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ANNUAL REPORT

OF THE

DIRECTOR, UNITED STATES COAST AND GEODETIC SURVEY

C. & G. SURVEY
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TO THE

SECRETARY OF COMMERCE

FOR THE

FISCAL YEAR ENDED JUNE 30, 1926

PRICE 35 CENTS

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National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

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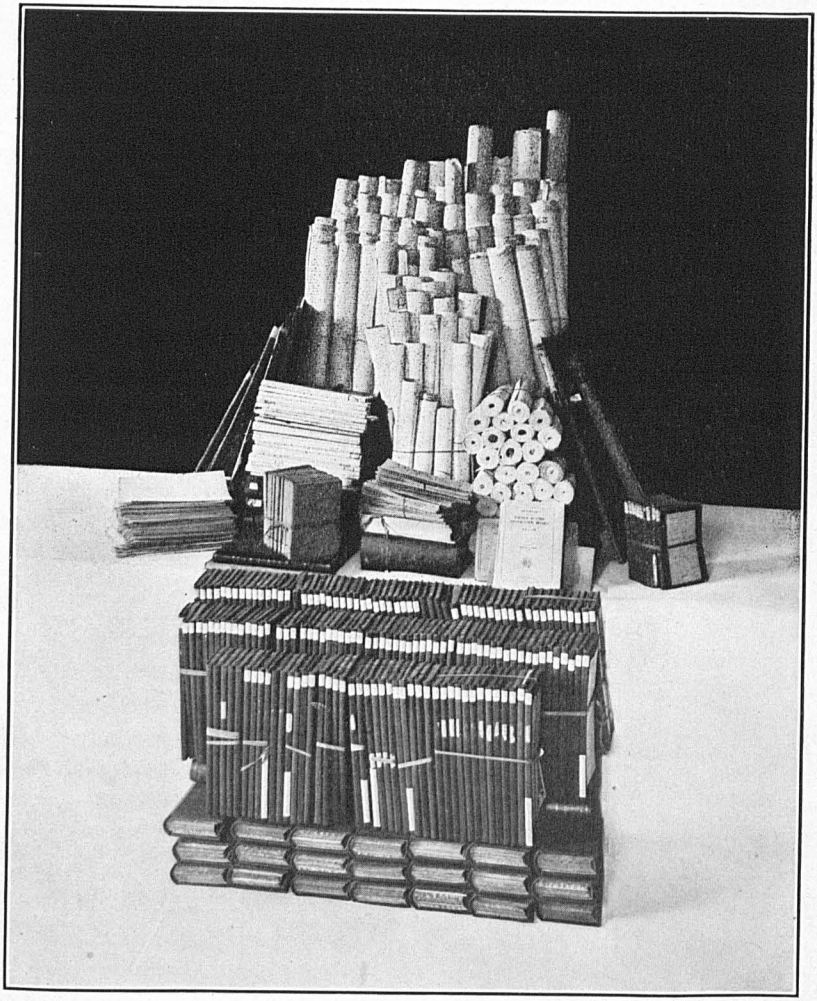

RECORDS USED IN COMPILING A COAST AND GEODETIC SURVEY CHART

This illustration, reproduced from a photograph which was exhibited at the Sesquicentennial Exposition at Philadelphia, 1926, shows the 469 field survey sheets, sounding, and tidal records and volumes of data required to supply information for the production of a single chart

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CONTENTS

	Page
Introduction	1
Increased chart production imperative	2
What modern instruments mean to the bureau's work	5
Additional commissioned officers conducive to economy	7
Matters affecting civil-service personnel	8
Economy of modern quarters	9
Helping the public	10
Benefit of providing seagoing vessels modernly equipped	11
Surveys for War and Navy Departments	12
Part I.—OTHER IMPORTANT BUREAU NEEDS	
Chapter I. Surveying necessary for aerial mapping	13
Chapter II. Need for a seagoing ship on the Atlantic coast	15
Need for tenders	15
Chapter III. Terrestrial magnetism and seismology	16
Seismology to date	17
Chapter IV. Tides and currents	18
Need of a tide and current survey in Chesapeake Bay and tributaries	18
Need of additional office personnel	18
Part II.—THE WASHINGTON OFFICE	
Chapter I. Accomplishments of the Washington office during the fiscal year	20
Chief clerk	20
Division of hydrography and topography	21
Division of geodesy	23
Division of charts	23
Division of terrestrial magnetism and seismology	24
Division of tides and currents	26
Division of accounts	29
Instrument division	30
New charts issued during the year	32
Chapter II. Program for the current fiscal year in the Washington office	34
Chief clerk	34
Division of hydrography and topography	34
Division of geodesy	34
Division of charts	35
Division of terrestrial magnetism and seismology	35
Division of tides and currents	36
Division of accounts	37
Instrument division	37
Part III.—IN THE FIELD	
Chapter I. Accomplishments in the field during the fiscal year	38
Hydrographic and topographic work	38
Geodetic work	40
Magnetic and seismologic work	44
Tide and current work	45
Chapter II. Program for the current fiscal year in the field	49
Hydrographic and topographic work	49
Geodetic work	50
Magnetic and seismologic work	51
Tide and current work	51

Part IV.—DISTRIBUTION OF PARTIES OF THE COAST AND GEODETIC SURVEY DURING THE FISCAL YEAR ENDED JUNE 30, 1926

Page
Division of hydrography and topography 53
Division of geodesy 58
Division of tides and currents 59
Division of terrestrial magnetism and seismology 60

ILLUSTRATIONS

Frontispiece.
1. Illustrative diagram of survey data, Ohio 11
2. Organization chart 20
3. Diagram showing issues of charts, 1899 to 1926 32
4. Diagram showing annual distribution of Coast Pilots and Inside Route Pilots, 1904 to 1926 32
5. Diagram showing receipts from sales of charts and other nautical publications, 1897 to 1926 32
6. Progress of field work, fiscal year 1926, United States 47
7. Progress of field work, fiscal year 1926, Alaska 47
8. Progress of field work, fiscal year 1926, Philippine Islands 47
9. Progress of field work, fiscal year 1926, Hawaiian Islands and approaches to Panama Canal 47
10. Progress of field work, fiscal year 1926, Porto Rico and Virgin Islands 47
11. Condition of field work to June 30, 1926, Porto Rico and Virgin Islands 60
12. Condition of field work to June 30, 1926, Hawaiian Islands and approaches to Panama Canal 60
13. Condition of field work to June 30, 1926, Philippine Islands 60
14. Condition of field work to June 30, 1926, Alaska 60
15. Condition of field work to June 30, 1926, United States 60

REPORT

OF THE

DIRECTOR, UNITED STATES COAST AND GEODETIC SURVEY

DEPARTMENT OF COMMERCE,
COAST AND GEODETIC SURVEY,
Washington, October 5, 1926.

SIR: There is submitted herewith my twelfth annual report. This report is for the fiscal year ended June 30, 1926, and is the ninety-fifth annual report of this bureau.

INTRODUCTION

The Coast and Geodetic Survey has just closed the one hundred and tenth year of its active existence. It has been a year which has seen the bureau render the public a service greater in volume and variety than ever before and in that respect it has been a successful one. To this record of service I will revert later. It has also seen the growth, to seriously disturbing proportions, of certain problems vital to the welfare of the service; problems which have been visioned in the distance and commented on in previous reports, but which now loom so large that their serious consideration must not longer be deferred.

Briefly, the Coast and Geodetic Survey as the sole manufacturer of a product indispensable to certain important aspects of our industrial and commercial life is a sort of barometer of the Nation's prosperity. When harvests are abundant, when our factories are working full time, there is a noticeable increase in the foreign and domestic shipping by which those products are carried to the markets of the world, with a corresponding increase in the demand for the charts which are the sole guide of shipping through the navigable tidal waters of the United States and its possessions and dependencies. When the country is prosperous and money is plentiful many thousands of the people of our coastwise States turn to the sea for recreation. Yachts and motor boats throng our popular coast resorts and ply our extensive natural inland waterways, and these craft, like their larger sisters of the merchant marine, must have the charts to keep them to the security of the navigable channels. The growth in the demand for charts for this purpose has been most impressive; whereas only a few years ago that demand was negligible, it now, in a prosperous year, probably exceeds the total number of charts sold a decade or two ago.

Finally, these prosperous conditions are reflected in an accelerated development of our many ports. Increased shipping demands additional terminal facilities. Docks are remodeled to larger proportions or new ones built. Artificial channels are deepened and widened. Aids to navigation multiply. Ports formerly inactive reach out for their share of the golden flood, and through concerted action under the guidance of their port commissions undertake impressive harbor developments to enable them to compete successfully with their neighbors for a share of the business.

All these changes must be shown on the chart before it can be trusted to guide the mariner, and in consequence a period of national prosperity brings a great increase in the volume of work required of the Coast and Geodetic Survey, an increase resulting not only from the demand for more charts but even more from the necessity that every chart printed shall be modern and up to date with respect to the area portrayed.

This Nation is at present enjoying such a period of augmented industrial activity which, with some minor fluctuations, has prevailed since 1919. These years have imposed a great and constantly increasing burden upon the Coast and Geodetic Survey. The bureau has met that burden willingly and cheerfully; has, indeed, welcomed it, for the spirit of service, of doing difficult tasks well, which has dominated the service for the century and more of its existence, was never stronger than to-day. To give its best, to make one dollar do the work of two, has become traditional and is accepted as a matter too commonplace to justify comment. Therefore the Coast and Geodetic Survey has no complaint to offer. On the contrary, it has welcomed the increased obligations crowding in upon it from many directions because, although each separately adds its quota to a burden already heavy, in the aggregate they are symbolic of a national well-being to which the survey is glad to contribute the best effort of which it is capable.

That contribution is not complete, however, until the bureau, having first done everything within its own power to meet the situation, thereafter points out any remaining deficiencies which can be remedied only with outside assistance. Such deficiencies, and serious ones, exist at the present time. There is a limit to the size of the garment which can be cut from any given piece of cloth. In spite of its best efforts, of increased efficiency in many different directions, the survey to-day is unable adequately to perform the functions with which it is charged under the law. I regard, therefore, as the most important and constructive part of this report, the duty of pointing out the respects in which we are inadequate and of suggesting appropriate remedies to the final authorities who alone can make them available. In so doing I wish to emphasize that I am not reaching out to grasp any new functions. Every dollar requested is to enable us to do the things which we are now lawfully required to do.

INCREASED CHART PRODUCTION IMPERATIVE

The chart is the principal product of the bureau's efforts. About 80 per cent of our expenditures are of no benefit to the public unless and until the resulting information is given to the public in this

form. Unless our chart production is kept on an efficient basis we fail in our most important function.

Recent years have seen an outstanding increase in the demand from shipping interests for our charts. The increase for 1926 over 1925 was 29 per cent. For these reasons our situation with respect to chart production demands and receives constant scrutiny.

Briefly that situation is as follows: At present we have more or less modern charts of all navigable waters of the United States and its dependencies. Not all of these charts are what we would have them. Judged by modern standards some are seriously deficient, but except for some remote portions of our possessions, or an occasional inlet of exceptionally rapid change, we do at present furnish the navigator with charts which will assist him in traversing any of the waters under our jurisdiction.

When a new chart has been issued our problem with reference to the locality charted has only begun. Natural and artificial changes are in constant progress in the area, and the mariner must be kept informed of all such changes if we are to insure that he may sail those waters with safety. This means that the chart must be constantly corrected. To accomplish this we print small editions of the charts so that they are reprinted frequently, and before each reprinting the plate is corrected to show new information received since the date of the last preceding print. Until recently charts of important harbors were printed as often as five to six times a year, and the average frequency of reprinting of all charts has been a little more than twice a year.

When the time arrives to produce a new chart or to make an extensive reconstruction of an existing one, we can not simply abandon the old product and start work on the new. It is a time-consuming job to produce a new chart, requiring on the average about a year of elapsed time. During that period we must continue to supply the mariner with charts of the area. This means that, pending completion of the job, the existing charts of the same locality must be kept in stock and kept corrected just as though the new product were not under way.

In actual practice, therefore, the time of our chart force is devoted primarily to the correction of existing charts, and only such time as remains from this task can be devoted to the production of new charts or the extensive reconstruction of existing ones.

The data used for the production and correction of charts originate from sources both within and without the survey. Our own field parties are at work in all parts of our territory securing information for this purpose. Since the war, in order to try to meet the public demand for charts, there has been some expansion in the field force, which has increased its effectiveness. There has been a corresponding increase in some facilities and equipment. Small, obsolete vessels have been replaced by larger, modern ones. These augmented personnel and facilities have resulted in a considerable increase in the amount of work turned in by the field parties. There has been an even greater increase in the amount of data received from sources outside the survey. Such sources have long been important contributors of information. There are many agencies, Federal, State, municipal, and private, at work along our coasts, improving our

harbors and their approaches, dredging channels and basins, building docks, and establishing terminals. All these changes must be shown on the charts. To obtain the necessary information without sending its own field parties to make special surveys, this bureau has built up contacts with every possible agency engaged on work of this character, and so large is the total volume of data thus obtained that it is conservative to estimate that double our existing appropriation would be required to obtain it by special surveys of our own.

At the close of the war we got away to a flying start on the task of making up the existing arrears in our chart work, and in the years immediately following made very considerable progress. Gradually, however, the volume of incoming data has been increasing until at present it threatens to swamp us. The volume of data received in 1925 represented an increase of 245 per cent over the amount received in 1919.

There has been no corresponding increase in personnel to enable the office to cope with this constantly growing volume of incoming material. On the contrary, there has been an actual decrease. In 1920 the chart division had 102 authorized places; at present it has 101.

The bureau has exerted every effort to cope with this situation by increasing its productive capacity, and some noteworthy achievements along this line have been accomplished in recent years. To illustrate their cumulative effect by a typical example, the average elapsed time required to produce all new charts completed in 1920 was 27 months; for 1926 it was 8⅓ months. The average cost of producing the new charts completed in 1920 was $1,771; for 1926 it was $1,395, in spite of a 40 per cent increase in salaries as the result of reclassification.

In spite of these internal accomplishments, however, there has been a continued decrease in the amount of time which can be devoted to the production of urgently needed new charts. The following tabulation shows the percentages of the total time devoted to the production of new charts and the correction of existing charts, respectively. The falling off in the time devoted to production of new charts is indicative of an equivalent reduction in the volume of other necessary constructive work which should have been maintained at the higher level of the earlier period.

Kind of work	Per cent of working days						
	1920	1921	1922	1923	1924	1925	1926
Production of new charts	48.0	42.4	37.5	24.7	29.1	19.9	23.3
Correction of existing charts	24.5	37.9	44.2	52.1	48.5	58.8	54.4

The resulting situation is serious in many respects. We are compelled to make regrettable concessions in the quality of our service to the public. It means much more than simply that we are not getting out new charts as rapidly as we should. The quality of existing charts is also deteriorating. We are to-day printing charts

from plates so worn from long service that in some cases the prints are almost illegible. We have within the past year reduced the frequency of chart reprinting by about 33 per cent in order to cut overhead labor costs. This means that the mariner must use for a correspondingly longer period charts which should be superseded by others containing more up-to-date information. Parts of the information received can not be used at all because of the time required to apply them to the charts. In rejecting this material the greatest possible care is exercised to eliminate the least essential. Nevertheless the practice is a dangerous one because it is impossible to foresee some unusual combination of circumstances, such as the omission of some seemingly unimportant item, that might result in delay and inconvenience to the mariner and possibly even in the loss of lives and property. The chart is the mariner's principal safeguard. It should be at all times a true picture of the area covered, and to the extent that it falls short of that ideal it places the mariner in jeopardy. The only effective solution of this situation is additional personnel. No large increase is expected or required. The increase proposed is three cartographic engineers and three lithographic draftsmen at total annual salaries of $13,320.

WHAT MODERN INSTRUMENTS MEAN TO THE BUREAU'S WORK

The progress of this bureau in the execution of its work is vitally affected by the character of its instrumental equipment. No matter how skilled the observer, his results can be no better than the instrument with which he makes his observations. We have found by long experience that our work can be done better, quicker, and cheaper almost in proportion as we keep abreast of scientific research in metallurgy, electricity, optics, etc., and appropriate to our use such advances as will be of benefit.

Study is constantly being made to increase the accuracy of our instruments and to decrease their size and weight. Our present-day theodolites are only about half the size of those used only a few years ago, and weigh only about three-fifths as much, while in accuracy they are far superior. Decreased size and weight mean lower transportation charges and particularly greater ease in reaching the mountain tops or other remote points where the observations must be made. It makes a very great difference whether an instrument weighs 60 or 100 pounds, when it must be packed on a man's back for miles over rough mountain tracts or through Philippine or Alaskan jungles. Increased precision means that fewer observations need be made at each station to insure the required accuracy of the results, and in consequence that more work can be accomplished for a given expenditure.

Many instances might be cited of the increased efficiency resulting from better instruments.

One of the first essentials to our work is the determination of longitudes. This requires a very accurate knowledge of the time. By the old method, when no telegraph line was available, time was determined by carrying several chronometers repeatedly back and forth between the point of observation and the nearest point at which time and longitude were accurately known. Frequently this

distance was hundreds of miles, and as the chronometers must not be subjected to the slightest shock in transit, their transportation was a laborious and expensive undertaking, in which a seemingly minor accident might result in weeks of delay and perhaps necessitate abandoning the work until another season.

To-day, as a result of our adoption of the radio, and our development of certain automatic recording apparatus, exact time is obtainable daily in any part of the continent from the Annapolis Radio Station.

Instances might be multiplied of instruments designed and reconstructed in our own shop, by which we do more and better work at less cost. Such instruments will measure the angular position of a point on the earth's surface within 1 second of arc, which means that a point 40 miles distant can be located within the space of 1 foot; will determine the difference in elevation between two points 100 miles apart within ¾ of an inch; or will measure time to the one-millionth part of a second. Our tide-predicting machine does the work of 60 mathematicians with an infallible accuracy of which no human being is capable.

The work of our instrument division falls under two heads: (1) The original procurement of our instruments and apparatus and (2) their subsequent repair and upkeep.

Whenever a standard commercial type of instrument can be used in our work it is purchased in the market. In fact, the great majority of our instruments are procured in this way. But when the highly specialized work with which we are charged demands the creation of something radically different in design and construction, we find it very difficult and costly to find any commercial source of supply. The business of the instrument manufacturers, particularly in this country, is based on the idea of quantity production of standard types. The firms naturally are reluctant to undertake the manufacture of a new and radically different instrument, largely experimental in character and of which but a single one may be required. Special tools are needed; special patterns, dies, and jigs must be made.

Their workmen, although doubtless skilled in the standardized production with which they are familiar, have not the versatility to enable them to proceed readily to the production of something different. All these factors add greatly to the overhead cost, which must be charged against one instrument instead of being distributed among many. Finally, the inflexibility of Government procedure; the fact that the manufacturer must subscribe to a binding contract in which he assumes all the risk tends, particularly in a matter so essentially experimental in character, further to increase the cost. Since he is venturing into imperfectly known territory, when the Government is protected at his expense, it is natural that if he bids on the job at all he will quote a figure high enough to cover every possible contingency.

Consequently it has been our experience that such special instruments and apparatus cost very much more if procured by contract than if built in our own shop. Probably 50 per cent is a reasonable estimate of the average excess. In many cases it is much greater. For example, during the present fiscal year the lowest quotation re-

ceived for certain field apparatus used in sonic sounding was $4,000 and a six months' time for delivery. As the price asked and the time were considered excessive, the apparatus was built in our shops at one-third the cost and in less than one-third of the time; however, other important work in this shop had to be delayed on account of this work which was more urgent.

In short, the years have taught us that almost without exception the prices quoted by manufacturers for producing the special instruments indispensable to our work are in fact, although not necessarily by intention, exorbitant and in many cases prohibitive. There is not the slightest doubt that each year large sums could be utilized for more productive purposes if we were authorized to employ three or four additional trained instrument makers. We already have the shop, fully equipped with expensive machines of the finest type, but not sufficient personnel to operate them all to capacity.

The question naturally arises as to why our present force can not do the work. The answer is that they are already overtaxed by the task of keeping existing instruments in repair. That task must be given priority. Just as, in the case of the chart, we must continue to correct the old one until we are ready to issue the new, so, also, must we keep our present instruments at work until such time as they must be replaced. We can not afford to hold a field party idle while we are designing and building newer and better instruments for it to work with.

Our present force can not even keep existing instruments in repair. There has been a rapid increase in the bureau's activities in the last few years. We now have many more field parties than we had 15 years ago, and there has been a proportional increase in the number of instruments and other items of equipment. These instruments necessarily receive very hard usage in the field and require frequent repair and adjustment. This work, in so far as possible, is done by our instrument makers, and while the work required of them has increased very greatly during the past decade there has been no increase in their number during that period. In consequence, some of these instruments are now regularly sent to the manufacturers for repair. Done in this way, the work itself not only costs more, but there is the further cost of transportation to and from the factory.

It is difficult to imagine a less economical and less businesslike procedure. I strongly urge that the provision of three additional places in the instrument division, at a total annual cost of $5,400, will be productive of savings quite in excess of their cost.

ADDITIONAL COMMISSIONED OFFICERS CONDUCIVE TO ECONOMY

The present authorized commissioned personnel of the bureau is 141 officers. These officers direct the field work and perform the more difficult and intricate parts of the same, command the survey ships, disburse the funds provided for carrying on the work, and fill the major administrative positions in the Washington office. They are the nucleus about which the entire structure of our field operations is built.

This present complement is based on our requirements at the close of the war when we needed only 141 officers to utilize effectively the

facilities available to us and to get the most possible out of the funds appropriated. Since the war, however, conditions have changed radically. The demand for surveys has greatly increased. Five large modern seagoing ships have replaced an equal number of much smaller, obsolete craft. The new ships are more expensive to maintain and operate than were their predecessors, but in return, if properly utilized, are productive of so much greater accomplishments as to keep the unit cost of the work as low or lower than it was in 1917.

This effective utilization is not possible, however, because we lack the officers needed to provide proper complements. Ships which should be operating five or six surveying parties are actually operating three or four, and in consequence the returns they give for the heavy expenditures made are only about two-thirds of what they should be. In order to get the most out of our present equipment we should have a commissioned personnel of 151 officers.

The most significant part of the story remains to be told. Although 141 officers are authorized, at no time since the enactment of the Budget law have sufficient funds been appropriated to pay that number. The largest number we have heretofore been able to appoint without danger of incurring a deficit has been about 130. Appropriation of funds to pay the 10 additional required for effective operation would result in returns of value far exceeding their cost.

MATTERS AFFECTING CIVIL-SERVICE PERSONNEL

The classification act was passed in 1923. The act provided for the allocation of employees to grades in the several services on the basis of duties performed and, in general, provided seven salary ranges to each grade, to which employees were to become entitled by promotion based on efficiency in the performance of their duties. A later enactment imposed the limitation that promotions should not exceed the point where the total of the salaries paid the employees of any grade exceeded the average salary of that grade multiplied by the number of persons in the grade.

No time limit was formally set for the attainment of this maximum, but in the debate incident to the passage of the bill the impression seems to have been that it would be reached in about four years.

That period has now elapsed and finds that goal still beyond our reach. With a few exceptions our people were initially allocated to the minimum salaries of their several grades. Not a single one has yet been promoted up to the average salary of his grade. Fifteen per cent of our force have attained to the third salary rate, 36 per cent to the second, while 49 per cent have not received any promotion during the three years that the law has been in operation.

We may ignore but can not fail to observe the fact, which is obvious in other bureaus as well as in the Coast and Geodetic Survey, that the employees almost without exception feel that a great injustice has been done them in thus retarding the promotions to which their efficiency ratings entitle them, and that the discouragement they feel has a seriously detrimental effect upon their work. Hope constantly deferred is more demoralizing than a disappointing certainty. It is therefore greatly to be desired either that the present

act be so modified as to give the effect of law to the policy which at present determines the sums to be made available for the payment of salaries, or else that the financial condition of the Government will speedily permit of more generous appropriations by which the plan embodied in the present law may become a reality.

The services generally have cause for gratification in the recent liberalizing of the retirement law. This forward step in a matter of such import to the great body of Federal workers is keenly appreciated, and I speak for every member of the Coast and Geodetic Survey in expressing my thanks to the Members of Congress who contended so persistently for its enactment.

We must not forget, however, that the recent enactment was frankly a compromise, and that we still have some distance to go before we arrive at an equitable retirement system. The age limit is still too high. We do not yet have the proper relation between the annuity and the active-duty pay. The employee who earns $4,000 a year contributes twice as much to the retirement fund as does the one who receives $2,000. Both, however, assuming equal length of service, receive the same annuity; an arrangement which unduly burdens the higher salaried employee.

The bureau chief, who is constantly studying the problem of building up and maintaining the most efficient possible working force, is brought into contact with aspects of this subject which deserve careful consideration. He sees the excessive turnover in the Government personnel, chiefly in the highly specialized professional and technical positions, for which each new incumbent must undergo a considerable period of training. He sees the extravagance and wastefulness of a system which, by its unattractiveness, virtually forces so many of these people out of the service as soon as they have completed this unproductive training period. He knows of no valid reason why the Federal service should be a training school for certain of the technical private industries. He has seen many employees continued on duty after they have reached the age of retirement, although their capacity for service was manifestly impaired, and knows that one of the reasons for that retention was that administrative officers could not bring themselves to force retirement on an annuity manifestly inadequate to sustain life at the present cost of living. The new law has improved but by no means adequately remedied that condition in all cases. Seeing these things, he is convinced that true economy lies in a more liberal policy with respect to matters of this character; that what is apparently a direct saving of one dollar is sometimes in fact the indirect waste of two.

ECONOMY OF MODERN QUARTERS

Under this heading it is particularly gratifying to note the passage, at the last session of Congress, of a public building bill containing a home for the Department of Commerce which will include quarters for the Coast and Geodetic Survey.

Year after year, in these reports, I have emphasized the inadequacy of our present quarters. These consist of eight separate buildings, only one of which was designed for the use of the bureau. Related functions, which should be grouped together, are widely scattered. One division occupies 10 different floor levels in 5 different build-

ings. Such conditions result in difficulty of coordinating successive processes and in delay in the orderly progress of work. Work demanding a high degree of mechanical precision, such as our drafting, engraving, or instrument work, requires the best of light, yet our buildings are so crowded that some of the employees engaged on such work have no direct access to natural light. The buildings, with one exception, are old and in poor condition and for years have required expensive expenditures for upkeep and repairs.

Occupancy of new modern quarters, therefore, will result in more and better service to the public, as well as relieve some of our personnel from unnecessary present burdens.

HELPING THE PUBLIC

The campaign to increase the usefulness of the bureau to the public has been continued. To make this effective has called for more than an idle declaration of policy. It has necessitated wholesome stimulation of all members of the bureau as an organization to let no opportunity pass to increase the usefulness of the bureau and to render the utmost service. These efforts are bearing fruit. Its tangible evidence is found in the numerous commendatory letters received by the bureau, typical portions of some of which are quoted below.

Let me first of all thank you for the most civil and altogether satisfactory letter I have received from a governmental department in a number of years. The coast in which I am interested lies between Guys Point and Fishermans Island. The immediate locality is known locally as Picketts Harbor. If this is shown on your survey and Picketts Hole is located, that point, together with a mile each way, will suffice, and I am pleased to add that the embankment during the years 1904–5 is precisely what I wish to know; from this I can, as you state, have surveys that will disclose whatever there is of encroachment since the 1905 survey.

Repeating my thanks for your very courteous attention and hoping to hear from you at an early date, I am, ———.

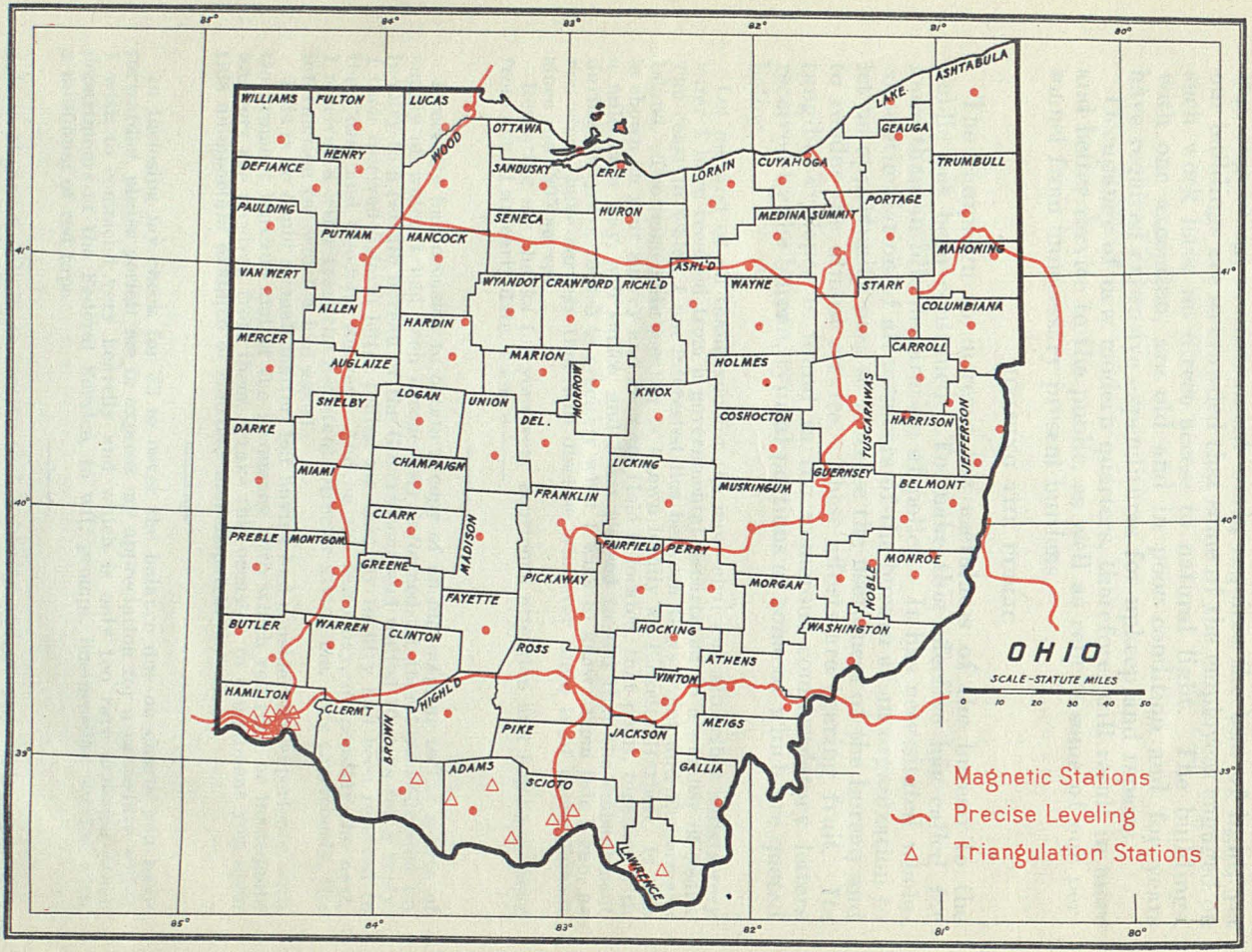
I recently had occasion to obtain a copy of an old map, as to the source of supply of which I had been erroneously informed. I therefore addressed an inquiry to a certain bureau of the Government and waited 10 days for a reply. I then received a form letter telling me that my inquiry had been referred to the Coast and Geodetic Survey. And on the same day, or possibly the next, I received a letter from the Assistant Director giving me, very courteously, the information for which I had asked.

This is no doubt a small matter, but having had considerable experience with Government bureaus and of the frequency with which retarded or inadequate answers are received from them, I take this occasion to compliment you upon this unimportant example of courtesy and dispatch.

In inclosing my check for $2 to cover the balance due on charts you have forwarded, please permit me to express my appreciation for a procedure which I wish to commend very heartily and which is only too rare amongst other departments of the Federal Service, to wit, prompt, businesslike service with a minimum of red tape.

It is always a delight to receive such a hearty and prompt reply, and such a practical one that leaves nothing more to be said, as was covered by your sending me forthwith a copy of the canceled map of Penobscot Bay that I had requested.

The immediate action, the absence of red tape, and unnecessary time-consuming correspondence all make for much appreciation of your human and practical interpretation of my request.



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Four or five years have passed since the inception of the bureau's plan to cooperate with local and county surveyors for the purpose of placing at their disposal data accumulated by the bureau and encouraging more accurate surveys. In this period cooperation has been extended to approximately 4,000 surveyors. By means of printed digests, in which counties are listed alphabetically, the descriptions of Coast and Geodetic Survey triangulation stations, magnetic stations, and precise level bench marks have been brought to the attention of surveyors throughout the following 27 States: Alabama, Arkansas, Colorado, Florida, Idaho, Indiana, Illinois, Iowa, Kansas, Kentucky, Maine, Massachusetts, Minnesota, Missouri, Montana, Nebraska, Nevada, North Dakota, Ohio, Oregon, Rhode Island, South Dakota, Texas, Utah, West Virginia, and Wyoming. The illustration opposite is a graphic representation of the work of this bureau in the State of Ohio. Digests for the other States of the Union will be prepared as soon as possible.

Through the use of the standard control points established by this bureau local surveys can be connected with the most accurate control system in existence; thus elimination of all gaps, offsets, and overlaps such as constantly occur where local surveys uncontrolled by standard datums are extended until joined with other local surveys likewise uncontrolled by standard datum, sometimes causing costly lawsuits.

BENEFIT OF PROVIDING SEAGOING VESSELS MODERNLY EQUIPPED

The work of certain ships during the past year has again proved the great benefit of providing these stanch vessels properly equipped. For some years the bureau had been forced to use small vessels of low power, weakened by age. Areas are now being covered by hydrography which for many years were inaccessible for the old ships whose operation was necessarily restricted to working grounds favorable to them. The methods for obtaining hydrographic information on these ships are now in advance of those used by all other vessels and are made possible by the fitting of modern equipment to seagoing vessels of the size and power which have been found most efficient for this work.

Many vessels traversing the sea lanes along our coast are now equipped with apparatus for quickly determining depths similar to those used on the surveying ships and the extension of such apparatus to others is constantly being made in the realization that such equipment is a distinct advance in the prevention of strandings in thick weather. Dependence on soundings by these vessels for the determination of their position when other navigational aids are not available requires the location of the geographic positions of the soundings by this bureau with an accuracy equal to that of the location of the aids. This has been accomplished by the radio acoustic ranging method used on our larger surveying ships. Although beyond the visibility of land these ships have been within control of the hydrophone stations at all times.

Of these modern survey vessels, special mention should be made of the *Guide* and *Pioneer*, which have already made successful use of the latest hydrographic equipment off the coasts of Oregon and California, and which are now engaged off the mouth of the Columbia River in a section of important traffic where thick weather is a frequent occurrence; the *Surveyor*, which has pushed the surveys

north of Cape Spencer, Alaska, to include the well-traveled approach to the inside passage from southwestern Alaska; the *Discoverer*, now well started on the charting of the waters of the Hawaiian Islands.

Another vessel, although not in the class of the above, is the *Lydonia*, which has recently been equipped to better accomplish the offshore hydrography of the southern Atlantic coast. Efforts must now be made to supplement the work of this vessel by the acquisition of a new ship for the extension of the surveys along this coast. This vessel will not require the power of those previously mentioned, but must be equally seaworthy and thoroughly equipped with modern surveying apparatus.

A necessary adjunct in the accomplishment of the results mentioned has been the work of the personnel manning these vessels. The new equipment has required extensive application in the perfection of the methods used. Difficult landings for the establishment of the shore stations have been successfully carried out, although the hazards have been great, without injury to the crew or loss of property. I am firmly convinced that the officers and men of these vessels have performed these most satisfactory accomplishments in the confidence inspired by the aid of modern equipment and seaworthy material.

SURVEYS FOR WAR AND NAVY DEPARTMENTS

The wire-drag survey of the Vieques Sound, P. R., was completed this year. This survey was begun in the summer of 1921, at the request of the Navy Department, for the protection of war vessels which congregate in this locality for the winter maneuvers. A hydrographic survey of the sound was made soon after the island was acquired by the United States, but the Navy Department desired that this survey be supplemented by a drag survey to guarantee that none of the small coral heads, with which these waters are infested, had been overlooked in the original hydrographic survey. Work has been prosecuted intermittently since 1921 and was completed this fiscal year.

The survey of Malampaya Sound, Palawan Islands, P. I., which was begun during the latter part of last fiscal year, was completed early this year. This survey was made in accordance with a request from the commander in chief of the Asiatic Fleet for a confidential chart of the sound.

In the Hawaiian Islands one survey party was employed throughout the year on special hydrographic surveys for the War Department. Accomplishment of this survey in the great detail desired by the military authorities is especially difficult, and progress is necessarily slow because of prevailing heavy swells along the coast. Several times the survey boat has capsized in the surf, but there has been no serious accident. The work is still in progress.

A detailed hydrographic survey was made along the south coast of Oahu, Hawaiian Islands, as the basis of special large-scale anchorage charts for the Navy Department. This work was begun and completed during the year.

A special revision survey of the Strait of Juan de Fuca, Wash., was made at the request of the Navy Department for a maneuvering chart of this water. The work was begun last spring and was practically completed at the close of the fiscal year.

Part I.—OTHER IMPORTANT BUREAU NEEDS

CHAPTER I

SURVEYING NECESSARY FOR AERIAL MAPPING

The time has come in this country, as it has in many others, when accurate surveying and mapping are considered as absolute essentials for economic progress and the elimination of waste in industry and commerce.

When land was cheap it was impracticable to incur the expenses incident to very accurate surveys, also when this country was largely agricultural in its pursuits surveys of a detailed and accurate nature were not justified. All this has changed. Our people are engaged in great industrial and commercial work as well as in agriculture. These industrial operations require accurate knowledge of the configuration of the ground as well as of elevations and geographic positions. Very valuable property must be accurately located and its boundaries permanently established and recorded.

This is the situation in regard to industries and commerce; but we have another problem which is due to the development of the aerial navigation during the past two decades. The pilot of an airship must have a map. He is frequently out of sight of land above the clouds or in the fog or is traveling at night. He must be guided in his flight over the land much as the navigator of a ship is guided over the sea by charts and aids to navigation.

The aviator who can not see the ground must depend upon the barometer, but the barometer is set to give elevations above the sea and not of the actual land surface. He may think he is one, two, or some other number of thousands of feet above the earth when, as a matter of fact, he may be in imminent danger of colliding with a mountain slope or peak. Therefore, any aviation map between terminal points of an aerial route must show in some way the elevation of the ground.

The aviator needs to know the relative positions of topographic features along his route, such as railroads, highways, rivers, cities, villages, woods, and open country. These features should be shown in their correct shapes and in their correct positions. All of this information can be obtained from an accurate topographic map such as is made by the United States Geological Survey.

Only about 40 per cent of the area of the United States is now covered by maps of that character, and many of the areas covered will have to be resurveyed in order to bring the maps up to date for changes which have occurred since the survey was made. Many parts of our country have had rapid developments since they were first surveyed 30, 40, or more years ago.

There are very few large areas of the United States having continuous topographic maps. An index map, showing the quadrangles

which have been covered by the topographic maps of the United States, reminds one of a cross-word puzzle. This situation should be remedied, not only for the industrial and commercial uses of our people, but in order that route maps for airplanes may be accurately and expeditiously constructed.

The Department of Commerce was recently charged by Congress with furthering the interests of civil aviation. A part of the duties involved will be the establishment of aids to aviation and the construction of route maps which will enable the aviator to sail over his course without getting lost by lack of map information.

The Coast and Geodetic Survey has for years been extending accurate triangulation and leveling over the interior of the country for surveying, mapping, and other engineering uses. With this triangulation the highway system and the railroad system of the country can be correlated and placed in at least approximately their right positions on maps. The elevations furnished by the survey can be used for furnishing mean sea-level datum for surveying, mapping, and engineering operations. The topographic map can not be accurately made if the fundamental control work of the Coast and Geodetic Survey in the form of leveling and triangulation has not been completed for the area that is to be mapped.

It would be difficult to prepare route maps for aviators with the data we now have. There will be many routes for which the maps will not be as good as they should be, but pending the completion of the topographic mapping they will be all that can be furnished.

It seems that the time has arrived when we should realize that the many uses to which the geodetic work of the Coast and Geodetic Survey can be put would require, in the interests of economy and efficiency and the elimination of waste in industry, that the geodetic work be expedited. It has been estimated that $4,000,000 would complete the primary work, even to the publication of the results. There would be furnished for this sum an elevation on mean sea level and the geographic position on the North American Datum within 25 miles of every place in the country; that is, the maximum distance between lines of leveling and arcs of triangulation would be about 50 miles.

With a slight increase of the engineering personnel of the Coast and Geodetic Survey, the fundamental control systems of the country could be completed within 10 years. It is urged that increased appropriations may be made for the triangulation and leveling. The money spent on this class of work is of lasting benefit and would result in almost 100 per cent dividend each year. After its completion the work would never have to be done over. Its accuracy is such as to meet the needs of all time, and it would only be necessary occasionally to replace a triangulation station or levelling bench mark where the old ones had been destroyed by the works of man or nature, and to make minor extensions of the system where intensified mapping may later be required.

CHAPTER II

NEED FOR A SEAGOING SHIP ON THE ATLANTIC COAST

The bureau has available on the Atlantic coast only one ship that is seaworthy and able to operate on the open coast at any distance from a harbor of refuge. Within the lifetime of that one ship, working alone, the offshore and coastwise surveys needed to bring our charts up to date can not be accomplished. As only a seaworthy vessel can undertake the work, I would urge favorable consideration of the acquisition of a modern survey ship of 600 tons now needed for this duty.

This service requires a ship that will operate economically at different speeds and where the fuel consumption while at anchor is reduced to a minimum. Fuel consumption is a large item in operating expenses, and the power installation should permit the ship to proceed to and from the working ground at full speed; then, while taking soundings, to cruise efficiently at reduced speed. While at anchor, fuel consumption should cease. A Diesel installation admirably meets these conditions because of its multiple power units and the fact that when not actually in operation there is no fuel consumption.

We now have on survey work two wooden ships restricted to sheltered waters or the coasts close to shelter, because they can not be made seaworthy. They are expensive to maintain on account of mounting expenditures for repairs and costly to operate, as they are no longer efficient units. One new vessel to replace these two ships would equal their combined production and would in a very reasonable period of time save the original cost by reducing operating expenses.

NEED FOR TENDERS

For years there has been emphasized the need on the Pacific coast for seaworthy launches or tenders of approximately 60 feet in length to work in conjunction with the large ships and to do that work for which the ship is too large and too expensive and for which boats carried on the ship's davits are too small. The need is urgent for three such tenders.

The two ships now surveying on the coasts of Washington and Oregon are operating with hired launches which are poorly suited to the work. There are many times and places, however, where it is impossible to hire a launch. Then it becomes necessary to carry on the work with the small boats while the ship stands by. Although the cost of leasing launches is greater than to own and operate them, the consideration of unit cost of the work demands that this expensive practice of leasing launches continue until necessary tenders are provided.

CHAPTER III

TERRESTRIAL MAGNETISM AND SEISMOLOGY

As a result of sustained efforts through 26 years the first magnetic survey of the United States covers the entire country though the frequency of stations varies with the density of the population. The original aim was to have a station at each county seat and this has been fairly well accomplished. About 100 county seats remain to be occupied, principally in remote, sparsely settled localities, or as a result of the subdivision of large counties after the completion of the work in that region. Thirteen of these were occupied during the year.

As soon as a magnetic survey is completed a number of causes begin to lessen its value unless certain steps are taken. The causes include change in the magnetic field of the earth, civic improvements which may destroy the station mark or the objects used as reference marks, and the introduction of steel structures or electric-power lines near the station. The work necessary to maintain the usefulness of the stations includes the occupation of a definite number of repeat stations at five-year intervals and the operation of several magnetic observatories for determination of the changes in the earth's magnetism; the inspection of stations and correction of minor defects; and the complete replacement of stations. The present field magnetic work includes the items that have been mentioned and the occupation of new stations at county seats or elsewhere.

The magnetic survey of Alaska is inadequate and additional stations should be occupied. The pressing need at present is for the occupation of repeat stations along the main routes of travel. These have not been occupied for eight years, a longer interval than is considered safe.

The results of these magnetic surveys are of great value in various ways. They are indispensable to local surveyors who have frequently to reestablish property boundaries located many years ago by means of the compass. So great is the interest and appreciation of these surveyors that within the past few years they have reported voluntarily on the condition of more than half of the 3,700 marked stations thus far established. About 600 of the stations reported on need replacement.

Observatory results also have been used during the year to standardize magnetic instruments used in the search for oil formations. They have also proved valuable in the investigation of peculiar radio reception difficulties last winter. In addition to observations in progress several years by the observer at Sitka, Alaska, the Cheltenham records are being studied by the Bureau of Standards, Carnegie Institution of Washington, General Electric Co., Dr. W. Greenleaf Pickard, and others. The investigation still in progress seems to indicate a definite relation between transmission difficulties and the condition of the earth's magnetic field.

There is pressing need for additional office personnel to carry on this work. Many of the important publications are badly in arrears. New methods have been developed which greatly decrease cost of work, but there is not enough personnel to put them in effect. There has been no increase for more than 12 years.

There is need for an additional field party to occupy repeat stations, and for replacement of stations in the Middle Atlantic States, Middle Western States, and Western Mountain States, including new stations in the latter region.

SEISMOLOGY TO DATE

The past year, which was the first after enactment of legislation authorizing seismological investigation by the Coast and Geodetic Survey, has been spent in appraising the situation and developing methods to meet the outstanding needs. Up to this year activity on the part of the Government was represented by the operation of seismographs by the Weather Bureau and by this bureau incidental to magnetic work, and by the collection by the Weather Bureau of reports of visible and felt earthquake effects. This work was good, but insufficient effort was made to completely utilize the results and make available the information obtained. Complete information is an essential step in development of plans of prevention of earthquake damage.

As a measure of the task during the first nine months of 1925, 470 earthquakes were felt or recorded by instruments in the United States or outlying territories, not including local earthquakes in the Hawaiian and Philippine Islands. Of these, 98 were felt within the continental United States and 6 of these were severe, shaking the New England States, New York, New Jersey, Ohio, Michigan, Illinois, Kentucky, Kansas, Oklahoma, Texas, Colorado, New Mexico, Wyoming, Montana, Idaho, and California; in all, 21 States. The securing of adequate information in regard to all these earthquakes was quite a task, reports being received from the Weather Bureau, State geologists, the press, and miscellaneous observers. There is need for more intensive information in some regions. The demand for such information is strong but it has not been possible to meet it.

The preparation of this information in the form of a catalogue is being undertaken for the first time in the United States. The contribution made by the magnetic observatories of this bureau is important though a number have obsolete types of seismographs. That at Tucson became useless and was replaced by a modern seismograph.

Prevention of earthquake damage is the object of a number of organizations but all feel the need for the accomplishment of that part of the work which only the Government can do.

The public is much interested and the requests for information alone are a heavy burden which can scarcely be handled at the present time.

There is need for improved instruments, increased personnel at the observatories, and more detailed study, but the pressing need is for increased personnel in the office, to assure results of the desired precision published and made available. For this purpose six additional office positions are required, at a total annual cost of $13,100.

CHAPTER IV

TIDES AND CURRENTS

NEED OF A TIDE AND CURRENT SURVEY IN CHESAPEAKE BAY AND TRIBUTARIES

Extending over a number of years numerous current observations have been made at various times scattered over the area comprising the main part of Chesapeake Bay. These observations should be tied together by simultaneous observations over the area in the same manner as done in the comprehensive current surveys being made of all the important harbors along the coast and the work extended into the tributaries, in many of which practically no current observations have been made.

To bring out detailed knowledge of the general circulation in the bay a comprehensive tide and current survey is absolutely necessary, and the cost of such surveys is small in comparison with the financial return to shipping and engineering operations in the waterway. Beginning in 1922, such surveys have been made in New York, San Francisco, Delaware Bay, Puget Sound, and at present Boston and Portsmouth Harbors are being covered. For the coming year it is proposed to take up a comprehensive survey of Chesapeake Bay and tributaries. While these surveys of important harbors are of primary value for the purposes of navigation, the data obtained is also of great value to the civil and military engineers engaged in harbor improvements and marine construction of all kinds.

In the matter of sewage disposal and sanitation the data from current and tide surveys are of vital importance to the United States Public Health Service for the determination of pollution of the waters of the various harbors and waterways of the country. In these matters this bureau is furnishing data wherever available.

During the past year, in connection with a sanitary survey of the Potomac River in the vicinity of Washington, the sanitary engineer of the United States Public Health Service requested the results of current observations in the vicinity, but no comprehensive survey had yet been made on the Potomac River by this bureau. This area will be included, of course, in the proposed survey for the whole of the bay. In time it is planned to extend these current surveys to every harbor of importance, so that the information may be at hand when needed; and it may be emphasized again that the data needed in these various lines of work are all derived from a single survey made primarily for purposes of navigation.

NEED OF ADDITIONAL OFFICE PERSONNEL

The distribution and sale of a considerable amount of tide predictions, current predictions, and bench-mark descriptions are lost each year because of insufficient personnel to handle the requests for

these data. An increase of three employees (computers, subprofessional), at a total cost of $4,500, is now needed, and this will enable most of these demands to be met. Furthermore, with this increase of three subprofessional computers it will be possible to so arrange matters in the division of tides and currents as to remove some of the routine work from the mathematicians who are in the professional grade and have this work done by the three subprofessional computers, which will result in a lower unit cost.

In addition to the above, Congress has charged this bureau with the current surveys of the important harbors of the country which has entailed a considerable amount of increase in the work of the bureau with no increase in the personnel to get out the results from these surveys. These current surveys of the harbors of the country and of narrow passes where current velocities are considerable have naturally resulted and will further result in a decrease in insurance risks on shipping.

Part II.—THE WASHINGTON OFFICE

CHAPTER I

ACCOMPLISHMENTS OF THE WASHINGTON OFFICE DURING THE FISCAL YEAR

The organization of the Washington office of the bureau is presented by the organization chart opposite. The accomplishments during the fiscal year by divisions and sections follow.

CHIEF CLERK

The principal duties of this division are the care, custody, and upkeep of the buildings occupied by the bureau; the supervision of the expenditures for office expenses, including the purchase of supplies for the office, for chart-printing work, and to some extent for the field, the care of most of the original records of the field surveys, as well as the library of printed publications; the general supervision of all matters relating to the personnel work, including reports of leaves of absence; the custody and accounting for the receipts from the sale of charts, publications, etc.; and the direction of the engineer, electrician, watch, messenger, labor forces, and other employees engaged in the care, maintenance, and protection of the buildings occupied by the bureau in the District of Columbia.

The more important accomplishments during the year have been a continuation of the thorough renovation of the buildings. While this work is still in progress, and it is a lengthy program with the small force of employees and funds available and the improvements and sanitation that are necessary, the present accomplishments in the way of painted rooms and modern fixtures offer a very pleasing contrast when compared with conditions and equipment previously existing. During the year the installation of all-metal storage racks, in which to place the copper plates from which are printed navigation charts issued by the bureau, and racks for one storage room was completed.

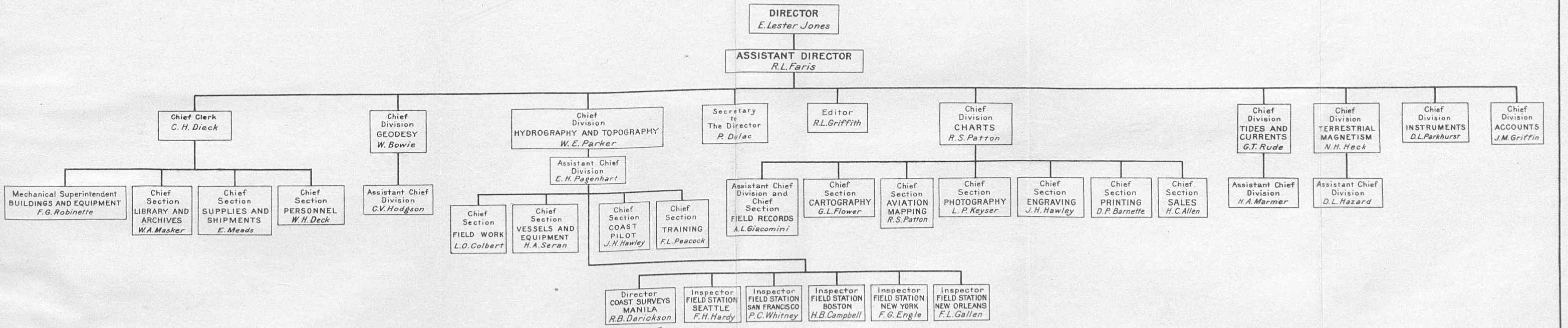
Cooperation with the division of terrestrial magnetism and seismology in stimulating interest of county surveyors and civil engineers in the inspection and maintenance of the magnetic stations already established by the bureau has continued throughout the year.

In the library and archives 93 hydrographic and 72 topographic sheets, each representing new surveys made by the bureau, were received. Other additions were blue prints (mostly showing surveys made by Army engineers), 1,730; maps, 1,725; charts, 1,810; field, office, and observatory records, 3,320; photographs and negatives, 538; prints, 770; lantern slides, 282; books, 606. During the year

U.S. Coast & Geodetic Survey

Effective Oct. 15, 1915
Revised to Oct. 5, 1926

CHART SHOWING ORGANIZATION OF THE
U.S. COAST AND GEODETIC SURVEY
1926



C&GS. Print

the expenditures for general expenses of the bureau, including credits to the appropriation, were $62,961.43.

The total number of permanent and temporary employees in the office and field forces, which includes commissioned officers and all employees appointed through civil-service certification, is office force, 209; field force, 198; total, 407. These figures do not include the persons engaged as rodmen, chainmen, heliotropers, and others in the field parties nor any enlisted men on vessels.

The statistics in regard to leave of absence during the calendar year are annual leave, 7,588 days; sick leave, 1,776 days; without-pay leave, 431 days; and accrued leave, 2,392 days. While the number of employees naturally varied on account of resignations and vacancies, calculated on the number actually in the service on June 30, 1926, as a basis of computation, the average annual leave taken during the year by each employee was approximately 18.64 days and sick leave 4.36 days.

The receipts from the sale of charts and nautical publications prepared by the bureau amounted to $64,290.52, and the funds realized from the sale of old property, work done, and miscellaneous sources amounted to $1,646.88. The receipts from the sale of charts and other nautical publications are in excess of those for any other fiscal year in the history of the bureau.

DIVISION OF HYDROGRAPHY AND TOPOGRAPHY

This division is charged with the supervision of all hydrographic and topographic surveys, with the preparation of coast pilots and sailing directions, with the construction and maintenance of vessels and surveying equipment, except instruments, and with the training of surveying personnel. For convenience in the performance of these duties, the division is subdivided into four sections, each under a section chief, and the whole under a chief and an assistant chief of division.

The section of field work makes careful studies of existing surveys, of the needs for additional surveys and resurveys, and prepares detailed instructions for such work. From monthly progress reports and inspections of field parties the division, through this section, is kept informed of the progress of survey work and, by careful examination of record books and survey sheets, the quality of the work being performed by these parties. Although the surveys executed by parties under the supervision of this division are primarily hydrographic and topographic, yet these parties undertake such triangulation, base measurements, and field astronomy as may be required to provide control for the hydrography and topography. Observations in terrestrial magnetism and of tides and currents are also made in conjunction with the other survey work so that the work of these parties is designated as combined operations.

Through the section of vessels and equipment the floating equipment and hydrographic surveying appliances of the bureau are procured, inspected, and maintained in efficient operating condition. Plans and specifications are prepared in this office for new vessels and equipment and for repairs to the same.

The coast-pilot section compiles, writes, and supervises the publication of coast pilots and inside-route pilots of the navigable coastal waters of the United States and its possessions. These publications are based on field examinations by officers of the section and upon information supplied by surveying parties of the bureau, by mariners, and others. In so far as it is possible to do so, all nautical information contained in these publications is verified by hydrographers of the bureau.

The training section, which is now being organized, will give instruction in hydrographic engineering, seamanship, and navigation to junior officers and special advanced courses of instruction to senior officers. Heretofore new officers who were appointed from among the graduates of engineering schools have received their education in hydrographic engineering, seamanship, and navigation through study and experience while serving as junior officers on survey ships of the bureau. Facilities for teaching are not of the best on these ships, as the entire efforts of the party must be directed toward the rapid completion of the surveys because of the usual urgent demand for the data for chart construction. Development of new officers to a point where they can take an important part in survey work can be effected more quickly and economically by putting them first through an intensive course of instruction in the office and on a small vessel employed entirely for that purpose. Instruction of senior officers will be accomplished by study of field records, treatises on the subject, and operation of new appliances under the direction of experts.

During the past fiscal year new programs have been prepared for surveying and resurveying parts of the Atlantic and Pacific coasts of the United States and for completing the surveys of the Hawaiian Archipelago and the American West Indies. A new type of hydrographic power boat for use in very shallow water was designed and is now under construction. New and improved apparatus for radio acoustic sound ranging was designed and is now under construction in the bureau instrument shop. In cooperation with the Submarine Signal Corporation, extensive tests have been made of the echo sounding apparatus known as the fathometer which have resulted in important improvements of this apparatus. Experiments have been made for the purpose of devising a simple and inexpensive hydrometer suitable for use on shipboard in measuring the density of sea water with sufficient precision for echo sounding and subaqueous sound ranging. One set of instruments has been produced that gives results nearly good enough for this purpose, and it is believed that with slight modifications it will prove satisfactory.

During the year new editions of the Gulf Coast Pilot; of Part I, Alaska Coast Pilot; and of the Inside Route Pilot, Key West to the Rio Grande were issued. Manuscripts were prepared and sent to the printer for new editions of the California, Oregon, and Washington Coast Pilot; of the Atlantic Coast Pilot from Cape Cod to Sandy Hook; of Alaska Coast Pilot, Part II; and of the Inside Route Pilot, Coast of New Jersey. Annual supplements were published for all the other coast pilots. A special publication on the construction and operation of the wire drag and sweep and a new edition of the uniform regulations were also compiled and published.

DIVISION OF GEODESY

The following important pieces of work were completed during the year or were in progress at the end of the fiscal year:

The computation and adjustment of the following pieces of triangulation:

1. Readjustment of first-order triangulation west of ninety-eighth meridian.
2. Southeast Alaska.
3. In South Carolina.

The computation of the following base lines:

1. Gastineau Channel, Alaska.
2. Eagle River, Alaska.
3. Bozeman, Mont.
4. Mount Reed, N. Y.
5. Winton, N. Y.
6. Havre, Mont.
7. Boundary, Mont.
8. Glacier Point, Alaska.
9. Wall, S. Dak.
10. Ranchester, Wyo.
11. Osoyoos, Wash.,
12. Santa Maria, Calif.
13. Presho, S. Dak.
14. Kimball, S. Dak.
15. Alki Point, Wash.

The computations of the following lines of first-order leveling:

1. Sioux Falls-Edgemont, S. Dak.
2. Colorado Springs–Leadville, Colo.
3. Laws–Mojave, Calif.
4. Chatsworth–Pomona, Calif.

Investigations were carried on during the year in the following subjects:

1. Interior of the earth.
2. Gravity.
3. Variation of latitude.
4. California earthquake.

The computation of the reduction for topography and isostatic compensation at one station in the United States and at four sea stations determined on a submarine by Dr. F. A. Vening Meinesz, of the Netherlands, on a trip from Holland to Port Said. A computation was made to test the effect on the anomalies at 56 gravity stations in mountainous regions in the United States of distributing the isostatic compensation between various upper and lower limits of depths below sea level.

The computation of the following astronomic work:

1. Azimuths: 27 stations in the western part of the country, in Canada near the forty-ninth parallel, and in New York.
2. Longitudes: 20 wireless stations in Alaska, Nebraska, South Dakota, Wyoming, Montana, Washington, and in Canada near the forty-ninth parallel.
3. Computation of true geodetic azimuth at 15 Laplace stations.

DIVISION OF CHARTS

The total issue and condemnation of charts at Washington and Manila was 232,286 as compared with 230,535 for the preceding year. As the Navy Department used about 24,000 less Coast and Geodetic Survey charts than in 1925, these figures represent an increase of nearly 30 per cent in purchases by the general public. For the first time sales exceeded free issue plus condemnation, sales being 57.1 per cent of the total issue.

In the preceding report comment was made upon the popularity of the series of inside route strip charts, Norfolk to Key West. The issue for 1925 was 4,404, which was considered excellent. How-

ever, the issue for 1926 was 7,888, an increase of over 79 per cent. This should be considered a convincing argument for completing the series. Even if it is necessary to omit the Chesapeake Bay section, a strip chart should be issued showing the route from the head of the bay to New York City.

The division now has on hand approved schemes for 27 new charts, including those remaining unfinished at the end of the year. Of these, 11 have been taken up and 16 are awaiting available personnel. It is hoped to complete half of the charts on hand, as well as those carried over from last year for reconstruction or simplification.

DIVISION OF TERRESTRIAL MAGNETISM AND SEISMOLOGY

Magnetic work.—The accomplishment of this division has been measured by the fact that there has been no increase in permanent office personnel for more than 12 years. During the past year not even the two temporary junior mathematicians who have been attached to the division for the past several years were available. Some of the work was practically stopped, but service to the public was given first consideration. Information service to local surveyors continued to meet the urgent demand, and as a result of such activity 3,000 local surveyors have benefited by obtaining information available only from this bureau.

There has been a special demand for magnetic-observatory information. During the winter there was a period of several months of abnormally bad radio reception. This appears to have been in some manner related to the conditions of the earth's magnetism, and there has been a strong demand for magnetic information from investigators in the Bureau of Standards, Department of Terrestrial Magnetism of the Carnegie Institution of Washington, the General Electric Co., the American Telephone & Telegraph Co., and from Dr. Greenleaf W. Pickard, of the Wireless Specialty Apparatus Co. of Boston. The information included in some cases immediate report of magnetic storms in progress, and in one case the Carnegie Institution of Washington arranged for special solar observations at the Mount Wilson Solar Observatory while the storm was in progress.

Magnetic-observatory results were furnished to several companies and individuals endeavoring to locate oil fields in Texas by magnetic methods. These investigators also made use of the magnetic field stations of the bureau and reported on the condition of these stations.

Magnetic declination tables have been prepared for the World Almanac.

Information was furnished the Department of Terrestrial Magnetism of the Carnegie Institution of Washington.

Very little progress has been made in the preparation of observatory results on account of lack of personnel. Of the volumes for 1923 and 1924 that for Cheltenham, Md., is partly completed, but the others have not been started. This is the most unsatisfactory condition for many years. It could be in a large measure remedied by the addition of two junior mathematicians to the permanent force.

An important advance has been made in the development of the method of direct scaling of the magnetic elements at the observatories, which is being put into effect. This substitutes for the present method of scaling another method which requires scarcely more time but which gives final or nearly final values, thereby eliminating three office operations which require a large amount of tedious computing. This will become entirely effective when certain instrumental improvements have been completed.

Excellent progress has been made by the instrument division during the year in improving field and observatory instruments.

Members of the division have taken part in the activities of the American Geophysical Union and the International Geodetic and Geophysical Union, and have held several offices in these organizations. Since the work of the bureau bears a definite relation to national and international activities in the same subjects, close contact with those interested in the work is important to avoid overlapping or omissions of important functions.

Several officers of the Chinese Navy received advice and instruction in the use of the magnetic methods of this bureau.

An isogonic map of the Philippine Islands for January 1, 1925, has been prepared.

An isogonic map of the United States for January 1, 1925, has been prepared by a somewhat different method than heretofore. All the magnetic stations in the United States and some in Canada and Mexico were plotted on a base map of the largest size that could be prepared on a single plate. The position of each station is shown by a small letter which is the initial of the name of the station. Copies of the base map have been printed and used in the preparation of the isogonic map. The advantage of this method is that replotting of the position of stations is not necessary.

The following publications were issued during the year:

Results of Observations Made by the Bureau in 1924.
Magnetic Declination in Missouri, 1925.
Compass Surveys. (This publication was revised.)

The following publication was in the hands of the printer at the close of the fiscal year:

Results of Observations for 1925.

The following publications were in preparation:

Observatory Results for Cheltenham, Md., 1923–24.
Magnetic Declination in California and Nevada.
Magnetic Declination in Texas.
Magnetic Declination in the United States for 1925.

The chief clerk's campaign to get in touch with local surveyors was extended to Iowa, Minnesota, Nebraska, North and South Dakota, Colorado, and the New England States. This leaves six States which have not yet been reached, but all necessary preliminary work has been done for these, and a new method of preparing descriptions of stations which results in considerable economy in time and labor has been devised.

Seismology.—The transfer of seismological investigations to this bureau coincided with a period of unusual earthquake activity. This caused the public to demand service which could not be given in the

absence of funds. It was possible, however, to meet the demand in part, because seismological work had been carried on as an adjunct to magnetic work for many years.

The Weather Bureau has adopted a form of report similar to that prepared for this bureau and has renewed its activity in reporting visible and felt effective earthquakes. About three-fourths of the State geologists are also furnishing such reports. There is demand for a still more intensive reporting system in regions of nonearthquake activity, which will be made as soon as personnel becomes available.

A series of publications to continue the reports of the Weather Bureau was started, to be issued quarterly instead of monthly. The reports include the instrumental records at our own and other cooperating stations, but excludes those who publish their own results. It also includes reports of visible and felt earthquake effects throughout the country, and tables in which this information is analyzed, so as to be in readily available form, a summary being given both by date and by region, with the preliminary determination of earthquake epicenters during the period. The reports for the first two quarters of 1925 have been issued and that for the third quarter is ready for the printer.

A considerable amount of work has been done in systematizing the methods of handling earthquake information. Preliminary determinations of the principal earthquakes are made without delay as the results of reports received from the stations of the bureau and cooperating stations. During the year there has been a very considerable demand for information, which has been met as far as practicable.

There has been cooperation with Canada, especially the Dominion Observatory at Ottawa, with the Seismological Society of America, the National Board of Fire Underwriters, and various individuals. It is desired to express appreciation of the fine cooperation received from all these organizations and from individuals who have made reports of earthquake activity.

DIVISION OF TIDES AND CURRENTS

The work of the division of tides and currents is comprised under the following sections: Field work, reductions, datum planes, and predictions. The routine work of all sections is practically up to date. The personnel of this division should be increased by three computers of subprofessional grade in order to relieve the full mathematicians from the greater part of this routine work and to assign them to the more important duties which are in keeping with their experience, and which should be taken up.

Tide observations were made at nine primary tide stations on the Atlantic coast, four on the Gulf coast, six on the Pacific coast, three in Alaska, and one at Honolulu, Hawaii.

In order to relieve the burden of routine work in this office every effort is now made when appointing tide observers, who are part-time employees, to obtain the services of men of such intelligence that the tabulations of the marigraph curves can be made at the tide

station and forwarded to this office for the final reductions and checking. In addition to furnishing general tidal control for large areas for hydrographic work, the tabulations from these tide stations furnish sea-level datum determinations for the use of engineers locally and for initial or "tie-in" points for the net of precise levels being extended throughout the country.

Tide predictions for 1928 tide tables were begun October 5, 1925, and completed May 15, 1926. Tide predictions for all current tables for the calendar year 1928 were begun January 18 and completed June 10, 1926.

The predictions and submittal to the Government Printing Office of all manuscripts of the tide and current tables issued by this bureau have been advanced as to date each year for the past five or six years with the intention of having all tables for any calendar year ready for issue by July 1 of the preceding calendar year. This schedule has now been reached and is being maintained.

The following table, showing the number of copies of the tide tables issued each fiscal year for the 10 years 1916–1925 is indicative of the usefulness of these publications:

	United States and foreign ports tide tables	Atlantic coast tide tables	Pacific coast tide tables	Total
Tide tables for fiscal year—				
1916	741	2,545	10,227	13,513
1917	1,598	3,852	13,346	18,696
1918	3,334	3,970	14,492	21,796
1919	4,217	4,398	14,768	23,383
1920	3,469	5,357	16,061	24,887
1921	3,577	5,678	14,957	24,212
1922	3,067	5,704	14,902	23,673
1923	2,479	5,440	15,054	22,973
1924	2,509	7,097	15,234	24,840
1925	2,218	6,727	15,849	24,794

In addition to the tide and current tables sold by this bureau many thousands of privately printed tables are issued all over the country for various localities. These private tables are copied directly from our tables and due credit is given this survey as the source of these data. In addition the public receives the benefit of these predictions through the medium of daily newspapers, almanacs, and calendars.

The following table shows the number of copies of the current tables issued for the fiscal years 1923 to 1925. Prior to 1923 information on currents was contained in the tide tables. The current tables are now being issued as separate publications, which are being enlarged in size and scope each year.

	Atlantic coast current tables	Pacific coast current tables	Total
Current tables for fiscal year—			
1923	2,029	1,786	3,815
1924	3,124	2,002	5,126
1925	2,452	2,474	4,926

Observations of currents were made at two light vessels on the Atlantic coast and one on the Pacific coast with the cooperation of the Lighthouse Service.

It has been the aim during the past year to arrange the regular routine work so as to give as much time as possible for the preparation of publications dealing with tides and currents, and to make available to the mariner, engineer, scientist, and general public the important data accumulating in our files. In accordance with this policy several special publications were prepared.

Special Publication No. 113, Portable Automatic Tide Gauge, was received from the printer early in the fiscal year. This publication gives a description of the portable gauge recently developed by this bureau and gives detailed instructions for its installation and operation.

Special Publication No. 115, Tides and Currents in San Francisco Bay, was received from the printer on August 18, 1925. This is the second of a series of special publications presenting the results of tide and current surveys made in the important waterways of the United States. It contains 125 pages and 39 illustrations.

Special Publication No. 119, Tidal Bench Marks, District of Columbia, was received from the printer in December, 1925. It comprises 14 pages and 1 illustration.

Special Publication No. 121, Coastal Currents Along the Pacific Coast of the United States, was received from the printer in June, 1926. This publication comprises 80 pages and 23 illustrations and discusses in detail the tidal currents, nontidal currents, and wind-driven currents at each of the five light vessels on the Pacific coast.

During the year the manuscript of Special Publication No. 123, Tides and Currents in Delaware Bay and River, was prepared. The page proof has been received from the printer and delivery is expected early in the next fiscal year. This will be the third of the series of special publications presenting the results of tide and current surveys in the important waterways of the United States.

The manuscript of Special Publication No. 124, Instructions for Tidal Current Surveys, was prepared during the year. The galley proof has been received from the printer. It is the purpose of this publication to give field engineers of the survey descriptions of the instruments used and detailed instructions for conducting current surveys.

The observations obtained from the current and tide survey of southeast Alaska have been analyzed during this fiscal year. The manuscript of a publication on tides and currents in southeast Alsaka will go to the printer early in the coming fiscal year. In addition, the improvements to our present current predictions, made possible by this survey, have been incorporated in the current tables for the use of the mariner.

Work was done on the manuscript of a special publication entitled "Tidal Datum Planes," which will be sent to the printer during the coming fiscal year.

Work was also begun on the manuscript of three special publications entitled:

Tidal Bench Marks, State of Rhode Island.
Tidal Bench Marks, State of Connecticut.
Tidal Bench Marks, State of New Jersey.

It is planned to complete the manuscript of these three publications during the coming fiscal year.

For many years the need has been felt for a semipopular stylebook on the tides which would serve as an introduction to the more technical publications of the Coast and Geodetic Survey, and which would acquaint the general public with the importance and interest of tides and currents. It was felt that it must be so written and so illustrated as to preclude its issue as a Government publication. H. A. Marmer, chief tidal mathematician of the division of tides and currents, had been privately working on such a publication since 1919. In April, 1926, D. Appleton & Co. issued his book, called The Tide.

The cooperative arrangement with the British Admiralty in the exchange of tidal predictions has been continued and extended to one more station, Bahia Blanca. This cooperation began with the exchange of predictions for six American ports for the predictions of six British ports. It has now been extended to 17 ports each. Since this constitutes about 20 per cent of our tide predictions, the economy effected for each country is obvious.

A cooperative agreement was made during the past year with the Canadian Hydrographic Office, effective for 1928. Under this plan data for three standard ports will be received: Quebec, Halifax, and St. John. Halifax and St. John have been previously predicted by this survey and Quebec will be included as an additional port. This will furnish daily predictions for an important port and will furnish a better reference port for a number of subordinate stations along the St. Lawrence River.

During the year a current diagram, larger than heretofore published in the current tables and printed on heavy chart paper, was issued for Chesapeake Bay. This is the second of a proposed series covering the inland waters of the United States. One for Nantucket and Vineyard Sounds was issued last year.

DIVISION OF ACCOUNTS

From July 1, 1925, to June 30, 1926, the actual disbursements on account of appropriations for the Coast and Geodetic Survey amounted to $2,255,247.78. It must be understood, however, that this does not represent the actual expenses of the survey for the fiscal year 1926, but only the actual disbursements. In a separate report to Congress will be found an itemized statement showing disbursements from each appropriation and subitems thereof with all detailed information as to the character of the expenditure.

These expenditures include the accounts of all chiefs of parties in the field located throughout the United States, Alaska, Hawaii, Porto Rico, the Philippines, and the Virgin Islands. From 30 to 50 chiefs of parties were engaged on field duty at various times during the year, being financed through advances made to them by this division, and accounts arising under such advances were submitted to and through this division to the Treasury Department.

The total appropriations for the fiscal year 1926 were $2,327,650.

INSTRUMENT DIVISION

It is the duty of the instrument division to provide the equipment used by all the field parties and observatories of the survey which are engaged in geodetic surveying, precise leveling, terrestrial magnetic work, study of ocean tides and currents, hydrographic charting, and all the other activities in which this bureau engages. This involves purchase and inspection of standard and special makes of surveying and navigating instruments, numerous articles of general property, and the storage and issue of such instruments and equipment. Whenever special instruments or apparatus are needed it is the function of the instrument division to design such instruments or apparatus, to compile specifications, make detailed drawings, etc. The repair and adjustment of the instrument stock also comes under the jurisdiction of this division, as well as the construction of new models of original design where such models can not be obtained through commercial channels, which is usually the case. The division also maintains the property record system by means of which the transference of equipment to and between field parties is accounted for.

A number of new instruments and improvements were effected during the past year, the more important of which are listed as follows:

Large tide gauge.—The clock mechanism used in this gauge has required the use of two timepieces, which it has been necessary to synchronize. This arrangement has never been satisfactory, nor in the original design was provision made for interchangeability, which made replacement of defective parts difficult. The entire timepiece mechanism was redesigned so that one clock now serves the purpose of the former two, and this clock is so mounted on a special plate that it can be removed from the gauge and a new one inserted without adjustment and without the use of any other tool than a small screw driver. All units are interchangeable and the work of removing a defective clock and installing a new one requires but a few minutes. Ten gauges have been remodeled after this design and are in operation. The remainder will be altered as soon as time permits.

Magnetic recording box.—This instrument was entirely redesigned and a more accurate and rugged timepiece substituted for the delicate mechanism formerly used. The intricate linkage which operated the shutter was replaced by a single lever with a simple tripping device. In the original box it was necessary to change the sensitized recording film in absolute darkness, which was decidedly inconvenient. A small electric lamp in a light-proof housing was built into the box, with a red window on the interior to shut out the actinic rays. The film can now be easily changed.

First-order theodolite.—There has been a demand for a number of years for an improved first-order theodolite. Such an instrument was designed in this division embodying all the features which our field experience with a wide variety of makes of such instruments has indicated to be desirable. This instrument will have a 9-inch graduated circle with vertical microscopes, with two micrometer boxes reading to one second. The telescope will be internal focusing and will transit through the wyes. The vertical axis is designed to

reduce friction to a minimum and to eliminate the effect of temperature changes. It will be provided with a means of bringing an electric current from an outside source without the use of external wires to the bulbs which illuminate the telescope crosswires and the micrometer drums.

Signal lamps.—A new and more powerful signal lamp was designed along the lines of the 1924 model, which is entirely inclosed. The body of the lamp was strengthened so as to eliminate the special packing box, which has added greatly to the expense of this instrument. A more powerful bulb was procured for this lamp. It has the same design of special filament which the survey has been using for several years.

Wave-recording apparatus.—A request was received from the State of New Jersey to cooperate in the study of the effect of waves on the coast. The instrument division designed a machine which records on a moving sheet of paper the height, form, frequency, and speed of the ocean waves. This record will furnish information as to the number of waves, their height and speed, and the amount of water which is projected upon the beach during any given period of time at a given place.

Sounding tubes.—The device used for measuring the depth to which the tube has descended when making soundings (indicated by the amount of water contained in the tube when brought to the surface) has never been entirely satisfactory, as it is affected by moisture. An instrument for use with these tubes was designed to indicate the depth by electric means. The instrument is expected to be more accurate and more easily used than the former type. It will eliminate the loss of soundings by spillage of the water in the tube and will reduce the accuracy necessary in the construction of the tube itself, with a consequent reduction in the cost.

Chronograph.—These instruments, which were originally designed for laboratory use and which were extremely heavy, have been a very cumbersome piece of apparatus to use in field work. The weight has been materially reduced by the lightening of the parts and by the use of ball bearings, cutting down friction, and thereby reducing the weight necessary to operate the mechanism.

Sounding engraving machine.—A duplicate of the machine built last year for the Washington office was partially completed. When finished it will be sent to the office at Manila. In connection with this machine experiments were carried on to procure a more durable engraving point. The finest grade of hardened steel soon wears blunt. A sample point was made of stellite, an exceedingly hard nonferrous alloy, which has stood up to the work much better than steel. It is intended to carry the experiments further, testing the possibility of using jewels or a metal point plated with chromium.

Current-meter wire.—The wire used with current meters has not been entirely satisfactory, as the insulation is readily broken. An experimental lot of similar wire protected by metal armoring such as is commonly used with automobile lighting cable has been procured and is now undergoing a test in the field. It is expected that this wire will be much more durable and consequently less expensive.

Radio acoustic apparatus.—A complete ship's set of radio equipment, such as is used in radio acoustic ranging, was nearly completed

during the year. This work is being done at a decided saving over the commercial cost.

Tapes.—A sample lot of pocket tapes made of stainless steel was procured during the year and are being tested out under field conditions. These tapes are not so easily broken as the common steel tape nor are they readily corroded. They are sufficiently stiff so that they are not readily kinked, in which characteristic they are superior to monel metal. Preliminary reports have indicated that these tapes will be satisfactory when used under severe conditions and it is thought that they will be superior to anything previously used.

Sesquicentennial Exposition.—An elaborate exhibit has been prepared for the Sesquicentennial Exposition at Philadelphia, consisting of a variety of the instruments used in our various kinds of work, illustrated slides showing the work in progress, an exhibit of the various steps involved in the production of charts, and a working model of the wire-drag apparatus. This model consists of a pair of small launches which tow a miniature wire drag over a distance of 5 feet in a metal-lined tank filled with water dyed sea green. Suitable islands and mainland made of concrete and properly painted are placed in the tank. Three sides are inclosed by a canvas screen painted to furnish a landscape effect. To illustrate the use of the radio acoustic apparatus a ship was painted upon this screen, apparently at some distance from the shore, with a radio tower in the foreground. A sinuous line of miniature electric bulbs between the ship and the radio tower, lighted by a motor-driven flashing apparatus, furnishes the illusion of a sound wave passing from the ship to the shore station, and a straight line of similar lights from the shore to the ship illustrate the radio waves of the return signal.

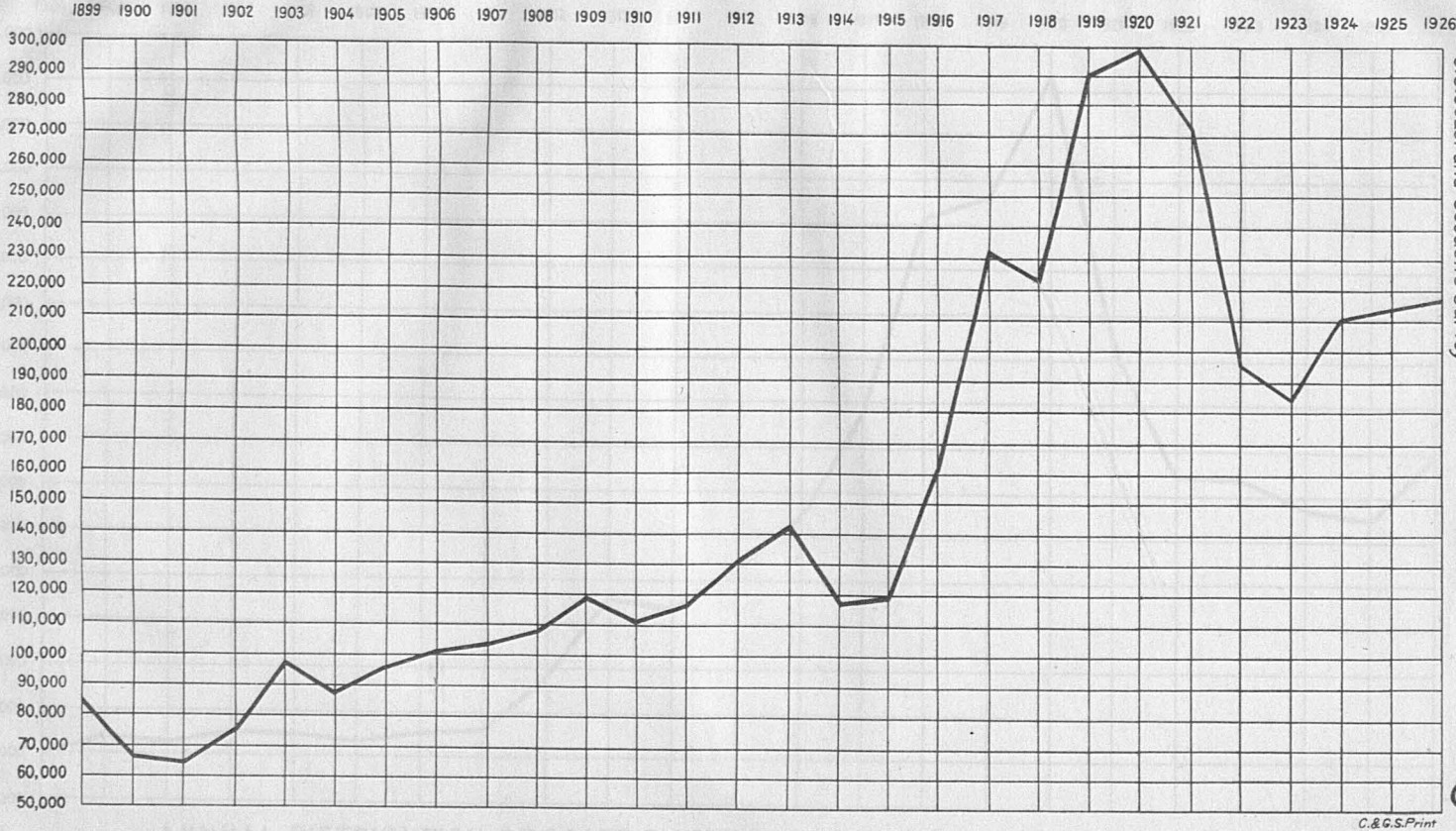
NEW CHARTS ISSUED DURING THE YEAR

232. Scituate Harbor, Mass. July, 1925. Scale, 1:5,000; dimensions, 15 by 19 inches. Price 25 cents. This chart is issued to meet the demand for a large-scale chart of the harbor and to give to the public the results of a recent survey.

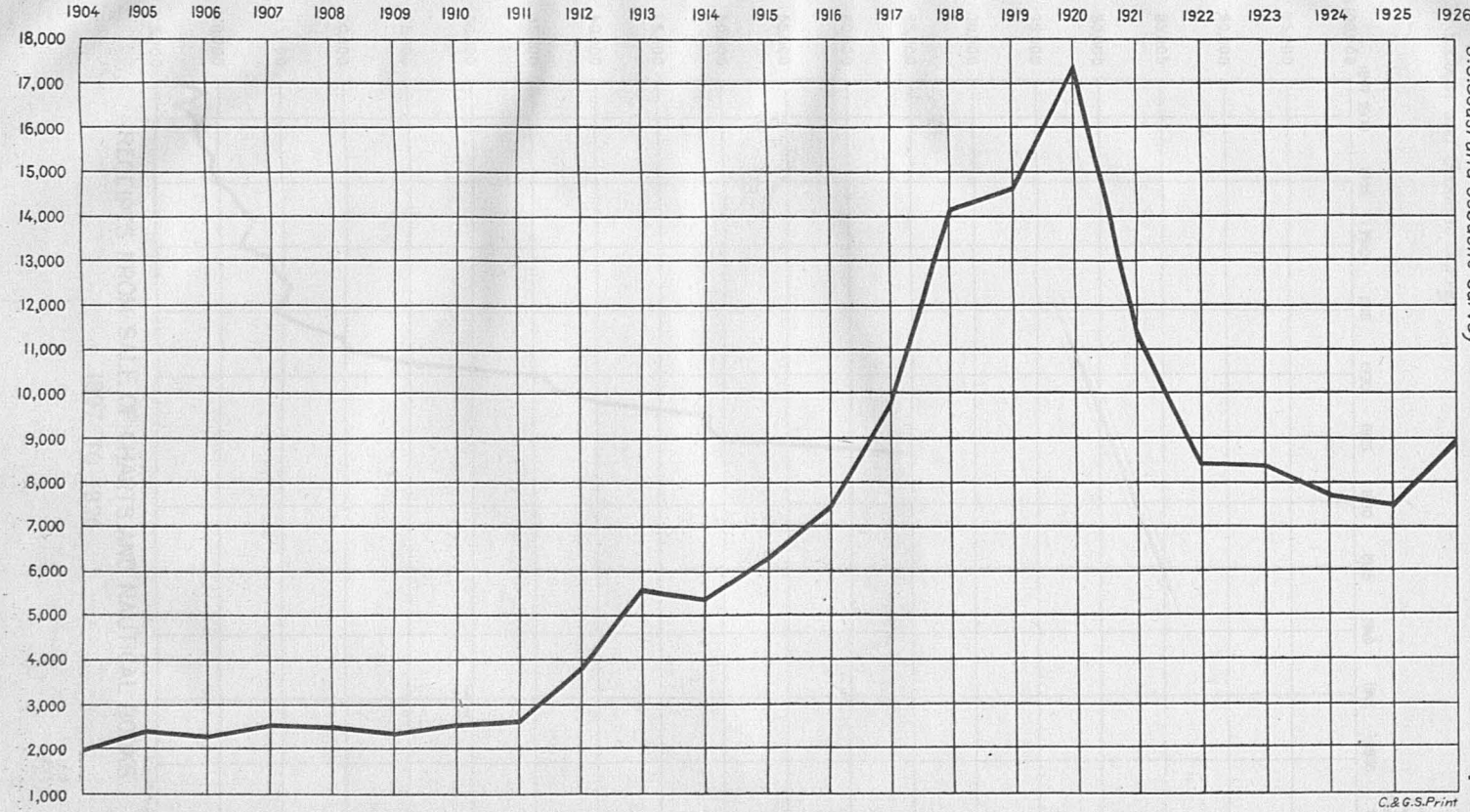
231. Saco Bay and vicinity, Me. August, 1925. Scale 1:20,000; dimensions 29 by 40 inches. Price 75 cents. This chart extends from High Head to Fletcher Neck, Me., and includes Richmond Island Harbor, Saco Bay, and the Saco River up to Saco. The soundings are in feet and give the depths at mean low water. The soundings in the Saco River are from a survey by the United States Engineers in 1923 and the other soundings from surveys by the United States Coast and Geodetic Survey in 1923, with a few offshore soundings from older surveys. Chart 327. Richmond Island Harbor is canceled, as the area is covered by this chart.

8704. Pavlof Bay and approaches, Alaska Peninsula, Alaska. January, 1926. Scale, 1:80,000; dimensions, 28 by 40 inches. Price 75 cents. This new chart is constructed on the Mercator projection, scale 1:80,000, in latitude 55° 39′. It shows the results of a survey of Pavlof Bay made in 1924 and earlier. The eastern approaches to the bay are not as yet surveyed.

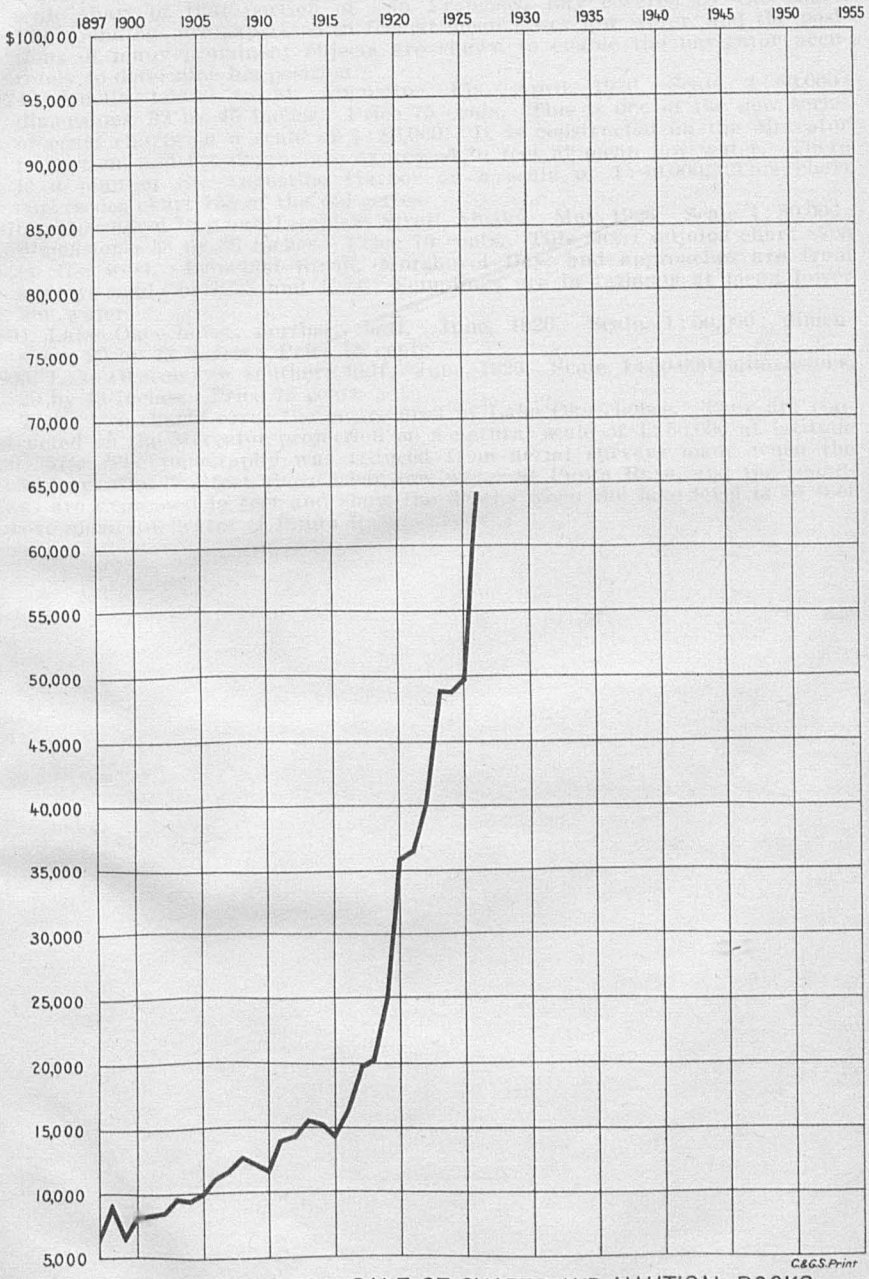
8253. Cape Ommaney to Byron Bay, Baranof Island, Alaska. February, 1926. Scale, 1:20,000; dimensions, 33 by 44 inches. Price 75 cents. This chart is constructed on the Mercator projection, and the soundings are expressed in fathoms at mean lower low water. It includes the numerous bays on the west coast of Baranof Island to Byron Bay and gives the results of surveys made in 1923, 1924, and 1925. The plan of Redfish Bay on chart 8262 is to be canceled.



ISSUE OF CHARTS FROM 1899 TO 1925



ANNUAL DISTRIBUTION OF COAST PILOTS AND INSIDE ROUTE PILOTS



RECEIPTS FROM SALE OF CHARTS AND NAUTICAL BOOKS
1897 TO 1926

5535. Visitation Point to Point Blunt, San Francisco Bay, Calif. February, 1926. Scale, 1:20,000; dimensions, 28 by 37 inches. Price 75 cents. This chart is published at the request of the United States Navy for a large-scale chart of that portion of San Francisco Bay covered by the chart. The soundings are expressed in feet at mean lower low water, and the positions of many prominent objects are shown to enable the navigator accurately to determine his position.

1243. Amelia Island to St. Augustine, Fla. April, 1926. Scale, 1:80,000; dimensions, 32 by 45 inches. Price 75 cents. This is one of the new series of coast charts on a scale of 1:80,000. It is constructed on the Mercator projection, and the depths are expressed in feet at mean low water. There is a plan of St. Augustine Harbor on a scale of 1:40,000. This chart supersedes chart 158 of the old series.

8701. Morzhovoi Bay and Isanotski Strait, Alaska. May, 1926. Scale, 1:80,000; dimensions, 33 by 33 inches. Price 75 cents. This chart adjoins chart 8703 on the west. Isanotski Strait, Morzhovoi Bay, and approaches are from surveys made in 1923 and 1924. Soundings are in fathoms at mean lower low water.

804. Lake Okeechobee, northern half. June, 1926. Scale, 1:50,000; dimensions, 29 by 43 inches. Price 75 cents.

805. Lake Okeechobee, southern half. June, 1926. Scale, 1:50,000; dimensions, 29 by 43 inches. Price 75 cents.

These two charts cover the entire area of Lake Okeechobee. They are constructed on the Mercator projection on a natural scale of 1:50,000 at latitude 26° 57′. The topography was reduced from aerial surveys made when the lake level was 19.2 feet above mean low water at Punta Rasa, and the soundings are expressed in feet and show the depths when the lake level is 15 feet above mean low water at Punta Rasa.

CHAPTER II

PROGRAM FOR THE CURRENT FISCAL YEAR IN THE WASHINGTON OFFICE

CHIEF CLERK

The program for this division will be, in addition to the routine duties of the division, the continuation of the renovation of the buildings occupied by the bureau and the installation of fixtures and equipment that result in better sanitation, economy in operation, and increased production.

DIVISION OF HYDROGRAPHY AND TOPOGRAPHY

The program for this division for 1927 includes:

(*a*) Preparation of instructions for field work.

(*b*) Preparation of plans for the construction of new vessels and for repairs to the present fleet.

(*c*) Investigation and design of new instruments and surveying appliances.

(*d*) Preparation of service manuals and specifications for field work.

(*e*) Inspection of field work and equipment.

(*f*) Compilation and publication of new editions of the Atlantic Coast Pilot from St. Croix River to Cape Cod; the Inside Route Pilot, New York to Key West; and the Philippine Islands Pilot, Part I. Publication of an inside route pilot for the waters north of New York City is under consideration and will be issued if there appears to be sufficient demand to justify the expense.

DIVISION OF GEODESY

The program of office computations for the division of geodesy for 1927 by projects is as follows:

(*a*) *Triangulation and traverse.*—In Washington along the boundary between United States and Canada; from the vicinity of San Luis Obispo, Calif., to Nevada; readjustment of triangulation west of ninety-eighth meridian; in Alaska; Green Bay, Wis., westward through Minnesota to the ninety-eighth meridian in South Dakota; in Iowa, Missouri, and Arkansas.

(*b*) *Levels.*—In North Dakota; in South Dakota; in Colorado; in New Mexico; in Arizona.

(*c*) *Astronomic.*—Latitudes, longitudes, and azimuths in southern California on an arc of triangulation near the thirty-fifth parallel; azimuths to be determined by triangulation and traverse parties mostly in Wisconsin, Minnesota, South Dakota, and Washington;

longitudes at Honolulu and Manila as a part of the international world longitude net to be observed in October and November, 1926.

(*d*) *Gravity.*—Computations of several gravity stations which will be determined in southern California, Hawaiian Islands, and the West Indies. Isostatic reduction of a number of gravity determinations at sea, made by Dr. F. A. Vening Meinesz, of Holland; special isostatic investigations and miscellaneous computations.

(*e*) *Publications.*—Instructions for First-Order Leveling; An Investigation of the Depth of Isostatic Compensation; Manual for the Computation of Triangulation; Preliminary Report on the Readjustment of the First-Order Triangulation Net of the Western Half of the United States; First-Order Leveling in Alabama; Triangulation, Coast of North Carolina; Instructions for Computing Long Geodetic Lines.

DIVISION OF CHARTS

Because of the lack of personnel to devote to production of new charts or reconstruction of old ones, it is difficult to make an accurate forecast for the fiscal year 1927. Schemes for 27 new charts are listed for taking up, of which 11 were on hand at the close of the fiscal year 1926. It is hoped that half of the charts listed can be completed during this year.

DIVISION OF TERRESTRIAL MAGNETISM AND SEISMOLOGY

The program for 1927 is as follows:

Magnetic work.—Attempt to complete the observatory publication for Cheltenham, 1923–24, for the printer.

Complete the publications for California, Nevada, and Texas, and, if possible, commence work on the publication for Georgia.

Prepare for publication magnetic results obtained during 1926.

Continue to furnish information to local surveyors and those persons or institutions investigating difficulties in radio, telegraph, and cable communication.

Continue work on the publication to replace Magnetic Tables and Magnetic Charts, 1915.

Furnish magnetic information for charts.

Supervise investigations at Cheltenham in regard to magnetic instruments and carry out, in cooperation with the instrument division, a program of improvement of instruments and instrumental methods.

Supervise the replacement of the office building at the Tucson Magnetic Observatory.

Take part in the discussion of observatory results in cooperation with other organizations and in an effort to solve some of the mysteries of the earth's magnetism.

Furnish information to those making geological investigations by magnetic methods.

Seismology.—Continue to secure reports of visible and felt effect of earthquakes and expand this program to some extent.

Investigation of instrumental records and determination of epicenter.

Special study of results obtained from the Wood-Anderson seismograph at Tucson in order to determine the value of this instrument in teleseismic work.

Attempt to develop a vertical seismograph which will meet our conditions.

Study of earthquake literature.

Cooperate with existing organizations interested in seismological investigation, including Seismological Society of America, National Research Council, Carnegie Institution of Washington, and others.

DIVISION OF TIDES AND CURRENTS

The program for the division of tides and currents for the fiscal year ending June 30, 1927, is as follows:

The predictions for the tide and current tables for the calendar year 1929 will be made and the manuscripts submitted to the printer in time for issue on or before July 1, 1928.

The sounding records received from hydrographic parties will be checked for tidal datum planes as received, so that the chart division will not be delayed by this phase of the work in the publication of charts.

The bench-mark records received from the field will be computed for those demanding immediate attention and the remainder kept up to date as the force of mathematicians will allow.

The manuscript of a publication on the currents and tides of southeastern Alaska will be completed and sent to press early in the fiscal year.

The manuscript of a publication on the currents and tides of Boston and Portsmouth Harbors will be prepared and sent to press late in the fiscal year.

The observations obtained on the current and tide survey in Boston and Portsmouth Harbors will be analyzed as soon as possible upon their receipt from the field parties; and the improvements to our present current predictions, made possible by this survey, will be incorporated in the current tables for use of the mariner.

With a view to economy in the prosecution of the current surveys attention will be given to the correction of weaknesses which may develop this season in the Pettersson automatic current meter, which is being given a thorough test during the Boston and Portsmouth current surveys. Plans will be developed for the use of these meters, unattended, in order to reduce the unit cost of this work.

The foregoing constitutes the outstanding features of the program for the next fiscal year in addition to the normal routine work of the division. In general, the work of the division will be so arranged as to take up immediately the work upon which the predictions of tides and currents and the publication of charts depend; after that the energies of the division will be directed toward keeping the tide and current tabulations and reductions up to date and issuing in the form of publications the large mass of material that has accumulated and which is of considerable value to the navigator, the engineer, the scientist, and the public generally.

DIVISION OF ACCOUNTS

The program for this division will be a continuance of the duties incident to disbursing the funds appropriated for the operation of the bureau, including the financing of all chiefs of parties at the work in the field, together with the verification of all accounts arising under such advances.

INSTRUMENT DIVISION

The program for the fiscal year 1926–27 will be to construct, repair, and purchase such instruments as are necessary to maintain a suitable stock ready for issue, so that our field parties will at all times have adequate equipment in sufficient quantity to avoid delay when unavoidable breakages occur. Constant effort will be made to improve the existing designs and to design and build such new instruments as may be needed, more particularly the completion of a new theodolite, sounding-tube measuring device, and such other instruments as the needs of the year may require.

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Part III.—IN THE FIELD

CHAPTER I

ACCOMPLISHMENTS IN THE FIELD DURING THE FISCAL YEAR

HYDROGRAPHIC AND TOPOGRAPHIC WORK

The hydrographic and topographic surveys made during the fiscal year 1926 are listed with reference to their geographic location as follows:

Atlantic coast.—Revision of surveys was made along the Camden shore line of the Delaware River, and work has been begun on the revision of the shore line of Raritan Bay, N. J., and on the south side of Long Island east of Far Rockaway, N. Y. A field examination was made for the Coast Pilot from Cape Cod to Sandy Hook, and for the Inside Route Pilot, New York to Key West. Reconnaissance for later revision surveys was made on the Gulf coast between Tampa and Key West. Complete resurveys have been made of Tampa Bay for the construction of large-scale charts showing the extensive developments which have been carried since the previous survey, which was made a number of years ago. Control points were established for accurate location of navigational aids in the St. Johns River, Fla., between Jacksonville and the coast. The survey of South Carolina from shoal water inlets out to the 100-fathom curve is nearing completion. Experimental work in echo sounding is being carried on in conjunction with this work. Additional soundings were made in the southern approach to Cape Henry, Va.

Pacific coast.—A survey of Newport Bay was completed. Soundings were obtained in San Pedro Channel and in the large area south of Santa Cruz and Santa Rosa Islands, Calif. A special hydrographic investigation was made of the water front of San Francisco, also of the South Channel and Bonita Channel, San Francisco Bay Entrance. These channels were swept with a wire drag, to locate a reported danger and for the least depth in the vicinity of Centissima Rock. A wire-drag survey of Greenwood Landing, Calif., is in progress. Soundings were taken off the coast of Oregon from Port Orford south. A reconnaissance was made of the inshore area near Cape Blanco. Surveys of the coasts of Oregon and Washington in the vicinity of the Columbia River have been recently begun. Two separate surveys, in September and February, were made of the channels across Willapa Bar. A survey of the shore line along the Strait of Juan de Fuca west of Point Wilson was completed. Field examination of the Pacific coast for pilot information was completed.

Alaska.—In southeast Alaska surveys have been extended in the following sections: Chatham Straits, from Cape Decision to Port Malmesbury and in the vicinity of Port Alexander; in Pybus Bay, Frederick Sound; in Cordova Bay along the shore of Long Island and through Kaigani Strait; also into Port Refugio on Suemez Island. In various parts of the main ship channels supplementary examinations are being made. The outer coast is now completely surveyed from Dixon Entrance to Cross Sound, the northern part of

this work having been accomplished during this year. Surveys were completed on the southeast side of the Alaska Peninsula, in Chignik and Kujulik Bays and their approaches, in Ikotan Bay, and in the area between Cold and Belkofski Bays. Work was started in Balboa Bay. Echo sounding lines were run in making passage to and from the field and between points in the field. An original survey was begun in May in Shuyak Strait between Afognak and Shuyak Islands to chart this newly developed region and permit steamers to enter with safety. The preliminary reconnaissance of the Aleutian Peninsula was completed.

Hawaiian Islands.—Surveys were extended on the south coasts of Oahu and Kauai Islands. This included intensive development of the reefs and of the roadsteads in which ships anchor to load and discharge. Hydrographic investigations were made on Penguin Bank and in the waters west of Niihau Island.

Philippine Islands.—In the Philippine Islands surveys were carried on in the regions north of Luzon Island, in the Sulu Sea, along the Sulu Archipelago, and in Malampaya Sound. Reconnaissance for triangulation in the Cagayan Valley of Luzon has been made. A current survey of San Bernardino Straits was completed.

Porto Rico.—The examination of the waters east of Porto Rico and in the Virgin Islands was nearing completion at the close of the year.

Hydrography, topography, and triangulation (third order) performed during year

Locality	Hydrography		Topography		Triangulation (third order)		
	Number of soundings	Area in square miles	Length of shore line surveyed in miles	Area surveyed in square miles	Length of scheme, in miles	Area covered in miles	No. of pos. det.
Long Island, N. Y.			39	9	9	27	20
North shore, N. J.			5	1	10	20	16
Delaware River, vicinity of Camden, N. J.			37	8	16	15	110
South of Cape Henry, Va.	8,544		27	13			
Cape Fear to Winyah Bay	49,453	3,819	40	15			8
Coast of South Carolina	18,618	144	104	31			
Tampa Bay, Fla.	44,692	245	323		57	280	94
Approaches to Tampa Bay	61,721	336	159	42	18	60	64
South of Santa Cruz Island, Calif.	8,762	3,270					
Vicinity of San Pedro Channel	27,344	4,837	31	17			
Vicinity of Port Orford, Oreg.	10,077	1,916	10	3			
South of Columbia River, Oreg.	2,311	82	22	8			
Willapa Bay, Wash.	597	2					
Strait Juan de Fuca, Wash.	10,808	25	115	22		48	68
Southeast Alaska, vicinity of Dall Island	5,820	62	150	61	39	684	30
Southeast Alaska, various waterways	14,987	118 / 1 237	249	91		137	114
Southeast Alaska, outside coast	41,704	3,045	583	96		189	64
Chignik and vicinity, southwest Alaska	9,940	780	131	154	5	240	
Belkofski Bay, vicinity of southwest Alaska	11,860	181	70	126	27	175	34
Shuyak Strait, southwest Alaska	1,228	10	37	15	10	18	22
Aleutian Islands reconnaissance	522	3	26		9	16	47
Porto Rico and Virgin Islands	24,673	157 / 1 157			35	80	58
Hawaiian Islands	43,335	704	70	29	20	100	79
North of Luzon Island, P. I.	18,428	260	106	220			
Sulu Archipelago, P. I.	107,568	969	81	64		350	34
Palawan Island, P. I.	37,410	29	19	7			
Sulu Sea, P. I.	1,370	28,335					
Tawitawi Island group, P. I.	28,612	646	72	201	75	1,430	107
Northern Luzon reconnaissance					120	21	
Total	590,385	50,369	2,506	1,233	450	3,890	978

[1] W. d.

GEODETIC WORK

	Length of scheme	Area covered
	Miles	*Square miles*
Triangulation, first order:		
Alaska, Lynn Canal–Skagway	30	165
Montana and Idaho, forty-ninth parallel	85	2,100
Washington, forty-ninth parallel	175	3,500
Washington, Umatilla–forty-ninth parallel	235	5,000
Wyoming and Montana, one hundred and fourth-one hundred and eleventh meridian	400	10,000
Arizona, California, Nevada, and Utah, Needles–Salt Lake City	175	11,000
Nevada, thirty-ninth parallel revision	100	6,500
California, Ukiah and Point Arena connections	35	865
California, Santa Barbara revision and Santa Maria base net	55	1,250
Total	1,290	40,380
Triangulation, second order:		
Alaska, Chatham Strait	65	500
Triangulation, third order:		
Alaska, Sukkwan Strait	7	3
Washington, Columbia River–Grays Harbor	25	35
Oregon, Columbia River to Tillamook Bay	45	100
Florida, Saint Johns River	25	20
Pennsylvania, Schuylkill River	1.5	1.5
Total	103.5	159.5
Traverse, first order: New York, Rochester	30	----------
Traverse, second order: New York, Rochester	20	----------
Traverse third order: Washington, Columbia River–Grays Harbor	32	----------
Base lines, first order:		
Alaska, Glacier Point	2.3	----------
Wyoming, Ranchester	5.6	----------
Washington, Osoyoos	5.5	----------
California, Santa Maria	12.5	----------
Total	25.9	----------

	Length of scheme	Area covered
	Miles	*Square miles*
Reconnaissance:		
Washington, Umatilla–forty-ninth parallel	185	4,000
Iowa and Missouri, ninety-third meridian	465	5,500
California and Nevada, San Luis Obispo–Las Vegas	315	12,000
Wisconsin, Green Bay–La Crosse traverse	225	----------
Alabama, oblique arc–Union base	50	900
Alaska, Fairbanks–Eagle	270	4,600
Washington, forty-ninth parallel	100	1,750
Total	1,610	28,750
Reconnaissance, preliminary:		
Arkansas, ninety-third meridian	125	----------
Mississippi and Louisiana, Mississippi River	375	----------
Mississippi and Alabama, Vicksburg–Columbus	385	----------
Total	885	----------
Leveling, first order:		
South Dakota, Sioux Falls–Edgemont	377	----------
Colorado, Colorado Springs–Leadville	204	----------
California, Laws–Mojave	240	----------
California, Chatsworth–Pomona	114	----------
Colorado, Salida–Grand Junction	25	----------
Total	960	----------
Summary:		
First-order triangulation	1,290	40,380
Second-order triangulation	65	500
Third-order triangulation	103.5	159.5
First-order traverse	30	----------
Second-order traverse	20	----------
Third-order traverse	32	----------
First-order base lines	25.9	----------
Reconnaissance	1,610	28,750
Reconnaissance, preliminary	885	----------
First-order leveling	960	----------

The plans made at the beginning of the fiscal year 1926 contemplated the completion of certain arcs of first-order triangulation to the westward of the ninety-eighth meridian, which would fill out in general outline the first-order triangulation net of that half of the country. It is inevitable that readjustments of triangulation over large areas must be made from time to time in order to get the best and most reliable geographic positions of the triangulation stations. When the work of the Coast and Geodetic Survey was first begun, 110 years ago, it was necessary to start the surveys of the coast from a number of astronomic stations. As the triangulation was extended from each of these stations and was joined, there was a failure to check. In order to eliminate this trouble, large stretches of the

coast were computed from a single astronomic station or an adopted astronomic position. Eventually the Atlantic and Gulf coasts of the United States had a continuous triangulation as had also the Pacific coast. Then the two coasts were joined by an arc of first-order triangulation which extended across the country along the thirty-ninth parallel. About 25 years ago, after this transcontinental arc had been completed, it was decided to compute all of the triangulation of the two coasts and the interior from a single station. The station selected was Meades Ranch in central Kansas. This station with its latitude and longitude adopted with reference to Clark's spheroid of 1866 was termed the United States Standard Datum. This datum was later adopted by Canada and Mexico for computing their triangulation, and a continuous single network for the whole of North America was thus obtained. The name of the datum was then changed to North America Datum.

The triangulation executed during the past 25 years has been fitted to the arcs or network in existence at the time the single datum for the country was adopted. As the new work was fitted into the old, it had to take up all the closing errors of the loops of which it was a part. In many cases much larger corrections had to be applied than the quality of the new work justified.

Two years ago it was decided that a readjustment of the first-order triangulation to the westward of the ninety-eighth meridian could be made as soon as a comparatively small amount of field work had been executed to complete the net. The resulting geographic positions could then be held for all time except in so far as the triangulation stations might be affected locally by earthquakes, or earth movements between earthquakes.

A plan for this readjustment was worked out and has been used in the office of the survey at Washington since the early part of the fiscal year 1926. It has proven to be entirely successful and it marks a long step forward in geodetic practices.

The arcs of triangulation needed at the beginning of the fiscal year 1926 to complete the skeleton network of the western part of the country included the arc along the forty-ninth parallel from longitude 115° westward to Point Roberts, comprising the western extremity of the boundary between Canada and the United States; an arc from the vicinity of Umatilla, Oreg., northward to the Canadian boundary in the vicinity of Oroville; an arc extending from a point just to the eastward of the Black Hills in South Dakota westward through Wyoming to the vicinity of Bozeman, Mont.; an arc extending from the vicinity of Needles, Calif., to the vicinity of Salt Lake City, Utah; an arc extending from the vicinity of San Luis Obispo, Calif., across the Sierra Nevada Mountains, Death Valley, and into Nevada.

All of this triangulation was accomplished during the summer of 1925 except the last-mentioned arc and a short stretch of the arc extending along the forty-ninth parallel through the Cascade Mountains. The party working in the Cascade Mountains encountered very dense smoke resulting from the many forest fires in northern Washington and in British Columbia. The smoke was so dense that a mountain side 500 yards away could not be seen even in its barest outlines. Every effort was made to complete the work before the

winter set in, but this was impossible, and the party got out of the high mountains just ahead of heavy snows which would have made traveling very dangerous for the men.

A party with five observers went into the Cascade Mountains on June 29, 1926. With a party as strong as this it was hoped that the observing might be completed during the month of July and the early part of August, 1926, before the smoke from forest fires became troublesome. It is important to complete the work in the early summer because of the glaciers leading up the high peaks on which the triangulation stations are located. From about the middle of June to the middle of August the surfaces of the glaciers are smooth and firm, but after the middle of August the heat of the summer starts the movement of the glacial ice, and crevasses are formed which make travel over the ice very dangerous. Travel over the exposed surfaces of the mountains is very difficult and in places somewhat hazardous. This makes it desirable that the surfaces of the glaciers be used for reaching the peaks, and this can only be done before the crevasses are formed.

It is certain that the work in California mentioned above and that in the Cascade Mountains will be completed in the early part of the fiscal year 1927, and then there will be nothing to interfere with the early completion of the readjustment of the triangulation net to the west of the ninety-eighth meridian.

In order to supply astronomic data to be used in the adjustment of the triangulation net a party observed astronomic azimuths and longitudes at a number of triangulation stations in South Dakota, Wyoming, Montana, Idaho, Washington, and Canada. This party also observed the astronomic latitude of each of these points, the latter work being accomplished with no additional expense.

Other field work accomplished during the fiscal year consisted of the selection of triangulation stations along the arc from Umatilla, Oreg., to Oroville, Wash.; the selection of stations along the arc from San Luis Obispo, Calif., to Las Vegas, Nev.; and the selection of triangulation stations along an arc extending from the vicinity of Albert Lea in southern Minnesota southward through Iowa and Missouri into Arkansas. Selection of triangulation stations was also made in Mississippi and Alabama. At the close of the fiscal year a party was just starting the selection of stations for triangulation from the vicinity of Harpers Ferry on the Potomac River northwestward toward Lake Erie. This arc of triangulation will extend past Pittsburgh, Pa., where a connection will be provided with the triangulation being executed by that city.

First-order leveling was executed in South Dakota from Sioux Falls westward to Rapid City. This line of levels was designed to break up a large area in which no first-order bench marks had been established. Another line of levels was run in Colorado from Colorado Springs southward through Pueblo, thence west to Salida, and thence northward to Leadville. This line was run at the request of the United States Geological Survey, which is making topographic surveys along the route followed. Field expenses were paid by that organization.

First-order leveling was executed in California from Laws southward to Mojave. This line of levels was run in connection with

earthquake studies. It extends across Owens Valley just to the northward of Owens Lake. The line began at an elevation of approximately 8,000 feet on the eastern slope of the Sierra Nevada Mountains and ended at a point high up at the western slope of the Inyo Mountains.

First-order leveling was executed in Los Angeles County, Calif., at the request of the United States Geological Survey, the field expenses being paid from the appropriation made to that bureau.

In connection with earthquake studies, first-order triangulation was executed along the thirty-ninth parallel part way across Nevada. Stations of the old transcontinental arc were reoccupied and angles remeasured. Earthquake studies were also the main purpose for the first-order triangulation which was extended from the vicinity of San Francisco Bay northward to Point Arena and the Ukiah latitude station. Under the plan for earthquake studies there was also executed certain triangulation near Santa Barbara Channel and a base line was measured to the eastward of San Luis Obispo, Calif.

The Coast and Geodetic Survey continued its cooperation with Rochester, N. Y., in the extension of a first-order horizontal control system over the city and its suburbs. This work is designed to furnish the basis for cadastral and topographic surveys of the city and for its many engineering operations.

Plans were made late in the fiscal year to cooperate with the Conservation Commission of the State of New Jersey in the execution of a short arc of triangulation along the coast of New Jersey southward of Barnegat Bay. It is expected that a party will take the field to begin this work in the early part of the fiscal year 1927.

It is of considerable interest that a determination of the old longitude station at Seattle, Wash., by means of radio time signals sent by the Naval Observatory at Washington through the Annapolis Radio Station, differs only 0.003 second of time from the value obtained for that station by the old method of longitude determinations where telegraph lines were used to exchange the time signals between observatories. This close agreement is a source of great satisfaction and it indicates clearly that the longitudes determined by means of the radio signals have a very high degree of accuracy.

Some work was done on the international plan to determine the national base longitude stations throughout the world. The field work will be executed between October 1 and November 30, 1926. The United States Naval Observatory will make observations in Washington and at San Diego, Calif., while observers of the Coast and Geodetic Survey will occupy stations at Honolulu, Hawaiian Islands, and Manila, P. I.

These base stations will be used in connection with the charting and mapping systems of this and other countries. The longitude work contemplated will have a scientific value in that a comparison of these determinations with other determinations in the future will furnish a test of the stability of the relation of land masses to each other.

In Alaska the arc of first-order triangulation extending from Dixon Entrance to Skagway was completed by the measurement of

the Glacier Point base and by extending the triangulation from the head of Lynn Canal to Skagway.

The selection of triangulation stations for an arc which will extend from the vicinity of Fairbanks eastward to Eagle at the international boundary between Canada and Alaska was also completed.

No field work was done in the determination of the values of gravity during the fiscal year, but some work was done in the reduction of gravity stations by the isostatic method. It has been found that the values reduced by that method furnish valuable geological information which will make geological studies and investigations in the future more effective. There is a probability also that the values of gravity reduced by the isostatic method will have a value in disclosing subsurface structures in regions where oil investigations are made. One American oil company is now using a gravity apparatus in studying subsurface structure, and another company has been corresponding with this bureau and plans to take up gravity work in the near future.

In the office at Washington computations were made for reducing by the isostatic method certain gravity stations which were established by an official of the Geodetic Committee of Holland in voyages on a submarine. The results obtained at sea supplement the gravity data now available on land and will aid much in geophysical and geological studies.

MAGNETIC AND SEISMOLOGIC WORK

The magnetic work accomplished during the year was as follows:

Work in progress in the Northwestern States at the close of the last fiscal year was continued, repeat and new stations being occupied and defective stations replaced in Montana, Idaho, Oregon, Washington, North Dakota, and Minnesota.

Defective stations were replaced in Minnesota, Iowa, Missouri, Kansas, and Oklahoma.

Repeat stations were occupied in Maine, New Hampshire, Vermont, and Massachusetts.

A party engaged in reconnaissance in the Aleutian Islands occupied several stations, thereby contributing valuable information in this region.

Vessels at work in southeastern and western Alaska made observations at triangulation stations.

Routine observations of the magnetic elements were made at all the observatories throughout the year, except San Juan, P. R. where only a half year's observations were obtained owing to change of site. The following additional work was done:

Cheltenham.—Work on temperature compensation of H variometer was completed. Investigation of method for improving design of Z variometer was begun and was in progress at close of the fiscal year. There was cooperation with the instrument division in design of details of temperature compensation of H and Z variometers. A number of instruments were standardized for use of the bureau. A magnetometer belonging to the U. S. S. *Niagara* was standardized. Officers of the Chinese Navy spent some time at Cheltenham learning details of magnetic work as carried on by the bureau.

Direct scaling of magnetograms began with October records. Improvements were suggested to facilitate the work.

Members of the Department of Terrestrial Magnetism, Carnegie Institution, of Washington, spent considerable time at the observatory on various investigations, using the small experimental building. Certain instrumental improvements resulting may prove of universal application.

Porto Rico.—Construction was sufficiently completed so that instruments could be installed and operation started in January. Since that date instrumental adjustments have been found necessary, but by the end of the fiscal year all were functioning and temperature compensation was in effect. Direct scaling awaited completion of adjustments.

Tucson.—The activity of the station was interfered with by burning of the house and office building during June. No records or important instruments were lost. During the year reports of fires observed were made to the Forest Service.

Sitka.—Investigation of auroras in connection with telegraph and radio disturbances was continued. This work bears a definite relation to the study of the International Research Council on this subject.

Honolulu.—A number of possible observatory sites were examined. Meteorological observations were made for the naval air station. Special luminosity observations were made for Lord Rayleigh at the request of the Mount Wilson Solar Observatory at Pasadena.

Seismology.—Bosch Omori seismographs were kept in operation at Cheltenham, Sitka, San Juan (half year), and Tucson (half year), and a Milne Shaw seismograph was operated at Honolulu. A Wood-Anderson seismograph was installed at Tucson during the year and the unsatisfactory Bosch Omori put out of commission. Immediate reports were made of all the important earthquakes and routine reports of others were recorded.

TIDE AND CURRENT WORK

Tidal observations, primary stations.—Automatic tide gauges were operated at the following primary tide stations during the fiscal year. These stations furnish tidal control for the hydrographic work in the various sections and also furnish datum planes based on a long-period tidal definition.

Portland, Me.
Boston.
Atlantic City.
Cape May.
Philadelphia.
Washington.
Charleston.
Daytona.
Key West.
Cedar Key.
Pensacola.
Galveston.
Galveston Jetty (part year).
San Diego (part year).
La Jolla.
Los Angeles.
San Francisco.
Astoria.
Seattle.
Ketchikan.
Sitka (part year).
Valdez.
Anchorage (part year).
Seward.
Honolulu.
Manila.

Tidal observations, secondary stations.—In addition to the primary stations, tidal observations were made at 97 secondary stations in connection with hydrographic work, these records totaling 17 years.

Tidal observations, outside sources.—Tidal records were received from sources outside this bureau from five tide stations, totaling one and three-fourths years of record.

Following is a brief summary of tide records for the full fiscal year:

Summary of tidal records received

	Stations	Years	Months
Eastern division	41	15	8.2
Gulf of Mexico division	15	9	5.3
Western division	18	5	11.8
Alaska division	41	6	7.5
Outlying territory	19	8	8.3
Total	134	46	5.1

Current observations.—During the year current observations were made on the following light vessels: Nantucket Shoals, Boston, Diamond Shoals, Savannah, and Blunts Reef. In addition, short series of current observations were made at a number of stations as listed in the summary below:

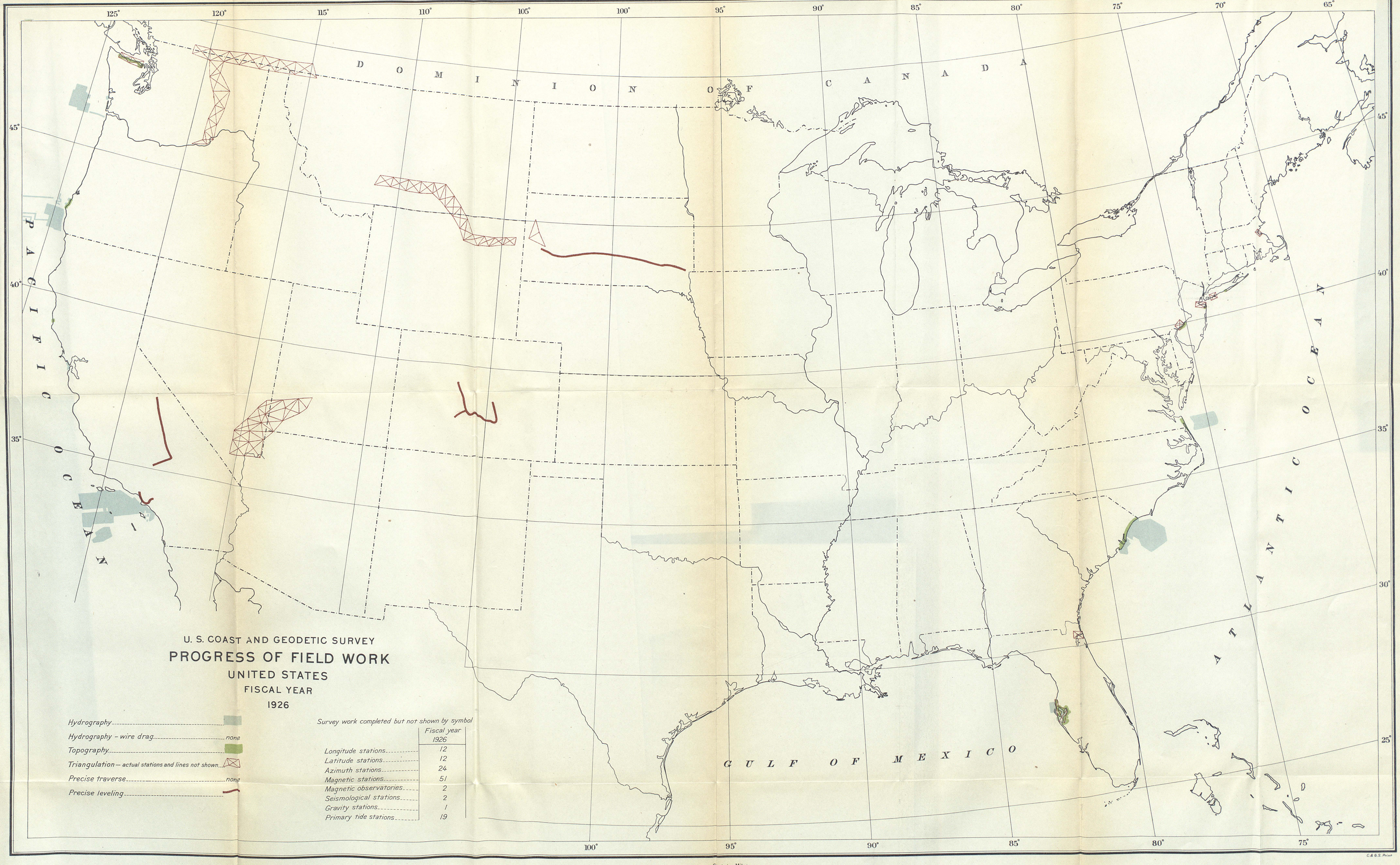
Summary of current observations received

	Stations	Years	Months
Light vessels	5	2	11.5
Short series	136	1	2.5
Total	141	4	2.0

In connection with a sanitary survey of the Potomac River in the vicinity of Washington, a portable automatic tide gauge was maintained during the month of August, 1925, at the Potomac Boat Club near the Aqueduct Bridge, Washington, D. C., in cooperation with the sanitary engineer of the Public Health Service. The results of current observations in the vicinity of Washington were also desired by the sanitary engineer, but no comprehensive observations had been made by this bureau.

During the past year an important current and tide survey was made in southeast Alaska and in Puget Sound. This work, extending over a period of three months, was carried on from 30 current stations, covering the important passages between Puget Sound, Wash., and Cross Sound, Alaska, where the current velocity is sufficient to be a menace to shipping.

This bureau cooperated in the maintenance of tide stations at Los Angeles and Honolulu, and arrangements are being made for cooperation with the Navy Department in maintaining tide stations at San Diego, Calif., and Portsmouth, N. H. The tide station at



U. S. COAST AND GEODETIC SURVEY

PROGRESS OF FIELD WORK

UNITED STATES

FISCAL YEAR

1926

Hydrography	
Hydrography – wire drag	none
Topography	
Triangulation – actual stations and lines not shown	
Precise traverse	none
Precise leveling	

Survey work completed but not shown by symbol

	Fiscal year 1926
Longitude stations	12
Latitude stations	12
Azimuth stations	24
Magnetic stations	51
Magnetic observatories	2
Seismological stations	2
Gravity stations	1
Primary tide stations	19

Statute Miles 100 50 0 100 200 300 400

Nautical Miles 100 50 0 100 200 300 400

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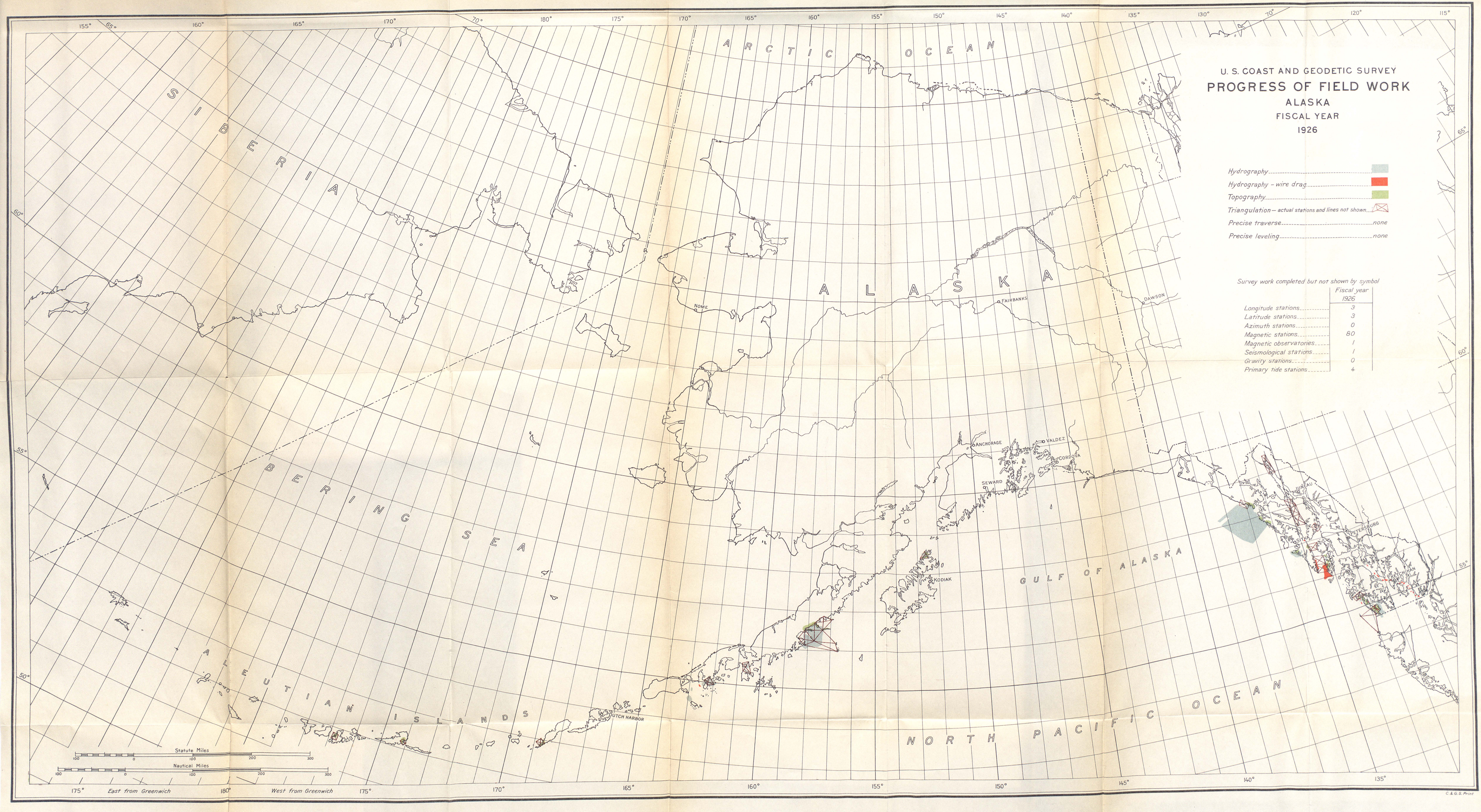

U. S. COAST AND GEODETIC SURVEY
PROGRESS OF FIELD WORK
ALASKA
FISCAL YEAR
1926
Hydrography
Hydrography – wire drag
Topography
Triangulation – actual stations and lines not shown
Precise traverse ..... none
Precise leveling ..... none
Survey work completed but not shown by symbol
Fiscal year 1926
Longitude stations 3
Latitude stations 3
Azimuth stations 0
Magnetic stations 80
Magnetic observatories 1
Seismological stations 1
Gravity stations 0
Primary tide stations 4
ARCTIC OCEAN
SIBERIA
ALASKA
BERING SEA
ALEUTIAN ISLANDS
GULF OF ALASKA
NORTH PACIFIC OCEAN
NOME
FAIRBANKS
DAWSON
ANCHORAGE
VALDEZ
CORDOVA
SEWARD
KODIAK
DUTCH HARBOR
JUNEAU
PETERSBURG
WRANGELL
KETCHIKAN
Statute Miles
Nautical Miles
East from Greenwich
West from Greenwich
C. & G. S. Print

U. S. COAST AND GEODETIC SURVEY

PROGRESS OF FIELD WORK

PHILIPPINE ISLANDS

FISCAL YEAR

1926

Hydrography ..... ▭

Topography ..... ▭

Triangulation — *actual stations and lines not shown* .....

Survey work completed but not shown by symbol

	Fiscal year 1926
Longitude stations	0
Latitude stations	0
Azimuth stations	0
Magnetic stations	29
Magnetic observatories	0
Seismological stations	0
Gravity stations	0
Primary tide stations	3

Statute Miles 10 5 0 50 100 150 200

Nautical Miles 10 5 0 50 100 150 200

BASHI CHANNEL

BATAN ISLANDS

BASCO

BALINTANG CHANNEL

BABUYAN ISLANDS

BABUYAN CHANNEL

LAOAG
VIGAN
BANGUED
TUGUEGARAO
BONTOC
ILAGAN
SAN FERNANDO
LINGAYEN GULF
BAYOMBONG
LINGAYEN
TARLAC
CABANATUAN
IBA
LUZON
S. FERNANDO
MALOLOS
BALANGA
MANILA
CAVITE
PASIG
STA CRUZ
POLILLO ISLANDS
LAMON BAY
DAET
LUCENA
BATANGAS
CATANDUANES I
NAGA
LAGONOY GULF
RAGAY GULF
BOAC
MARINDUQUE I
CALAPAN
ALBAY
SORSOGON
MINDORO
MINDORO STRAIT
SIBUYAN SEA
San Bernardino Strait
ROMBLON
TABLAS I
SIBUYAN I
MASBATE
MASBATE I.
SAMAR SEA
SAMAR
CATBALOGAN
CAPIZ
BILIRAN I
VISAYAN SEA
TACLOBAN
LEYTE
LEYTE GULF
CALAMIAN GROUP
PANAY
S. JOSE DE BUENAVISTA
ILOILO
BACOLOD
CAMOTES IS
CAMOTES SEA
Suluan I.
SURIGAO STRAIT
CEBU
PANAY GULF
NEGROS
TAÑON STRAIT
BOHOL STRAIT
CANIGAO CHANNEL
DINAGAT I
BOHOL
SURIGAO
TAGBILARAN
DUMAGUETE
SIQUIJOR I
CAMIGUIN I
MINDANAO SEA
BUTUAN
PUERTO PRINCESA
PALAWAN
CAGAYAN
DANSALAN
MALAYBALAY
MINDANAO
SIBUGUEY BAY
ILLANA BAY
COTABATO
DAVAO
DAVAO GULF
ZAMBOANGA
MORO GULF
BASILAN I
BALABAC STRAIT
JOLO
SULU ARCHIPELAGO
SIBUTU I
BORNEO
SULU SEA
CELEBES SEA
SARANGANI IS.
PHILIPPINE SEA
PACIFIC OCEAN

120° 125° 20° 15° 10° 5°

C.&G.S. Print

U. S. COAST AND GEODETIC SURVEY

PROGRESS OF FIELD WORK

HAWAIIAN ISLANDS

FISCAL YEAR

1926

Hydrography

Topography

Triangulation — actual stations and lines not shown

Survey work completed but not shown by symbol

	Fiscal year 1926
Longitude stations	0
Latitude stations	0
Azimuth stations	0
Magnetic stations	0
Magnetic observatories	1
Seismological stations	1
Gravity stations	0
Primary tide stations	8

KAUAI

KAULAKAHI CHANNEL

LEHUA

NIIHAU

KAUAI CHANNEL

OAHU

HONOLULU

KAIWI CHANNEL

PENGUIN BANK

MOLOKAI

KALOHI CHANNEL

PAILOLO CHANNEL

LANAI

AUAU CHANNEL

MAUI

KEALAIKAHIKI CHANNEL

KAHOOLAWE

ALALAKEIKI CHANNEL

ALENUIHAHA CHANNEL

HILO BAY

HILO

HAWAII

U. S. COAST AND GEODETIC SURVEY

PROGRESS OF FIELD WORK

APPROACHES TO PANAMA CANAL

FISCAL YEAR

1926

Hydrography ..... none

Topography ..... none

Triangulation — actual stations and lines not shown ..... none

CARIBBEAN SEA

Limon Bay

Colon

Cristobal

Gatun

PANAMA CANAL

Culebra

Panama

BAY OF PANAMA

Survey work completed but not shown by symbol

	Fiscal year 1926
Longitude stations	0
Latitude stations	0
Azimuth stations	0
Magnetic stations	0
Magnetic observatories	0
Seismological stations	0
Gravity stations	0
Primary tide stations	2

C. & G. S. Print

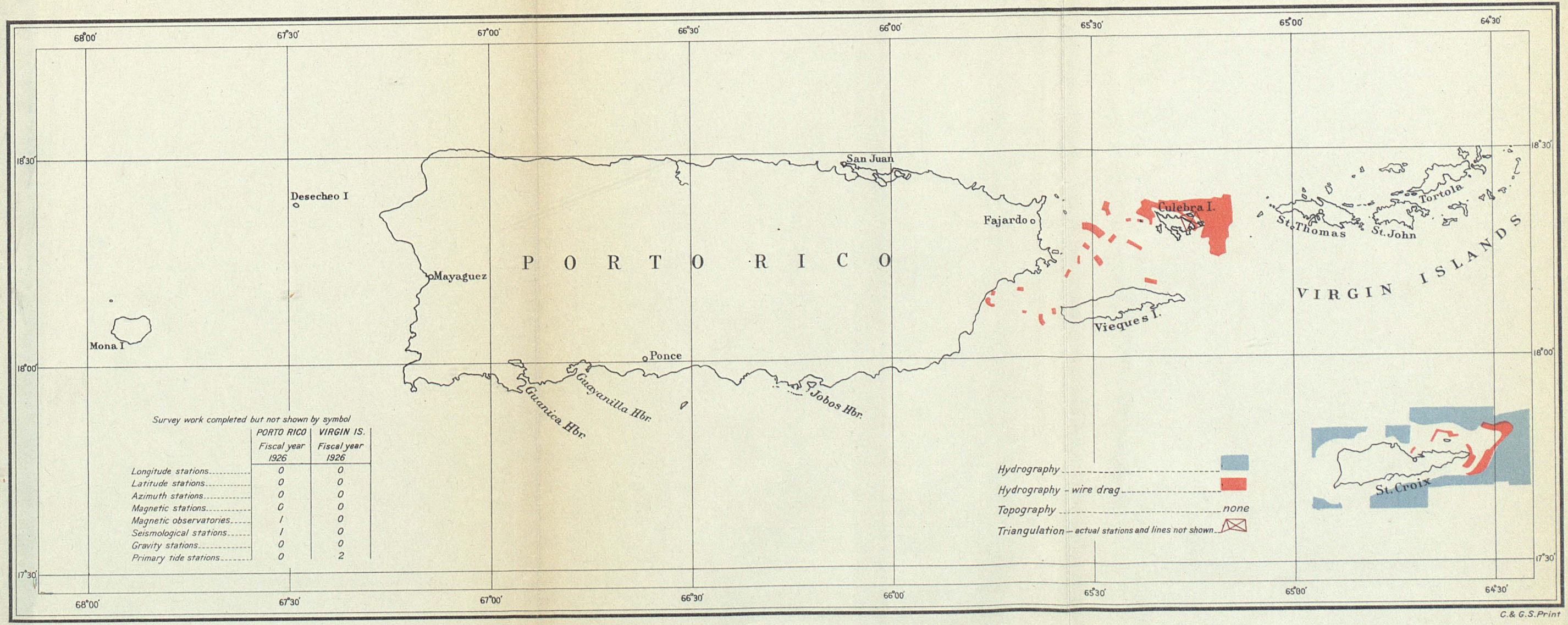
U. S. COAST AND GEODETIC SURVEY

PROGRESS OF FIELD WORK

PORTO RICO AND VIRGIN ISLANDS

FISCAL YEAR

1926



Survey work completed but not shown by symbol

	PORTO RICO Fiscal year 1926	VIRGIN IS. Fiscal year 1926
Longitude stations	0	0
Latitude stations	0	0
Azimuth stations	0	0
Magnetic stations	0	0
Magnetic observatories	1	0
Seismological stations	1	0
Gravity stations	0	0
Primary tide stations	0	2

C. & G. S. Print

San Diego was established by the inspector at San Francisco at the end of the fiscal year.

Special interest is attached to tidal results obtained from a deep well at Longport, N. J., through a cooperation with the New Jersey Department of Conservation and Development. In connection with an investigation of ground-water conditions by the State of New Jersey, one of the portable tide gauges recently designed in this bureau was loaned to the authorities of the State. Observation of the tidal fluctuations in the well at Longport, which is approximately 800 feet deep, were made for a period of a year. These observations were reduced in this office and compared with the simultaneous observations at our primary tide station on the Atlantic City steel pier. In the well the high waters occurred on an average 14 minutes later and the low waters 12 minutes later than at the steel pier. The mean range of tide in the well was a little more than one-half as great as at the steel pier. Irregular meteorological fluctuations in the open ocean were reflected by corresponding fluctuations of smaller magnitude in the well. This is brought out by the tide record of a day in which a tide in the well was compared with the ocean tide at a time when the ocean was disturbed by a strong northwest gale.

The Weather Bureau station and the commandant of the naval submarine base at Key West, Fla., cooperated with this bureau in the establishment of a new tide station at Key West at the submarine base.

During the past year the tide stations at San Diego, Calif., and Anchorage, Alaska, were discontinued. The station at Anchorage fulfilled the purpose for which it was established—the determination of a sea-level datum for the precise leveling in the vicinity. The tide station at San Diego was discontinued after a year of simultaneous observations with La Jolla, which will hereafter furnish tidal control for this region. In addition, La Jolla is a more satisfactory location as it is an open-ocean station.

The tide-gauge station at Sitka, Alaska, having been operated for 18 months for the purpose of obtaining modern observations for a standard port, was closed on December 31, 1925.

The tide station at Washington, D. C., was destroyed by fire on June 4, 1926. The observer was placed on furlough until the station could be reestablished.

The tide station on the jetty at the entrance to Galveston, Tex., established to determine the relation of the outside Gulf of Mexico tides with those at the primary station at Galveston, was discontinued on March 4, 1926.

Due to the fact that the tide station at Cedar Keys had about fulfilled the purpose for which it was established, and further to the fact that the wharf on which the station was located is in bad condition, that station was discontinued on June 30, 1926.

The current and tide survey of Boston and Portsmouth Harbors was begun on June 1. At the end of the fiscal year the observing in Boston Harbor was in progress.

During the month of October a portable automatic tide gauge was maintained on the open coast at San Francisco, Calif., at the Lurline

pumping station, in order to obtain a comparison of tide conditions on the open coast with those at the primary tide station at Presidio inside the Golden Gate.

During the latter part of the fiscal year current observations were made by the steamer *Fathomer* in San Bernardino Strait, P. I. The data from these observations will be used for the predictions of the currents for this strait for the current tables. This will be the first station not on the continent of North America to be included in these tables, which have been enlarged each year since their inception.

Temperature and density observations, frequently requested of this office by prospective builders in connection with cold-storage plants, by fishing concerns, and especially by investigators in the study of pile-boring limnoria, are being made at the primary tide stations at no increased cost to the survey. In addition, short series of temperature and density observations were made at 16 stations in Alaska and four in Puget Sound and vicinity, in connection with the tide and current survey carried on last summer.

CHAPTER II

PROGRAM FOR THE CURRENT FISCAL YEAR IN THE FIELD

HYDROGRAPHIC AND TOPOGRAPHIC WORK

Atlantic and Gulf coasts.—Offshore hydrography to a depth of 100 fathoms will be continued on the North Carolina coast from Cape Fear to Cape Lookout by the steamship *Lydonia*. The steamship *Bache* will perform similar work on the Virginia coast northward of Cape Charles and on the Florida coast after completing the survey of Tampa Bay.

Revision surveys will be made by launch parties of the south shore of Long Island, of parts of New York Harbor and the seaward approach to the harbor, of several parts of the Potomac River, and of several small harbors. The steamship *Hydrographer* will be employed, after completing the resurvey of Tampa Bay, on resurveys and chart revision along the southern Gulf coast of Florida from Charlotte Harbor to Cape Romano, and then from Cape Romano to Cape Sable, if satisfactory arrangements can be made for obtaining airplane photographs of this section of the coast. A resurvey of parts of the upper waters of Chesapeake Bay and tributaries will be made by the steamship *Ranger* on completion of the work in Porto Rico.

Wire-drag surveys will be resumed in northern New England waters and along the Florida Keys if funds are available.

Wire-drag work between Porto Rico and the Virgin Islands will be completed and close surveys will be made of five or six important roadsteads around Porto Rico to enable the bureau to compile large-scale charts of these places. Ocean-going vessels load sugar from these places and, accordingly, there is a strong demand for large-scale charts that will enable these vessels to anchor as close to the shore as possible.

Pacific coast and Alaska.—The steamships *Guide* and *Pioneer* will be employed on the Oregon coast in the vicinity of the Columbia River entrance during the summer, fall, and late spring months, and on the southern California coast during the remainder of the year. This work will extend from close inshore to depths of 1,000 fathoms. The motor ship *Natoma* will be employed on various surveys in Puget Sound and the Strait of Juan de Fuca. Launch parties will make resurveys in San Francisco Bay and at several landings along the California coast where lumber is taken by large vessels. A resurvey will be made of Willapa Bar.

The survey of the outer coast of southeastern Alaska will be completed as far north as Icy Point by the steamship *Surveyor*, after which this vessel will take up the survey of the coast between Prince William Sound and Cook Inlet. If possible, some of the tributaries of Prince William Sound will be surveyed.

The steamship *Explorer* will survey Tebenkof Bay and Keku Strait together with the intervening section of the eastern shore of Chatham Strait. Shuyak Strait, in western Alaska, will also be surveyed during the year.

Hawaiian Islands.—The steamship *Discoverer* will continue work among the Hawaiian Islands on a project that contemplates the early survey of this entire group. The work will be centered largely around Kauai and Niihau. A small field party will also continue the detailed inshore hydrography around Oahu.

Philippine Islands.—The Federal survey ship *Pathfinder* will work north of Luzon between northeast monsoons and in the deep area of the Sulu Sea at other times. The two Philippine survey ships, *Fathomer* and *Marinduque*, commanded by officers of this bureau, will work in the southern part of the Sulu Archipelago. Triangulation for the control of a hydrographic and topographic survey of the east coast of Luzon and to strengthen the survey of the north coast of Luzon, which was begun last spring, will be continued during the next fiscal year. Field work is being done largely by native surveyors under the supervision of officers of the Coast and Geodetic Survey and is supported jointly by the Philippine Bureau of Lands and the United States Coast and Geodetic Survey.

GEODETIC WORK

Triangulation.—With the completion of the triangulation in the Cascade Mountains in northwestern Washington, along the boundary between the United States and Canada, and of the arc of triangulation from the vicinity of San Luis Obispo, Calif., to a point in Nevada, the skeleton framework for the triangulation of the western half of the country will be finished. This will be accomplished during the first half of the fiscal year 1927.

The greatest necessity then remains for the completion of a sufficient amount of triangulation and traverse in the eastern half of the United States to make it possible to readjust the triangulation of that area. Work will also be done on an arc of first-order triangulation which will extend north and south through Minnesota, Iowa, Missouri, and Arkansas, running approximately between longitudes 93° and 94°. These arcs of horizontal control will meet a great need in a thickly settled country where, at present, there are no accurate control data available.

An arc of first-order triangulation will be extended from a point near Harpers Ferry, on the Potomac River, northwestward to the vicinity of Painesville, Ohio, on the southern shore of Lake Erie, running across the States of Maryland and Pennsylvania into northeastern Ohio. That arc will pass just to the eastward of Pittsburgh, Pa., where a connection will be made with the triangulation executed by the city of Pittsburgh.

Traverse.—During the fiscal year 1927 it is planned to have first-order traverse and triangulation extended from the vicinity of Green Bay, Wis., westward through La Crosse, Wis., thence westward through southern Minnesota to the ninety-eighth meridian in South Dakota.

First-order leveling.—Leveling has been planned for North and South Dakota, Colorado, New Mexico, and Arizona.

Astronomic work.—Astronomic work will be done in connection with the world-wide plan for the radio determinations of base longitude stations, the observers of the United States Coast and Geodetic Survey occupying the stations at Honolulu, Hawaiian Islands, and Manila, P. I.

Gravity.—Gravity observations will be made on the island of Hawaii, in the Philippines, and probably at several places in the West Indies which are important from a geophysical standpoint.

Reconnaissance.—One party will work from a point near Harpers Ferry, on the Potomac River, northwestward to the vicinity of Painesville, Ohio, on the southern shore of Lake Erie, through Maryland and Pennsylvania; in Wisconsin, Iowa, Illinois, and Nebraska.

MAGNETIC AND SEISMOLOGIC WORK

Occupation of repeat and new stations and replacement of defective stations are proposed to be carried out in three sections of the country—Western Mountain States, Middle Western States, and Middle Atlantic States. The building at Tucson destroyed by fire will be rebuilt. Needed replacement of damaged structures will be made at Honolulu. Improvement of observatory instruments will be carried on until conditions are such that operations will be fully economical.

Improvement of installation at Tucson will be given special attention. Improvements will be made at other observatories. There will be cooperation with various institutions engaged in seismologic work. The seismograph at the University of Chicago, formerly operated by the Weather Bureau, will be kept in operation. Several officers will be trained in field seismologic work so as to be available in case of an important earthquake, as heretofore valuable information has been lost because regions were not visited at once by skilled observers.

TIDE AND CURRENT WORK

During the months of July, August, and part of September, 1926, the bureau will continue the current and tide survey of Boston and Portsmouth Harbors which was begun June 1, 1926. The data from this survey will be used for furnishing better-determined values for our tide and current tables and for preparation of a special publication dealing with the tides and currents of these two harbors.

It is proposed to take up a comprehensive current and tide survey of Chesapeake Bay and tributaries toward the end of the fiscal year 1927 and through the first of the fiscal year 1928. At various times in the past considerable current work of value has been done in the main area of the bay. It is intended to tie these observations together by simultaneous observations over the area and to extend this work into the tributaries, in practically all of which no current observations have been obtained.

Primary tide stations representative of tide conditions along the different stretches of coast will be maintained at the following places:

Portland, Me.
Boston.
Atlantic City.
Philadelphia.
Cape May.
Baltimore.
Old Point Comfort.
Washington.
Charleston.
Key West.
Pensacola.
La Jolla.
San Francisco.
Daytona.
Astoria.
Seattle.
Ketchikan.
Seward.
Valdez.

Stations will be operated at the following places with the cooperation of outside organizations:

Los Angeles.
Honolulu.
Hilo.
Manila.
San Diego.
Portsmouth.
Jamaica Bay, N. Y.

Having obtained long series of hourly current observations on the light vessels along the coasts of the United States, it is planned to discontinue these observations on all vessels on the Pacific coast this year, and continue on the Atlantic coast at two stations only—Diamond Shoals and Nantucket. At these two stations, however, observations will be made only twice daily for currents, temperatures, and densities.

The present appropriation does not permit of operating a precise-level party to carry on the work of visiting locations of discontinued tide stations, for the purpose of leveling to old nonregulation bench marks as they may be recovered and installing sufficient standard disks to protect the series from total loss. This work should be continued to perpetuate long series of observations which are now protected by few nonregulation bench marks, many of which have been destroyed and others in danger of being lost. It is intended to extend this work over several years and gradually bring it up to date by doing a small amount of work each year. The present appropriation is not sufficient to carry on this work. It is hoped that the plans outlined for more economical prosecution of the current surveys will result in a saving sufficient to take up this important work again.

Part IV.—DISTRIBUTION OF PARTIES OF THE COAST AND GEODETIC SURVEY DURING THE FISCAL YEAR ENDED JUNE 30, 1926

DIVISION OF HYDROGRAPHY AND TOPOGRAPHY

[Abbreviations used: A=area square statute miles; M=statute miles; P=number geographic stations, S=number soundings; sta=stations; D=area wire dragged]

Locality	Operations	Persons conducting operations
South shore, Long Island, vicinity of Long Beach, N. Y.	Triangulation, M9, A27, P20; topography, M39, A9.	Shore party, May 5-June 30; Lt. (J. G.) C. D. Meaney in charge; Charles A. Schank, jr., engr.
North shore, New Jersey, Sandy Hook-Raritan Bay.	Triangulation, M10, A20, P16; topography, M5, A1.	Shore party, May 10-June 30; Lt. (J. G.) R. F. A. Studds in charge; Ensign Bennett G. Jones.
Eastern shore, Delaware River, Fishers Point-Woodbury Creek.	Triangulation, M16, A15, P110; topography, M37, A8.	Shore party, Oct. 8-Jan. 13; Lt. L. D. Graham in charge; P. L. Bernstein, jr., engr., F. G. Bryan, jr., engr., Oct. 8-30.
Southeast of Cape Henry, Va., July 1-Oct. 31.	Topography, M27, A13; hydrography, S8544; tides, sta. 1.	Ship Bache, Lt. F. S. Borden comd'g.; Lt. C. A. Egner, exec.; Lt. (J. G.) J. A. McCormick from Aug. 1; R. C. Overton, mate, from Aug. 1; F. L. Chamberlin, from Sept. 15; Ensign J. M. Neal, to July 17; E. J. Burke, H. K. Hilton, B. G. Jones, G. M. Marchand, deck offs.
Cape Fear-Winyah Bay, coasts of North and South Carolina, July 1-June 30.	Triangulation, P8; topography, M40, A15; hydrography, A3819, S49453; tides, 3 sta.; currents, 92 sta.	Ship Lydonia, Lt. Comdr. F. G. Engle comd'g., to Dec. 1; Lt. K. T. Adams comd'g., from Dec. 1; Lt. E. W. Eickelberg, exec., to Jan. 18; Lt. L. D. Graham, exec., from Mar. 28; Harry Ely, ch. engr.; Franz Okeson, mate, from Nov. 1; Lt. (J. G.) E. O. Heaton from Jan. 2; Lt. (J. G.) H. C. Warwick; Lt. (J. G.) Alfred Ogram to Oct. 20; Lt. (J. G.) W. G. Craib to Nov. 1; Lt. (J. G.) J. H. Service, Apr. 22-May 22; Ensign W. M. Gibson, to Oct. 26; E. R. McCarthy D. O., July 14-Oct. 31; W. J. Turnbull, D. O., July 14-Oct. 31; J. D. Thurmond, D. O., from Nov. 1; V. M. Gibbens, D. O., from Nov. 1.
Coast of South Carolina north of Bull Bay, July 9-Nov. 25.	Topography, M104, A31; hydrography, A144, S18618; tides, 5 sta.	Launch Mikawe, Lt. (J. G.) L. C. Wilder in charge; Lt. (J. G.) J. A. McCormick to July 18; Ensign J. M. Neal from July 18; F. B. Quinn, D. O., from July 10.
Tampa Bay, Fla., Dec. 23-June 30.	Triangulation, M57, A280, P94; topography, M323; hydrography, A245, S44692; tides, 4 sta.	Ship Bache, Lt. R. L. Shoppe, comd'g.; Lt. C. A. Egner, exec.; F. L. Chamberlin, ch. engr.; R. C. Overton, mate; Lt. (J. G.) J. A. McCormick; Lt. (J. G.) F. G. Johnson from May 23; Ensign H. K. Hilton; Ensign B. G. Jones to May 15; E. J. Burke, D. O., to Apr. 26; G. M. Marchand, D. O.

Division of Hydrography and Topography—Continued

Locality	Operations	Persons conducting operations
Approaches to Tampa Bay and vicinity of Anclota Keys, Fla., July 1-June 30.	Triangulation, M18, A60, P64; topography, M159, A42; hydrography, A336, S61721; tides, 6 sta.	Ship Hydrographer, Lt. R. P. Eyman comd'g.; Lt. W. T. Combs, exec., to Mar. 22; Lt. (J. G.) L. M. Zeskind, exec., Mar. 22–May 31; Lt. (J. G.) J. C. Sammons, exec., from June 13; Lt. (J. G.) P. A. Smith; Ensign W. E. Strohm to Nov. 30; H. J. Healy, D. O., July 7 to Dec. 19; J. P. Lushene, D. O., from Dec. 6.
Vicinity of Santa Rosa, Santa Cruz, San Nicolas, and Santa Barbara Islands, Calif., Nov. 16–June 30.	Hydrography, A3270, S8763; tides, 1 sta.	Ship Pioneer, Lt. Comdr. R. F. Luce comd'g.; Lt. Charles Shaw, exec., to Mar. 22; Lt. L. P. Raynor, exec., from May 15; Lt. Herman Odessey from Feb. 20; Lt. (J. G.) F. W. Hough; Lt. (J. G.) A. J. Hoskinson to May 26; Lt. (J. G.) E. P. Morton; Lt. (J. G.) J. C. Bose from Nov. 10; Lt. (J. G.) S. B. Grenell; Ensign R. L. Pfau; Ensign J. M. Neal, from Feb. 6–Apr. 16; W. E. Greer, ch. engr.; H. E. Lawn, surgeon.
San Pedro Channel, approaches to San Pedro, Tanner Bank, San Clemente Island, and Newport Bay, Calif., Feb. 1–May 10.	Topography, M31, A17; hydrography, A4837, S27344; tides, 3 sta.	Ship Guide, Lt. Comdr. T. J. Maher comd'g; Lt. L. P. Raynor to May 15; exec. to Mar. 15; Lt. G. C. Jones, exec. from Mar. 16; Lt. E. H. Bernstein; Lt. (J. G.) I. Rittenberg to Mar. 28; Lt. (J. G.) T. B. Reed; Lt. (J. G.) W. F. Malnate; W. F. White, D. O. to Mar. 29; C. A. Burmister, D. O.; Frank Seymour ch. engr.
Coast of Oregon south of Columbia River, May 29–June 30.	Topography, M22, A8; hydrography, A82, S2311.	Ship Pioneer, Lt. Comdr. R. F. Luce comd'g; Lt. L. P. Raynor, exec.; Lt. Herman Odessey; Lt. (J. G.) F. W. Hough; Lt. (J. G.) E. P. Morton; Lt. (J. G.) J. C. Bose; Lt. (J. G.) S. B. Grenell; Ensign R. L. Pfau; W. E. Greer, ch. engr.; H. E. Lawn, surgeon.
Coast of Oregon, Port Orford-Brookings, July 1–Nov. 7.	Hydrography, A1893; S10077; tides, 1 sta.	Ship Guide, Lt. Comdr. T. J. Maher comd'g; Lt. G. D. Cowie, exec. to Oct. 31; Lt. L. P. Raynor; Lt. E. H. Bernstein from July 15; Lt. (J. G.) J. H. Service to July 15; Lt. (J. G.) A. J. Hoskinson from Oct. 19; Lt. (J. G.) I. Rittenburg from Nov. 1; Ensign V. A. Powell; Ensign W. F. Malnate from July 3; W. S. La Londe, jr., D. O. to Nov. 1; W. F. White, D. O. from July 15; C. M. Ross, D. O., July 18–July 26; C. A. Burmister, D. O. from Oct. 4; R. P. Marshall, ch. engr. to July 18; John Wyer, ch. engr. from Sept. 20.
Coquille River–Cape Blanco, Oreg	Topography, M10, A3; hydrography, A23, S1158; tides, 1 sta.	Shore party, Lt. E. H. Bernstein in charge, Sept. 9–Oct. 31; Ensign V. A. Powell.

Division of Hydrography and Topography—Continued

Locality	Operations	Persons conducting operations
Entrance to Willapa Bay	Hydrography, A2, S597	Shore party, Comdr. R. B. Derickson in charge, Sept. 23–Oct. 1; Lt. (J. G.) I. Rittenberg.
Strait of Juan de Fuca, Wash., vicinity of Port Angeles, Apr. 7–June 30.	Triangulation, A48, P68; topography, M115, A22; hydrography, A25, S10808; tides, 5 sta.	Motor ship Natoma, Lt. Harold A. Cotton, comd'g; Lt. O. S. Reading, exec.; Lt. M. O. Witherbee; Lt. (J. G.) Carl I. Aslakson; Ensign John Bowie, jr., to June 14; Antone Silva, ch. engr.
Kaigani Strait, Meares Pass, Port Refugio, and Long Island, southeast Alaska, July 1–Oct. 24.	Triangulation, M39, A684, P39; topography, M150, A61; hydrography, A62, S5820, D3; tides, 3 sta.	Motor ship Natoma, Lt. H. B. Campbell, comd'g; Lt. O. S. Reading, exec.; Lt. M. O. Witherbee; Ensign C. I. Aslakson; Antone Silva, ch. engr.
Gambier Bay, Pybus Bay, Chatham Strait, south of Point Harris and north of Port Alexander, southeast Alaska, July 1–Oct. 15.	Triangulation, A40, P38; topography, M147, A48; hydrography, A72, D200, S8225; tides, 5 sta.; currents, 2 sta.	Ship Explorer, Lt. F. B. T. Siems, comd'g; Lt. Roland D. Horne, exec.; Lt. (J. G.) Fred E. Joeckel; Lt. (J. G.) H. W. Tyler; Lt. (J.G.) Bruce E.Lancaster.; Ensign D. H. Askew; E. B. Latham, D. O.; G. R. Shelton, D. O.; G. A. Nelson, D. O.: A. N. Loken, ch. engr.
Main ship channels Kaigani Strait, Port Refugio, Red and Warm Spring Bays, Chatham Strait, southeast Alaska, Apr. 7–June 30.	Triangulation, A97, P76; topography, M103, A43; hydrography, A46, D35, S6762; tides, 6 sta.; currents, 1 sta.	Ship Explorer, Lt. F. B. T. Siems, comd'g; Lt. Roland D. Horne, exec.; Ensign A. F. Jankowski; W. Weidlich, mate; Ensign Philip R. Hathorne; Ensign George R. Shelton; George A. Nelson, D. O.; Adolf N. Loken, ch. engr.
Outer coast southeast Alaska, Necker Islands, off Kruzof Island, Khaz Point–Icy Point, July 1–Oct. 21, Apr. 8–June 30.	Triangulation, A189, P64; topography, M583, A96; hydrography, A3045, S41704; tides, 5 sta.	Ship Surveyor, Lt. A. M. Sobieralski comd'g; Lt. H. A. Cotton, exec., to Feb. 6; Lt. E. W. Eickelberg, exec, from Feb. 6; Lt. C. M. Durgin to Nov. 25; Lt. William D. Patterson from Feb. 21; Lt. (J. G.) W. M. Scaife, to Nov. 8; Lt. (J. G.) E. B. Roberts to Dec. 16; Lt. (J. G.) A. P. Ratti; Ensign P. R. Hathorne to Mar. 20; Ensign A. F. Jankowski to Mar. 20; Ensign E. B. Latham from Mar. 12; Ensign I. T. Sanders from Mar. 26; Ensign C. R. Bush, jr.; Ensign E. H. Kirsch from Mar. 26; L. C. Johnson, D. O., to Dec. 16; E. H. Kirsch, D. O., July 27–Mar. 25; I. T. Sanders, D. O., Mar. 20–Mar. 25; Gustav Johanson, ch. engr., from Dec. 24; R. W. Healy, mate; F. J. Soule, surgeon.
Chignik–Sutwik Island, Alaska Peninsula, July 1–Sept. 15.	Triangulation, M5, A240; topography, M131, A154; hydrography, A780, S9940; tides, 1 sta.	Ship Discoverer, Lt. Comdr. C. L. Garner comd'g; Lt. R. L. Shoppe, exec.; Lt. (J. G.) Charles Pierce; Lt. (J. G.) R. W. Knox; Lt. (J. G.) L. S. Hubbard; Ensign H. J. Peterson to July 29; Ensign J. C. Partington; R. F. Bishop, D. O.; T. T. Davey, D. O.; J. C. Herman, ch. engr.; W. R. Scroggs, surgeon.

Division of Hydrography and Topography—Continued

Locality	Operations	Persons conducting operations
Isanotski Strait, Ikatan Bay, Thin Point, Deer Island Passage, Belkofski Bay, Balboa Bay, Alaska Peninsula, July 1–Oct. 2	Triangulation, M27, A175, P34; topography, M70, A126; hydrography, A181, S11860; tides, 5 sta.	Ship Pioneer, Lt. Comdr. R. F. Luce comd'g; Lt. Charles Shaw exec.; Lt. (J. G.) F. W. Hough; Lt. (J. G.) A. J. Hoskinson; Lt. (J. G.) E. P. Morton; Ensign S. B. Grenell; Ensign R. L. Pfau; W. E. Greer, ch. engr.; William Weidlich, mate; H. E. Lawn, surgeon.
Shuyak Strait, southwest Alaska	Triangulation, M10, A18, P22; topography, M37, A15; hydrography, A10, S1228; tides, 2 sta.	Shore party, Lt. Charles Shaw in charge, May 20–June 30; Lt. (J. G.) H. W. Tyler; Lt. (J. G.) K. G. Crosby.
Aleutian Islands, Alaska	Reconnaissance triangulation, M9, A16, P47; topography, M3; hydrography, A3, S522.	Shore party, Lt. G. C. Jones in charge, July 1–Sept. 20; Lt. (J. G.) J. C. Bose.
Virgin Islands and Porto Rico, July 1–June 30.	Triangulation, M37, A83, P73; hydrography, A157, D157, S24673; tides, 2 sta.	Ship Ranger, Lt. G. C. Mattison comd'g; Lt. C. K. Green, exec., to Feb. 28; Lt. R. J. Auld, exec., from Mar. 27; Lt. (J. G.) H. E. Finnegan; Lt. (J. G.) R. C. Rowse; Lt. (J. G.) C. F. Ehlers; Ensign A. C. Thorson; R. W. Retter, D. O., to Oct. 3; W. R. Porter, D. O., from Oct. 10.
Kauai, Niihau, Molokai, Oahu Islands, Penguin Bank, Hawaiian Islands, Jan. 14–June 30.	Triangulation, M20, A100, P18; topography, M33, A29; hydrography, A680, S19132; tides, 5 sta.	Ship Discoverer, Lt. Comdr. Clem L. Garner comd'g; Lt. Jack Senior, exec.; Lt. (J. G.) Robert W. Knox; Lt. (J. G.) Leonard S. Hubbard; Lt. (J. G.) Earl M. Buckingham; Ensign J. C. Partington; Ch. Engr. Jesse L. McIver; W. R. Scroggs, surgeon; Harold K. Brickey, D. O.; Walter J. Chovan, D. O.
Oahu Island, Hawaii	Triangulation, P61; topography, M37, hydrography, A24, S24203.	Shore party, Lt. Eoline R. Hand in charge, July 1–Dec. 31, Mar. 8–June 30.
Bashi Channel–north coast Luzon Island, P. I., July 1–Oct. 10.	Topography, M106, A220; hydrography, A260, S18428; tides, 4 sta.	Ship Pathfinder, Lt. O. W. Swainson comd'g; Lt. F. L. Gallen, exec.; Lt. (J. G.) R. F. A. Studds; Lt. (J. G.) H. L. Bloomberg; Lt. (J. G.) J. C. Sammons; Ensign H. A. Paton; J. C. Collins, ch. engr.; J. V. Tormey, surgeon; A. Hunycutt, ch. writer.
Sulu Sea, P. I., Nov. 27–Dec. 6, Jan. 8–Feb. 10, Mar. 24–May 1.	Hydrography, A28335, S1370	Ship Pathfinder, Lt. O. W. Swainson comd'g; Lt. F. L. Gallen, exec., to Dec. 16; Lt. (J. G.) R. F. A. Studds to Feb. 27 (exec. from Dec. 17–Feb. 27); Lt. (J. G.) H. L. Bloomberg, exec., from Feb. 28; Lt. (J. G.) J. C. Sammons to Feb. 27; Lt. (J. G.) C. Pierce from Mar. 22; Ensign H. A. Paton; F. G. Bryan, D. O., from Dec. 15; L. C. Johnson, D. O., from Mar. 22; J. C. Collins, ch. engr.; J. V. Tormey, surgeon, to Mar. 22; P. A. Davis, surgeon, from Mar. 22; A. Hunycutt ch. writer.
Malampaya Sound, Palawam Island, P. I., July 1–Aug. 6.	Topography M19, A7; hydrography, A29, S37410.	Ship Marinduque, Lt. F. L. Peacock, comd'g; Lt. John A. Bond, exec.; C. N. Conover, ch. engr.; Franz E. Okeson, mate, to July 14; Lt. (J. G.) George L. Anderson; Lt. (J. G.) Kenneth G. Crosby; Paul A. Davis, surgeon.

Division of Hydrography and Topography—Continued

Locality	Operations	Persons conducting operations
Sulu Archipelago, P. I., Aug. 31–Jan. 25.	Triangulation, A350, P34; topography, M81, A64; hydrography, A969, S107568; tides, 10 sta. currents, 1 sta.	Ship Fathomer, Lt. J. H. Peters, comd'g; Lt. R. R. Moore, exec.; Lt. (J. G.) C. D. Meaney to Dec. 1; Lt. (J. G.) H. A. Karo to Jan. 1; Lt. (J. G.) V. A. Bishop; G. W. Hutchison, ch. engr.; P. A. Davis, surgeon from Dec. 1.
Tawitawi group, P. I., Oct. 1–Nov. 27, Feb. 25–June 30.	Triangulation, M75, A1430, P107; topograhy, M72, A201; hydrography, A646, S28612; tides, 6 sta.	Ship Marinduque, Lt. F. L. Peacock, comd'g, to Nov. 27; Lt. George D. Cowie, comd'g, from Nov. 27; Lt. John A. Bond, exec., to Oct. 9; Lt. R. R. Moore, exec., from Nov. 1–27 and after Apr. 3; C. N. Conover, ch. engr.; Lt. (J. G.) George L. Anderson to Nov. 27; Lt. (J. G.) Kenneth G. Crosby to Nov. 27; Paul A. Davis, surgeon, to Nov. 27; Ensign W. M. Gibson, exec., Feb. 25–Apr. 2; Ensign E. R. McCarthy from Feb. 25; W. J. Turnbull, D. O., from Feb. 25; C. N. Conover, ch. engr., W. J. Leary, surgeon from Feb. 25.
San Bernadino Strait, P. I., May 9–June 14.	Currents, 1 sta.; tides, 4 sta.	Ship Fathomer, Lt. F. S. Borden comd'g; Lt. (J. G.) W. M. Scaife, exec.; Lt. (J. G.) Charles Pierce; Ensign L. C. Johnson; Ensign H. J. Healy; G. W. Hutchison, ch. engr.
Northern Luzon, P. I.	Triangulation Reconnaissance, M120, A2160.	Shore party, Lt. (J. G.) E. B. Roberts in charge, Apr. 11–June 3.
Coast of New England	Furnishing information relative to our coasts to the public; inspection of navigable waters of district for purpose of keeping charts and other nautical publications of the Coast and Geodetic Survey correct to date.	Field station at Boston, Comdr. D. B. Wainwright (retired) in charge, July 1–Nov. 21; H. R. Russell, clerk in charge, Nov. 22–Feb. 22; Lt. H. B. Campbell in charge, Feb. 23–June 30; H. R. Russel, clerk.
Long Island Sound and coast to southward.	do	Field station at New York, Lt. K. T. Adams in charge to Nov. 20; Lt. B. H. Rigg in charge, Nov. 21–Dec. 18; Lt. Comdr. F. G. Engle in charge, Dec. 19–June 30; T. T. Lyons, clerk.
Gulf coast	do	Field station at New Orleans, Robert Boyd, clerk in charge, July 1–May 5 Lt. F. L. Gallen in charge, May 6–June 30; Robert Boyd, clerk.
Coast of California and Hawaiian Islands.	Furnishing information relative to our coasts to the public; inspection of navigable waters of district for purpose of keeping charts and other nautical publications of the Coast and Geodetic Survey correct to date; furnishing stationery and surveying equipment for vessels and field parties working in this district.	Field station at San Francisco, Comdr. P. C. Whitney in charge; H. S. Ballard, tide observer.
Coasts of Oregon, Washington, and Alaska.	do	Field station at Seattle, Comdr. R. B. Derickson in charge, July 1–Apr. 19; Lt. Comdr. F. H. Hardy in charge Apr. 20–June 30; Mary A. Palmer, clerk.

Division of Hydrography and Topography—Continued

Locality	Operations	Persons conducting operations
Philippine Islands	Planning and issuing instructions for field work; compilation and publishing charts and sailing directions of the Philippine Islands; all drafting, adjustments, and computing needed on field records; furnishing information to the public; sale of charts and nautical publications.	Office at Manila; Lt. Comdr. H. A. Seran in charge to May 26; Comdr. R. B. Derickson in charge from May 27; John Bach, chief, drafting division; R. Christman, chief, chart division, from May 28; C. E. Christopherson, chief, chart division, to May 27, assistant chief, drafting division, from May 28; W. L. G. Perry, chief, photolithographic division; C. F. Maynard, chief, computing division; Lloyd Miles, chief clerk.

DIVISION OF GEODESY

Lynn Canal to Skagway, Alaska; Glacier Point base.	Triangulation and base measurement, first order: Triangulation, 30 miles, 165 square miles; base line, 2.3 miles.	Lt. Jack Senior, chief; Lt. H. W. Hemple.
Forty-ninth parallel, Montana and Idaho.	Triangulation, first order, 85 miles, 2,100 square miles.	Lt. (J. G.) A. H. Wagener, chief; Lt. (J. G.) E. M. Buckingham.
Forty-ninth parallel, Washington; Osoyoos base.	Triangulation and base measurement, first order: Triangulation, 125 miles, 2,500 square miles; base line, 5.5 miles.	Lt. G. L. Bean, chief; C. A. Schanck, jr., engr.
Forty-ninth parallel, Washington.	Triangulation and reconnaissance, first order: Triangulation, 50 miles, 1,000 square miles; reconnaissance, 100 miles, 1,750 square miles.	Lt. (J. G.) P. C. Doran, chief; John Bowie, jr., jr. engr.; D. O. Smith, jr. engr.
Umatilla, Oreg., to forty-ninth parallel in vicinity of Oroville, Wash.	Triangulation, first order, 235 miles, 5,000 square miles.	Lt. (J. G.) W. H. Bainbridge, chief; J. H. Brittain, jr. engr.; Dan W. Taylor, signalman.
One hundred and fourth to one hundred and eleventh meridian, Wyoming and Montana; Ranchester base.	Triangulation and base measurement, first order: Triangulation, 400 miles, 10,000 square miles; base line, 5.6 miles.	Lt. H. Odessey, chief; Lt. (J. G.) D. B. Pheley; N. B. Smith, jr. engr.; W. J. Bilby, signalman.
Needles, Calif., to Salt Lake City, Utah.	Triangulation, first order, 175 miles, 11,000 square miles.	W. Mussetter, chief; Lt. (J. G.) E. A. Deily; I. T. Sanders, jr. engr.
Thirty-ninth parallel revision, vicinity of Reno, Nev.	Triangulation, first order, 100 miles, 6,500 square miles.	Do.
Connection to Ukiah latitude observatory and Point Arena, Calif.	Triangulation, first order, 35 miles, 865 square miles.	W. Mussetter, chief; I. T. Sanders, jr. engr.
Santa Barbara revision and Santa Maria base net, California; Santa Maria base.	Triangulation and base measurement, first order: Triangulation, 55 miles, 1,250 square miles; base line, 12.5 miles.	Do.
City of Rochester, N. Y.	Traverse, first order, 30 miles; second order, 20 miles.	Lt. (J. G.) E. O. Heaton, chief; N. B. Smith, jr. engr.
Chatham and Sukkwan Straits, Alaska.	Triangulation, second order, 65 miles, 500 square miles; third order, 7 miles, 3 square miles.	Lt. (J. G.) J. M. Smook, chief; Lt. (J. G.) B. Williams.
St. Johns River, Fla.	Triangulation, third order, 25 miles, 20 square miles.	Lt. (J. G.) W. H. Bainbridge, chief; J. H. Brittain, jr. engr.
Columbia River to Tillamook Bay, Oreg.	Triangulation, third order, 45 miles, 100 square miles.	Lt. (J. G.) L. G. Simmons; Dan W. Taylor, signalman.
Columbia River to Grays Harbor, Wash.	Triangulation and transverse, third order: Triangulation, 25 miles, 35 square miles; traverse, 32 miles.	Lt. (J. G.) J. M. Smook, chief; N. B. Smith, ensign.
Schuylkill River, Pa.	Triangulation, third order, 1.5 miles, 1.5 square miles.	Lt. H. W. Hemple, chief.
Umatilla, Oreg., to forty-ninth parallel in vicintiy of Oroville, Wash.	Reconnaissance, marking stations, and building signals, first order, triangulation, 185 miles, 4,000 square miles.	J. S. Bilby, chief.
Ninety-third meridian in Iowa and Missouri.	Reconnaissance, first order, triangulation, 465 miles, 5,500 square miles.	Do.

Division of Geodesy—Continued

Locality	Operations	Persons conducting operations
San Luis Obispo, Calif., to Las Vegas, Nev.	Reconnaissance, first order, triangulation, 315 miles, 12,000 square miles.	W. Mussetter, chief.
Green Bay to La Crosse, Wis.	Reconnaissance, first order, traverse, 180 miles.	J. S. Bilby, chief.
Oblique arc to Union base, Alabama.	Reconnaissance, first order, triangulation, 50 miles, 900 square miles.	Do.
Fairbanks to Eagle, Alaska	Reconnaissance, first order, triangulation, 270 miles, 4,600 square miles.	S. O. White, chief.
Ninety-third meridian, Arkansas	Preliminary reconnaissance, first order, triangulation, 125 miles.	J. S. Bilby, chief.
Mississippi River, Memphis to Red River, Mississippi and Louisiana.	Preliminary reconnaissance, first order, traverse, 375 miles.	Do.
Vicksburg, Miss., to Columbus, Ga., Mississippi, and Alabama.	Preliminary reconnaissance, first-order triangulation or traverse, 385 miles.	Do.
Sioux Falls to Edgemont, S. Dak.	Leveling, first order, 377 miles	Lt. (J. G.) C. M. Thomas, chief.
Colorado Springs to Leadville, Colo.	Leveling, first order, 204 miles	Lt. (J. G.) G. E. Boothe, chief.
Laws to Mojave, Calif.	Leveling, first order, 240 miles	Lt. (J. G.) E. A. Deily; Lt. (J. G.) L. G. Simmons, chief; C. A. Schanck, jr. engr.
Chatsworth to Pomona, Calif.	Leveling, first order, 114 miles	Lt. (J. G.) E. A. Deily; Lt. (J. G.) L. G. Simmons, chief; C. A. Schanck, jr. engr.; I. T. Sanders, jr. engr.
Salida to Grand Junction, Colo.	Leveling, first order, 25 miles	Lt. (J. G.) G. E. Boothe, chief.
South Dakota, Wyoming, Montana, Idaho, Washington, Canada.	Longitude, latitude, and azimuth, first order.	Lt. (J. G.) E. J. Brown; Lt. (J. G.) R. J. Sipe.

DIVISION OF TIDES AND CURRENTS

Series of tide observations at Portland, Me.	Tide observations	C. H. Hudson.
Series of tide observations at Boston, Mass.	do	D. B. Wainwright, H. B. Campbell, H. F. Russell.
Series of current observations at Nantucket Light Vessel.	Current observations	D. B. Studley.
Series of tide observations at Atlantic City, N. J.	Tide observations	S. S. Day.
Series of tide observations at Philadelphia, Pa.	do	J. R. Swartz, Warren M. Miller.
Series of tide observations at Cape May, N. J.	do	Kent M. Redgraves.
Series of tide observations at Baltimore, Md.	do	Fred. A. Kummell.
Series of tide observations at Washington, D. C.	do	E. S. Brown.
Series of current observations at Diamond Shoals Light Vessel.	Current observations	C. L. Swanberg, B. L. Harris.
Series of tide observations at Charleston, S. C.	Tide observations	L. C. Lockwood.
Series of current observations on Savannah Light Vessel.	Current observations	A. Nielson.
Series of tide observations at Daytona Beach, Fla.	Tide observations	T. J. Wright, jr.
Series of tide observations at Key West, Fla.	do	R. H. Sands.
Naval submarine base, Key West, Fla.	do	S. M. Goldsmith.
Series of tide observations at Cedar Keys, Fla.	do	T. C. Hodges.
Series of tide observations at Pensacola, Fla.	do	G. S. Kennedy.
Series of tide observations at Galveston, Tex.	do	C. F. Southwick.
Series of tide observations at San Diego, Calif.	do	J. R. Watkins.
Series of tide observations at La Jolla, Calif.	do	Dr. Geo. F. McEwen.
Series of tide observations at Los Angeles, Calif.	do	Harbor department, city of Los Angeles.
Series of tide observations at San Francisco, Calif.	do	P. C. Whitney, H. S Ballard.

Division of Tides and Currents—Continued

Locality	Operations	Persons conducting operations
Series of current observations on Blunts Reef Light Vessel.	Current observations	P. E. Henriksen.
Series of tide observations at Astoria, Oreg.	Tide observations	J. M. Coleman.
Series of tide observations at Seattle, Wash.	do	R. B. Derickson, F. H. Hardy, W. C. Meyer.
Tide and current survey of southeast Alaska.	Tide and current observations	L. M. Zeskind, R. W. Woodworth, I. Rittenberg, F. G. Johnson.
Series of tide observations at Ketchikan, Alaska.	Tide observations	Adolph Anderson.
Series of tide observations at Sitka, Alaska.	do	C. M. McGrath.
Series of tide observations at Valdez, Alaska.	do	Sam Knudson.
Series of tide observations at Seward, Alaska.	do	E. J. Snyder, B. B. Robison.
Series of tide observations at Anchorage, Alaska.	do	E. D. Buchanan.
Series of tide observations at Honolulu, Hawaii.	do	Territorial government of Hawaii.

DIVISION OF TERRESTRIAL MAGNETISM AND SEISMOLOGY

Maine, New Hampshire, Vermont, Massachusetts.	Repeat stations	Wallace M. Hill, magnetic observer.
Cheltenham, Md	Observatory	George Hartnell, S. G. Townshend, magnetic observers.
Minnesota, Iowa, Missouri, Kansas, Oklahoma.	Replacements	R. R. Bodle, magnetic observer.
Tucson, Ariz	Observatory	A. K. Ludy, magnetic observer.
North Dakota, Montana, Idaho, Oregon, Washington.	Repeat and new stations	R. R. Bodle, magnetic observer.
Sitka, Alaska	Observatory	F. P. Ulrich, magnetic observer.
Southeastern and western Alaska	Declination	Steamers Explorer, Discoverer, Pioneer, Surveyor.
Aleutian Islands	Repeat and new stations	Lt. G. C. Jones.
Honolulu, Hawaii	Observatory	H. E. McComb, magnetic observer.
Oahu, Hawaii	Investigation observatory sites	Do.
San Juan, P. R	Observatory erection	Lt. R. J. Auld.
Do	Observatory operation	Lt. R. J. Auld, Wallace M. Hill, magnetic observers.
Vieques and San Juan, P. R	Comparison observations	Lt. R. J. Auld, Wallace M. Hill.

Respectfully,

E. LESTER JONES, *Director.*

To Hon. HERBERT HOOVER,
Secretary of Commerce.

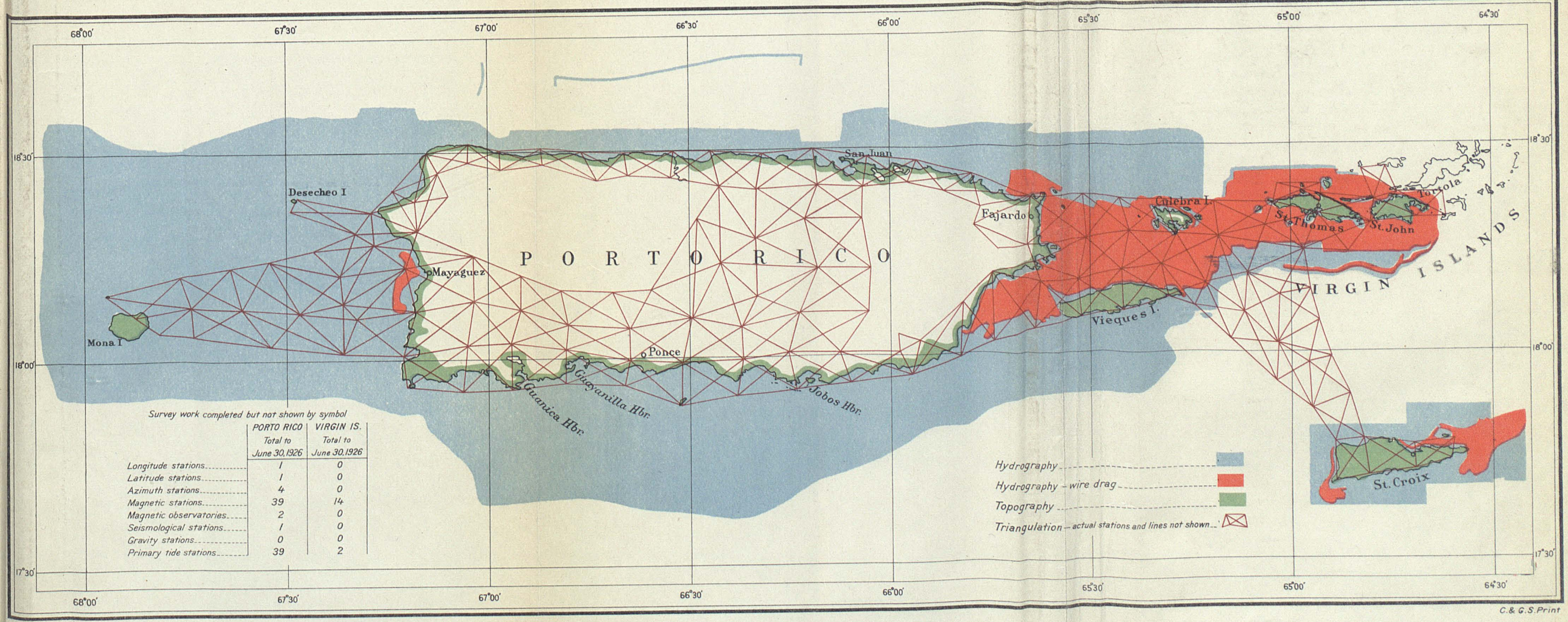
O

U. S. COAST AND GEODETIC SURVEY

CONDITION OF FIELD WORK

PORTO RICO AND VIRGIN ISLANDS

JUNE 30, 1926



Survey work completed but not shown by symbol

	PORTO RICO Total to June 30, 1926	VIRGIN IS. Total to June 30, 1926
Longitude stations	1	0
Latitude stations	1	0
Azimuth stations	4	0
Magnetic stations	39	14
Magnetic observatories	2	0
Seismological stations	1	0
Gravity stations	0	0
Primary tide stations	39	2

C. & G. S. Print

U. S. COAST AND GEODETIC SURVEY

CONDITION OF FIELD WORK

HAWAIIAN ISLANDS

JUNE 30, 1926

Hydrography

Topography

Triangulation — actual stations and lines not shown

Survey work completed but not shown by symbol

	Total to June 30, 1926
Longitude stations	1
Latitude stations	19
Azimuth stations	0
Magnetic stations	38
Magnetic observatories	1
Seismological stations	1
Gravity stations	5
Primary tide stations	24

KAULAKAHI CHANNEL

LEHUA

KAUAI

NIIHAU

KAUAI CHANNEL

OAHU

HONOLULU

KAIWI CHANNEL

PENGUIN BANK

MOLOKAI

KALOHI CHANNEL

PAILOLO CHANNEL

AUAU CHANNEL

LANAI

MAUI

KEALAIKAHIKI CHANNEL

KAHOOLAWE

ALENUIHAHA CHANNEL

HILO BAY

HILO

HAWAII

159°00′ 30′ 158°00′ 30′ 157°00′ 30′ 156°00′ 30′ 155°00′

22°00′ 30′ 21°00′ 30′ 20°00′ 30′ 19°00′

U. S. COAST AND GEODETIC SURVEY

CONDITION OF FIELD WORK

APPROACHES TO PANAMA CANAL

JUNE 30, 1926

Hydrography

Topography

Triangulation — actual stations and lines not shown

CARIBBEAN SEA

Limon Bay

Colon

Cristobal

Gatun L.

Gatun

PANAMA CANAL

Culebra

Pedro Miguel

Miraflores Locks

Panama

BAY OF PANAMA

80° 50′ 40′ 79°30′

20′ 10′ 9°00′ 50′ 40′

Survey work completed but not shown by symbol

	Total to June 30, 1926
Longitude stations	0
Latitude stations	0
Azimuth stations	1
Magnetic stations	6
Magnetic observatories	0
Seismological stations	0
Gravity stations	0
Primary tide stations	8

C. & G. S. Print

U. S. COAST AND GEODETIC SURVEY
CONDITION OF FIELD WORK
PHILIPPINE ISLANDS
JUNE 30, 1926

Hydrography

Topography

Triangulation — actual stations and lines not shown

Survey work completed but not shown by symbol

	Total to June 30, 1926
Longitude stations	49
Latitude stations	49
Azimuth stations	52
Magnetic stations	257
Magnetic observatories	0
Seismological stations	0
Gravity stations	0
Primary tide stations	3

Statute Miles 10 5 0 50 100 150 200

Nautical Miles 10 5 0 50 100 150 200

BASHI CHANNEL
BATAN ISLANDS
BASCO
BALINTANG CHANNEL
BABUYAN ISLANDS
BABUYAN CHANNEL
LAOAG
VIGAN
BANGUED
TUGUEGARAO
BONTOC
ILAGAN
SAN FERNANDO
LINGAYEN GULF
BAYOMBONG
LINGAYEN
TARLAC
CABANATUAN
IBA
LUZON
S. FERNANDO
MALOLOS
POLILLO ISLANDS
BALANGA
MANILA
CAVITE
PASIG
LAMON BAY
STA CRUZ
DAET
LUCENA
BATANGAS
CATANDUANES I
NAGA
BOAC
MARINDUQUE I
CALAPAN
LAGONOY GULF
ALBAY
SORSOGON
MINDORO
MINDORO STRAIT
SIBUYAN
San Bernardino Strait
ROMBLON
TABLAS I
SIBUYAN I
MASBATE
SAMAR SEA
CATBALOGAN
CALAMIAN GROUP
CAPIZ
VISAYAN SEA
BILIRAN I
TACLOBAN
PANAY
LEYTE GULF
S. JOSE DE BUENAVISTA
ILOILO
BACOLOD
Suluan I.
CAMOTES IS
CAMOTES SEA
CEBU
PANAY GULF
NEGROS
SURIGAO STRAIT
DINAGAT I
BOHOL
TAGBILARAN
SURIGAO
BOHOL SEA
DUMAGUETE
SIQUIJOR I
CAMIGUIN I
MINDANAO
BUTUAN
CAGAYAN
DANSALAN
MALAYBALAY
SULU SEA
PUERTO PRINCESA
PALAWAN
BALABAC STRAIT
SIBUTU I
BORNEO
SULU ARCHIPELAGO
SIBUGUEY BAY
ILLANA BAY
COTABATO
DAVAO
DAVAO GULF
ZAMBOANGA
MORO GULF
BASILAN I
JOLO
Traverse
SARANGANI IS.
CELEBES SEA
PHILIPPINE SEA
PACIFIC OCEAN

120° 125° 20° 15° 10° 5°

C.&G.S. Print

Scale 2 500 000 Lambert Conformal Conic Projection

U. S. COAST AND GEODETIC SURVEY
CONDITION OF FIELD WORK
ALASKA
JUNE 30, 1926

Statute Miles 50 0 50 100 150

Nautical Miles 50 0 50 100 150

- Wire drag surveys
- Unchangeable areas, surveyed
- Unchangeable areas, partly surveyed
- Changeable areas, surveyed and requiring future resurveys
- Reconnoissance
- Topography
- Triangulation — actual stations and lines not shown
- Precise leveling

Survey work completed but not shown by symbol

	Total to June 30, 1926
Longitude stations	18
Latitude stations	50
Azimuth stations	45
Magnetic stations	847
Magnetic observatories	2
Seismological stations	1
Gravity stations	10
Primary tide stations	10

O C E A N

N R I V E R

FAIRBANKS

DAWSON

YUKON ALASKA

MT. McKINLEY NATIONAL PARK

ALASKA R.R.

N. W. RY.

KENNICOTT

WHITEHORSE

154° 152° 150° 148° 146° 144° 142° 140° 138° 136° 134° 132° 130° 128° 126° 124° 70° 122° 120° 118° 116°

68° 66° 64° 62° 60°

Seismological stations	1
Gravity stations	10
Primary tide stations	10

MT. McKINLEY NATIONAL PARK

ALASKA R.R.

ANCHORAGE

SEWARD

VALDEZ

C.R. & N.W. RY.

KENNICOTT

CORDOVA

WHITEHORSE

YUKON

BRITISH COLUMBIA

SKAGWAY

JUNEAU

BRITISH COLUMBIA
ALASKA

SITKA

PETERSBURG

WRANGELL

KETCHIKAN

PRINCE RUPERT

KODIAK

GULF OF ALASKA

NORTH PACIFIC OCEAN

ALEUTIAN ISLANDS

KISKA I.

60°
58°
56°
54°
52°

176° 178° 180° 178° 176° 174° 172° 170°

176° 178° East of Greenwich 180° West of Greenwich 178° 176° 174° 172° 170°

152° 150° 148° 146° 144° 142° 140° 138° 136° 134° 132°

176° 178° E. of Greenwich 180° W. of Greenwich 178° 176° 174° 172° 170° 168° 166° 164° 162° 160° 158° 156° 154° 152° 150° 148°

68°

66°

64°

62°

60°

A R C T I C O C E A N

PT. BARROW

NOME

ST. MICHAEL

S E A

Y U K O N R I V E R

MT. McKINLEY NATIONAL PARK

ALASKA R. R.

BERING SEA

PRIBILOF IS

ST. MICHAEL

YUKON

KUSKOKWIM RIVER

MT. McKINLEY NATIONAL PARK

ALASKA R.R.

ANCHORAGE

SEWARD

GULF

KATMAI NAT'L. MON.

KODIAK

NORTH P

DUTCH HBR

ATTU I.

KISKA I.

ALEUTI

62°
60°
58°
56°
54°
52°

168° 166° 164° 162° 160° 158° 156° 154° 152° 150° 148°

174° 176° 178° East of Greenwich

C. & G. S. Print

U. S. COAST AND GEODETIC SURVEY

CONDITION OF FIELD WORK

UNITED STATES

JUNE 30, 1926

- *Wire drag surveys*
- *Unchangeable areas, surveyed*
- *Unchangeable areas, partly surveyed*
- *Changeable areas, surveyed and requiring future resurveys*
- *Reconnoissance*
- *Topography*
- *Triangulation — actual stations and lines not shown*
- *Precise traverse*
- *Precise leveling*
- *Precise traverse and precise leveling*

Statute Miles 100 0 100 200 300

Nautical Miles 100 0 100 200 300

C. & G. S. Print

Survey work completed but not shown by symbol

	Total to June 30, 1926
Longitude stations	397
Latitude stations	610
Azimuth stations	753
Magnetic stations	4703
Magnetic observatories	6
Seismological stations	2
Gravity stations	308
Primary tide stations	68