2½ miles off Takhenitch Creek, 1 red rockfish; in 13 fathoms, immediately south of the mouth of this creek, nothing; in 28 fathoms, about 2½ miles northwesterly from the mouth of Umpqua River, 27 red rockfish; about 2½ miles directly west of the mouth of the same river, 1 red rockfish. The duration of these trials was from 8 to 30 minutes each.

Heceta Bank.—Off Cascade Head, a short distance north of the parallel of 45° N. latitude, the 100-fathom curve is distant only about 13 miles from shore, but southward from this point the platform broadens regularly, attaining a width of 35 miles in latitude 44° N. A few miles farther south, however, it is abruptly constricted to a width of 18 or 19 miles. The southwestern part of this elongated triangular area is occupied by Heceta Bank, the only important distinctive offshore fishing-ground on the coast of Oregon. Its southern and western borders are defined by the abrupt sloping margins of the platform, but on the northern and eastern sides the bank is practically continuous with the general surface of the platform, and in those directions its precise limits have not yet been determined. The total area of the bank probably does not exceed 300 square miles. The depths range from 41 to 95 or more fathoms, and in some places they vary abruptly. Two small areas with depths between 41 and 46 fathoms occur on the extreme southwestern part of the bank, but as a rule the depths exceed 55 fathoms. A considerable part of the bank has a rocky bottom, alternating with patches of clay, pebbles, and gravel, but sand and mud are also found in places. Halibut occur on this ground, but they are not known to be abundant.

Heceta Bank was visited by the *Albatross* on October 19, 1888, June 8, 1889, and September 1, 1889, and its contour and principal characteristics have been pretty well determined. Ten dredging stations have been occupied in depths of 41 to 68 fathoms, but owing to the very rough character of the bottom the beam trawl was seldom used successfully, most reliance being placed upon the dredge and tangles, especially the latter, for obtaining specimens of the bottom life. A very rich fauna was discovered, fully equal to that of Flattery Bank, the large collection of invertebrates secured containing a great diversity of forms, among which were gorgonian, hydroid, and actinian corals, sponges, comatulæ, ophiurans, starfishes, sea-urchins, bryozoans,

ascidians, etc. In this respect the region presents every requisite for an excellent fishing-bank, which it will undoubtedly prove to be when it has been more thoroughly developed.

Fishing operations were actively carried on during each visit, by means of the beam trawl where possible, and with trawl lines and hand lines, the latter being generally employed and with the best success. The variety of food-fishes obtained was quite large, including halibut, black-cod, cultus-cod, sea trout, whiting, red rockfish, and several other species of the latter group.

On October 19, 1888, the catch was small, containing only 1 halibut, weighing 10½ pounds, in addition to several specimens of rockfish and black-cod, 1 shark and 1 dogfish. Stations 2886, 2887, 2888, 2889, and 2890 were made on this day, the last one being off the southern end of the bank, in a depth of 277 fathoms.

During the morning of June 8, 1889, a trawl line baited with fresh rockfish and salt herring was set for something over two hours in the position of stations 3050, 3051, and 3052, 46 to 48 fathoms, rough rocky bottom, the tide running strongly ebb toward the southeast. Eleven red rockfish, 1 orange rockfish and 1 sea trout were taken by this means, while with hand lines from the ship the catch was much larger, consisting of 26 red rockfish, 2 orange rockfish, 4 yellow-tails, and 1 cultus-cod. In the afternoon of the same day three small boats were lowered to test the bottom with hand lines in as many places at the same time. They were anchored within half a mile of each other, in a depth of about 43 fathoms, and at the end of an hour had secured 22 red rockfish, weighing 192 pounds. Twelve additional specimens were captured from the deck of the *Albatross* during the same interval with the aid of only three lines. Just before sunset, a trial with 11 lines was made at station 3054, depth 53 fathoms, rocky bottom, on the northern part of the bank, but only 1 yellow-tail was caught. The trials made during this day seemed to indicate that better results could be obtained with the hand lines by drifting than by anchoring, the fish apparently congregating on detached rocky spots. Good fishing would continue for a time and then suddenly cease, making it necessary to seek a new ground.

September 1, 1889, was a clear day with comparatively smooth sea, and thereby offered an excellent opportunity for continuing the work. Much time was spent in attempting to determine the area of the shoaler part of the bank, between depths of 41 and 50 fathoms. It was found to be very limited. The beam trawl and tangles were used successfully at stations 3078 and 3079, the former in 68 fathoms, muddy bottom, the latter in 55 fathoms, rocky bottom. Hand-line fishing was carried on at different times during the day, both from the ship and from small boats, with varying results, only a few fish being taken in some places, while at others, often close at hand, the catch would be large. The best success was met with in 52 fathoms, rocky bottom, where 24 specimens of the red and orange rockfish (*Sebastodes ruber* and *pinniger*) were obtained.

The only halibut taken by the *Albatross* on Heceta Bank was captured in the fall of 1888, and weighed 10½ pounds. Mr. Alexander states, however, that the schooner *George H. Chance*, of Portland, Oregon, anchored on the southern part of this bank in the evening of August 7, 1889, and in the course of a short time had captured several small individuals of this species. On a trawl line set over night the heads of 11 halibut were found the next morning, the bodies, apparently, having been destroyed by sharks and dogfish. The trip was finally abandoned owing to the annoyance caused by these pests. Further investigations are required to determine the value of Heceta Bank for

halibut fishing, but the observations thus far made are not encouraging in that respect. The abundance of several other species, however, especially of the red rockfish, will furnish sufficient inducement to fishing vessels, whenever they can be assured of a ready market for their catch. The use of the beam trawl and of trawl lines on the rougher parts of the bank is impracticable, hand lines being most serviceable in such localities.

Inside of Heceta Bank.—After leaving Heceta Bank on September 1, 1889, the investigations with the beam trawl were extended to the muddy and sandy bottom lying between there and the mainland. Station No. 3080 was made a few miles to the eastward of the bank, in a depth of 93 fathoms, green mud, and disclosed a great wealth of fish life, the catch including about 100 flounders, representing several species, many rockfish, 1 black-cod, and 1 cultus-cod. Station No. 3081 was still nearer to the land, in about the same latitude, the depth being 61 fathoms, and the bottom consisting of green mud and sand. In this position 200 flounders were captured, besides an abundance of several other species. As the duration of these hauls did not exceed 20 minutes each, the value of this region as a beam-trawl fishing-ground must be conceded.

Umpqua River to Cape Blanco.—The observations were carried southward from the Umpqua River on September 12, 1889. Four miles south of the river, in a depth of 53 fathoms, 3 orange and 1 black rockfish were taken on the hand lines in the course of 15 minutes. A second trial, about 3 miles farther south, in a depth of 40 fathoms and lasting 25 minutes, afforded 22 orange rockfish. From this point, however, to the Coquille River, a distance of 28 miles, no fishes of any kind were captured, although stations were made in 8 different places. In 25 fathoms, rocky bottom, directly off the mouth of the Coquille River, 1 orange rockfish and 1 cultus-cod were secured; but from here to Cape Blanco all of the fishing trials again proved unsuccessful. Dredging station No. 3094 was in this region, about 11½ miles south of Coquille Point, depth 35 fathoms.

Orford Reef.—The fishery investigations on the coast of Oregon terminated at Orford Reef on September 12, 1889, although the hydrographic observations were continued to the California State line. Reaching the vicinity of the reef during the afternoon, Mr. Alexander was detailed to examine the shallow waters in one of the small boats, while the *Albatross* worked farther off shore. Only 2 dredging stations, Nos. 3095 and 3096, were made here, both with the tangles. They were located just to the south and southeastward of the reef, in depths of 33 and 42 fathoms, the bottom being very rich in animal life.

The exposed part of Orford Reef consists of several very rough ridges which rise abruptly from the sea. They are covered in places with sea lions, but, notwithstanding this fact the surrounding waters contain an abundance of food-fishes of several varieties. By far the best fishing was obtained on the south side of the reef, in 6 to 8 fathoms, hard and very irregular bottom. As it generally proved very difficult to release the anchor, it was found most expedient to lay to and drift with the wind and tide, although there was constant danger of losing the hooks and leads by their catching upon the rocks. A very large and interesting assortment of fishes was collected, including red and orange rockfish, vermilion rockfish (*Sebastodes miniatus*), cultus-cod, one black-cod, and several large sculpins. The cultus-cod were especially abundant. Equal success was obtained by the use of hand lines from the ship south and west of the reef.

CALIFORNIA.

NORTHERN BOUNDARY LINE TO POINT REYES.

Boundary line to Point Arena.—On October 12 to 14, 1889, the investigations which had previously been conducted on the coast of Oregon were continued down the coast of California as far as Cape Mendocino. Operations, however, were entirely restricted to sounding, with the object of defining the contour of the bottom on the continental platform from the shore line into depths of about 200 fathoms. In September, 1890, on the return trip from Alaska to San Francisco, the sounding work was resumed off Cape Mendocino and was carried thence southward as far as Point Arena. A line of five stations with the beam trawl (Nos. 3348–3352), begun off Point Arena, in a depth of 455 fathoms, was extended inshore just to the north of this point, but no trials either with hand lines or trawl lines were made within these limits.

The continental platform is relatively narrow along this entire stretch of coast. Off Point St. George, near Crescent City, it has a width, within the 200-fathom curve, of about 9 miles. Off Klamath River this width increases to 17 miles, but it becomes reduced again to 8 miles at Trinidad Head, and is very much less at Cape Mendocino. In the vicinity of Point Arena the platform attains a maximum width of 10 to 12 miles. There are no fishing-banks, properly so called, in any part of this region, but the usual coast fishes will undoubtedly be found in spots along the shore. The beam trawl may be used in the neighborhood of Point Arena, but there are some rocky places to be avoided. The captain of the steam fishing schooner *George H. Chance*, of Portland, Oregon, reports the capture of several halibut close to Cape Mendocino, in a depth of 40 fathoms. It is not probable, however, that this species can be taken there in paying quantities.

Point Arena to Point Reyes.—This region was examined between March 24 and 29, 1890, sounding work chiefly being carried on. As before mentioned, the 200-fathom curve is about 12 miles from shore at Point Arena, whence it follows the direction of the coast line as far as Salt Point. From this point, however, the platform broadens out, attaining a width of 20 miles off Russian River, of 26 miles off Tomales Point, and of 21 miles off Point Reyes. The bottom is smooth and is composed of alternating stretches of black sand and mud, the latter almost invariably occupying the slope between 100 and 200 fathoms. Stony patches also occur occasionally, usually between depths of 40 and 70 fathoms.

The beam trawl was used at only five stations north of Point Reyes. Stations 3171 and 3172 were off Russian River, in depths of 76 and 62 fathoms, respectively, the former on sandy and rocky, the latter on sandy bottom. The remaining positions were as follows: No. 3173, about 7 miles west of Bodega Head, 62 fathoms, mud; No. 3174, about 8 miles southwesterly from the same head, 65 fathoms, green mud; No. 3175, 11½ miles northwesterly from Point Reyes, 57 fathoms, brown mud. The bottom was found to be especially rich in the various species of flatfishes which belong to this coast, and several other edible kinds were also taken with them.

The Italian and Greek fishermen of San Francisco operate during the entire year as far north as Point Arena. They fish mainly with hand lines in depths of 10 to 30 fathoms, or within 2 to 3 miles of the shore, and as good fares are generally obtained in these positions they seldom venture into deeper water. The principal species taken

are the red rockfish, which are especially abundant off Bodega Head, Tomales Point, and Point Reyes. Cultus-cod of extra large size are also found off the latter point.

Fishing is carried on in Tomales Bay and Bodega Bay throughout the year. From 30 to 40 fishermen restrict their operations exclusively to the former bay, using drag seines and trammel nets. Their catch is shipped to San Francisco by rail. The species secured here are red rockfish, perch, flounders, smelts, sea bass, herring, and anchovies. Hand lines and drag seines are employed in Bodega Bay, in which the catch consists chiefly of red rockfish, tomcod, and flounders.

POINT REYES TO POINT CONCEPTION.

Point Reyes to Monterey Bay.—Fishing and dredging operations were actively prosecuted by the *Albatross* on this part of the California coast between March 10 and April 13, 1890, affording very satisfactory results of a preliminary nature. As the contour and character of the bottom had been pretty thoroughly determined by previous surveys, the sounding work was mainly limited to special places in connection with the fishing and dredging trials, and to locating with greater care the positions of the 100 and 200 fathom curves along the outer border of the platform. Just north of the latitude of Point Reyes these curves bend abruptly outwards to include Cordell Bank and the Farallon Islands. The 200-fathom curve lies 21 miles off Point Reyes, and maintains about the same distance from the coast line until south of Pillar Point, passing within about 3 miles of Noonday Rock, 4 miles of the North Farallones, and 5 miles of the South Farallon. From about 25 miles off Pillar Point, however, the curve approaches to within 16 miles of Pigeon Point, bends abruptly inward at Point Año Nuevo, and at El Jarrow Point is only 8 miles from shore, retaining the same distance until off Santa Cruz in Monterey Bay.

This broad stretch of platform presents a generally uniform character of bottom. Between the Golden Gate, Pillar Point, the Farallones, and Point Reyes the bottom is sandy and free from rocks and stony patches, except in the immediate vicinity of the islands and of the shore line. Southward from Pillar Point rocky patches are frequently found near the shore, with fine gray sand farther off, finally merging into green mud at varying distances from land. Stony patches, apparently the result of drift, also occur between depths of 30 and 70 fathoms, on sandy or muddy bottom. The green mud has a strong odor which is occasionally offensive.

In view of the relatively short time spent in this region, it may be considered that the bottom was quite thoroughly tested with respect to its fishery resources, the beam trawl and hand lines being used for this purpose; but observations at other seasons would greatly increase the value of the results. Between the region off Point Reyes and the latitude of Pillar Point 26 dredging stations were made beside those on the defined banks which are elsewhere referred to. Twenty-four of these stations (Nos. 3099–3101, 3103, 3150–3157, 3163–3167, 3176–3182) were inside of the 100-fathom curve, while two (Nos. 3161 and 3162) were in depths of 191 and 552 fathoms. From the latitude of Pillar Point to the entrance to Monterey Bay 19 stations (Nos. 3106–3111, 3113–3122, 3147–3149) were occupied in depths less than 100 fathoms, and 9 stations (Nos. 3104, 3105, 3112, 3204–3209) in depths of 108 to 391 fathoms.

Some parts of the bottom were found to be much richer in life than others, and muddy depressions occur on which no food-fishes were obtained. As a result of the

trials with the beam trawl it was observed that the shoaler-water species were quite regularly distributed, flatfishes being the principal feature of every haul. Small specimens of the "deep-sea sole" were secured in depths of 50 fathoms and less. The "long-finned sole" was traced from near the shore into depths of 100 fathoms, the finest specimens occurring in the deeper water. These two species approach more nearly to the European sole than any others on the Pacific coast, the flesh of mature individuals being white, gelatinous, and exceedingly delicate in flavor. From experiments made on board the *Albatross* they were found, when kept on ice, to improve until the fourth day, but deteriorated after the seventh day. They can be captured only with the beam trawl or other form of drag net. Large specimens of the deep-sea sole seldom, if ever, reach the San Francisco market, as the fishermen restrict their operations to water too shallow for them. In consequence of this fact, no doubt, the fishermen have also had no incentive to increase the size of their fishing boats in this region, or to improve their character. While many of these boats, hailing from San Francisco as well as from Santa Cruz and Monterey, are stable and seaworthy, and often good sailers, they are lacking in accommodations and especially in comfortable quarters for the crew.

The variety of fishes taken during this investigation was quite large, but a discussion of them must be deferred until the completion of Prof. Gilbert's report upon the subject. Among them were a number of important food species, some of which occur in great abundance. The following list of the principal forms obtained has been prepared by Mr. Townsend. The remarks upon the relative abundance of the species are based entirely upon the observations of the *Albatross*.

List of the principal fishes obtained by the steamer Albatross between Point Reyes and Monterey Bay, March and April, 1890.

[Between the shore and the 50-fathom line.]

Scientific name.	Common name.	Relative abundance.
Citharichthys sordidus	Flounder	Abundant.
stigmæus	do	Rare.
Microstomus pacificus	"Deep-sea sole"	Few small ones.
Atheresthes stomias	Flounder	Rare.
Eopsetta jordani	do	Common.
Hippoglossoides exilis	do	Abundant.
Psettichthys melanostictus	do	Common.
Pleuronichthys decurrens	do	Do.
Parophrys vetulus	do	Abundant.
Glyptocephalus zachirus	"Long-finned sole"	Do.
Microgadus proximus	Tomcod	Few.
Porichthys porosissimus	Midshipman	Very abundant.
Sebastodes ruber	Red rockfish	Common.
pinniger	Orange rockfish	Do.
flavidus	Yellow-tail rockfish	Do.
miniatus	Vermilion rockfish	Do.
elongatus	Rockfish	Do.
auriculatus	do	Do.
goodei	do	Rare.
chlorostictus	do	Do.
(3 new species)	do	Very abundant.
(1 new species)	do	Rare.
Zaniolepis latipinnis		Common.
Ophiodon elongatus	Cultus-cod	Few.
Abeona	Perch	Common.
Genyonemus lineatus	Roncador	Do.
Atherinopsis	Smelt	Do.
Stolephorus	Anchovy	Do.
Chimæra colliei	Ratfish	Do.
Myxine glutinosa	Hag eel	Do.

List of the principal fishes obtained by the steamer Albatross between Point Reyes and Monterey Bay, March and April, 1890—Continued.

[In depths greater than 50 fathoms.]

Scientific name.	Common name.	Relative abundance.
Microstomus pacificus	"Deep-sea sole"	Abundant in 200 fathoms.
Atheresthes stomias	"Halibut" (flounder)	Rare.
Glyptocephalus zachirus	"Long-finned sole"	Common in 100 fathoms.
Sebastodes (3 new species)	Rockfish	Abundant.
Sebastolobus	Redfish	Do.
Anoplopoma fimbria	Black cod, Beshowe	Common.
Macrurus (3 species)	Grenadier	Few.
Lycodidæ (large species)		Rare.
Careproctus	Eel pouts	Abundant.
Chauliodus		Few.
Myctophum townsendi	Viper-fish	Do.
Alepocephalus		Common.
		Few.

The invertebrate fauna occupying this region is rich and diversified, the greatest variety of forms having been secured between depths of 100 and 600 fathoms. Inside of the 100-fathom curve the species differ essentially from those found on the coasts of Oregon and Washington. Shrimps and prawns, some of very large size, were obtained occasionally in depths of 50 fathoms and over. The common large edible crab (*Cancer magister*) was abundant, while *Cancer antennarius* and *Cancer productus*, both also edible, were common along the shores. The surface, however, was found to be practically barren of life, very little material being taken in the tow nets, but this may have been due to the season of the year.

The Farallon Islands.—The fishing-grounds adjacent to the Farallon Islands are among the most important on the coast of California. The fishing season lasts from September to May, and during this period work is actively carried on by means of trawls and hand lines. The principal anchorage is on the south side of the South Farallon, and the grounds surrounding this island are, as a rule, more productive than those about the North and Middle Farallones. The bottom is exceedingly rough and rocky, and very destructive to the fishing gear. Dredging station No. 3102, with the beam trawl, was off the Southeast Farallon, 27 fathoms, the bottom consisting of corals and broken shells. The principal edible fishes obtained by the *Albatross* around the Farallon Islands were flounders of several species, including two species of sole, and red rockfish.

Fanny Shoal is a small spot of fishing-ground, the center of which lies about 3½ miles northwesterly from the North Farallon. Large catches are sometimes made there. This locality was thoroughly examined by means of the dredge, tangles, and hand lines, stations 3158, 3159, and 3160 having been made in depths of 27 to 39 fathoms, rocky bottom. In the vicinity of Noonday Rock, flounders, soles, anchovies, tomcod, and other species were obtained in the beam trawl, but only red rockfish were taken on the hand lines.

Cordell Bank is located at the outer margin of the continental platform, about 21 miles northwesterly from the North Farallon, the shoaler part of the ground being between 19 and 20 miles due west from Point Reyes (latitude 38° N.). It was examined on March 24, 1890. The soundings showed numerous rocky patches extending over a somewhat larger area than is indicated on the published charts, but in a westerly

direction the depths increase rapidly with a bottom of green mud. The area of the bank, so far as it has been determined, amounts to about 20 square miles, according to Capt. Tanner, the bottom consisting of rocks, sand, and shells, intermixed with mud. The least depth discovered is 25 fathoms. The tangles were used occasionally, and trials with hand lines were made from time to time, but the swell and strong current which prevailed rendered it difficult to keep the latter on the bottom. A cod trawl was set on the western part of the bank, and was allowed to remain down seven hours, the catch comprising 47 red rockfish and 2 cultus-cod. The former averaged 6½ pounds in weight, while the latter weighed 18 and 20 pounds, respectively. One orange rockfish, 2 yellow-tails, and 2 cultus-cod were taken with hand lines during a drift of about three-quarters of an hour. Subsequent trials, however, farther to the south, both with hand lines and with the trawl line, proved less successful.

Mr. Alexander considers that a small vessel with 6 to 8 dories might, under favorable conditions, obtain 4,000 or 5,000 pounds of fish a day, but a satisfactory estimate of the value of the bank can not be based upon the investigations thus far made. During the winter months a few large boats from San Francisco fish on Cordell Bank for red rockfish and cultus-cod, but the Italian and Greek fishermen who engage in this business take little pains to extend their knowledge of the ground beyond the few spots with which they have accidentally become acquainted.

Drake Bay furnishes the first important inshore fishing-ground south of Point Reyes. Drag seines only are employed here by the fishermen, who make use of large boats, which generally go in companies of three to five, each taking its turn in carrying the catch to market. The *Albatross* visited this locality twice during March and April, 1890, but met with no success, either in the bay or about Point Reyes. The bottom was thoroughly tested with hand lines, and trials were also made with crab nets. A cod trawl was set for six hours across a rocky patch of ground on the northern side of the bay, but only 2 small flounders were secured. In summer rockfish are said to frequent this ridge, but never in great numbers.

At a beam-trawl station off the entrance to Drake Bay the catch consisted of 100 flounders, representing several species, half a dozen anchovies, a few herring, and several red rockfish and tomcod.

Ballenas Bay, situated not far northward from the Golden Gate, is a favorite locality for fishing with trammel nets. The principal species obtained there are red rockfish, sea bass, and cultus-cod.

Two beam-trawl stations, Nos. 3181 and 3182, were made off the entrance to this bay. The former was located 4 miles SW. by W. from Duxbury Point, in 16 fathoms, the catch comprising 20 flounders of three species, 50 anchovies, 3 tomcod, 1 smelt, 6 perch, and a large quantity of other forms. The latter was 1 mile WNW. from the northern edge of Four Fathom Bank, in 11 fathoms, flounders, anchovies, soles, and shrimps being obtained. The sole inhabiting these shallow waters are smaller than those taken farther offshore.

Coast line south of the Golden Gate.—Directly south of the Golden Gate, between Point Lobos and Point San Pedro, a distance of about 11 miles, the waters close inshore are said to be comparatively barren of food-fishes. From May to September trawl and hand-line fishing is carried on between Point San Pedro and Point Año Nuevo, red rockfish being the species chiefly sought for. The San Francisco fishermen do not venture beyond the latter point, but others, beginning there, follow this calling farther to the southward.

Monterey Bay and vicinity.—Monterey Bay has an extreme length, north and south, of about 22 miles, and is open to the ocean for nearly this entire distance. The greater part of the bay has depths less than 100 fathoms, but directly off the mouth of Salinas River begins a deep trough or valley, which extends westward, with irregular margins at the 100-fathom line, and widens somewhat rapidly until it opens into the deeper parts of the adjacent ocean. A maximum depth of something over 400 fathoms is found within the limits of the bay.

Two visits were paid to Monterey Bay by the steamer *Albatross*, the first between March 12 and 15, the second on April 10 and 11, 1890, and much sounding and dredging work was accomplished. A continuous series of dredging stations, outside of the limits of the bay, was run in a curved line from off Sand Hill Bluff, in the north (latitude 36° 57′ N., longitude 122° 10′ W.), to off Point Pinos, in the south, as follows: No. 3123, 37 fathoms; No. 3125, 65 fathoms; No. 3146, 62 fathoms; No. 3126, 456 fathoms; No. 3127, 418 fathoms; No. 3128, 627 fathoms, and No. 3129, 204 fathoms. Stations 3124 and 3136 to 3144, inclusive, were in the northern part of the bay, on a small bank off Santa Cruz and in the region adjacent to it; stations 3130 to 3135, inclusive, and 3145 were in different parts of the bay, in depths of 9 to 56 fathoms; and 3202 and 3203 in the submarine valley off the Salinas River, in depths of 382 and 138 fathoms, respectively.

This bay is regarded as one of the most productive fishing-grounds on the coast of California, but during the winter of 1889–90, when these investigations were made, fishes of all kinds were unusually scarce, owing, it is supposed, to the phenomenal rainfall which had taken place. Within 24 hours after a heavy rain the surface becomes covered with muddy water, which is said to have the effect of driving the fishes from the shallow grounds, and continued stormy weather has a tendency to keep them from such places.

The small bank off Santa Cruz, above referred to, is a rocky ground, the center of which lies about 2 miles SSW. from the light-house. It has an area of about 14 square miles, the depths ranging from 8 to 20 fathoms. The Coast Survey chart gave no indication of the rocky bottom, and the attention of the *Albatross* was attracted to it by the number of boats engaged in fishing there. The bank is resorted to both summer and winter. During the latter season the Monterey fishermen work mainly on grounds in the southern part of the bay near the entrance. Drag seines and gill nets are also employed on the smooth bottoms and sandy beaches throughout the region.

Fishing operations were diligently prosecuted by the *Albatross* during both visits, the trials being made chiefly with the beam trawl, seines, and hand lines. The tabular list of fishes given previously belongs also in part to this region, especially the outer or more exposed portion. Along the beaches perch and smelts were secured in large quantities by means of the drag seine. A small striped bass (*Roccus lineatus*) was also taken in the same manner, this being the most southern locality from which it has so far been recorded. It is not native to California, but has been introduced from the Atlantic coast. Gill nets and a trawl line were set about 1½ miles from the harbor anchorage at Monterey, one barracuda being captured in the former but nothing in the latter. The winter fishing-grounds are some 5 or 6 miles farther offshore, but during fine weather red rockfish are frequently caught close to the head of the bay.

Monterey Bay to Point Conception.—The examination of this region was begun on April 3, 1890, off Cypress Point, just south of Monterey Bay, and was carried thence southward, the beam trawl being frequently used in connection with the sounding operations. A depth of 245 fathoms was found within a mile and a half of Cypress Point, below which place the 200-fathom curve gradually leaves the coast until west of Point Sur, where it is distant between 9 and 10 miles from shore. Five miles southwest from this point, however, a depth of 293 fathoms was indicated by the lead, with 36 fathoms a little more than a mile inside. Thence to Lopez Rock the shore is exceedingly bold, the 200-fathom curve approaching within 2 miles or less. Subsequently it diverges slightly until off Piedras Blancas, where it is between 6 and 7 miles from the point. The coast from Carmel Point to Piedras Blancas is entirely open and exposed to the full force of the ocean swell, which causes a tremendous surf, even with the ordinary coast winds. Slight protection may be found under Point Sur, but even that can not be depended on in bad weather.

Southward from Piedras Blancas the character of the coast line changes materially, and there are various points where fairly good anchorage may be found, San Simeon Bay affording the best protection north of San Luis Obispo. As the shore line becomes less abrupt, shoal water extends farther seaward, 200 fathoms being found 7 miles off San Simeon Point, about 10 miles off Point Esteros and Point Buchon, and between 13 and 14 miles off Point San Luis. Then sweeping a little seaward, off Points Sal and Purisima, it approaches within about 8 miles of the bold headland of Point Arguello and 10 miles from Point Conception.

Stations 3183 to 3197, with the beam trawl, were made between Monterey Bay and Point Conception, in depths of 41 to 328 fathoms, the bottom consisting chiefly of sand and mud, with rocks in some places. Poor success attended the trials with the beam trawl and hand lines off Cypress Point. The fishermen do not resort to this locality in the winter, but fish are said to be abundant there during the summer months. Very large "deep-sea sole" (*Microstomus pacificus*) were taken in considerable numbers in deep water off the entrance to Monterey Bay, while the same and other species of flatfish, together with black-cod, red rockfish, whiting, etc., were obtained at most of the beam-trawl stations southward from the bay. Large quantities were never captured at a time, but these forms were found to range over an extensive area. Windy weather, unfortunately, prevented successful work with the hand lines.

A cod trawl was set off the northern entrance to San Simeon Bay, on a sharp, rocky patch of ground, and seining was carried on along the beaches, but neither mode of fishing gave satisfactory results. San Simeon Bay has been for many years one of the principal whaling stations on the Pacific coast, and very little attention is paid to other kinds of fishing. During the winter of 1889–90 ten boxes of smelts, weighing 160 pounds each, were caught in gill nets by one man. This is the largest catch recorded for a single season in this locality.

Seven whales were captured during 1888 and the same number during 1889. The former yielded 180 barrels of oil, the latter 260 barrels, this difference being chiefly due to a difference in their size. December, January, and February are the principal months during which whales frequent this locality, but sometimes a few are seen as late as the middle of March. During these months they are making the "down run," and they are then said to contain about 50 per cent more oil than during the return

or "up run," which is, as a rule, of shorter duration, lasting only from four to six weeks. Twenty-one men and nine boats are employed at this station during the whaling season.

POINT CONCEPTION TO THE MEXICAN BOUNDARY LINE.

This region was examined during January and February, 1889, but a few observations were also made at other times—in the course of the voyage from Norfolk to San Francisco, in 1888, and during the cruise southward from the latter place in March and April, 1890. Along this portion of the coast the continental platform, as defined by the 100-fathom curve, is everywhere narrow and yet quite irregular in its width, being sometimes less than a mile wide, and attaining a maximum breadth of about 13 miles off Santa Barbara. Notwithstanding this fact, however, the several islands surrounded by shallow water which occur off the land, and the two small but important banks farther south, combine with the surface of the platform to offer exceptional advantages for fishing, which can never be fully utilized until larger markets shall have been established within convenient distances. The most important hydrographic work accomplished by the *Albatross* was in connection with the deeper soundings between the outer islands and the mainland, and with those made on Cortes and Tanner banks and in the adjacent waters. Dredging and fishing operations were carried on extensively and with good success.

Santa Barbara Channel begins directly to the south of Point Conception and has a general east and west trend, being included between the mainland, on the one hand, and the islands of San Miguel, Santa Rosa, Santa Cruz, and Anacapa, on the other, the distance of these islands from the coast varying from 10½ to 25 miles. The channel is largely occupied by water over 100 fathoms deep, the maximum depth recorded being 366 fathoms.

Santa Catalina Island is situated about 18 miles off Point Fermin, from which it is separated by San Pedro Channel, having a greatest depth of 422 fathoms. The Gulf of Santa Catalina lies southeasterly of the island of the same name and between San Clemente Island and the mainland, the least distance between the two being about 50 miles. The intervening depths exceed 600 fathoms in some places. Santa Barbara Island is about 22 miles west of Santa Catalina Island, and San Nicolas Island about 24 miles farther in a southwesterly direction, the latter being distant about 54 miles from Point Mugu, the nearest point upon the coast. Cortes and Tanner banks are about 95 miles due westerly from San Diego.

The total area adjacent to the coast of California south of Point Conception investigated by the *Albatross* may be estimated at about 11,000 square geographical miles.

Capt. Andrea Larco, the principal fisherman of Santa Barbara, with eighteen years' experience along this section of the coast, accompanied the *Albatross* on several of the trips, and his thorough acquaintance with the region greatly increased the value of the fishing trials.

Santa Barbara Channel.—This channel, as already stated, has a varying width of about 10½ to 25 miles, being narrowest at the eastern end, between Anacapa and the mainland. On the northern side, between Point Conception and Goleta Point, the 100-fathom curve is generally from 3 to 4 miles from shore, but off Santa Barbara it bends abruptly outward to a distance of about 13 miles, so as to form an extensive area at

the eastern end of the channel with depths less than 100 fathoms. On the southern side the same curve approaches within about 5 miles of the nearest point of San Miguel Island (Harris Point), somewhat closer to the corresponding projection on Santa Rosa, and within 3 miles and less of Santa Cruz and Anacapa. South of this group the distances are somewhat less, the 100-fathom curve lying from 2½ to 4½ miles off San Miguel, and about 2 miles off Santa Rosa and Santa Cruz, with some exceptions to be explained below.

In the western half of Santa Barbara Channel the area of deep water (exceeding 100 fathoms) has, therefore, a relatively great width, occupying in the main about two-thirds of the entire breadth of the channel; but at the eastern end it becomes reduced in places to less than one-fourth the breadth. The bottom consists chiefly of mud, and this same material extends more or less into shoaler water. The greatest depth recorded is 366 fathoms, about midway of the channel.

Several dredgings with the beam trawl have served to indicate the principal features of this deeper area. Station 2840 was made during the voyage to San Francisco in the spring of 1888, and was north of San Miguel Passage, in a depth of 276 fathoms, the bottom consisting of green mud. The season of 1889 was begun at station 2891, about 12 miles west of Point Conception, where 1 black-cod, 7 red rockfish, and an abundance of deep-sea soles, together with two specimens of octopus, were obtained in 233 fathoms, mud bottom. Stations 2892 and 2893 were directly in the western entrance of the channel, in depths of 284 and 145 fathoms, respectively, yellow mud and fine gray sand and mud. Five other stations in the deeper water were subsequently occupied during the same season, as follows: No. 2903 (322 fathoms), No. 2904 (314 fathoms), and No. 2909 (205 fathoms), north of Santa Rosa Island; No. 2910, off Goleta Point, 229 fathoms; No. 2960, north of San Miguel Passage, 267 fathoms. Comparatively little life was discovered on the bottom at any of these positions, but at station 2960 several black-cod were secured.

In April, 1890, four stations (3198–3201) were made through the center of the channel from off Point Conception to off Goleta Point, in depths of 233 to 280 fathoms, green mud.

No surface organisms were taken in this region. Regarding this subject Capt. Tanner states:

> The total absence of life on the surface was notable, and it would seem that the season alone is not sufficient to account for it. The presence of petroleum, which may usually be seen forming a thin film over the surface waters of the channel, may have something to do with it.

Mr. Alexander describes the oil as sometimes occurring in small patches, and at others covering large areas, in the region off Santa Barbara light, at a few miles from shore. Its prevalence, he thinks, "probably prevents migratory fishes from schooling in this part of the channel, and possibly may tend to influence their movements over a considerable distance both up and down the channel." It is not unlikely that the barrenness of much of the bottom may also be due to this cause.

Vicinity of Point Conception.—On January 8, 1889, a trawl line was set in 20 fathoms of water, rocky bottom, about 7 miles east of Point Conception, hand lines also being used from the ship and from a small boat at the same time, but no fishes of any kind were taken. Four stations (2905–2908) with the beam trawl and tangles were then made in a short line running off from this position, the depths ranging from 31 to 96 fathoms, and the bottom being exceedingly variable in character. A consid-

erable number of invertebrates was secured, but nothing indicating a good fishing-ground.

Off Santa Barbara.—The examination of the fishing-grounds off this place, conducted on February 11, 1889, was described by Capt. Tanner as follows:

We left our anchorage at 7 a. m. on the 11th, and, piloted by Capt. Larco, examined a fishing-bank, the center of which lies E. ¼ N. (magnetic) about 3 miles from Santa Barbara light-house. It is about a mile in length NE. and SW., by half a mile in width, soundings regular, with depths from 12 to 20 fathoms, fine black sand, with frequent stony patches or spots, on which there is a live bottom.

Another bank was examined and found to be between 2 and 3 miles in length, E. by S. and W. by N. (magnetic), and almost 1 mile in width, its center being 5 miles ESE. from the light-house. The soundings were regular with depths from 26 to 29 fathoms, which agreed closely with the Coast Survey chart, as did those on the bank previously examined. The bottom was sandy, with frequent stony patches, as before described.

The stones were composed of hardened clay, filled with holes, easily crumbled in the hand, and strongly resembling the tosca of South American coasts. It was covered with kelp, sponges, bryozoans, and other marine growths. The lead did not give the true character of the bottom, and it was ascertained by dragging the trawl or tangles between stations, stony patches, some of them very small, being encountered every two or three ship's lengths. Kelp was found growing on all of them, much of it being brought up by the trawl, the roots still adhering to their stony ballast. It seemed to be a young growth, as none of it reached the surface. According to Capt. Larco, these banks were at one time alive with fish, but being so near the harbor they were soon fished out, and are visited now only by rowboats or sailing craft too small to go to the islands. There are no indications of these rocky or stony patches on the Coast Survey charts.

Later in the day, a small rocky patch, marked on the chart 4 miles south (magnetic) from the light-house, was partially examined, and muddy bottom, with rocks and coral patches, was found in from 50 to 60 fathoms. It was not known to the fishermen of Santa Barbara, but Capt. Larco was confident that it was a spot on which, many years ago, an old Indian used to fill his canoe when others failed to catch anything on the known banks.

Eleven stations (2961–2971) with the beam trawl and tangles were made in the vicinity of the first-mentioned grounds, in depths of 20 to 31 fathoms, and three stations (2972–2974) outside of the last and the deeper ground, in depths of 61 to 73 fathoms, green mud.

Viviparous perch were the principal fishes obtained by seining on the beach at Santa Barbara during a visit made early in April, 1890.

Vicinity of San Miguel Island.—Investigations were conducted in the neighborhood of Richardson Rock, and between there and San Miguel Island, on January 5, and again on February 8, 1889. Stations No. 2894 and 2895, with the dredge and tangles, were made on the former date, in a depth of 53 fathoms, sand and broken shells, about a mile and a half to the westward of the rock, but the bottom, so far as could be determined, was very barren. In nearly the same position a trawl line was set for about an hour and hand lines were also employed. Four red rockfish were caught upon the former, but nothing with the latter, and the baits generally remained untouched.

On February 9 a line of fishing stations was occupied between Richardson Rock and the northern side of San Miguel Island, by way of Wilson Rock, and a party was sent out under the direction of Capt. Larco to investigate localities inaccessible to the ship. The fishing trials are thus described by Mr. Alexander:

The first fishing was done in 44 fathoms, Richardson Rock bearing WSW. ¼ W. (magnetic), distant 1½ miles. Ten red rock-cod and 10 yellow-tails were caught in a few minutes' time. The next berth was in 41 fathoms, Wilson Rock bearing E. by S. (magnetic) 2.3 miles distant, only one small

flounder being taken during a 10-minute trial. The last trial made between Richardson and Wilson rocks was in 36 fathoms, the latter rock bearing ESE. (magnetic), distant 1.6 miles; 4 red rock-cod and 3 rock bass were captured.

From the above station the ship ran E. ¼ S. 1.2 miles and hove to in 42 fathoms, Wilson Rock bearing S. by E. ¼ E. and close to. Fifteen lines were soon over the ship's side and fishing began. Mr. Larco and the writer went out in the dingey to try for fish around the rock. Seven or eight trials were made in depths varying from 25 to 35 fathoms, but we did not meet with as good success as was expected by Mr. Larco. He had frequently anchored over the same ground where we were fishing and had loaded his boat in a few hours, but this was late in the season. Many trials were also made to the southward of the rock, where large numbers of whitefish generally feed in summer, and still our efforts were only poorly rewarded. The total catch was 4 red rock-cod, 3 whitefish, 1 cultus-cod, 1 sculpin, 1 rock bass, 1 scorpion, and 1 black rock-cod. On returning to the ship we found the deck covered with fish. It had drifted but a few minutes when they were encountered in great abundance, every line hooking at once and those who participated had keen enjoyment for 2 hours. Fishing began in 34 fathoms and was continued into 23 fathoms. The total number of fish taken was 555, viz: 481 yellow-tail rockfish (*Sebastodes flavidus*), 49 red rock-cod, 1 cultus-cod, and other species.

Yellow-tail fishing very much resembles pollock fishing on the New England coast. The former species will invariably follow the lines to the surface, and frequently bites at the hook just before reaching the ship's side. Another peculiarity in which these fish resemble the pollock is that as soon as they begin to bite they swim up in the water, and more can be caught on short lines than on the bottom. After a few have been taken they will rise to within a few fathoms of the surface and dart in schools at the lines. They then immediately disappear, soon to repeat the same performance.

On the afternoon of the same day, while on the way to Santa Barbara, three dredging stations were made to the northward of the eastern end of San Miguel Island. The first two (Nos. 2957, 2958) were only a short distance from the shore, in the vicinity of Prince Island, the depth being 26 fathoms and the bottom consisting of gray sand and rocks. The dredge and beam trawl were used and a rich bottom was discovered. Station No. 2959 was about 4½ miles north of this end of the island, in a depth of 55 fathoms, sand, mud, and broken shells. Several black-cod were taken in the beam trawl.

The beam trawl and tangles were employed on January 6, 1889, to the west and southwest of the island, at distances of about 1 to 6½ miles from shore. Station 2899 was nearest the island, off Wyckoff Ledge, in a depth of 44 fathoms, gray sand and broken shells, but the net caught on some projecting rocks and was wrecked. At station 2897, Point Bennett, on San Miguel Island, bearing NE. by N. ½ N., 3¼ miles, 197 fathoms, rocky bottom, the tangles were used and a trawl line was set for about an hour, securing 4 black-cod, 1 red rockfish, and 2 ratfish (*Chimæra*). This and other similar localities along this portion of the coast may possibly offer good advantages for a fishery for the black-cod, but further trials are necessary to determine that fact. Station 2898 was near 2897, in a depth of 158 fathoms, while No. 2896 was in 376 fathoms, yellow mud. A rich fauna was found at both of these places.

On February 8 a beam-trawl station (No. 2956) was occupied off the southern entrance to San Miguel Passage, about 3½ miles from the eastern end of the island of the same name, depth 52 fathoms, the bottom consisting of fine gray sand and rocks. Later, on the same day, the *Albatross* anchored off the southern side of the island, and a fishing party was rowed close inshore among the rocks and kelp, where, in a short time, 28 specimens of red rockfish, whitefish, and rock bass were taken. Fishing trials from the ship proved ineffectual. During the summer the salt-water crayfish (*Panulirus*) is abundant about the shores of San Miguel Island, and large numbers are obtained there both for bait and for the market.

Vicinity of Santa Rosa Island.—In the evening of January 6, 1889, a trawl line was set in the outer part of Becher Bay, at the eastern end of this island, the depth being 20 fathoms. It was allowed to remain down over night, but in the morning only 1 puffer shark (*Cephaloscyllium ventricosum*), 3 sea-anemones, and 1 crab were found on the hooks. Shore collections were also made at this place, but the surf was too heavy to permit of seining. The small dredge was then hauled in the bay at station No. 2900, 13 fathoms, sandy bottom, and subsequently two beam-trawl stations (Nos. 2901, 2902) were made about 4 miles north of Beacon Reef, in depths of 48 and 53 fathoms, many interesting specimens being obtained.

On the morning of February 8, a line of dredging and fishing stations was run through Santa Cruz channel, and thence several miles southward along the crest of a ridge which extends in the direction of San Nicolas Island, but the full extent of this shallow water was not determined. Subsequently the work was continued off the southern side of Santa Rosa Island as far as San Miguel Island. The bottom consisted of clean hard sand, with frequent sharp rock projections.

The following dredging stations were made during the day, namely: No. 2950, in Becher Bay, 21 fathoms; No. 2949, 155 fathoms, and No. 2951, 48 fathoms, at the southern entrance to Santa Cruz Channel; No. 2952, 57 fathoms, No. 2953, 82 fathoms, No. 2954, 65 fathoms, and No. 2955, 121 fathoms, on the ridge extending south from Santa Rosa Island. The following account of the fishing trials is from Mr. Alexander's report:

> At station 2953, latitude 33° 47′ N., longitude 110° 58′ 15″ W., depth 82 fathoms, the dingey was lowered for the purpose of testing the bottom with hand lines. A short distance from the above station the bottom suddenly dropped off into 100 fathoms and a fair trial failed to give us any results. We shifted our berth several times in the direction of the shore, gradually shoaling the water to 60 fathoms, in which depth we obtained 2 red rock-cod. The position where we left the ship was about 10 miles from Santa Rosa Island. In changing berths we probably worked a mile in towards shore. Adding this to the distance steamed by the ship in going over this ground and we have a rocky ledge about 5 miles long and with a depth of 65 to 90 fathoms developed during the morning, on which red rock-cod, whitefish, and fat-heads will probably be abundant at certain seasons. The extent of the ledge, however, may be much greater. The results of dredging indicate a rich bottom.

Off the south side of Santa Cruz Island.—The beam trawl was used on February 7, 1889, in two positions not far apart off the southern side of Santa Cruz Island. The results obtained have been described as follows by Capt. Tanner:

> Two of the hauls of the afternoon, Nos. 2947 and 2948, in 269 and 266 fathoms, were among the richest of the cruise, a great variety of specimens, including 4 black-cod, being obtained. The latter were rather under the medium size, but their flesh was excellent in flavor, nearly, if not quite, equal to those taken off the Oregon and Washington coasts. The deep-water sole is another excellent fish found here, and ranks among the best sea fishes on the Pacific coast, far superior to any that reach the Santa Barbara or San Diego markets.

The "deep-water sole" referred to is the *Glyptocephalus zachirus*, a relative of the pole flounder of the North Atlantic Ocean. It could be taken only in the beam trawl or some similar bottom drag net. The black-cod, however, is an active fish, which could best be captured by hook and line, and the fact that 4 specimens were secured in the beam trawl may possibly indicate its presence here in considerable numbers.

Anacapa Passage and Island.—Investigations were made in this region on February 6 and 12, 1889. On the former date dredging stations No. 2943, 2944, and 2945 were made directly in the passage, in depths of 30 to 31 fathoms, rocky and pebbly bottoms; while station No. 2946 was to the southward of Smuggler Cove, Santa Cruz Island, in a depth of 150 fathoms, coarse gray sand. It was found that the eastern or Anacapa side of the passage has a live bottom, and is a favorite fishing-ground, while on the opposite side the bottom consists of clean sand with little or no life.

The following account of the fishing operations is by Mr. Alexander:

We commenced fishing in 30 fathoms, the SE. end of Anacapa Island bearing E. by N. ½ N., San Pedro Point NW. ¾ W. After remaining there about fifteen minutes we shifted to the south and west into 27 fathoms, the above-mentioned points bearing E. by N. ¾ N. and NW. ½ W., respectively. In these two drifts of short duration, 20 red rockfish and fat-heads were captured.

Two other trials were subsequently made on the following bearings: In 28 fathoms, San Pedro Point NW. by W. ½ W.; south and eastern end of Anacapa Island, E. by N. In 27 fathoms, the former point bearing NW., the latter ENE. The result of these trials was as follows: 22 whitefish (*Caulolatilus princeps*), 4 fat-heads (*Trochocopus pulcher*), 26 red rockfish, 8 black rockfish (*Sebastodes mystinus*). A short distance to the eastward of Anacapa Passage the bottom is sandy and comparatively barren.

Early in the evening an anchorage was made by the ship in Smuggler Cove, where a large-mesh gill net was set for two hours among the rocks and kelp close by the shore. This was done about dark, a little too late to expect a large catch, such species as are generally taken in a gill net usually meshing just before dark or before sunrise. Only one crayfish was secured. The next morning the net was set in the same place, and at the time several sea lions were observed upon the rocks. The net was hauled after breakfast and contained 90 fish, of which the greater number were viviparous perch. The sea lions had been there before us, however, as was made manifest by the number of large holes in the net caused by their efforts to steal the fish. Sea lions are still found scattered about the Santa Barbara Islands, where they greatly annoy the fishermen, not only by devouring the fish taken but also by injuring and often entirely destroying their nets.

The remainder of the morning was spent in seining along the sandy beach of Smuggler Cove, an excellent locality for that purpose, as there are no sharp rocks or other obstacles in the way. Notwithstanding its advantages, however, only a few perch, sharks, etc., were collected.

On February 12 the following dredgings were made entirely with the beam trawl: No. 2975, 36 fathoms, in Anacapa Passage; No. 2976, 31 fathoms; No. 2977, 45 fathoms, and No. 2978, 46 fathoms, directly off the south side of Anacapa Island; No. 2979, 388 fathoms, about 4 miles south of Anacapa Island, and No. 2980, 603 fathoms, about 11 miles south of Anacapa Island. At the last two stations the bottom consisted of green mud; at the preceding ones of sand, gravel, pebbles, and broken shells. Mr. Alexander describes the results of fishing trials as follows:

On the morning of February 12 many hauls were made with the beam trawl in Anacapa Passage and off the southern end of Anacapa Island. A haul 11 miles south of the island in 603 fathoms (station 2980) was one of the richest made in this region. Two trials were also made for bottom fish on the southern side of Anacapa. The first was in 52 fathoms, 1¼ miles south of Arch rock; the second was in 36 fathoms, 1 mile north of the same rock. Six red rockfish were captured. A strong breeze was blowing at the time, which caused the ship to drift rapidly, and consequently a large catch could not be expected, but a sufficient number were secured to demonstrate the presence of fish in this position, and they might have been taken in abundance under more favorable circumstances.

List of the principal food-fishes obtained in the vicinity of the Santa Barbara Islands.

[Prepared by Charles H. Townsend.]

Serranus clathratus, Rock bass.
nebulifer, Bass.
Sphyræna argentea, Barracuda.
Abeona minima, Perch, Shiner.
Micrometrus aggregatus, Shiner, Sparada.
rosaceus.
Amphisticus argenteus, Surf-fish.
Trochocopus pulcher, Fat-head.
Caulolatilus princeps, Whitefish.
Anoplopoma fimbria, Black-cod, Beshowe. Only obtained in the deeper water and taken only in the beam trawl.
Sebastodes vexillaris, Rockfish.
chlorostictus, Rockfish, Vermilion fish.
Sebastodes miniatus, Vermilion rockfish.
elongatus, Rockfish.
proriger, Rockfish.
entomelas, Rockfish.
flavidus, Yellow-tail rockfish.
crassus, Rockfish.
notospilotus, Rockfish.
Sebastolobus, Rockfish. Taken only in deep water.
Parophrys vetulus, Flounder.
Citharichthys sordidus, Flounder.
Hippoglossoides exilis, Flounder.
Microstomus pacificus, "Deep-sea sole."
Glyptocephalus zachirus, "Long-finned sole."
Pleuronichthys verticalis, Flounder.

Notes on the fisheries of the Santa Barbara region.—The following notes on the fisheries of this region are extracted from the report of Mr. Alexander made in 1889:

Mackerel strike in at the Santa Barbara Islands and Channel about the 1st of March and remain until October. Mr. Larco has never seen any fat mackerel on the coast and doubts if they ever become fat. They sometimes school in small "pods" during the summer months in Santa Barbara Channel, but he has never seen them school in the vicinity of San Pedro or farther south. They are caught by trolling and in gill nets, but chiefly by the former method.

The herring accompany the mackerel, but remain much longer in this region. Strong westerly winds drive them offshore, where they remain until the wind changes. They are taken in gill nets and drag seines.

Sardines (*Clupea sagax*) are found here the year round in considerable numbers, and are captured in gill nets and drag seines, chiefly for bait. They are affected by westerly winds in the same manner as the herring.

Fat-heads, yellow-tails, red rockfish, black rockfish, and whitefish are similar in their habits to the shore cod and pollock of the Atlantic coast.

Rock-lobsters or crayfish, sardines, and herring make the best bait, although whitefish and perch are very good. Squid are sometimes caught in great numbers in nets and drag seines, but it is said that the fish will not bite at them.

Sea bass, of which no specimens were taken by the *Albatross*, are said by Mr. Larco to be first seen some time in March. After remaining upon the coast about two months they suddenly leave, reappearing in July and August. They have been known to strike the coast three times during a season, but as a rule they appear only twice. The customary method of fishing for them is with gill nets. The net is 40 fathoms long and 3 fathoms deep, with a 6-inch mesh. A southeast wind causes them to seek deeper water and very few are taken at such times.

Sharks and dogfish give the fishermen much trouble in the summer, when they are very abundant, playing sad havoc with the nets and all other kinds of fishing appliances. There are many excellent places on the Santa Barbara Islands where try works could be built at slight expense in localities where these fishes might be captured in large numbers within half a mile of the shore.

During January, February, and March only hand-line fishing is resorted to. Through the four succeeding months no attempt is made to catch any fish but barracuda and mackerel. During the last months of summer but little attention is given to fishing of any kind, there being little demand for this kind of food. The poor demand for fish at that season arises from the fact that the fishermen have not the means of preserving and marketing their catch in suitable condition. The price of ice is so high that its use would increase the cost of fish beyond the means of the majority of the people. Most of the fish are now sold at from 10 to 15 cents per pound in the Santa Barbara market, but 18 cents is sometimes paid for fat-heads, whitefish, red rockfish, and yellow-tails.

Nearly every spot about the Santa Barbara Islands where rocky bottom is found may be considered a fishing-ground. Red rockfish and fat-heads are found from close to the rocks out into depths of 90 fathoms, but they are most abundant where the water is from 15 to 25 fathoms deep. Some places are much more favorably regarded than others. Anacapa Passage is one of the best grounds, and can generally be relied on throughout the entire year. In the vicinity of Richardson Rock is another good ground, and Wilson Rock is considered the most prolific spot about the islands during the first three months of the year. Between these rocks and the northern end of San Miguel Island red rockfish, fat-heads, and whitefish occur in considerable numbers in the summer, but during winter these species are more abundant about the rocky patches off the shores of Santa Rosa, Santa Cruz, and Anacapa. The best ground for yellow-tails is in close proximity to Wilson Rock.

The best season for fishing is during the winter months, when the winds are variable and gentle. In summer the northwest trades sweep down the coast, often with great velocity. At such times the fishermen resort to the northern end of the group, thereby receiving the benefit of a fair wind to Santa Barbara when a full load has been secured.

Rainy weather affects the movements of both surface and bottom fish. Mr. Larco states that he seldom finds anything in his nets during a rainy spell, and long experience has taught him to resort to some other method of fishing during such times.

The salt-water crayfish (*Panulirus interruptus*) is caught in trammel nets and in small net traps. The latter are very much like the traps used by the boat fishermen along the shores of Long Island Sound and Massachusetts Bay for catching cunners. They are somewhat smaller, however, and have two iron hoops instead of one, to which the net is fastened. One is at the top and measures about 2 feet in diameter, while the second, at the bottom, is only 10 inches across. They are placed 2½ feet apart, that being the length of the trap. A wire cage about the size of a saucer is attached at the bottom and serves to hold the bait. The bridle, to which the line for lowering and hauling the trap is fastened, consists of four lines tied to the upper hoop. These lines are rove through a small piece of wood which acts as a float to prevent their settling down over the cage and covering the bait. When resting on the bottom the top hoop falls in such a manner as to fully disclose the bait.

Mr. Larco's boats are all carvel-built and with keels; they are open and have a wash rail, small deck forward, and lateen rig. They are about 25 feet long, 7 feet wide, have a straight stem and sharp stern, with the rudder hung outside. The accommodations for sleeping and cooking, as in all other boats of this class, are very poor. The fish are thrown into the bottom of the boat as soon as caught, and covered with seaweed to protect them from the sun.

San Pedro region.—After completing a line of soundings and dredgings between San Diego and Point Fermin, February 4, 1889, search was made for a reported shoal off the latter place, but, apparently, it does not exist. Subsequently an examination was made of South Bank, which is described as follows by Capt. Tanner:

It extends about 10 miles SE. by E. (magnetic) from San Pedro light-house, and is from 3 to 3½ miles in width. The depths increased regularly to 20 fathoms 2 miles from the point, and to 29 fathoms at the outer extremity. The soundings correspond generally with those of the Coast Survey chart, and the bottom was usually the same dark-gray sand; but putting the trawl over, it frequently dragged over stony patches, on which kelp, sponges, bryozoans, etc., were growing.

Beam-trawl stations Nos. 2938 to 2942, inclusive, were on and about this bank at distances of 6 to 11 miles from Point Fermin, in depths of 20 to 47 fathoms. Mr. Alexander has reported as follows concerning South Bank and the fisheries generally of this region:

This bank is 3½ miles wide and covers an area of about 30 square miles; the good fishing-spots are confined to a much smaller area, however, being generally in depths of 20 to 28 fathoms. About twenty-five small fishing boats are engaged in fishing on this bank the year round. Flounders, red rockfish (called groupers locally), herring, bonito, mackerel, and smelt are caught in their proper seasons. Red rockfish are taken during the entire year and are in greatest demand. Herring, mackerel, and smelt are caught in gill nets and drag seines, and frequent chiefly the shoaler water close to the shore. Mackerel are often trolled for, as in the San Diego region. Los Angeles is the principal market for all fish taken on this bank, a uniform price of 5 cents per pound being paid for all the species, except mackerel. The price of the latter fluctuates, according to the supply and demand; 200 pounds of fish is considered a fair day's work with hand lines.

The fishing for red rockfish is carried on in a manner not unlike that for grouper in the Gulf of Mexico. When the ground is reached, the boat is luffed up into the wind and a sounding made with a baited hook attached to the lead. If no fish are found on two trials, the boat is again given headway, and a new berth taken a short distance from the first one. This operation is repeated until a place is found where the fish are abundant, when the jib is hauled down, the main boom guyed out, and the boat allowed to drift a short distance. If the fish continue to bite, the anchor is lowered. The fish feed upon small spots and ridges covered with kelp, and, as they can not be tolled away from their feeding-ground, an anchorage has to be made as nearly as possible over these localities; otherwise very poor results may be expected. Fishing is actively continued until the place is exhausted, when a new berth must be sounded out. Frequently one or two boats will have excellent fishing while a dozen or more may meet with no success. These fish appear to move about from place to place, and the good fishing-grounds of one day may be entirely deserted the next.

Most of the boats belonging to San Pedro that fish on South Bank and vicinity are sloop-rigged and keeled. They average 20 feet long and 6½ to 7 feet wide. Their accommodations are as good as could be expected on boats of their size, and are far better than on similar boats farther south. Herring and salt-water crayfish or rock-lobster (*Panulirus*) are used for bait.

The fishermen of San Pedro and adjacent places are mostly Scandinavians, Portuguese, and Italians, the Scandinavians being in the majority. Many of the Italians fish about San Clemente and Santa Catalina Islands, while those of other nationalities pay little attention to those islands, resorting chiefly to South Bank. The Italians have a few fish-houses and a flake-yard on Santa Catalina, where they dry fish in summer. No attempt is made to split and dry fish in the winter, and during that season the fishermen remain mostly on the inshore grounds. A favorite spot for summer fishing lies 1½ miles from the eastern end of Santa Catalina Island. Large quantities of red rockfish are taken there, and also whitefish (*Caulolatilus princeps*) and fat-heads (*Trochocopus pulcher*) at certain seasons.

Hand lines only are used for bottom fishing in this region. Trawl lines would be of little service on the rocky patches, as the fishing areas are of small extent and much of the trawl would be spread out over barren ground. The gear is rigged in the same manner as that of the hand-line fishermen of San Diego.

The San Pedro fishermen state that bonito strike this part of the coast the first of March and mackerel a month later. The method of catching them here, as previously explained, is by means of troll lines and gill nets. The fishermen also affirm that they have never seen mackerel schooling in the vicinity of South Bank, although herring and sea bass frequently school in large bodies. This is, however, the region from which most of the schools of mackerel have been reported by passing vessels. These reports are not unnatural, in view of the fact that even an experienced eye is often deceived in attempting to distinguish between schools of mackerel and herring, and it is sometimes impossible to determine the species until specimens have actually been taken in the nets.

Alamitos Bay and Newport Harbor.—These two inlets were examined by Prof. C. H. Gilbert on January 12 and 13, 1889, with reference to their adaptability for oyster-raising, the density and temperature of the water being carefully determined.*

Santa Catalina Island.—This island was visited by the *Albatross* on February 14, 1889, but unfavorable weather prevented an investigation of the fishing-grounds. The fisheries in its vicinity, however, have been referred to in the last extract given above, from the report of Mr. Alexander.

Santa Barbara Island.—The only dredge haul made in this vicinity was at station No. 2982, about 5½ miles southwesterly from Santa Barbara Island, depth 178 fathoms, the bottom consisting of sand, gravel, and mud. Mr. Alexander describes the fishing trials close by the island as follows:

An anchorage was made in the afternoon on the northern and eastern side of Santa Barbara Island, where the naturalists were landed. A crab net, baited with fresh whitefish, was put over the side, but nothing was captured in it. The hand lines did better, although during the first hour no

*Report upon certain investigations relating to the planting of oysters in southern California. By Charles H. Gilbert. Bull. U. S. F. C., IX, 1889, pp. 95-98, 3 maps, 1 plate.

bites were felt. Towards evening, however, a school of red rockfish and whitefish passed under the ship, and between 40 and 50 of them were caught. The longer we fished the more plentiful they seemed to become. The dingey, with Capt. Tanner and the writer, was rowed to a point about half a mile to the westward of a reef of sharp rocks which makes off from the shore, where we fished for about an hour, making several changes in our position during that time. The catch consisted of three red rockfish and one fat-head. One large flounder (*Paralichthys californicus*), of the kind called halibut by the fishermen of San Diego, was hauled to the surface of the water, but, owing to its being "lip-hooked," it managed to free itself, greatly to our disappointment.

San Nicolas Island.—This island was visited on January 18 and February 13, 1889, but stormy weather prevented extensive observations on both occasions. On the former date seining only was carried on, two hauls being made at the eastern end of the island. Abalone shells occur here in great abundance, and are collected for the market. A Chinese boat, in search of these mollusks, reached the island at about the same time as the *Albatross*. A small amount of fishing with hand lines was done during the morning of February 13. Two trials were made before good grounds were discovered. The third position was 2 miles WSW. from the island, in a depth of 21 fathoms, 17 red rockfish, 3 whitefish, 2 yellow-tails, 1 fat-head, 1 cultus-cod, and 4 jacks (*Sebastodes paucispinis*) being captured in the course of ten minutes. The boat then drifted into deeper water, where no fish could be obtained, but on returning to a depth of 22½ fathoms good fishing was again secured, the same species being taken, but in smaller quantities.

Lines of deep-sea soundings have been run, connecting San Nicolas Island with Tanner Bank at the south and San Clemente Island at the east, and defining the contour of the bottom for some distance to the north of San Nicolas Island.

Cortes and Tanner Banks.—These two banks, which are located about 95 miles due west of the coast end of the boundary line between the United States and Mexico, constitute the most important offshore fishing-grounds on the coast of California south of San Francisco. They are only a few miles apart, but are separated by depths of 100 to something over 200 fathoms. Coast and Geodetic Survey chart No. 5000 represents them on a very small scale, with their outlines defined by the 100-fathom curve. A more detailed chart is given in the report of Capt. Tanner, contained in the Annual Report of the Fish Commission for 1888–89. They are here outlined by the 50-fathom curve as inclosing that portion of each bank which has been most thoroughly surveyed and fished over, especially in the case of Cortes Bank, the larger of the two. Capt. Tanner's account of the examination of Cortes Bank is as follows:

Arriving at the bank the following morning (January 16), we commenced investigations by sounding, dredging, and the use of hand lines. The sea was breaking heavily over Bishop Rock, which made an excellent landmark, enabling us to locate ourselves on any part of the bank with certainty and without loss of time. The examination was completed on the evening of the 17th, and the general results may be stated as follows: The charts are on scales entirely too small to admit of details being shown. Bishop Rock, on which there is but 10 or 12 feet, is the shoalest part of the bank. The sea breaks over it heavily during moderate weather; but with a smooth sea, when facing the sun, it can not be seen at any distance and is at such times very dangerous. The depths correspond generally with those on the charts, with the exception of a 6-fathom spot which was found about a mile south and east of Bishop Rock. This might have led to a less depth, but there was a heavy swell at the time, which induced us to seek deeper water. Our soundings extended the area of the bank in a southwest direction, where it requires further examination. The bottom was composed of sand, shells, coral, and rock, the latter cropping out at short intervals over the entire surface. The fauna was very rich and varied. Fish were swarming over the bank in great numbers, and, in fact, it was found to be the richest ground we have found in the Pacific. The trawl line was set and quite a number of fish taken, but the bottom was too rough for that method of fishing. Dan-

gerous seas will be encountered on the bank in stormy weather, and heavy swells with moderate winds, but it is of small extent, and with the deep water surrounding it is not an unusually dangerous fishing-ground.

Starting from the northern end of the bank a little after dark on the evening of the 17th, we ran a line of soundings in the direction of San Nicolas Island for 12 miles, in depths less than 200 fathoms, 59 fathoms being found at 18 miles (Tanner Bank). This we marked for future investigation and continued our course to the island.

Tanner Bank, so named by the Superintendent of the U. S. Coast and Geodetic Survey, was not examined until the 24th of January. The following brief description is by Capt. Tanner:

Its greatest length inside of the 50-fathom curve is 8 miles east and west (magnetic) by 2 miles in width at its eastern extremity, narrowing to 1½ miles at the western end. The center of the bank, on which was found 48 fathoms, is in latitude 32° 43′ N., longitude 119° 10′ W., and the least water, 28 fathoms, was found near the eastern end, in latitude 32° 42′ 30″ N., longitude 119° 07′ 15″ W. The bottom is composed of sand and shells, with numerous rocky patches, on which the fauna was found to be identical with that of Cortes Bank in similar depths. The 50-fathom curve on the east end lies north (true) 16 miles from Bishop's Rock, both being on the same submarine plateau, with intervening depths of less than 300 fathoms. The same species of fish found on Cortes were taken on this bank, and it may be considered a valuable addition to the fishing-grounds of the Pacific coast.

The fishing trials on Cortes Bank are thus described by Mr. Alexander:

January 16 we sounded in 60 fathoms on Cortes Bank (dredging station No. 2911, latitude 32° 27′ 30″ N., longitude 119° 05′ W.) where hand lines were put over, taking 2 red rockfish and 1 whitefish (*Caulolatilus princeps*) in the course of about fifteen minutes. A second trial was made soon after at hydrographic station 1621, latitude 32° 25′ 30″ N., longitude 119° 05′ W., depth 17 fathoms, bottom rocky. Fishing was carried on with hand lines for forty-five minutes, during which time the vessel drifted into 5 fathoms of water. The results were as follows: 17 fat-heads (*Trochocopus pulcher*), 10 yellow-tails (*Sebastodes flavidus*), and 2 sea bass (*Serranus clathratus*). The strong and sharp teeth of the fat-heads played sad havoc with hooks and gangings, stripping the former from the snoods nearly as fast as they could be put on. These fish would be very destructive to trawl lines set across the rocky patches which they frequent. The yellow-tail rockfish would follow to the surface any struggling captive at the end of a line, their movements somewhat resembling those of the Atlantic coast pollock.

Having baited a trawl while the hand-line fishing was going on, we set it at 12:40 p. m., in 26 fathoms, hard bottom. It was allowed to remain down one hour, after which no little difficulty was experienced in hauling it, because many of the hooks caught on the bottom and it was necessary to break the hooks or part the gangings to recover it. When within about 10 fathoms of the end the ground line broke, and we were obliged to haul the remainder of the trawl from the other buoy. The result of the trial was 18 fish, as follows: 2 red rockfish, 3 whitefish, 1 treefish (*Sebastodes serriceps*), and 12 fat-heads. We arrived on board the steamer at 3:55 p. m. While the trawl was down, dredging and hand-line fishing were carried on from the ship, the following species being taken by the latter means: 39 fat-heads, 37 yellow-tails, 1 whitefish, 3 red rockfish, 2 black rockfish (*Sebastodes mystinus*), 1 scorpion (*Scorpæna guttata*), and 2 jewfish (*Stereolepis gigas*). The two specimens of the last-named species weighed 155 and 190 pounds respectively. The fat-heads averaged 10 pounds each in weight. Fishing began in 25 fathoms and was carried into 8½ fathoms.

January 17, sounding, dredging, and fishing were carried on continuously over Cortes Bank. Seven trials with the hand lines, from a quarter to half an hour each in duration, were made during the day, resulting in the capture of 95 fish. The first was at hydrographic station 1631, 47 fathoms, where 1 whitefish and 1 yellow-tail were caught. The second was at hydrographic station 1632, 26 fathoms, where 15 whitefish, 5 red rockfish, and 2 fat-heads were taken. One cultus-cod, 1 yellow-tail, 2 red rockfish, and 1 whitefish were the total results of about twenty minutes' fishing at hydrographic station 1633, depth 43 fathoms. The fish took the bait less eagerly than on the preceding trials, and we observed that the vessel had drifted from places where we were hauling them "pair and pair" into others where not a single bite would be felt. The bank seemed to have many spots or ridges where all the species mentioned occurred in great abundance, but on leaving these places good fishing stopped. The fishing greatly resembled that for red snappers in the Gulf of Mexico.

At hydrographic station 1636, 45 fathoms, no fish were taken. We were possibly drifting in a little gully, and a slight change of position to either side might have brought us over good ground. Twenty-two whitefish, 11 red rockfish, and 3 fat-heads were subsequently secured in twenty minutes at hydrographic station 1639, 30 fathoms; and 11 fat-heads, 4 yellow-tails, 1 black rockfish, and 1 scorpion (*Scorpæna guttata*) in a few minutes, at hydrographic station 1640, 11 fathoms. The last trial of the day was made shortly after dark at hydrographic station 1641, 51 fathoms, for the purpose of determining the effects of darkness upon the fishing. The results seemed to prove that the fish will not bite after dark, as we were in a good locality and could feel the fish constantly striking against our leads and lines, but not a single specimen was taken on the hooks.

Cortes Bank was found to be the most promising offshore fishing-ground on the California coast south of San Francisco. It has an area of 51 square miles, with depths less than 50 fathoms. The deeper parts of the bank have been surveyed to a slight extent only, but it is probable that good fishing will also be found outside of the 50-fathom limit. The shoal part of the bank is about 15 miles long (WNW. and ESE.), its center being in about latitude 32° 26′ 30″ N., longitude 119° 08′ W. Bishop's Rock, which reaches to within 2½ fathoms of the surface, lies in latitude 32° 25′ 40″ N., longitude 119° 06′ 30″ W. A fishing vessel at anchor on the bank to windward of this rock would probably find it extremely uncomfortable if caught out in a heavy gale; but as the rock is small, a staunch schooner could work out by it into deep water, if not anchored too near it when the storm began.

Previous to the investigations of the *Albatross* nothing was known respecting the food-fishes inhabiting this bank. The demand for fish along this part of the coast is so limited at present that the fishermen do not find it necessary to venture outside of a few headlands in search of new grounds. They can give but little authentic information respecting the fishing-grounds 25 to 30 miles off the coast. The fishing areas adjacent to San Diego and Santa Barbara are sufficient for the immediate requirements of those places, but with a considerable increase in population, more distant and deeper grounds will have to be sought for, necessitating the building of a larger and better class of fishing boats. Small vessels patterned after the eastern well or smack boats could make quick and safe passages to and from Cortes Bank. A week or a fortnight could be spent, if necessary, in obtaining a fare, and by the end of that time fish would still be in good preservation, whereas the present methods compel the fishermen to market their fish daily to prevent their becoming unfit for sale.

Twelve stations were made on and about Cortes Bank with the dredges, tangles, and beam trawl. They are as follows: No. 2911, 60 fathoms; No. 2912, 10 fathoms; No. 2913, 26 fathoms; No. 2914, 26 fathoms; No. 2915, 55 fathoms; No. 2916, 93 fathoms; No. 2917, 99 fathoms; No. 2918, 67 fathoms; No. 2919, 984 fathoms (about 12½ miles southwest of Bishop Rock); No. 2920, 87 fathoms; No. 2921, 145 fathoms; No. 2922, 47 fathoms.

Deep-sea soundings were run from Tanner Bank to San Nicolas Island and to the southern end of San Clemente Island. A third line connects Cortes Bank with the region off Point Loma. The latter developed a series of elevations and depressions over which the depths varied from 211 to 1,047 fathoms.

The following are the principal food-fishes obtained on Cortes Bank by the use of hand lines:

Serranus clathratus, Rock bass.
Stereolepis gigas, Jewfish.
Trochocopus pulcher, Fat-head.
Caulolatilus princeps, Whitefish.
Ophiodon elongatus, Cultus-cod.
Sebastodes paucispinis, Jack.
flavidus, Yellow-tail rockfish.
melanops, Black rockfish.
mystinus, Black rockfish.
Sebastodes miniatus, Vermilion rockfish.
constellatus, Rockfish.
rosaceus, Corsair.
chlorostictus, Rockfish.
vexillaris, Rockfish.
serriceps, Treefish.
Scorpæna guttata, Sculpin.
Citharichthys sordidus, Flatfish.

Vicinity of San Clemente Island.—While passing up the coast on the voyage to San Francisco, in May, 1888, a short stop was made in Smuggler Cove at the southeastern end of San Clemente Island, but only shore collecting was attempted. Subsequently the beam trawl was hauled successfully in a depth of 414 fathoms, gray sand bottom, about 7 miles off the northern end of the same island (station 2839).

The region was again visited on January 23 and 25, 1889. In the evening on the former date, a gill net was set in Smuggler Cove, and was allowed to remain down over night, but, although a school of fish, supposed to be herring, was seen at the surface, nothing at all was captured. The exceeding phosphorescence of the water, which imparted a glow to the entire net, may have been accountable for their failure to mesh. On the 25th a party was landed at the southeastern end of the island, where they found an excellent beach for seining, although the surf was running somewhat heavily at the time. Repeated hauls were made with the net, securing a good representation of the shore fishes, among which were large numbers of viviparous perch (*Amphisticus argenteus*) and a few smelts.

Several fishermen belonging to a San Diego sloop were encamped on the island. They made use of hand lines, fishing in depths of 30 to 40 fathoms, and obtaining fat-heads, rockfish, whitefish, etc., which were split and salted. Short trawl lines were also employed at times, and traps were set for capturing salt-water crayfish. The sloop visited the island once every week or ten days and carried the catch to San Diego.

Gulf of Santa Catalina and the region off San Diego.—Two lines of deep-water soundings, including a few dredging-stations, were run through the Gulf of Santa Catalina from off Point Loma, one in the direction of Point Fermin, the other extending through the passageway between Santa Catalina and San Clemente Island. A third line extends from off Point Loma to Cortes Bank, as explained above. In addition to these a number of dredging and fishing trials were made directly off San Diego and about Los Coronados.

The dredging stations were distributed as follows: No. 2937, 359 fathoms, near the center of the Gulf of Santa Catalina; No. 2923, 822 fathoms; No. 2924, 455 fathoms; No. 2925, 339 fathoms; No. 2926, 69 fathoms; No. 2929, 623 fathoms; No. 2934, 36 fathoms; No. 2935, 124 fathoms, and No. 2936, 359 fathoms, off San Diego, within a maximum distance of 15½ miles from land; No. 2930, 60 fathoms; No. 2931, 34 fathoms; No. 2932, 20 fathoms, and No. 2933, 36 fathoms, in close proximity to Los Coronados; No. 2927, 313 fathoms, and No. 2928, 417 fathoms, between San Diego and San Clemente Island.

Los Coronados are located just south of the boundary line between California and Lower California. Important fishing-grounds exist in their immediate vicinity, and, lying very near to San Diego, they are much resorted to. The following account of investigations made in this locality on January 26, 1889, is from the report of Mr. Alexander:

On the morning of January 26 investigations were begun in the vicinity of Los Coronados Islands. The first trial for fish was made with hand lines at hydrographic station 1706, latitude 32° 25′ N., longitude 117° 18′ W., 51 fathoms, 5 red rockfish and 1 fat-head being taken. The next fishing was done at dredging station 2931, 34 fathoms, latitude 32° 25′ 30″ N., longitude 117° 16′ 45″ W., and was a failure. These stations were between the North and South Coronados. A small Italian fishing boat was anchored close by where the last trial was made. She was on a favorite spot, but had met with poor success, the catch for the previous twenty-four hours having amounted to only about 50 pounds of red rockfish, whitefish, and fat-heads. During the summer months these species are sometimes very abundant.

Such fish as are taken in the vicinity of Los Coronados and San Diego bring from 3 to 4½ cents per pound. Very few are salted by the Italian fishermen, the salt-fish trade being monopolized by the Chinese. The Italians fish with both hand lines and line trawls, but chiefly with the former on account of their cheapness. Trammel nets are frequently used among the rocks close inshore, and fish that will not readily take the hook are often caught with them. A trammel net 30 fathoms long and 2½ fathoms or 40 meshes deep costs $25. A trawl of 500 hooks, completely rigged, and including the basket in which it is coiled, is valued at $5. Baskets are used on this coast for the storage of the trawls in preference to the tubs of the Atlantic coast. The trawl hooks used by these fishermen are the same as those employed by the French fishermen on the Grand Bank and by the fishermen on the coast of Spain. * * * The best fishing about the islands is found between the Northern and Southern Coronados in 25 fathoms. Close to the southern side of the northern island the water is deeper, having an average depth of 45 fathoms. In this latter place red rockfish are the principal species taken. About 5 miles south of the southern island is a small shoal ground sometimes resorted to by San Diego fishermen. These two "spots" are the only offshore fishing-grounds known in the immediate vicinity of San Diego.

The Italian fishing boat previously referred to was a primitive affair about 18 feet long, 7 feet wide, and 2 feet deep, with a flat bottom. * * * The hand lines employed were as rudely constructed as some of those made by the Alaskan Indians. Many sizes of lines were noticed with pieces of lead attached. Each line is generally provided with from 3 to 5 hooks, fastened to short snoods arranged one above the other about 18 inches apart. This style of gear is found about Kadiak, Alaska. Demijohns of various sizes, tied to the buoy lines by their handles, serve in place of keg buoys. The reason for using the former, as well as many other inconvenient devices, is their greater cheapness.

Mr. Alexander also furnishes the following notes respecting the mackerel, barracuda, and bonito in this region:

While in San Diego several fishermen were consulted who were more or less acquainted with the habits of the species of mackerel belonging to that part of the coast. According to their statements these fish strike the coast in the vicinity of San Diego in April and May on their way north. They are invariably poor at that season, and, in fact, during most if not all of the year, although some claim to have seen a few fat mackerel in October. Their migratory habits are similar to those of the Atlantic mackerel. The fishermen assert that they have seldom seen them schooling at the surface, notwithstanding the many reports of steamers and other vessels respecting large schools of mackerel along the coast. It is probable that many of the schools of fish so reported are not mackerel, but herring, the appearance of these two species, when at a distance, being readily confounded by those who are not familiar with them.

It is very doubtful if mackerel approach this coast in sufficient numbers to warrant the fitting out of vessels for their capture, after the manner followed on the New England coast. Many persons have thought that it would be a paying investment to do so, in order to compete with the New England fishermen for the Pacific coast markets, supplying both the salt and fresh fish. Any such venture would be precarious, however, until the habits and abundance of the species have been positively determined, and certainly not more than two vessels should be fitted out in the beginning. All the evidence goes to prove, moreover, that the Pacific mackerel (*Scomber colias*) is greatly inferior in quality to its Atlantic relative (*Scomber scombrus*), and those eaten on the *Albatross* were pronounced insipid.

The fishermen of San Diego, Santa Barbara, and San Pedro resort almost wholly to trolling for the capture of mackerel. The practice of heaving to and raising them with troll bait seems to be unknown in this region. A few are caught in gill nets, but large quantities are never taken at a time by either method. The greater part of the catch is sold in San Francisco.

During the summer barracuda are abundant about San Diego and along the coast toward Santa Barbara, but after September they become scarce, although scattering individuals are taken the year round. Ten or 12 schooners and sloops, of from 10 to 28 tons each, belonging to San Diego, follow down the coast of Lower California a distance of about 170 miles in search of both barracuda and bonito. The latter species is also sometimes called Spanish mackerel. They are caught by trolling, and, after being split down the back like mackerel, are salted in bulk in the hold of the vessel, the same as codfish. The catch is chiefly landed in San Diego, where the fish are dried on flakes and then shipped to the Sandwich Islands and China by way of San Francisco.

INVESTIGATIONS SOUTH OF CALIFORNIA.

During the several trips made by the *Albatross* southward from California very important fishery, biological, and hydrographic information has been obtained, but it is not intended to make more than a brief reference to these investigations in this connection. On the voyage from Norfolk, Va., to San Francisco, in the winter of 1887–88, observations were continued during the entire cruise, and after leaving the coasts of South America stops were made at the Galapagos Islands, Panama, Acapulco, La Paz, and several places along the outer shores of Lower California. During the early spring of 1889 a visit was paid to the Gulf of California, and from January to April, 1891, the ship was engaged upon a special scientific investigation, under the direction of Prof. Alexander Agassiz, off the coast of Mexico, Central America, and Ecuador, including the region about the Galapagos Islands.

OUTER COAST OF LOWER CALIFORNIA.

After completing the investigations on the coast of California, in February, 1889, the *Albatross* proceeded southward en route for the Gulf of California, but in order to examine certain reported dangers to navigation off Lower California the cruise was not made direct. A line of soundings was carried first to Guadeloupe Island, and thence to the Alijos Rocks, in latitude 24° 58′ N., longitude 115° 52′ 36″ W., and to the Revillagigedo group, of which Clarion, Socorro, and San Benedicto islands were visited in the order named. Important collections of fishes and other marine animals were obtained at each of these places and also by dredging in the intervening deeper waters. Interesting observations upon the physical and natural-history features of the different islands were likewise made and have been published in the annual report for 1888–89, pp. 432–436, 466–468. The hydrographic results have been summarized as follows by Capt. Tanner:

> Reports of islands, rocks, and reefs in the regions recently traversed by the *Albatross* have been current from time immemorial. The U. S. S. *Narragansett's* investigations resulted in their being expunged from the charts, but she gave us no information regarding the contour of the ocean bed, which is the only sure method of deciding the existence or non-existence of submarine elevations. This gap has been filled by the soundings of the *Albatross*, which prove definitely that these vigias do not exist in the positions assigned them.
>
> Another important problem has been solved. The chain of islands commencing with Guadeloupe and extending to Los Alijos and the Revillagigedo group have been considered as a submerged mountain range, extending parallel with the peninsula, connected with it by a submarine ridge at one extremity, and previous to the submergence inclosing a gulf similar to the Gulf of California. The *Albatross* soundings not only show this to be an error, but demonstrate the fact that the several islands are isolated volcanic elevations, entirely independent of the continent and of each other, the sea reaching its normal depth between each of them and also between them and the peninsula.

The observations directly along the outer coast of Lower California, both in 1888 and 1889, were carried northward from Cape St. Lucas, and they will be referred to in the same geographical order.

Only one dredge haul (No. 2829) has been made in the vicinity of Cape St. Lucas, the tangles having been used in a depth of 31 fathoms, rocky bottom, off the Frailes. Station No. 2830 was in 66 fathoms, fine sand, latitude 23° 33′ N.

Visits were paid to Magdalena Bay in both years, and considerable collecting was done in that vicinity by means of the dredging appliances, nets, etc. Food-fishes were

found to be abundant, many specimens of mullet, perch, anchovies, smelts, and flounders being captured in the seines and beam trawl. Several schools of mackerel were observed off the entrance to the bay on April 9, 1889; they were working northward. Excellent oysters had been reported from this locality, and a search was made for them, but without success. Mangrove oysters, however, were discovered about 40 miles farther north, near Boca del Soledad.

On May 4, 1888, several dredge hauls were made in the shallow waters about Abreojos Point, and on April 11, 1889, numerous fishing trials were conducted in San Bartolome Bay (latitude 27° 40′ N.) by means of seines and hand lines. This bay has been reported to be an excellent fishing-ground, but nothing was captured on the hand lines, which were used in several places among the submerged rocks and ledges off the mouth of the harbor, although mullet, smelts, anchovies, and flounders were plentiful along the beaches. The U. S. S. *Ranger* arrived at the bay at about the same time as the *Albatross*, and, making use of a very large seine, secured 167 green turtles, besides two or three dozen fishes, of several species, in a single haul. Some of the turtles were of very large size.

Cerros Island was visited on May 5, 1888, and again on April 12 of the next year, several dredging stations being occupied about the island, while the shore fishes were collected by seining. Subsequently, in 1889, seine hauls were made in San Quentin Bay and on the shores of San Martin Island.

GULF OF CALIFORNIA.

On the voyage north in April, 1888, a stop was made at La Paz, Lower California, for the purpose of coaling, and advantage was taken of the opportunity to dredge at several stations in La Paz Bay, in San Lorenzo Channel, and between Cerrabro Island and the mainland, off Point Gorda.

In 1889 the investigations were carried to the extreme head of the gulf, the main object of the cruise having been to ascertain the principal characteristics of this sheet of water in their relations to the Colorado River, in which plantings of shad had previously been made by the Fish Commission. The course of the ship was from La Paz to San Josef Island, Carmen Island, Conception Bay, Guaymas, San Pedro Nolasco Island, Angel de la Guardia Island, Georges Island and Bay, Consag Rock, and the mouth of the Colorado River. Thence it returned to Guaymas and La Paz, making several stops on the way. Sounding and dredging operations, together with fishing trials and observations of temperature and density, were continued throughout the cruise, much valuable and interesting information being obtained. An account of the work accomplished is contained in the Annual Report for 1888–89, pp. 436–443, 468–471. The shallow waters at the mouth of the Colorado River were found to be very barren of life, and the conditions generally seemed unfavorable to the successful stocking of that river with shad or other anadromous fishes. The gulf itself, however, has many important fishery resources, some of which have been developed to a limited extent, while others must await the demands of future markets.

While in the neighborhood of Guaymas an examination was made of the extensive oyster beds occurring in Algodones Lagoon, the introduction of this southern species on the coast of California having been suggested. This oyster is of excellent quality and closely resembles the Atlantic coast species of the United States. It was

formerly marketed in San Francisco, and is still transported to other places not so far distant from the grounds. Beds of oysters are quite widely distributed through the gulf, but comparatively little is known about them except in this vicinity. The beds of Algodones Lagoon have been discussed by Prof. Charles H. Gilbert and Mr. Charles H. Townsend. (F. C. 14, 15.)

THE SOUTHERN CRUISE OF 1891.

This important expedition, under the scientific direction of Prof. Alexander Agassiz, occupied the three months from February to May, 1891, the area covered by the investigations lying off the western coast of Mexico and of Central and South America, between Cape San Francisco in the south and Guaymas in the north, and extending seaward to include the region about the Galapagos Islands. The biological and physical features of this region, as well as the contour and character of the bottom, except in the vicinity of the coast, were then almost entirely unknown, the *Albatross* having made only a few observations there during the voyage from Washington to San Francisco, while H. M. S. *Challenger*, during her famous expedition around the world, sailed directly from the Sandwich Islands to Chile and thence into the Atlantic Ocean. The inquiry, as planned, had reference mainly to the natural history and temperature of the deeper waters off the coast, at the bottom and surface, and also at intermediate depths.

Beginning off Cape Mala near Panama, a line of stations was carried to Cocos Island, and then, with some deviation toward the south, to Malpelo Island, and back to Panama, while several short lines were run immediately outside of the 100-fathom curve. On the second cruise the steamer proceeded first to the vicinity of Cape San Francisco, thence to the Galapagos Islands, and from there to Acapulco. Subsequently dredgings were made from off Cape Corrientes to Guaymas, in the Gulf of California. The greatest depth of water explored was 2,232 fathoms. Short stops were also made at the different islands lying in the course of the expedition for the purpose of studying the land and shallow-water animals and plants. While it was observed that the marine fauna of this region is not so rich as that occupying the corresponding waters off the east side of the continent, very large collections were secured, and the general results obtained are of great importance.

One of the most important outcomes of the expedition has been the determination by Prof. Agassiz, through the instrumentality of a new form of intermediate towing net devised by Capt. Tanner, of the vertical distribution of the surface pelagic fauna, which he considers to descend only to a depth of about 200 fathoms. Some forms among the bottom animals may work up a distance of several fathoms, but between these levels in the open sea he found no evidences of life. Regarding this subject there are still some differences of opinion among explorers, and further investigations will be awaited with much interest. As a solution of the problem will probably have some bearing upon the study of the habits of pelagic fishes, the practical importance of continuing the experiments can readily be appreciated.

Detailed accounts of this expedition have been given by Commander Tanner and Prof. Agassiz (F. C. 9, 17 and 18).

LIST OF CHARTS AND OTHER PUBLICATIONS BEARING UPON THE FISHERY INVESTIGATIONS OF THE STEAMER ALBATROSS.

The Fish Commission publications here enumerated include only the reports descriptive of the hydrographic and fishery investigations of the *Albatross*, and a few papers from the "Fisheries and Fishery Industries of the United States," which contain a complete review of all that was known respecting the marine fisheries and fishing-grounds of the Pacific coast down to 1882. The charts of the U. S. Coast and Geodetic Survey and Hydrographic Office of the Navy are those on which the soundings of the *Albatross* have been plotted, and they also otherwise illustrate the regions over which her work has been extended. The most useful charts for the Alaskan coast, in connection with this subject, are Fish Commission Nos. 19, 20, 21, 22; Coast Survey, S and T, together with the several harbor charts, and Hydrographic Office chart 68. The general coast charts of the Coast Survey, on a scale of 1:200,000, constitute a uniform series covering the entire coast line of Washington, Oregon, and California, and contain a sufficient amount of detail to answer for most fishing purposes. For the work accomplished south of California, the Hydrographic Office charts and Fish Commission No. 25 should be consulted.

REPORTS AND CHARTS OF THE U. S. FISH COMMISSION.

REPORTS.

1. The fishery resources and fishing-grounds of Alaska. <By Tarleton H. Bean. The Fisheries and Fishery Industries of the United States. By George Brown Goode and a staff of associates. (U. S. Fish Commission.) Section III, pp. 81–115, 1887.
2. The cod fishery of Alaska. By Tarleton H. Bean. *Idem.* Section V, vol. I, pp. 198–224, 1887.
3. [Discussions of the economic fishes of the Pacific coast of the United States.] By David Starr Jordan. *Idem.* Section I, 1884. The discussion of the different economic species will be found under the several natural groups to which they respectively belong.
4. The sea fishing-grounds of the Pacific coast of the United States from the Straits of Fuca to Lower California. By David S. Jordan. *Idem.* Section III, 1887, pp. 79, 80.
5. The fisheries of the Pacific coast. By David Starr Jordan. *Idem.* Section II, 1887, pp. 591–630.
6. Report on the work of the U. S. Fish Commission steamer *Albatross* from January 1, 1887, to June 30, 1888. By Lieut. Commander Z. L. Tanner, U. S. Navy, commanding. Report U. S. Fish Comm., XV, for 1887, pp. 371–435. [Includes the narrative of the cruise from Washington, D. C., to San Francisco, Cal., 1887–88.]
7. Report on the investigations of the U. S. Fish Commission steamer *Albatross* for the year ending June 30, 1889. By Lieut. Commander Z. L. Tanner, U. S. Navy, commanding. Report U. S. Fish Comm., XVI, for 1888, pp. 395–512. [Contains narrative of investigations off the south side of the Alaska peninsula, summer of 1888; off the coasts of Washington, Oregon, southern California, and Lower California, and in the Gulf of California, 1888 and 1889. Includes also report of A. B. Alexander, fishery expert, and chart of Cortes and Tanner banks.]
8. Explorations of the fishing-grounds of Alaska, Washington Territory, and Oregon, during 1888, by the U. S. Fish Commission steamer *Albatross*, Lieut. Commander Z. L. Tanner, U. S. Navy, commanding. Bull. U. S. Fish Comm., VIII, for 1888, pp. 1–95. [In this report the investigations of 1888 are discussed in geographical sequence beginning at the north. It contains two large charts, one covering the fishing-grounds off the south side of the Alaska Peninsula, the other showing the operations on the coasts of Washington and Oregon as far south as Tillamook Rock and on Heceta Bank. The latter chart is now incomplete, much additional work having been done in that region during subsequent years. Recent Coast Survey charts, enumerated below, give full data in this respect. A few places and subjects of fishery interest are illustrated by reproductions of photographs.]

9. Report upon the investigations of the U. S. Fish Commission steamer *Albatross* from July 1, 1889, to June 30, 1891. By Lieut. Commander Z. L. Tanner, U. S. Navy, commanding. Report U. S. Fish Comm., XVII, for 1889-91, pp. 207-342. [Contains narrative of explorations as follows: Southeastern Alaska and coasts of Washington, Oregon, and California, season of 1889; fishing-grounds of Bering Sea, season of 1890; special scientific expedition off the west coast of Mexico, and of Central and South America, 1891.]
10. The fishing-grounds of Bristol Bay, Alaska: A preliminary report upon the investigations of the U. S. Fish Commission steamer *Albatross* during the summer of 1890. By Lieut. Commander Z. L. Tanner, U. S. Navy. Bull. U. S. Fish Comm., IX, for 1889, pp. 279-288. [Contains three charts on a scale sufficiently large to serve for navigation purposes, as follows: Bristol Bay and Alaska Peninsula, showing all the fishing-banks located in the former; Port Moller and Herendeen Bay, and the lower Nushagak River.]
11. A preliminary report on the fishes collected by the steamer *Albatross* on the Pacific coast of North America during the year 1889, with descriptions of twelve new genera and ninety-two new species. By Charles H. Gilbert, Proc. U. S. Nat. Mus., XIII, pp. 49-126, 1890.
12. Descriptions of thirty-four new species of fishes collected in 1888 and 1889, principally among the Santa Barbara Islands and in the Gulf of California. By Charles H. Gilbert, Proc. U. S. Nat. Mus., XIV, pp. 539-566, 1891.
13. Report upon certain investigations relating to the planting of oysters in southern California. By Charles H. Gilbert. Bull. U. S. Fish Comm., IX, for 1889, pp. 95-98. [Illustrated by maps of Alamitos Bay and Newport Entrance, California, and the vicinity of Guaymas, Mexico.]
14. Report upon the pearl fishery of the Gulf of California. By Charles H. Townsend. Bull. U. S. Fish Comm., IX, for 1889, pp. 91-94, 3 plates.
15. Report of observations respecting the oyster resources and oyster fishery of the Pacific coast of the United States. By Charles H. Townsend. U. S. F. C. Rept. 1889-91, pp. 343-372, plates 6-11.
16. Report on the fisheries of the Pacific coast of the United States. By J. W. Collins. Report U. S. Fish Comm., XVI, for 1888, pp. 3-269.
17. Three letters from Alexander Agassiz to the Hon. Marshall McDonald, U. S. Commissioner of Fish and Fisheries, on the dredging operations off the west coast of Central America to the Galapagos, to the west coast of Mexico, and in the Gulf of California, in charge of Alexander. Agassiz, carried on by the U. S. Fish Commission steamer *Albatross*, Lieut. Commander Z. L. Tanner, U. S. Navy, commanding. Bull. Mus. Comp. Zoöl., XXI, No. 4, pp. 185-200, 1891.
18. General sketch of the expedition of the *Albatross*, from February to May, 1891. By Alexander Agassiz. Bull. Mus. Comp. Zoöl, XXIII, No. 1, pp. 1-89, pls. 1-22, including a detailed chart of the explorations, 1892.

CHARTS.

19. Bristol Bay and Alaska Peninsula, Alaska, 1890. Illustrating investigations of 1890 on the fishing-grounds of Bristol Bay and adjacent waters. [Contained in No. 10.]
20. Port Moller and Herendeen Bay, Alaska, 1890. [Contained in No. 10.]
21. Lower Nushagak River, Bristol Bay district, Alaska, 1890. From a reconnoissance made in June, 1890. [Contained in No. 10.]
22. Alaska Peninsula and adjacent islands, 1888. To accompany report on Explorations of Alaskan fishing-grounds, in Bulletin U. S. Commission of Fish and Fisheries for 1888. Represents the fishing grounds south of the Alaska Peninsula from Unalaska to Middleton Island. [Contained in No. 8.]
23. Western coast of the United States from Umpqua River to the boundary. Illustrates the fishing investigations of 1888 on the coasts of Washington and Oregon, but is now incomplete, as much additional work has since been done in the same region. [Contained in No. 8.]
24. Reconnoissance of Cortes and Tanner banks, 1889. [Contained in No. 7.]
25. Hydrographic sketch of the Pacific, from the Gulf of California to northern Ecuador, with the track of the *Albatross*. [Contained in No. 18.]

COAST PILOTS AND CHARTS OF THE U. S. COAST AND GEODETIC SURVEY.

PACIFIC COAST PILOT.

California, Oregon, and Washington, 1889.—This edition does not embody any of the work accomplished by the steamer *Albatross*, having been published at too early a date.

Alaska.—The published edition of the Alaska Coast Pilot is exhausted, and a new edition is now in course of preparation. It will include the results of the *Albatross* investigations on the Alaskan coast to date.

SAILING CHARTS.

5000. San Diego to Point Arena, California. Scale, 1:1,200,000.
5050. San Francisco Bay to the Strait of Juan de Fuca. Scale, 1:1,200,000
6400. Seacoast and interior harbors of Washington, from Grays Harbor to Olympia, including Washington Sound. Scale, 1:300,000.
7000. Cape Flattery, Wash., to Dixon Entrance, Alaska. Scale, 1:1,200,000.
8000. Dixon Entrance to Cape St. Elias, Alaska. Scale, 1:1,200, 000.
8001. Inland passages, Olympia, Wash., to Mount St. Elias, Alaska. Scale, 1:1,200,000.
8500. Icy Bay to Semidi Islands, Alaska. Scale, 1:1,200,000.
S. San Francisco to Bering Sea. Scale, 1:3,600,000.
T. General chart of Alaska. Scale, 1:3,600,000.

GENERAL COAST AND HARBOR CHARTS.

California.

5100. San Diego to Santa Monica, including the Gulf of Santa Catalina. Scale, 1:200,000.
5200. Santa Monica to Point Conception, including the Santa Barbara Channel. Scale, 1:200,000.
5241. Anacapa Island and eastern part of Santa Cruz Island. Scale, 1:30,000.
5300. Santa Rosa Island to Point Buchon. Scale, 1:200,000.
5400. Point Buchon to Point Pinos. Scale, 1:200,000.
5487. Point Carmel to Point Pinos. Scale, 1:12,000. Adjacent to the southern end of Monterey Bay.
5491. Monterey Harbor. Scale, 1:40,000.
5498. Monterey Bay. Scale, 1:60,000.
5500. Point Pinos to Bodega Head, California. Scale, 1:20,000. Includes Monterey Bay and a part of the region off San Francisco.
5581. San Francisco Entrance. Scale, 1:40,000.
5599. Drake Bay. Scale, 1:40,000.
5600. San Francisco to Point Arena. Scale, 1:200,000. Includes a part of the region off San Francisco.
5618. Tomales Bay. Scale, 1:30,000.
5627. Bodega Bay. Scale, 1:30,000.
5700. Point Arena to Cape Mendocino. Scale, 1:200,000.
5800. Cape Mendocino to Point St. George. Scale, 1:200,000.

Oregon.

5900. Point St. George, California, to Umpqua River, Oregon. Scale, 1:200,000.
5952. Cape Orford and Reef. Scale, 1:40,000.
6000. Umpqua River to Cape Lookout. Scale, 1:200,000.
6100. Cape Lookout, Oregon, to Grays Harbor, Wash. Scale, 1:200,000.
6149. Approaches to the Columbia River. Scale, 1:200,000.

Washington.

6100. Approaches to the Columbia River. Scale, 1:200,000.
6149. Approaches to the Columbia River. Scale, 1:200,000.
6265. Cape Flattery. Scale, 1:40,000.

Alaska.

8451. Middleton Island. Scale, 1:130,000.
8881. Semidi Island and Chirikof Island. Scale, 1:400,000.
8881. Shumagin Islands. Scale, 1:447,000, with the following harbor charts: Northwest Harbor, scale 1:122,000; Northwest and Yukon harbors, scale 1:64,000; Simeonof Harbor, scale 1:90,000; Eagle Harbor, scale 1:90,000; Falmouth Harbor, scale 1:65,000.
8891. Harbors in the Shumagin Islands, as follows: Sanborn Harbor, scale 1:40,000; Popof Strait and Humboldt Harbor, scale 1:40,000; Coal Harbor, scale 1:20,000; Zacharefskaia Bay, scale 1:100,000.
8891. Chignik Bay, Alaska Peninsula. Scale, 1:23,000.
8896. Alaska Peninsula and adjacent islands, from Coal Cape to Issannakh Strait. Scale, 1:596,000.
8901. St. Paul Harbor, Kadiak Island. Scale, 1:62,000.
8901. Sannak Islands and Reefs; scale 1:490,000. Acherk Harbor; scale, 1:31,000.
8901. Port Moller, Alaska Peninsula. Scale, 1:133,000.
8901. Iliuliuk Harbor, Unalaska. Scale, 1:9,400.
9007. Captain Bay, Unalaska. Scale, 1:43,000.

CHARTS OF THE UNITED STATES HYDROGRAPHIC OFFICE.

OCEAN CHARTS.

68. Bering Sea and Arctic Ocean.
526. North Pacific Ocean, Sheet I, from the coast of United States to 112° west longitude and from the equator to 29° north latitude, with plan showing streams, currents, and drifts in the Pacific Ocean.
527. North Pacific Ocean, Sheet II, from 110° west longitude to 162° west longitude and from the equator to 63° north latitude.
528. North Pacific Ocean, Sheet III, from 160° west longitude to 150° east longitude and from the equator to 60° north latitude.
823*a*. South Pacific Ocean, Sheet I, eastern sheet, upper part. Includes the Galapagos Islands.

COAST CHARTS.

904. West coast of North America. Latitude 51° 30′ to 55° 30′ N., including the Queen Charlotte Islands, Heceta Strait, and Dixon Entrance.
903. West coast of North America. Juan de Fuca Strait to Queen Charlotte Islands, including Vancouver Island.
961. Southern part of Vancouver Island and adjacent coast. (From Barclay Sound on the south to Nanoose Harbor on the north, and including Juan de Fuca, Haro, and Rosario straits, the adjacent islands, and coasts of Washington and British Columbia from Cape Flattery to Burrard Inlet).
1006. Pacific coast of the United States and Mexico. San Francisco, Cal., to San Blas, Mexico. [Includes Gulf of California, the Revillagigedo Islands, etc.]
1007. Pacific coast of Mexico and Central America. San Blas to Panama and the west coast of the United States of Colombia to Port Buenaventura.
619. West coast of Mexico and Gulf of California. Latitude 29° 15′ N., to San Diego and mouth of the Colorado River, including both coasts of Lower California.
620. West coast of Mexico and Gulf of California. Latitude 26° N. to 29° 20′ N., including both coasts of Lower California.
621. West coast of Mexico and Gulf of California. Cape San Lucas and Mazatlan to latitude 26° N., including both coasts of Lower California.
622. West coast of Mexico. Mazatlan to Tenacatita Bay, and the Revillagigedo Islands.
933. West coast of Mexico. Chamela Bay to Maldonado.
932. West coast of Mexico. Maldonado to Ocos River.
1176. Coasts of Colombia and Ecuador. Panama to Cape San Francisco.
1018. West coast of Central America. Burica Point to Morro Puercos.
1019. West coast of Central America. Morro Puercos to Cocalita Point, Gulf of Panama.
1216. The Hawaiian Islands, with the islands and reefs to the westward. [Contains data from cable survey by steamer *Albatross*, winter of 1891–92.]
867. Southern part of Oahu [Contains data from cable survey by steamer *Albatross*, winter of 1891–92.]

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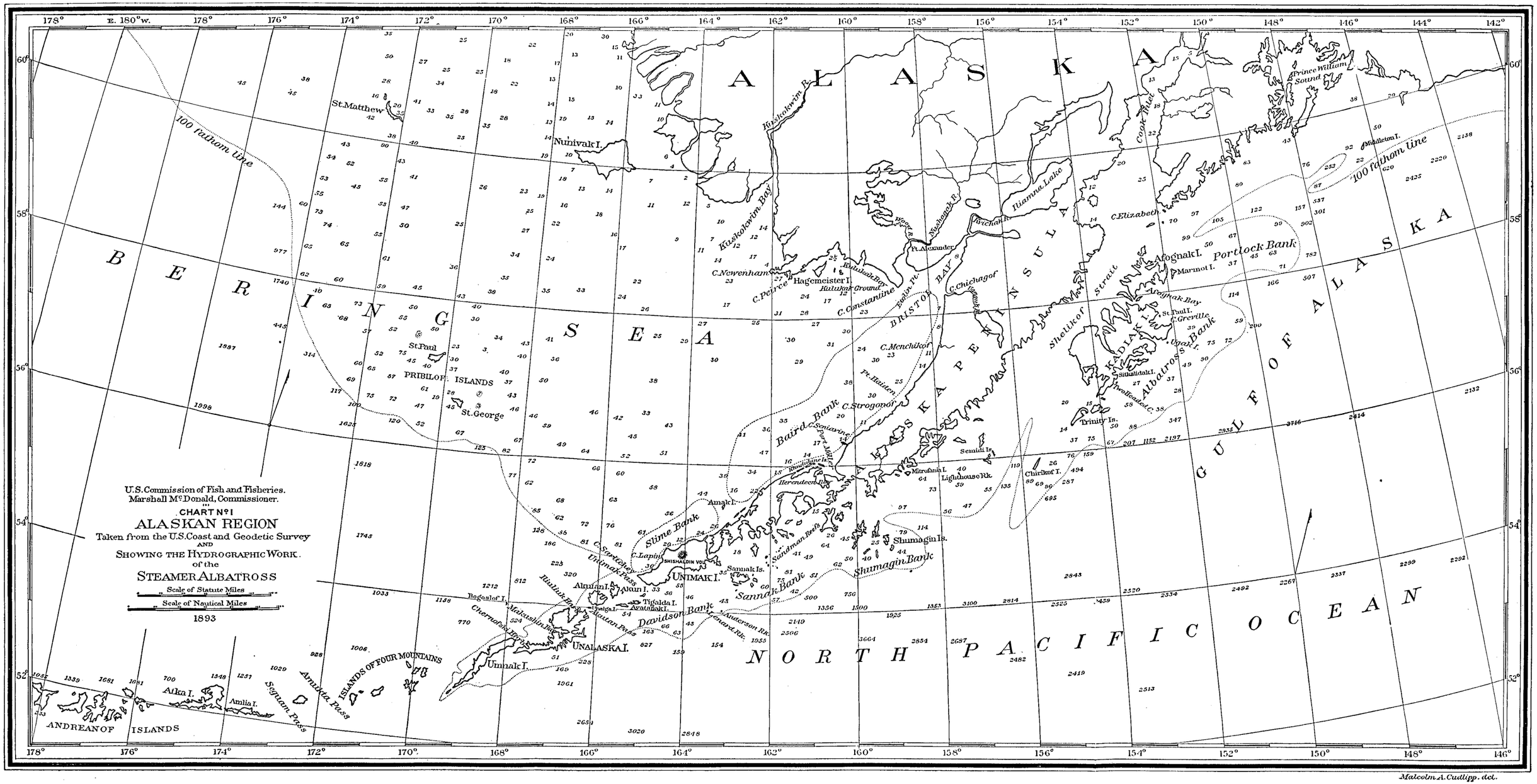
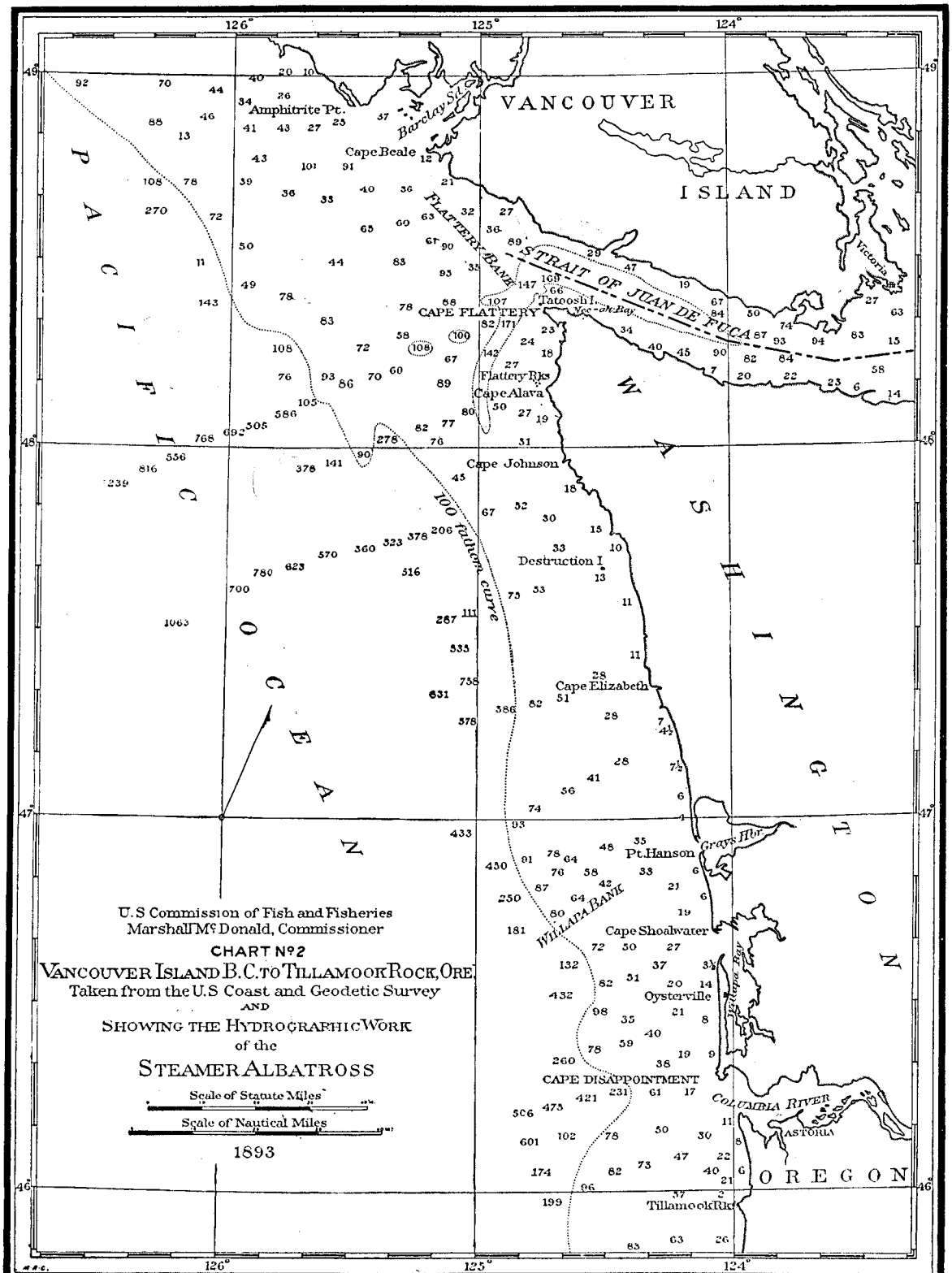


Malcolm A. Cudlipp, del.



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

CHART No 2

VANCOUVER ISLAND B.C. TO TILLAMOOK ROCK, ORE.

Taken from the U.S Coast and Geodetic Survey

AND

SHOWING THE HYDROGRAPHIC WORK

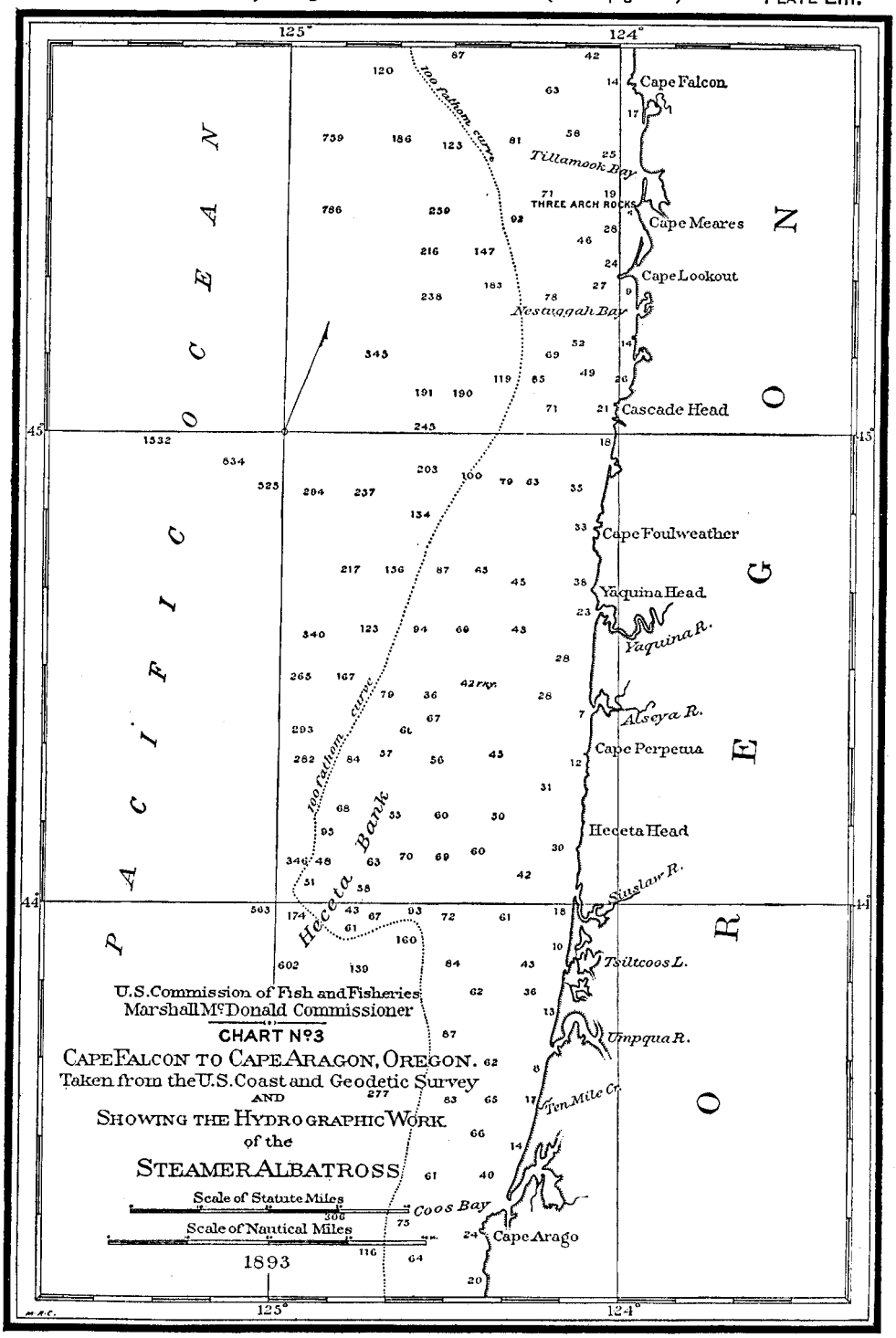
of the

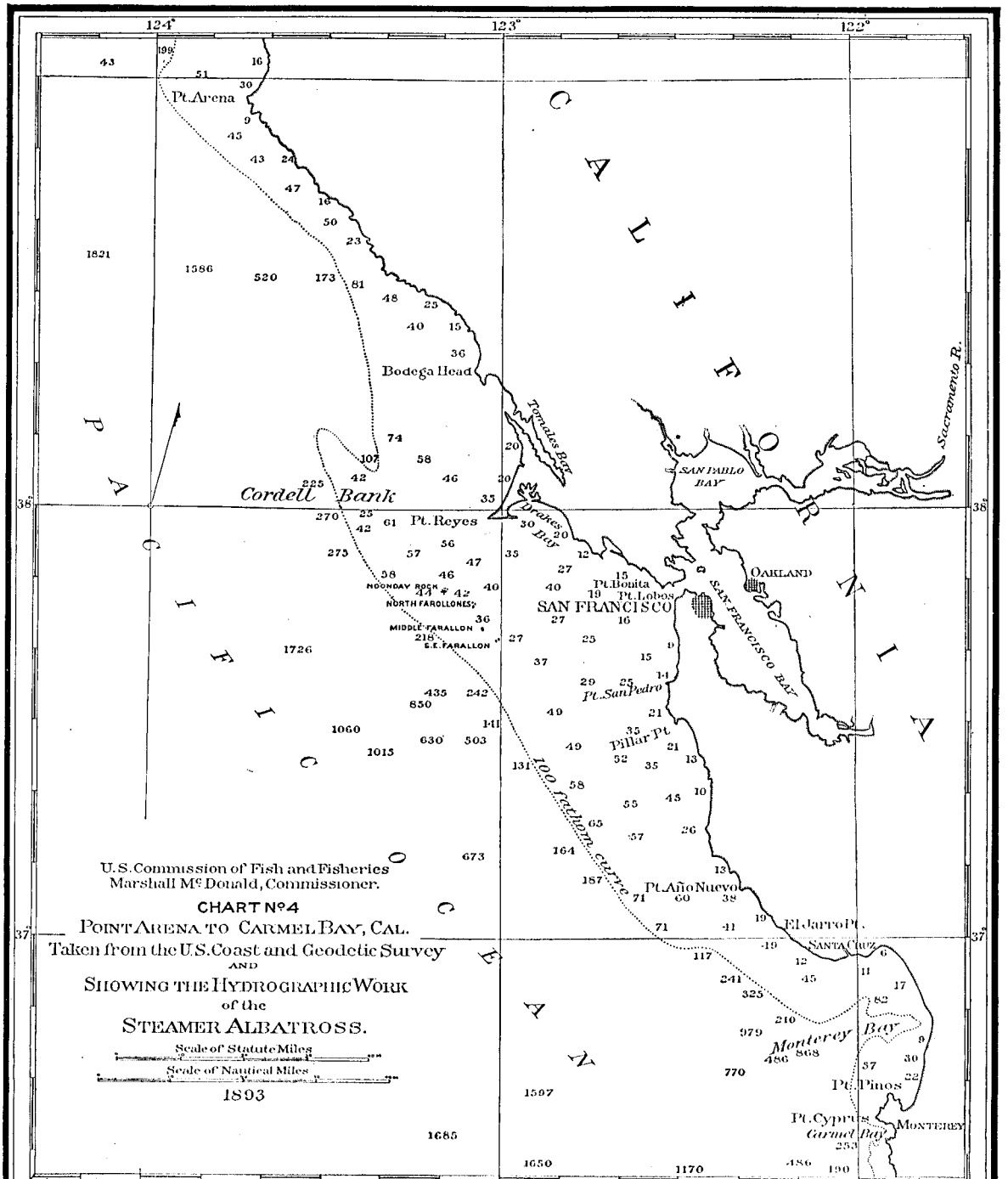
STEAMER ALBATROSS

Scale of Statute Miles

Scale of Nautical Miles

1893


125°
124°
45°
44°
PACIFIC OCEAN
OREGON
100 fathom curve
Tillamook Bay
THREE ARCH ROCKS
Cape Falcon
Cape Meares
Cape Lookout
Nestuggah Bay
Cascade Head
Cape Foulweather
Yaquina Head
Yaquina R.
Alsea R.
Cape Perpetua
Heceta Head
Siuslaw R.
Tsiltcoos L.
Umpqua R.
Ten Mile Cr.
Coos Bay
Cape Arago
Heceta Bank
U.S. Commission of Fish and Fisheries
Marshall McDonald Commissioner
CHART No 3
CAPE FALCON TO CAPE ARAGON, OREGON.
Taken from the U.S. Coast and Geodetic Survey
AND
SHOWING THE HYDROGRAPHIC WORK
of the
STEAMER ALBATROSS
Scale of Statute Miles
Scale of Nautical Miles
1893



U.S. Commission of Fish and Fisheries
Marshall Mc Donald, Commissioner.

CHART No 4

POINT ARENA TO CARMEL BAY, CAL.

Taken from the U.S. Coast and Geodetic Survey

AND

SHOWING THE HYDROGRAPHIC WORK

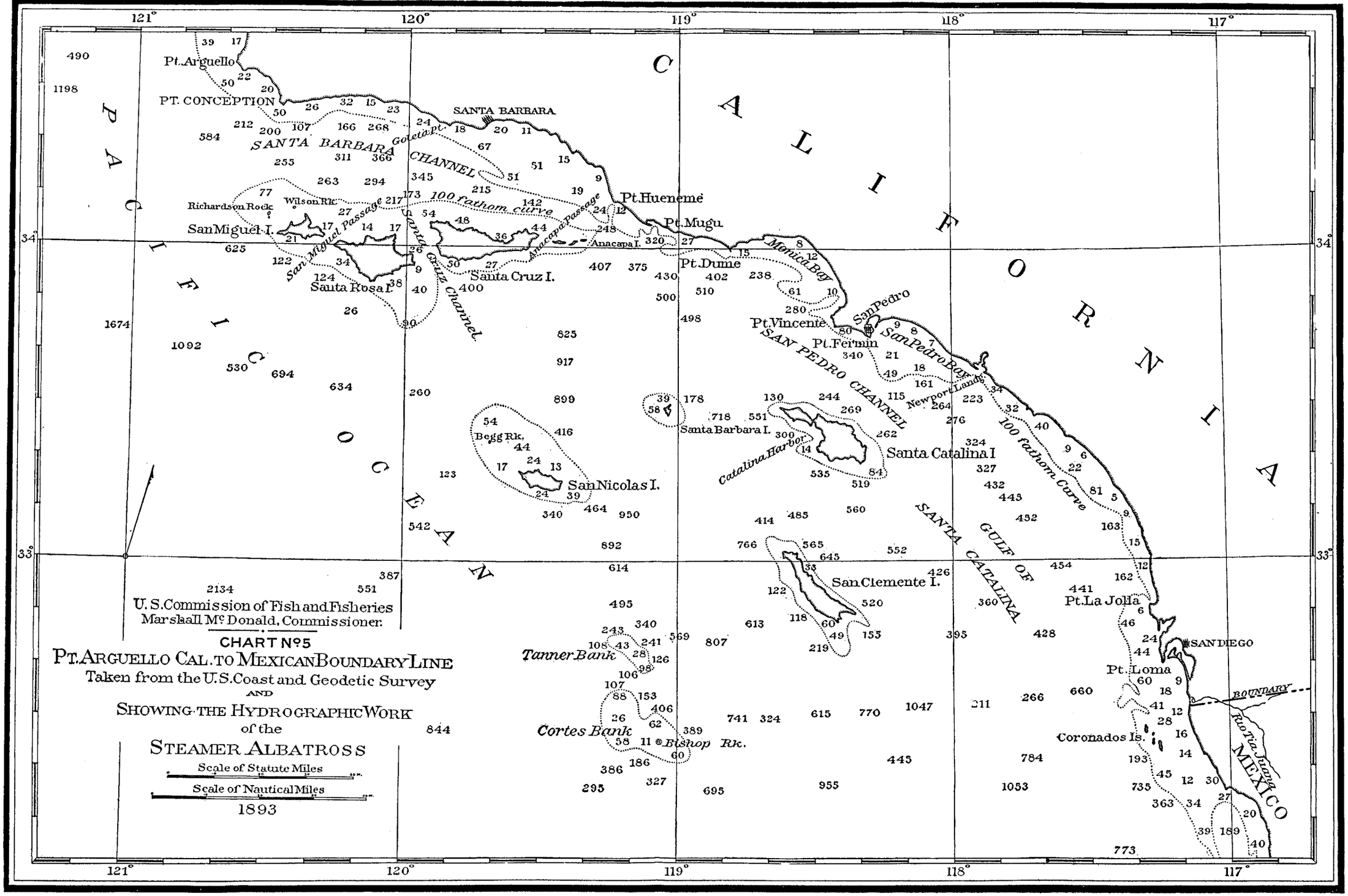
of the

STEAMER ALBATROSS.

Scale of Statute Miles

Scale of Nautical Miles

1893



U. S. Commission of Fish and Fisheries
Marshall Mc Donald, Commissioner.

CHART No 5

PT. ARGUELLO CAL. TO MEXICAN BOUNDARY LINE

Taken from the U. S. Coast and Geodetic Survey

AND

SHOWING THE HYDROGRAPHIC WORK

of the

STEAMER ALBATROSS

Scale of Statute Miles

Scale of Nautical Miles

1893