



# Hydrographic Manual Fourth Edition

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## **U.S. DEPARTMENT OF COMMERCE**

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## Foreword

Continual and unrelenting demands and pressures on the National Ocean Survey for accurate nautical charts of the coastal waters of the United States and her possessions have led to the development of new concepts and techniques in surveying, innovations in cartography, and the introduction and use of sophisticated automated data acquisition and processing methods. Acquisition, analysis, and dissemination of related basic oceanographic, hydrographic, and littoral zone data for coastal engineering and scientific research are charting by-products nearly equal in importance to our nautical charting mission. Exploitation of the Nation's submerged lands and natural resources and man's increased concern for his environment, wetland area, flood plains, and ecosystems have altered many of our traditional priorities and have encouraged the development of new techniques to meet these new responsibilities.

This edition of the *Hydrographic Manual*, a revision of *Coast and Geodetic Survey Publication 20-2* (Jeffers 1960), was compiled to meet these demands and to define the applications of the latest available technology. It describes current National Ocean Survey methods of planning, executing, and processing a hydrographic survey. No claims are made for originality nor do we propose that the techniques described become universally adopted.

This new *Hydrographic Manual* is designed so that revisions, additions, and extractions of the material can be made to maintain currency with the state of the art. Our attitudes, approaches, and applications to meet our Nation's ever-changing needs are not stagnant; thus, we cannot allow this instruction manual, that defines the standards and methods through which we meet these needs, to become stagnant. It is incumbent upon the readers and users of this publication to ensure vitality in the information by constant review, evaluation, and improvement of the contents.



Allen L. Powell  
Rear Admiral, NOAA  
Director  
National Ocean Survey

(Foreword; July, 1976)

## Preface

This *Hydrographic Manual, Fourth Edition*, by the National Ocean Survey was prepared under the able direction of Captain Robert C. Munson, Associate Director, Office of Marine Surveys and Maps, and represents the culmination of more than 160 years of experience in nautical surveying and marine charting. These contemporary instructions for hydrographic and related data surveys that define the applications of the most modern available technology will allow the second and third editions to be retired.

In this fourth edition, extensive changes have been introduced in both format and content; the major changes are, of course, based on the use of modern automatic data collection and processing techniques. Few of the basic requirements of hydrography have been altered. An attempt has been made to identify stringent specifications for hydrographic surveys and to describe survey methods and techniques of accomplishment that result in the most effective utilization of manpower and equipment. I hope each salty old hydrographer who looks askance at what he considers to be radical departures from tradition is offset by one of our dedicated young crusaders from the binary generation who is convinced we are moving too slowly. If this is the case, then I believe a satisfactory balance has been achieved; thus this edition will retain the tradition of usefulness characterizing the previous editions.

Recent streamlining of procedures between the completion of a hydrographic survey and the production of a nautical chart has added responsibility upon both commanding officers and those engaged in survey verification. In many areas, increased emphasis is placed on quality control, completeness, and cohesiveness of field survey data. *Quality of our data is as important as quantity.* The shopworn adage that "miles bring smiles" can no longer be considered a hydrographic commandment.

New ideas and information were received and added continually throughout the preparation period. Ultimately, however, editorial deadlines neared, causing the manuscript to be sent to the presses. Because the technology and state of the art of hydrographic surveying are dynamic, the National Ocean Survey will make a constant effort to keep this manual current by issuing periodic amendments and supplements. Readers are urged to make suggestions and advise us on improvements. Through your written comments, the manual can reflect changes in the state of the art.

The many improvements in this edition stem directly from the enthusiastic response received from personnel throughout the NOAA fleet and at the Marine Centers and Headquarters. Space does not permit one to credit each person who contributed in a technical sense, although their efforts are sincerely appreciated; but special thanks must go to those who made major outstanding contributions: Betty V. Arozian, Gabriel J. Bren, Raymond H. Carstens, Donald R. Engle, I.Y. Fitzgerald, Walter F. Forster II, Wayne L. Mobley, William J. Monteith, Robert K. Norris, Hugh L. Proffitt, Jack WALLACE, and Dale E. Westbrook.

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## Introduction

The "Survey of the Coast," the earliest forerunner of the National Ocean Survey (a major element of the National Oceanic and Atmospheric Administration), conducted its first hydrographic surveys in 1834. In that year, the U.S. Naval schooners *Jersey* and *Experiment*, under the respective commands of Lieutenant Thomas R. Gedney and Lieutenant George S. Blake, initiated field operations for nautical charting in the vicinity of Long Island, N.Y.

On February 10, 1807, an Act of Congress authorized the President ". . . to cause a survey to be taken of the coasts of the United States. . . ." As it happened, 27 frustrating years passed before Lieutenant Gedney's *Jersey* would run that first line of soundings on the south coast of Long Island between Conklins Point and Green Point. This first hydrographic survey eventually was registered and achieved in 1837 (Wraight and Roberts 1957).

Hydrographic surveying and the cartographic representation thereof in the form of nautical charts were not unknown mysteries in 1807 when President Jefferson appointed Ferdinand Hassler as the first Superintendent of the "Survey." Over 4,000 years ago, Cretan warships and merchantmen plied the Mediterranean. Sea-going junks had spread Chinese trade throughout the Indian Ocean well before the time of Marco Polo's explorations. These early navigators neither relied entirely upon memory in familiar waters nor did they entrust the safety of their commands to chance in uncharted or strange waters. While the instruments and methods used by these ancient mariners are considered crude and unreliable by today's standards, water depths were measured, shoals and channels delineated, landmarks and aids to navigation established, and hazards identified; all were recorded and charted to the best of their ability. By the 19th century, hydrography was accepted as a scientifically based surveying element capable of meeting rigorous engineering standards. Unrelenting pressures and demands for surveys to make maritime commerce safe resulted in placing responsibility on the newer "Coast Survey" for the publication and maintenance of nautical charts of the coastal waters of the United States and her possessions. Upon the arrival of the 20th century, the achievement of this mission by what was then the Coast and Geodetic Survey required the execution of surveys and the continual updating of charts that included a water area in excess of 2 million square nautical miles.

Since the end of World War II, the demand for hydrographic surveys to update nautical charts has increased tremendously because of expanded development in coastal areas, an enormous boom in the popularity of recreational boating, and a sustained growth in waterborne commerce. The more than 9,000 hydrographic surveys filed in the archives of the National Ocean Survey are the basis for an assemblance of about 970 nautical charts regularly updated and published. Each survey represents a unique and comprehensive record of the coastline and adjacent waters. A detailed record of changes brought about by natural and cultural causes can be compiled from a review of contemporary and prior surveys of the same area. These surveys, conducted primarily for nautical charting, are used extensively for engineering, research, and various legal purposes. Only selected important details and soundings from the surveys are shown on published nautical charts.

The hydrographer is engaged in a unique and unusually complex arena within the field of surveying. Unique because, unlike topographic surveying, hydrographic surveying is essentially inferential and deductive since the hydrographer cannot directly view the sea bottom features and so must rely upon discrete sampling methods to construct a continuum of the bottom configuration. And complex in that hydrographic surveying includes consideration of and direct dealing with geodetic control networks, nautical datums based upon an analysis of water level conditions, submarine topography, shoreline delineation, and foreshore detail (e.g., the precise location of navigational aids and landmarks), the total requiring a legion of surveying methods and instrumentation to bring about the desired results.

Tools and techniques used in hydrographic surveying have improved continuously at varying rates. In the early days of hydrography, water depths were measured and bottom characteristics determined solely by lead lines, sounding poles, and wire sounding machines. Positions of the sounding vessel were determined by three-point sextant fixes or, if the shore was not visible, by astronomic observations or dead reckoning. All data were recorded manually for subsequent manual calculation, reduction, correction, and, eventually, plotting. During the past four decades, considerable advances in the science of hydrography have been achieved through the development of echo sounders and electronic navigation systems. With these instruments, the hydrographer acquired much more information for detailed charting of submarine relief than ever before. Although these instruments enabled a substantial increase in the rate and volumes of data acquisition and greatly improved the accuracy and completeness of the hydrographic survey, the volume of manual labor in recording, processing, and plotting the data was not reduced.

More recently, computer assisted data acquisition, machine plotting, and information processing systems have materially increased the speed and efficiency of producing a hydrographic survey. Automated data acquisition and treatment permits the hydrographer to select the optimum sounding line direction without being constrained by the geometry of the electronic positioning system. Time, depth, and position are recorded automatically at a much higher rate than was possible manually and with minimal possibility of recording error. Automatically entered data correctors have speeded the development of new instruments and techniques, such as the real-time telemetering tide gage. The shipboard computer has opened new possibilities for the future; among these are digital electronic sextants, which may result in more efficient surveys in areas where visual control must be used, and heave correctors that compensate for vertical motion of the sounding vessel.

Other technological advances are beginning to tear away the veil of water that obscures the configuration of the sea bed. Photobathymetry—underwater mapping with aerial photography — is showing its operational usefulness. A family of swath mapping instruments is being developed, refined, and tested operationally to provide complete sonar records analogous to aerial photography. Remote-sensing measurement devices, such as laser depth scanners and air gap echo sounders, are around the corner. Worldwide high precision positioning systems are in sight. All of these, together with computer analysis and processing that is replacing the inefficient drudgery of processing data manually, promise to make the hydrographer more efficient and effective.

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