56TH CONGRESS, 1st Session. } SENATE. { DOCUMENT No. 120.

SURVEY OF COASTS OF UNITED STATES, ETC.

LETTER

FROM

THE SECRETARY OF THE TREASURY,

TRANSMITTING,

IN RESPONSE TO RESOLUTION OF THE SENATE OF DECEMBER 20, 1899, A REPORT BY THE SUPERINTENDENT OF THE UNITED STATES COAST AND GEODETIC SURVEY RELATIVE TO THE PROGRESS AND PRESENT STATE OF THE SURVEY OF THE COASTS OF THE UNITED STATES, INCLUDING ALASKA, AND WHICH HAVE BEEN INAUGURATED ON THE ISLANDS UNDER THE JURISDICTION OF THE UNITED STATES, ETC.

JANUARY 29, 1900.—Referred to the Committee on Coast and Insular Survey and ordered to be printed.

TREASURY DEPARTMENT,
OFFICE OF THE SECRETARY,
Washington, D. C., January 22, 1900.

SIR: In response to the Senate resolution of December 20, 1899, I have the honor to transmit herewith a report by the Superintendent of the United States Coast and Geodetic Survey, which embodies a reply to the resolution and certain recommendations called for, which have received my full concurrence.

It will be noted that so far as Puerto Rico, Hawaii, and the smaller island groups under the jurisdiction of the United States are concerned, the resources of the Survey are adequate to complete their survey quickly and economically.

In the case of the Philippine Islands, the problem is a much larger one and presents altogether different responsibilities. I respectfully recommend that the Secretary of the Treasury be authorized to establish a suboffice of the Coast and Geodetic Survey in Manila for the inauguration, upon a systematic plan, of the coast survey of those islands.

In view of the unsettled political and social conditions existing there, and in view of the fact that these islands are under military government, I respectfully suggest that, in case such authority is granted, an Executive order of the President defining the relation which this suboffice shall bear to the existing government will enable the Secretary

of the Treasury to carry out the direction of Congress in the most efficient manner. While such surveys must ultimately, in my judgment, form a charge upon the revenues of the islands, the preliminary steps for collection of data and the inauguration of such an office can be provided by a small addition to the present estimates.

I respectfully urge upon Congress the importance of maintaining in good order the coast-survey fleet of vessels, some of which date back to the time of the civil war, and which should be replaced at once by modern ships of small draft if the work is to be quickly and economically pushed.

Respectfully,

L. J. GAGE,
Secretary of the Treasury.

The PRESIDENT OF THE SENATE.

TREASURY DEPARTMENT,
OFFICE OF THE COAST AND GEODETIC SURVEY,
Washington, D. C., January 18, 1900.

SIR: On December 20, 1899, the United States Senate passed the following resolution:

Resolved, That the Secretary of the Treasury be, and he is hereby, directed to submit to the Senate of the United States a report on—

1. The progress and present state of the survey of the coasts of the United States, including Alaska.
2. The present condition and progress of surveys which may have been inaugurated on the islands now under the jurisdiction of the United States.
3. His recommendations as to further surveys in said islands.
4. The bearing of the recommendation contained in his last annual report on the use of the metric system of weights and measures in the proposed surveys of said islands.

This resolution having been referred to me for report, I have the honor to submit in reply the following statement for your consideration:

THE PROGRESS AND PRESENT STATE OF THE SURVEY OF THE COAST OF THE UNITED STATES, INCLUDING ALASKA.

Inasmuch as the full and detailed Annual Report of the Superintendent of the United States Coast and Geodetic Survey for the fiscal year ending June 30, 1899, has been submitted to Congress in compliance with law, it is assumed that only a brief general statement in reply to the first paragraph of the resolution is desired, which shall show in brief the present state of the surveys of the coast of the United States, including Alaska.

The object of surveys of the coast, as defined by existing law, is to furnish the information needed to commerce and in defense.

A survey sufficiently complete to furnish this information requires a hydrographic development showing the depth of water in the approaches to the coasts, on the bars, and in the harbors and estuaries frequented by navigators, a careful location of hidden dangers, whether they be rocks or shoals, and whether they are permanent or shifting.

There is also required a knowledge of the tides and currents whose bearing on the needs of the navigator is patent to everyone. A togographic survey of the shores is needed in order that the sailor may

identify the locality through natural and artificial aids to navigation on shore, for defensive purposes, for showing the facilities of commerce, and for the study of harbor improvements. The triangulation is the mensurational part of the survey on which the correctness of the hydrographic and topographic representations depend, and which properly connects in distance and bearing the features of the map. Last but not least in importance, the variations of the needle must be shown and data must be at hand for predicting it in advance.

THE ATLANTIC AND GULF COAST.

The first survey of the Atlantic and Gulf coast has been completed to the extent that we have data that permits the publication of charts of all essential localities. Portsmouth Harbor, New Hampshire, has not been surveyed by this office, but a chart is published from work by the United States engineers some fifty years ago. The delta of the Mississippi is still unfinished. The mouths of the main stream and the river itself to the vicinity of Donaldsonville has been surveyed, but the many outlets to the westward of New Orleans, all of which are a part of the approaches to that great commercial city, are yet to be developed.

There are also a number of localities where the topographic work is very deficient, especially on the Hudson and Potomac rivers. The latter being the approach to the national capital, it seems unfortunate that the only survey of it is the meager representation that was obtained under the pressure of the situation during the late civil war. It embraces only the mere outline of the river, with the necessary soundings to show the channels and shoals.

Topography in the vicinity of Washington—in fact, extending to Baltimore and the shores of Chesapeake Bay—should also be provided in consonance with the general scheme of the work of the survey to include the purposes of defense, as well as chart making.

There are other areas of similar character at the centers of commerce along these coasts that should receive the same treatment.

There have been many interruptions in the progress of the original work in order to provide resurveys of those localities where extended changes have taken place through natural causes, or by reason of improvement and works of construction authorized by acts of Congress. Among the most important of these have been the harbors of Portland, Boston, and New York, the resurvey of Nantucket Shoals, Long Island Sound, Delaware Bay and River to Philadelphia, and, farther to the south, the entrance to Chesapeake Bay, Charleston entrance, Tybee, Fernandina, and Mobile.

It is difficult to overestimate the value of the original surveys in view of the many purposes for which they are used, not the least being the basis for estimates for improvements in the numerous instances authorized by act of Congress in the river and harbor bills.

The resurveys have been equally valuable in this connection, and there can be no question but that the policy heretofore pursued by this office, to execute such resurveys promptly when the information received indicates their necessity, should be strictly adhered to.

Resurveys are also required at Charleston, Fernandina, St. Johns River, Key West, Mississippi Sound, Southwest Pass of the Mississippi River, and Galveston, besides many places of less importance.

The exploration of the Gulf Stream has resulted in deep-sea sound-

ings throughout its course from the Windward Islands to New Brunswick, including a part of the Caribbean Sea and the whole of the Gulf of Mexico. Current observations were made through the passages of the Windward Islands, in the Yucatan Channel, the Straits of Florida, and some other localities, also many observations of temperature and density. Further explorations of this important ocean current are needed.

The future work of the Survey on these coasts must necessarily be confined to resurveys, with the exception of the small areas heretofore indicated and the further development of the Gulf Stream. These resurveys are now of more importance than formerly, as the deep draft vessels of the present time require that they should be made in greater detail than was necessary in the early days before such vessels were constructed. The work of construction at the entrance of many important harbors materially change the conditions, and while the actual channels that have been improved are carefully watched by the engineers in charge of these works they rarely extend their operations to the surrounding areas, and it seems to be essential that such surveys be made as will demonstrate the changes outside the mere channels.

THE PACIFIC COAST.

On the Pacific coast the progress has been very similar to that described on the Atlantic and Gulf coasts. The whole coast line has been surveyed, but there are places north of the California boundary where finished work was deferred until the country should become more settled and it could be carried on more economically. A careful, plane-table reconnoissance, however, was made of these places that answered for all practical purposes for the present and can be extended in the future. Additional work is also required on the Columbia River, in the Straits of San Juan de Fuca, and on the eastern shore of Washington Sound. Resurveys on this coast have embraced San Diego Harbor, San Pedro Entrance, San Francisco Bay, and some of the smaller inlets. At the entrances to the northward of San Francisco the bars are usually composed of shifting sand, requiring frequent examination and consequent corrections of the charts. On the Pacific coast, between San Diego and the Straits of Fuca, the work yet to be accomplished, and which will occupy the Survey in the future, is very similar to that on the Atlantic and Gulf coasts.

ALASKA.

It has been repeatedly pointed out that the shore line of Alaska has an approximate extent of about 26,000 miles, exceeding that of the Atlantic, Pacific, and Gulf coasts by over 11,000 miles. The islands along its coast are estimated to be 1,100 in number. A course parallel with the trend of the shore from Cape Muzon, its most southerly point, to Point Barrow, its most northerly one, is about 2,800 miles.

The Aleutian chain of islands is about 1,100 miles long, and Attu, the most westerly one of this group, is over 2,000 miles west of Sitka. The foresight and judgment which this Government displayed in the acquisition of the territory bounded by this vast shore line is reaping its reward by the developments which are now taking place in that territory. As it is separated from the United States by foreign territory its commerce will always remain coastwise.

The southeastern waters have been charted with sufficient accuracy for the purposes of passing commerce, with the exception of some of the westernmost shore line of some of the islands forming the great archipelago between Dixon Entrance and Icy Straits.

The topographic features, however, have been largely sketched, and ultimately a more accurate topographic survey of the islands will have to be made. The triangulation may serve as the basis for land surveys, as has been suggested by officials of the General Land Office, and will therefore prove to be of great value on that account, though not originally designed for that purpose.

To the westward and northward of this region a few miles of shore line have been surveyed around Yukatat Bay; the mouth of the Copper River has been developed; a beginning has been made in Prince William Sound; the survey of the delta of the Yukon, one of the great rivers of the world, but hitherto practically unknown to the cartographer, has just been completed; a hydrographic development has been made, extending from this delta to Cape Nome.

This last-named region is now attracting wide attention on account of the extraordinary gold development. Gold appears to have been found along a region extending for 200 miles from Cape Prince of Wales eastward to Norton Sound. It is believed that the number of people which will visit this region in the coming spring will be limited only by the transportation facilities afforded them. Assuming this to be true, it is quite evident that a population not less than 20,000 people will be gathered there during the coming winter, and that they will look anxiously for a means of communication from these ice-bound shores with the outer world.

It seems desirable, therefore, to investigate at once the possibilities of some harbor along the southern limits of this ice-bound region which will remain open at all seasons of the year.

With the exception of the points enumerated and a few local surveys, our charts are but the reproduction of early Russian and British surveys, which in the nature of things are uncertain and incorrect. A survey of the passages of the Aleutian Islands is urgently needed, and surveys of harbors of refuge, and of all harbors through which commerce goes on, is called for. This is true also of the region of Cook Inlet and wherever accessible coal beds have been discovered.

The discovery of an accessible pathway into the interior of Alaska by way of Valdez emphasizes the necessity for accurate surveys in the region of Prince William Sound.

Magnetic, tidal, and current observations are needed equally with the tracing of the shore line and the development of the hydrographic features of all these shores.

The work of the Survey in this region is being pushed by this office with all possible dispatch. During the past season five Coast Survey vessels were at work in Alaskan waters, and a large amount of valuable charting was completed. This work will be continued as rapidly as the resources of the Survey will admit.

CARTOGRAPHIC RESULTS.

The cartographic results of all this work is shown on about 500 charts. These charts are distributed to all Government Departments on application to the superintendent, and are sold to the public at the

cost of printing and paper. The distribution of charts for the past five years has been as follows:

Fiscal year.	Number distributed.	Receipts.[1]
1895	51,456	$11,773.10
1896	64,541	12,402.75
1897	57,188	11,166.20
1898	103,588	14,528.20
1899	83,197	15,696.30

[1] Including tidal tables and coast pilots.

MAINTENANCE OF CHARTS.

It seems in place here to call attention to the fact that the constant changes in artificial aids to navigation and the ever varying channels of the bars and harbors require corresponding changes on this great number of charts. In this way a large part of the energy of the Survey is absorbed in keeping the surveys up to date in order that the confidence which the maritime public reposes in them may not be misplaced.

Through the courteous and systematic cooperation of the Chief of Engineers and the Light-House Board, the information obtained by these separate establishments which affects our coast charts is at once communicated to this office and utilized. Notwithstanding this cooperation, the coastwise resurveys alone, which are continually required, necessitate the maintenance of a small but thoroughly equipped fleet of vessels.

CONDITION OF THE VESSELS.

The following vessels are now borne on the rolls of this office:

Name.	Class.	Tonnage.
ATLANTIC COAST.		
G. S. Blake	Steamer	234
A. D. Bache	do	182
Endeavor	do	86
Eagre	Schooner	191
Matchless	do	94
Quick	do	38
Transit	do	21
Spy	do	17
PACIFIC COAST.		
Pathfinder	Steamer	469
C. P. Patterson	do	453
Gedney	do	174
McArthur	do	130
Cosmos	do	25
Taku	do	25
Yukon	do	25

The condition of the vessels on the Atlantic coast, owing to their age and hard service, has already been reported to the Secretary of the Treasury and recognized by him in certain recommendations to Congress that the steamer *A. D. Bache* be rebuilt and that a small additional steamer for the use of the coast pilot be provided. At present the *G. S. Blake* is the only seaworthy steamer on the Atlantic coast. The rehabilitation of this small fleet is urgently required in the interest of economy.

NOTICES TO MARINERS.

In advance of entering upon the charts themselves the changes which are constantly occurring this office publishes widely distributed "Notices to Mariners" of changes affecting the charts which may have been issued, and as an auxiliary to the use of the charts.

COAST PILOTS.

A series of books called "Coast Pilots," and covering the Atlantic and Gulf coasts, have been published, and they, like the charts, require continual correction and additions.

The preparation of suitable Coast Pilots for the Pacific coast and the coast of Alaska is now in hand.

MAGNETIC OBSERVATIONS.

In addition to the topography along the shore, the lights and buoys, the depth and character of the bottom of the sea, the rise and fall of the tides, an essential feature of the chart is the variation of the compass for each particular location in question.

Since the establishment of the Coast Survey systematic observations of the magnetic constants have been made in order to enable the office to predict the fluctuations of the needle. The investigations of the laws governing the magnetic phenomena is, however, of much wider usefulness than has here been set forth.

The continued appeals to this office for information from surveyors and civil engineers throughout the country attest the correctness of this statement. The extension of the magnetic observations to the sea is urgently demanded in order to perfect our knowledge. It is not deemed necessary to enter into the full consideration of this subject here. It is only intended to point out that it has received the earnest and careful consideration of competent men, and that as a result appropriations have been asked for to enable this office to keep abreast of the times, and to enable this Government to do its share in similar work undertaken by foreign governments.

TIDE TABLES.

Formerly this office published only predictions for the various phases of the tide along our own coasts and Alaska, but the extension of our commerce required the compilation, in one volume, predictions for all the principal ports of the world. Such a publication has been issued for a number of years. It has been rendered possible by the courteous cooperation of foreign governments in furnishing the results of tide observations in their respective ports, observations which represent the labor of years, and which having been brought together in one volume, subserve the uses of commerce throughout the world. But, valuable as these tables are, they in the main foretell only the times of high and low water and the range of the rise and fall of tide.

CURRENTS.

As yet the very important feature of the currents in our harbors and along our coasts, the time of whose occurrence and the velocity of whose flow is of the utmost importance to the navigator, remain to

be investigated and to be published on the charts and in the tide tables. For this reason alone the fleet of vessels should be maintained in all the perfection which modern science can suggest.

"PRESENT CONDITION AND PROGRESS OF SURVEYS WHICH MAY HAVE BEEN INAUGURATED ON THE ISLANDS NOW UNDER THE JURISDICTION OF THE UNITED STATES."

In reply to paragraph 2 of the Senate resolution to insure brevity by avoiding repetition, a few fundamental considerations are submitted before treating of the surveys in the individual islands. It is considered of prime importance that before taking up these surveys the general method on which they are to be conducted should be approved.

CHARACTER OF THE SURVEYS.

The surveys under consideration are to be mensurational. Their foundation in each case must be a general trigonometric survey on which all others are to be based.

As in the case of the great trigonometric survey of India, in the surveys of Great Britain and the European Continent, and as in the case of the United States the trigonometric surveys will form the connecting link between such local surveys as expediency may require to be made, either in advance of the general trigonometric work or which will follow it in the advance of civilization.

Most urgent are the coast surveys, which will be primarily for the safety and purposes of navigation. Simultaneously with these, tidal, current, and magnetic observations are required. A rapid triangulation along the coast will be necessary to furnish the basis of the chart. This triangulation will also serve as a basis for the topographic and geological work of the United States Geological Survey.

GENERAL STATEMENT.

The work of the Coast and Geodetic Survey was by the last Congress extended to embrace all "islands under the jurisdiction of the United States."

It will be seen from the foregoing statement that the resources of the Survey are sufficient to deal with the question of triangulation and coast surveys in Puerto Rico and its neighboring islands, the Hawaiian group, the Samoan Islands, and other small possessions in the Pacific.

The case of the Philippines, however, presents an entirely new problem, and one of such magnitude that it can be successfully dealt with only by establishing an office in Manila and by detailing trained officers to supervise such native assistants as may be found capable of this work, the expense to form a charge upon the revenues of the island and to be under the general control of the governor-general.

PUERTO RICO.

It is well known that the existing charts of Puerto Rico are exceedingly incorrect. It was probably due to the recognition of this fact that the Secretary of the Navy, in August, 1898, requested the Coast and Geodetic Survey to begin the survey of this island. As soon as

practicable a vessel was dispatched to the southern shore and the surveys begun. At the present time two of the vessels of this survey have been ordered there to work in cooperation with two other surveying parties which are continuing on land the work begun last year.

About 50 miles, including the harbor of Ponce and extending to he eastward have been charted; the entrance to and the anchorage in the harbor of San Juan has also been surveyed and resulting maps have in part been published. The surveys which have thus been undertaken are for the purposes of commerce and defense. A trigonometric survey over the whole island should follow, in order that topographic maps of the interior may be made speedily.

For many years a Spanish hydrographic commission was engaged in surveys of the island, but with the exception of a chart of the harbor of San Juan no accurate results have been published. The data of a trigonometric survey made by them, so far as they have fallen under the inspection of this office, is not deemed of sufficient accuracy to subserve the purposes of a basic survey.

Inasmuch as no accurate map of Puerto Rico and the outlying islands exists the trigonometric survey before referred to is being rapidly made. The cadastral feature of such a trigonometric survey, in the absence of any good maps, is of very great importance.

The general survey of the island can be conducted readily and economically by this office, but the cadastral work should be left to the island authorities, under proper guidance, if necessary.

For this purpose this office will be prepared to furnish the coordinates of the geographical positions determined and descriptions of stations to the local authorities, as well as for the use of other departments of the Government engaged in topographical or geographical surveys.

CUBA.

The remarks concerning lack of accurate knowledge of the hydrography and topography of Puerto Rico apply as well to the island of Cuba. To furnish the information which is involved in the development of this island a systematic survey needs to be made which should finally furnish the data upon which the mineral and agricultural resources of the island may be sketched. Valuable additions to our knowledge of the harbors of the island have been made by the work of the naval survey vessels *Yankton* and *Eagle* during the past year.

The matter of the systematic survey of this island will doubtless be considered by the governor-general, and some recommendations from him as to the organization and conduct of such survey would naturally form the basis of any further action.

THE HAWAIIAN ISLANDS.

The Hawaiian Government has maintained for years a trigonometric survey under the direction of Prof. W. D. Alexander. Almost from its beginning the Hawaiian survey has been conducted in cooperation with the Coast and Geodetic Survey, and its operations have been aided by the loan of instruments, the detail of observers, and in other ways.

Under Mr. Alexander an excellent trigonometric survey of the principal islands has been practically completed. The knowledge of the

general topography, as shown by this survey, is shown on Coast Survey Chart No. 4100.

Our knowledge of the harbors and of the adjacent waters is, however, very deficient. Surveys of Honolulu Harbor and of Pearl Harbor have been made by the Navy Department and by the British admiralty, and to these two organizations is due our present limited knowledge of the hydrography of the islands.

At present the Coast Survey steamer *Pathfinder*, the newest and best equipped vessel of the Survey, is at work on the surveys of Hilo and Kahului harbors, points at which the local authorities deemed surveys most urgent. These surveys will be prosecuted as rapidly as appropriations will admit.

It is the intention to send vessels working in Alaska in the summer to Hawaii and other islands of the Pacific for winter work.

It is recommended that employees now employed in the Hawaiian government survey be made eligible for appointment to similar positions in the Coast and Geodetic Survey as opportunity may occur.

THE SAMOAN ISLANDS.

The existing charts of this whole group of islands are based on surveys made by the Wilkes exploring expedition in 1838–1842. These have been supplemented by local hydrographic surveys made by the British and Germans. The harbor of Pago Pago, on Tutuila, which is under the jurisdiction of the United States, has been surveyed by officers of the United States Navy, and is doubtless an important naval station.

The approximate area of the islands involved is as follows:

	Square miles.
Tutuila	40
Manua	15
Ofoo	1.6
Oloosinga	.4
Minor islands	.5
Total	57.5

The survey of this small group of islands can be quickly and economically completed during the winter months by vessels which in summer are at work in Alaska, and without addition to the estimates already submitted.

GUAM.

The island of Guam has an area of about 175 square miles. Our present knowledge of the cartography of the island is based on British and Spanish hydrographic surveys, and is shown on Coast Survey Chart No. 4202. The small area indicates that an expedition could complete a satisfactory survey in a short time at no great expense.

WAKE ISLAND.

Wake Island, according to the Wilkes exploring expedition, is a low coral island of triangular form and 8 feet above the surface. This report is contained in Volume V, page 268, from which the following abstract is also taken:

From appearance the island must at times be submerged, or the sea makes a complete breach over it. The appearance of the coral blocks and of all the vegetation

leads to this conclusion, for they have a very decided inclination to the eastward, showing also that the violent winds or rush of water when the island is covered is from the westward. The reef around the island is very small in extent.

MIDWAY.

These two small islands are situated on an atoll, the encircling reef being 18 miles in circumference and without an opening except on the western side. This gap is about 3½ miles in width, but is closed to navigation on account of shoals and detached rocks except at the entrance to Welles Harbor, which is three-fourths of a mile broad.

Eastern Island is at the eastern extremity of the reef, is 1¼ miles in length, three-fourths of a mile wide, from 6 to 15 feet high, and covered with coarse grass.

Sand Island is 1¼ miles west of Eastern Island, is 1½ miles long, three-fourths of a mile wide, and 57 feet high. There is very little vegetation on the island.

THE PHILIPPINES.

At the instance of the Philippine commission, the Department of State requested the Coast and Geodetic Survey to undertake the reproduction of a series of maps of the islands composing the Philippine archipelago.

These maps, now in the course of publication, were prepared recently by the jesuit fathers at Manila at the request of the Philippine commission, and it is supposed that they represent the present state of our knowledge in regard to the general cartography of the islands. Aside from original information in possession of the jesuit fathers, which has been incorporated in these maps, the sources of information appear to be maps published by Don Enrique de Almonte and Don Enrique Abella.

It may be assumed that the general basis of these maps are the surveys made by English and Spanish hydrographers, and published by the admiralty and the Spanish hydrographic commission. As far as can be judged, the topographic representations are compiled largely from unofficial sources and can not be accepted as accurate.

In regard to our knowledge of the waters of this vast archipelago, of the dangers to navigation, and the safe anchorages which are of vital importance to commerce, we have better knowledge of the sources of information. What these sources are is shown in a translation taken from the official Directory of the Philippine Archipelago, published by the Spanish hydrographic commission. This paper professes to trace the history of the hydrographic surveys and explorations from the earliest time to the year 1879, but an examination of the most modern charts indicates that what was said in that report in regard to the condition of the survey in 1879 is still applicable to the condition of affairs in the present year, notwithstanding the fact that a hydrographic commission was organized in the Philippines at so early a date as 1834. It is doubtless true that the unsettled social and political conditions in that great archipelago retarded the survey in these islands. It is none the less true, however, that the work appears to have been done in a desultory and unsystematic way and that it is largely owing to this fact that the results are so very unsatisfactory.

Looking at the most recent charts, it appears that the eastern coast of Luzon, the shores of Samar and Leyte, and those of the great island of Mindanao have hardly been touched.

In addition to the general hydrographic charts of the archipelago, numerous local charts, based on British and Spanish surveys, more or less accurate, have been published, and these will continue to be the only ones available until the work of surveying is resumed. The area of the Philippine Islands is estimated to be about 119,000 square miles. The islands and islets number over 1,700, and the extent and intricacy of the shore line is very great. The archipelago extends about 1,000 miles in a north and south and about 600 in an east and west direction. (See Appendix A.)

The magnitude of the work to be done is such that much time will be required to produce charts that may be considered efficient to insure the safety of navigation.

Owing to the remoteness of these islands, and the necessity for continuity of plan and action, it is recommended that this Survey be authorized to establish a suboffice in the Philippines for the purpose of inaugurating a systematic coast and trigonometric survey, similar to our own in its function, and which will, therefore, include, besides its hydrographic and topographic features, the systematic observations of the tides and currents and of the magnetic elements. Such survey will not only furnish the information now needed for commerce, but would form the basis for any topographic or geological mapping inaugurated by other departments.

To carry this out successfully the resources of the islands should be largely drawn upon. Native surveyors and engineers should be employed and trained to this special work, and the cost of the surveys and of the publication of their results should form a charge upon the revenues of the islands. This Government, however, should appropriate enough money to render the inauguration of the survey successful and to pay the salaries of its officials who are intrusted with the direction of the work. Duplicates of the records and results should be forwarded to Washington, and their publication in this country should not be excluded though provision be made for their advance publication by the local office in the Philippines. It goes without saying that this work would be performed under direction of the governor-general.

METRIC SYSTEM OF WEIGHTS AND MEASURES IN THE PROPOSED SURVEY OF SAID ISLANDS.

The military authorities in Puerto Rico have already directed that the metric system of weights and measures established by Spain should remain in force in that island. As the system has been legalized in the United States, and in view of the action taken, it is recommended that the national surveys should also employ that system. In view, however, of the fact that the hydrographic charts issued by this Government give soundings in feet and fathoms, conformity with this custom is recommended for the present and until further legislation by Congress in regard to weights and measures requires a change to be made.

The same remarks apply to surveys in the Philippines, except that publication by the proposed local office in the Philippines may be entirely metric.

HENRY S. PRITCHETT,
Superintendent.

The SECRETARY OF THE TREASURY.

APPENDIX A.

NOTE ON THE STATE OF THE HYDROGRAPHY IN THE PHILIPPINE ARCHIPELAGO, AND OF THE DIFFERENT RECONNOISSANCES THAT HAVE BEEN MADE THERE FROM THE EARLIEST TIMES TO THE PRESENT.

[Extract from the Derrotero del Archipelago Filipino. Madrid, 1879. Appendix No. 3, pp. 1201-1207.]

The oldest document that we possess of this kind is the map by P. Murille Velarde, a Jesuit historian, which was published in Manila in 1744, and which gives a general idea of the extent of the archipelago and of its islands, but which can in no way be useful for the navigation of its seas and straits.

The little importance which was attached in Spain to these possessions during the long period of domination of the American continent explains why the activity of our sailors was directed, preferably, to other regions. The famous expedition of Malaspina among these islands during the years 1792–93 can therefore be considered as the first visit of scientific men especially provided with material suitable for this class of explorations.

Unfortunately, the time at their disposition was not in proportion to the importance and extent of the work undertaken. This was recognized by Malaspina, who, after having established a base for a general reconnoissance and determined the position of a great number of notable points in his ship's course through the archipelago from the north of the island of Luzon to the south of the island of Mindanao, established subaltern commissions, of which assuredly the most notable was that given to the pilot of the armada, D. J. Maqueda. With a small party, and, according to his notes, provided with a bad sextant and timepiece, the latter executed a great number of reconnoissances in the Visayas Islands, which, however, can only be considered as preparatory and as forming a basis for better work to be done later.

All these works of Maqueda, those of Pilot D. G. Delgado on the coast of the island of Mindoro, and those of the Naval Lieut. D. J. Viana in the Polillo Islands, etc., can be regarded as accessory to the expedition of Malaspina; but it may be said, with all respect to those who have preceded us and who have given us the result of their labors, that these parties did nothing more than sketch the passes and straits. Badly provided with resources, isolated, and desiring to accomplish much in a short time and with scant means, they left the navigation between the islands as insecure as before.

A precious document has come down to us from the expedition of Malaspina, in his map of the archipelago, in two sheets, which have been utilized up to the present time, and which honor in an especial way the officers of that celebrated expedition. The royal marine did not figure again in the archipelago, except in a very modest way, after the squadron of General Alava and the expedition of Malaspina had disappeared from those seas. Their work, however, forms an epoch in the history of the country.

When peace was made with England, in 1808, and Spain was free from this powerful rival—which seized, persecuted, and sometimes made prisoners the galleons which brought the resources with which Mexico aided the metropolis in the expense of the administration of the Philippines—the only enemy to commerce and a weak population on the coast was the eternal parasite Jolo, against whom, as a domestic enemy, was created the small Philippine marine out of the resources of the country. It was represented by divisions composed of small launches provided with cannon, and commanded by officers whose other duties were not compatible with hydrographic work, destined as they were to a rough life and constant persecution by and combat with the innumerable pirates that infested the archipelago, and who comprised the population from the epoch stated down to the year 1847.

The introduction of steamers, and the expedition of General Claveria against Balanguingui, now closed this long period of struggle and work; but there were not lacking, during the interval, officers with a good will who dedicated themselves to filling a large void which was felt in the hydrography of these seas in spite of so many inconveniences and difficulties; as, for example, Bernacci, naval captain, who made a map of the strait of San Bernardina, published in 1849, which has been very useful to navigation; Atienca, who executed a reconnoissance of the "silanga" of Iloilo; Vargas, who explored the coast and shore line of Albay, and, finally, Camps, who worked on the coast of Cebu, Tanon, north of Mindanao, etc. These names are associated with useful reconnoissances which are fully appreciated.

In the year 1834 a hydrographic commission of the Philippines was created by royal order. Its direction was given to Naval Capt. D. J. M. Halcon, who has transmitted to us a beautiful chart called the "recalada" (landfall) of Manila, comprised between the parallels of 13° 15′ and 16° north latitude, a very useful work, accompanied by special plans and very interesting descriptions. He also has given us a volume of

descriptions of the coasts which he visited superficially in his voyages to Jolo and Mindanao, and a collection of sheets which he called "elementos."

Interesting as all these reconnoissances and partial labors are, they do not satisfy the necessity of having a general knowledge of the seas of the archipelago. The navigation from Manila to Cebu and Iloilo was uncertain and risky. The sea which is formed on the north of Cebu, Negros, and Panay, between these islands and Masbate, Cibuyan, etc., had not been sounded, neither had the sea of Mindoro; and the same can be said of many other places in the archipelago.

We ought here to make special mention of an interesting work executed in 1845 by the naval division of Admiral Cecile in the Basilan Passage and on this island and adjacent ones together with the canals which they form, and a reconnoissance of Captain Belcher in the same strait at the south of Mindoro and in the Batanas Islands.

The hydrography was in this condition in 1850, when Commander Bate, of the English navy, received from his Government orders to reconnoiter the island of Paragua and the passage included between the western coast of the same and the great series of reefs which appear as another submerged island. This distinguished chief carried out, happily, this important task during the years 1850–1854 on the corvette *Royalist* and auxiliary steam launches, giving as a result a very good complete chart, with the Calamianes Islands taken from the work, which was executed simultaneously by the Spanish hydrographic commission, under the command of the then Ensign D. Claudio Montero.

The commander above named (Bate) was charged with the execution of a chart in the Strait of Balabac, a work which was carried out very successfully during the years 1868–69. Relieved by Commander Chimmo, the latter undertook to complete the reconnoissance of Bate on the western coast of Paragua, and continued his operations on the archipelago of Jolo, where he met, in 1873, the commander of the Spanish hydrographic commission, Naval Lieut. D. M. Villavicencio, who, taken there by the exigencies of the service, was making very interesting reconnoissances of the group of Taui-taui, at the same time fulfilling the duties of a blockade.

Capt. D. P. Cervera, who relieved Villavicencio as chief of the hydrographic commission, and Lieuts. D. F. Montojo and D. P. Aguirre, who succeeded the former, continued the task in the archipelago of Jolo—the first executing, in 1874, a map of the island of Jolo and adjacent ones and the two latter completing the group of Taui-taui, with a reconnoissance of the canal of Noche-Buena and the coast near the northeast of Taui-taui, in 1878, which works, taken with those of the English in this part of the archipelago, make up the seventeenth sheet of the collection of Philippine maps.

In 1850, on the initiative of the commanding general, D. Manuel Quesada, hydrographic reconnaissances which had been abandoned for some time were again undertaken. The commander of the division of the light forces of Calamianes, D. Claudio Montero, was charged with the execution of a map of that group of islands, without leaving off his principal work (which was the persecution of the pirates), and, in spite of many vicissitudes, on account of continual persecutions and combats throughout the great extent of the archipelago, was able to present, in 1852, the first of his works, which was published under the name of the map of Calamianes. This was the origin of the successive maps, to the number of 16, which the hydrographic commission executed under the orders of that officer, and which have been published by the hydrographic office in Madrid.

However, notwithstanding the great amount of work in recent years on the hydrography of the Philippines, and notwithstanding the method by which these partial reconnaissances were carried out, there remains a considerable extent of coast line to explore, which should have, preferably, the attention of our officers, in order to arrive soon at a complete knowledge of the coasts and seas of the archipelago.

These gaps, which should be made to disappear by a special effort, and which comprise many principal points insufficiently known or described, are as follows: In the island of Luzon the shore line, bays, and adjacent islands, and all its western part from the port of Bicobian to the estuary of the San Bernardina. This same estuary, although greatly frequented for a long time, requires a careful reconnaisances and soundings of its coasts and shores. In the islands of Samar and Leyte the eastern shore line is little known, and there is lacking a detailed exploration of the northern part of Samar. In the group of Calamianes islands there remains to be explored the western part. In the great island of Mindanao, the eastern shore, from Cape San Augustin to General Island, has been traced according to anonymous maps, but we are not in possession of any document which gives them value; also its southern coast, comprised between the Rio Grande and the Cape of San Augustin, has not been reconnoitered with the accuracy that it deserves. Finally, after completing these reconnaissances and soundings of the coasts in places of little depth, up to the point

where the usual sounding begins, it would be well, with the introduction of the submarine electrical telegraph, to make deep soundings, in order to arrive at a knowledge of the depth, character, and temperature of the beds of the deep canals which separate the islands.

Of the 17 maps of the archipelago which have been published successively, 10 were constructed at the beginning without being subjected to a definitive connection which would result from a general series of astronomical determinations of its principal points, joined by azimuth observations in place of a primary triangulation. Later, after having concluded definitively the general operation which connected satisfactorily the Babujanes or Batanas Islands, on the north of Luzon, with the southern shore of the island of Mindanao, all the longitudes were corrected for small chronometric errors, and there was established entire harmony between all the stations and shores of the archipelago, referred to the cathedral of Manila, which was the origin of longitudes. The positions of longitude of the principal points of the work, determined by different methods and independently, never differ in the extreme points of the archipelago more than five seconds of arc.

Recently the chief of the hydrographic commission, D. M. Villavicencio, after having rated in Manila with great exactness 20 chronometers, journeyed in the schooner *Vad-Ras* to the island Maripipi, on which he determined the longitude of its mountain, which is one of the principal points of the general survey of the archipelago. The difference from that deduced previously did not exceed three seconds of arc. As there are 13 intermediate stations between Maripipi and Manila, the verification of the determination of the former station carries with it the verification of all the intermediate points.

No less remarkable is the final verification of positions in the extreme southern part of the archipelago. Commander Villavicencio determined Natos on the little island of Papahag, in the group of Taui-taui, directly by chronometers, and referred it to the zero of Manila The result is entirely consistent with that referred to Zamboanga, a principal station, and agrees within two seconds of arc with the determination by Commander Chimmo, of the English ship *Nassau*, in the same year (1873). We therefore believe that we hazard nothing in saying that our naval officers in the Philippines would lose no time in trying to secure now a greater accuracy than that already obtained, and they should, therefore, devote all their activity to closing up the many gaps which still remain between the principal points.

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