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UNITED STATES DATA COLLECTION ACTIVITIES AND REQUIREMENTS

FINAL REPORT - VOLUME I

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JANUARY 1977

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I. EXECUTIVE SUMMARY

INTRODUCTION

Satellite data collection offers the capability of automatic and flexible user service, as well as quick data availability over wide geographical areas. This has been previously demonstrated using the NASA experimental satellites called Landsat-1, -2, ATS-3 (OPLE), Nimbus-3, -4 (IRLS), and SMS-1, -2. Since these programs were so successful, there has been much interest focused towards developing an expanded satellite Data Collection System (DCS) which has greater capabilities for the early 1980's. Before embarking further on such a satellite program, it was deemed necessary to fully investigate the potential DCS user market to determine whether or not the user needs would be sufficient to support a satellite relay DCS design.

This final report represents the efforts and results to date on Contract NAS5-22467 entitled "DCS User Requirements and Cost/Benefits Analysis Study." The primary objective of this study is:

- To establish a set of requirements parameters upon which future evolving DCS designs may be confidently based.

In order to satisfy this objective, it is necessary to determine just how many potential satellite DCS users exist, as well as their pertinent system characteristics and flexibility of data transmission.

The purpose of this study effort is to define a list of DCS users that could potentially utilize satellite data relay as the means for data collection. Our effort will be basicly limited to collecting information on DCS users and their stations that are contained within the United States and near coastal areas. Subsequent study efforts should consider the international data collection user market. It should be emphasized at the outset of this effort that our approach is to examine existing (and near term planned) data collection users in order to provide a definitive and realistic user data base. Future studies should include systems or applications that do not now exist but that could be implemented if low cost remote data collection techniques become available. Hence, estimates of potential users in new applications areas is not a part of this study. Whenever new applications are uncovered, they will be noted but not examined in detail. Because of these guidelines, it is felt that our potential user data base for satellite relay will more closely relate to the "real world of data collection services." Another important point worth mentioning is that every effort has been made to properly document the user and station information with two or more references substantiating all information gathered. It should be noted that many data collection stations are shared by two or more user agencies and hence, are catalogued over and over again in different reports. This initially represented a major problem in terms of double counting stations. Our heavy emphasis on documentation, however, alleviated this problem and resulted in an insignificant amount of double counting of stations among users.

OVERVIEW OF THE REPORT

This report is organized into two volumes. Volume I consists of seven major sections and three appendices. Section II describes the study approach which consists of eight separate tasks. Three of these tasks deal with the data collection user data base. The remaining five tasks are concerned with the development of the data collection station data base. In Section III the user parameters and potential data collection users are identified. Having done this, the user information acquisition phase of the program was performed primarily by literature survey and, on occasion, by person-to-person contact with agency personnel. Following this procedure, the data collection user data base is presented in Section IV. This data base consists of descriptions of 50 data collection networks and a data collection station population in excess of 100,000. This section concludes with a short tutorial on several new applications for data collection.

Sections V through VII deal with the data collection station data base. In Section V the station parameters and data collection information acquisition process are described. Since the amount of data to be gathered was so large, it was decided to computerize the station data base. This would then allow for computer analysis of the data which would, in turn, result in a more timely and detailed analysis of the data base. Section VI presents a description of the computer program used in the analysis of the station data base. Appropriate descriptions, flow charts, computational procedures, index assignments, and sample printouts are discussed in this section. In Section VII, the results of the computerized analysis of the station data base are given. These results are generally in the form of histograms of the various data collection parameters, and are divided into three separate parts:

- General characteristics of data collection stations,
- Characteristics of specific groups of stations, and
- Analysis of number of stations and amount of data collected.

Additional information is supplied by three appendices and a reference list comprising over one hundred documents examined during this study effort. Appendix A contains an expanded version of the computer program flowchart and a complete listing of the program and all of the subroutines. Nearly one thousand statements were necessary in the program to accept and manipulate the station data base in the manner that was desired. In Appendix B, a description is given for the coding information used for the data collection station data base. Data card formats and some sample data are discussed in this Appendix. Following this, a bibliography of additional literature sources consulted during the study is documented in Appendix C.

Volume II of this report is a computerized (data card) compilation of the data collection station data base. In order to understand and use the information contained in Volume II, it is imperative to have a thorough understanding of the data card format as described in Appendix B of Volume I. To illustrate the size of the station data base, approximately 11,000 computer cards were necessary to characterize a total of 107,407 data collection stations.

SUMMARY OF RESULTS

The basic results of this study effort include the following:

- Development of a user data base
- Development of a station data base
- Development of a computer program method of analysis
- Computerized analysis of the station data base.

As indicated earlier, both the user and station data base describe present (and near-term future planned) data collection activities within the geographical boundaries of the United States and surrounding coastal areas.

Once a set of data collection user parameters had been established, it was then possible to compile a list of potential data collection users. This list of agencies and organizations that was examined for data collection stations is shown in Table 3.2. In referring to Table 3.2 it is clear that data collection encompasses many broad and diverse functions involving hundreds of separate and distinct organizational entities. Using this list of user agencies, the data collection user data base was developed. This data base represents a set of descriptions of 50 data collection networks comprising a total of 128,734 data collection stations. These data collection activities are classified according to the following science applications.

- Agriculture
- Climatology
- Environment
- Forestry
- Geology
- Hydrology
- Meteorology
- Oceanography

For convenience, the user data base was condensed and is shown in Table 4.1. This condensed user data base represents 47 networks and a population of 102,474 data collection stations. This decrease of 26,260 stations from the previous above figure is due to monitoring activities involving the collection samples for laboratory analysis (e.g., pesticide monitoring). This particular type of data collection was not considered presently applicable to satellite data collection and, hence, was not considered further. An additional amount of 4,933 stations were added to the station data base making a grand total of 107,407 stations. The reasons for this increase occurs from entering air quality monitors in the data base rather than the number of stations (discussed in Section V), and considering multiple observations of single stations as single observations of several stations (discussed in Section VI).

In summary, the final user and station data bases are characterized by:

- User data base - 47 major networks
- Station data base - 107,407 data collection stations.

The station data base is printed out in Volume II of this report. After collecting this information and placing it on computer cards, it was then necessary to develop the software computer program to analyze this data. This program was written in FORTRAN and was operated on an IBM 360/95 computer. It represents a major tool for analyzing the vast amount of data collection station information. The basic information placed on the data cards and accepted by the program consists of:

- Number of data collection stations
- Data collection station description
  - Station information
    a. location
    b. fixed/mobile type
    c. identification of the agency that operates the station or the network of which the station is a part
  - Observation information
    a. observation identification
    b. indicator of whether the amount of data is a quantity of bits or characters
    c. indicator of usage of automatic recording and telemetering equipment
    d. the amount of data produced as the result of a single measurement
    e. measurement interval
    f. collection interval

The data collection station description may include as many as four sets of observation information. This option provided the capability needed to handle the multiple observations of many stations.

The output of the computer program consists of profiles of individual states, and more detailed profiles of regions consisting of groups of states. From these profiles, much valuable data collection information was developed and is presented in histogram form in three parts of Section VII.

- Part I - General characteristics of data collection stations (Figures 7.1 - 7.15)
    - Number of data collection stations versus location, message size and collection interval for all stations in the data base
    - Number of data collection stations versus location, message size and collection interval for four specific types of stations
        a. automatic recording and/or telemetering
        b. fixed and mobile
        c. slow, medium and fast collection interval
        d. federal and non-federal agency
- Part II - Characteristics of specific groups of stations (Figures 7.16 - 7.36)
    - Number and density of data collection stations with automatic recording devices versus location
    - Number and density of data collection stations with automatic telemetering devices versus location
    - Number of stations with automatic recording and telemetering devices versus message size and collection interval
    - Amount and density of data collected for automatic recording devices versus location
    - Amount and density of data collected for automatic telemetering devices versus location
    - Number of continuous and event initiated stations versus location

  - Number of mobile and event stations versus message size and collection interval
  - Number and density of stations versus location for

    a. fast collection interval (1 minute to 3 hours)
    b. medium collection interval (6 hours to 2 months)
    c. slow collection interval (3 months to 1 year)

  - Number of stations versus measurement interval

- Part III - Analysis of number of stations and amount of data collected (Figures 7.37 - 7.54)
  - Density of data collection stations versus location
  - Distribution of states versus density of stations
  - Amount of data collected versus location
  - Density of data collected per year versus location
  - Distribution of states versus density of data collected
  - Regression analysis on number of stations and amount of data collected as a function of

    a. area
    b. population
    c. average annual rainfall
    d. per capita income

These paragraphs do not attempt to summarize the results of each of the histograms in this report but rather just to indicate their content. Careful reference to the appropriate parts of Section VII is necessary to obtain more specific and detailed information.

RECOMMENDATIONS FOR FURTHER STUDY

It is recommended that the following five areas of effort be given attention in the near future.

Computer Program Analysis Extension

It is recommended that the computer program and the station data base be used to produce profiles or histograms of some additional groups of stations.

Groups of stations should be identified by the agency which operates them. Profiles of this type would provide all of the information needed to produce histograms of the stations operated by a single agency. Also, profiles of groups of stations identified by each of the eight applications for which the data are being collected (meteorology, hydrology, etc.) should be produced. This would provide the information needed to produce histograms of groups of stations that measure the same types of parameters (e.g., water quality) for the same purposes. Both of these types of profiles can be easily produced by incorporating some slight alterations into the existing computer program.

The program can also be extended to produce profiles of almost any selected group of stations, e.g., stations that make surface water measurements between 500 and 1,000 bits.

Data Collection Brochure

It would be highly useful and informative to take portions of this report and develop a general brochure on United States data collection activities. This brochure could be circulated widely throughout the appropriate governmental and private sectors. As such, it would represent a major link in publicizing the existing data collection activities. Agencies would then be informed, on a nationwide basis, of all data collection efforts currently in progress and anticipated in the near future. This brochure could then be updated annually and recirculated, resulting in a continuous update of United States data collection activities to all possible users.

National Data Base of DCS Activities

During this study effort, a large amount of information has been gathered concerning data collection stations within the United States and coastal areas. A tool for analyzing this data base has also been developed in the form of a computer program. It would be useful to have and maintain the status, on a national scale, of all of these as well as any future data collection stations. The data base and the program could be continuously updated and modified to yield any desirable outputs. Cooperating agencies could view this national DCS data base as a library of all services. These agencies would be able to access any available information concerning data collection activities from the national data base. A useful result of this effort would be the inter-agency cooperation that would follow and, perhaps, minimal duplication of efforts amongst different organizations and agencies.

Economic Assessment of Satellite DCS Market

It is recommended that an in-depth cost/benefit tradeoff study be directed towards assessing the viability of satellite relay for satisfying the existing user and station data base market. A rationally based dollar cost/benefit ratio could be developed for satellite relay for each of the 47 networks under study, and compared with the cost and benefits of presently existing services. Both polar and geosynchronous satellite relay techniques should be considered. The output of this study would be a set of major user networks (≤ 47) and data collection stations ($\leq 107,407$) that could utilize satellite data relay in a cost-effective manner.

International DCS Market Forecast

Almost all of our data collection information is presently constrained to the confines of the United States. It would be extremely useful to extend this data base to include the international data collection market. As a first cut, the correlation analyses of this study (number of stations versus rainfall rate, area, population) could be extended on an international scale to develop gross forecasts for the international DCS market. Polar satellites, in particular, are ideally suited to perform global data collection. In summary, the larger the potential user data base, the more likely the need for some common international form of satellite data relay. Hence, every effort should be directed towards finding additional international users.

II. STUDY APPROACH

The approach used to meet the study objectives stated in the previous section consists of eight tasks. Three of these tasks deal with the data collection user data base. The other five tasks deal with the data collection station data base. Each of these tasks are given below:

- Task 1 - Identification of data collection users and definition of user data base parameters
- Task 2 - Acquisition of user information
- Task 3 - Development of data collection user data base
- Task 4 - Definition of station data base parameters
- Task 5 - Acquisition of station information
- Task 6 - Development of computerized data collection station data base
- Task 7 - Development of computer program to analyze station data base
- Task 8 - Analysis of station data base.

A study flow diagram that illustrates the relationship between these tasks is shown in Figure 2.1. The objectives and results of each of these tasks are discussed individually in the following paragraphs.

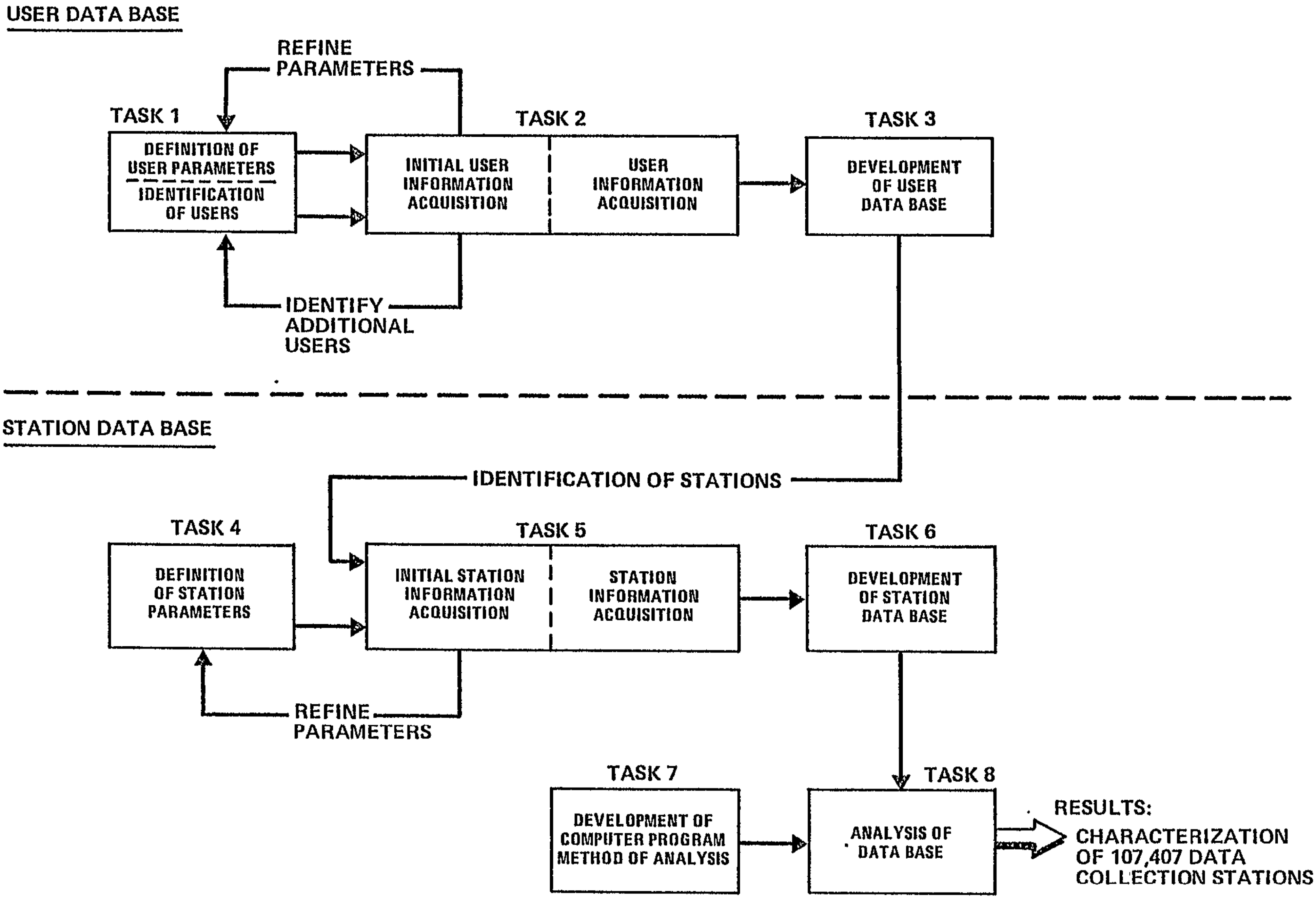


FIGURE 2.1. STUDY FLOW DIAGRAM

The objective of Task 1 is to specify the information that will be contained in the data collection user data base. This task consists of two distinct sub-tasks. The first sub-task is to identify the data collection users that will be described in the user data base. The second sub-task is to develop a group of parameters that are both necessary and useful to describe data collection activities. These parameters define the information in the data base. The output of Task 1 can be envisioned as the labels of the rows and columns of a large matrix that will become data collection user data base.

Task 2, the acquisition of user information, consists of gathering publications (mostly government documents) that contain information pertaining to the user data base. This task can also be separated into two sub-tasks. The first sub-task involves the acquisition of general information about the data collection activities of a variety of users. This information is needed to refine the set of user parameters developed in Task 1. As expected, this information also identified some additional data collection users. The second sub-task involves gathering all of the information in the user data base. Special emphasis was placed on gathering at least two references to document each piece of information in the user data base. Additional users were identified by this part of Task 2 also.

In Task 3 the data collection user data base is developed. This involves reviewing the information gathered in Task 2, first by cataloging and formatting it, and then finally by presenting it. The information in the user data base has been presented in two ways:

- Descriptions of each user that contain detailed information about each of the user parameters, and a
- Condensed summary table of the users that provides the most important information.

Tasks 4 through 6 deal with the development of the data collection station data base, and are similar in approach to Tasks 1 through 3. Like Task 1, the purpose of Task 4 is to specify the information that will be contained in the station data base. This involves developing a useful and manageable set of parameters that adequately describe the characteristics of a data collection station. Identifying the stations that will be in the data base is not required because they have already been identified in the user data base.

Task 5 deals with the acquisition of the information in the station data base. Like Task 2, this task begins first with gathering information about many different types of data collection stations. This information is used to refine the set of parameters developed in Task 4. The second part of this task consists of gathering as much information as was reasonably possible concerning all of the parameters that describe each of the stations in the data base. This includes gathering information in the form of lists of data collection stations and their specific characteristics, as well as documents that contain descriptions of the characteristics of data collection networks.

The development of the data collection station data base is performed in Task 6. This involves reviewing and interpreting the gathered information. It also involves specifying accurate values for some of the information in the data base. This was done when information had not been published on a station-by-station basis. Most of the information needed to specify these parameters is available in documents that contain descriptions of the data collection activities of individual networks. This task also includes formatting all of the information in the data base so that the analysis of this data can be done using a computer.

The purpose of Task 7 is to develop a computer program to analyze the station data base. This task can be divided into two parts. The first part deals with defining the results that the computer analysis will produce. This consists of identifying every value that the computer program should produce and the methodology required to perform these calculations. This part of Task 7 also involves organizing the desired results into a basic set of results, and several variations of this basic set. This will permit the development of a simple program that will produce the basic set of results, and will also be easily modifiable to produce each of the variations of the basic results. The second part of this task is the development of the computer program that will analyze the data base and produce the desired results.

The station data base developed in Task 6 and the computer program written in Task 7 are then used in Task 8 to perform the analysis of the station data base. The program was used to produce a set of basic results. A total of eight variations of the program were then used to produce more detailed results on selected groups of stations. The results of this analysis characterize the data collection activities of 107,407 data collection stations.

III. DATA COLLECTION USER INFORMATION ACQUISITION

This section presents our approach to the task of gathering information about data collection users. This involves: (1) the definition of the information to be gathered; (2) the development of a list of agencies which could be involved in data collection activities; and (3) gathering the necessary information. Each of these subtasks are discussed individually in the following paragraphs.

USER PARAMETERS

Before any useful data collection user information could be obtained, it was necessary to establish a set of specific user parameters. The usefulness of the results of the user information acquisition task depends entirely upon providing the correct answers to the proper questions. These questions represent the user parameters.

At first, a rather lengthy set of user parameters was considered. After an initial survey of the largest and most well known data collection users was made, it was concluded that this initial list of user parameters was too detailed, and that information should be gathered based on a smaller but more pertinent set of user parameters shown in Table 3.1.

TABLE 3.1

DATA COLLECTION USER PARAMETERS

Network identification
Application
Description or purpose of network
Number of stations
Geographical location of stations
Parameters measured
Method of measurement
Frequency of measurement (sampling)
Method of data relay
Frequency of data relay (collection)
Location and identification of users
Estimated data delay
Reference information

Most of these parameters are self-explanatory and need no further discussion. However, to avoid any confusion or ambiguous assumptions, the following definitions are given:

- Method of Measurement
  - Manual measurements are those which require an observer to be at the station at the time at which the measurement is made. An observer reading a thermometer is an example of a manual measurement. Automatic measurements are those which do not require an observer at the station at the time at which the measurement is made. A stage gauge that automatically records stage measurements is an example of an automatic measurement.
- Frequency of Measurement
  - The frequency (how often) with which a parameter is measured or sampled during a specified period of time.
- Method of Data Relay
  - A description of the way in which data travels from the point at which it was measured to the point at which it is used.
- Frequency of Data Relay
  - The frequency (how often) with which data is transferred from the point at which it was measured, to the point at which it is used (sometimes referred to as the data collection interval).
- Estimated Data Delay
  - An estimate of the amount of time that elapses from the moment at which the data is measured until the moment that it reaches the user.

By thoroughly searching the literature on data collection activities, most of this information was obtained for each of the data collection users examined. It should be noted that the parameter 'Estimated Data Delay' is an estimate because little specific information on this parameter was contained in the available literature.

POTENTIAL DATA COLLECTION USERS

After establishing the set of data collection user parameters, a list of potential data collection users was defined. This is a list of the agencies and organizations that were examined for data collection platforms. The list is shown in Table 3.2.

INFORMATION ACQUISITION

Having established a list of potential data collection users and a set of user parameters, the potential users were examined and the needed information was gathered. The information was obtained through appropriate literature searches and occasionally by person-to-person contact with agency personnel.

In compiling the user information, emphasis was placed on the following:

- Present data collection activities and near-term future plans when available
- Documentation of user information, including two or more references substantiating all information gathered
- No double counting of stations among users
- Minimal discussion of networks where monitoring is done by laboratory analysis of collected samples and current research and development efforts are not directed at developing monitoring methods applicable to satellite data collection.

TABLE 3.2

POTENTIAL DATA COLLECTION SYSTEM USERS

- Department of Agriculture
  - Forest Service
  - Soil Conservation Service
- Department of Commerce
  - National Bureau of Standards
  - National Oceanic and Atmospheric Administration
    - Environmental Data Service
    - National Environmental Satellite Service
    - National Marine Fisheries Service
    - National Ocean Survey
    - National Weather Service
- Department of Defense
  - Department of the Air Force
    - Air Weather Service
  - Department of the Army
    - Corps of Engineers
    - Defense Civil Preparedness Agency
  - Marine Corps
  - Department of the Navy
    - Naval Facilities Engineering Command
    - Naval Oceanographic Office
    - Naval Weather Service
- Department of the Interior
  - Bonneville Power Administration
  - Fish and Wildlife Service
  - Geological Survey
    - Water Resources Division—Office of Water Data Coordination
- Department of the Interior (Cont)
  - Bureau of Indian Affairs
  - Bureau of Land Management
  - National Park Service
  - Bureau of Reclamation
  - Bureau of Sport Fisheries and Wildlife
- Department of Transportation
  - Coast Guard
  - Federal Aviation Administration
- Office of Emergency Preparedness
- Energy Research and Development Administration
  - Nuclear Regulatory Commission
- Environmental Protection Agency
  - Office of Air Programs
  - Office of Water Programs
  - Office of Pesticide Programs
  - Office of Radiation Programs
- International Boundary and Water Commission
- National Aeronautics and Space Administration
- National Science Foundation
  - Office of Polar Programs
- Smithsonian Institute—Center for Short-Lived Phenomena
- States
  - Division of Forestry
  - Division of Water Resources
  - Department of Health
- Tennessee Valley Authority
- World Meteorological Organization

IV. DATA COLLECTION USER DATA BASE

This section consists of the data collection user data base which is a set of descriptions of 50 data collection networks comprising a total of approximately 128,734 data collection stations. A condensed version of the data base is also presented. In addition to the user data base, several data collection users, for which little information was available, are discussed along with several new applications for satellite data collection.

NETWORK DESCRIPTIONS

In the following pages descriptions of 50 data collection networks are given. These networks represent the data collection user data base. It should be noted that the networks that were not considered applicable to satellite data collection, due to the circumstances mentioned previously in Section 3, have abbreviated network descriptions.

The descriptions of the networks all contain the information that was gathered concerning each of the data collection user parameters identified in Section 3. For the most part, these parameters have been identified individually in the description format. However, when necessary for clarity, several parameters have been combined, or additional parameters required to describe a special characteristic of a network, have been used.

The data collection user parameter called application identifies the science in which the collected data is used. The following explanations of each application are provided.

- Agriculture - the science of cultivating the soil, producing crops, and raising livestock.
- Climatology - the science that deals with the average condition of the weather at a place over a period of years.
- Environmental - the science that deals with the climatic, edaphic, and biotic factors that act upon an organism or an ecological community.
- Forestry - the science of developing, caring for, or cultivating forests.
- Geology - the science that deals with the history of the earth as recorded in rocks.
- Hydrology - the science dealing with the properties, distribution, and circulation of water on the surface of the land, in the soil and underlying rocks, and in the atmosphere.
- Meteorology - the science that deals with the atmosphere and its phenomena, especially with weather and weather forecasting.
- Oceanography - the science that deals with the ocean and its phenomena.

In the following pages the user data base is presented. It describes a total of 50 distinct data collection networks. After these network descriptions, a condensed version of the user data base is given.

NETWORK IDENTIFICATION: Surface Observation Stations of the National Weather Service

APPLICATION: Meteorology

DESCRIPTION: The National Weather Service gathers meteorological data to provide the raw materials meteorologists need to prepare forecasts and warnings for general use and for specialized uses such as aviation, forestry, and agriculture. Information is also collected to document climatological history and to support international commerce.

The Basic Weather Program for the acquisition of surface weather data is divided into the Synoptic Weather Network, designed primarily to serve forecast programs and provide data for international exchange, and the Basic Weather Network, the larger of the two and the one that serves nearly all users. The observations of the Basic Weather Network are usually referred to as aviation weather observations. The NWS stations in these two networks provide high-quality surface weather observations for the Basic Weather Program.

NUMBER OF STATIONS: 278

LOCATION OF STATIONS: There are 237 stations in the 48 states, 25 in Alaska, 3 in Hawaii, 9 in the Pacific, 2 in the Caribbean, 1 in the Antarctic, and 1 ocean station in the Atlantic.

PARAMETERS MEASURED AND FREQUENCY OF MEASUREMENT: Synoptic observations consist of amount of sky cover, wind speed, direction, and character, type and amount of clouds, visibility, present and past weather, temperature, precipitation, dewpoint, pressure and pressure tendency, and occurence of special phenomena. Synoptic observations are generally made either four or eight times a day at world standard synoptic times (0000, 0600, 1200, and 1800 GMT).

Basic observations consist of amount of sky cover and height of ceiling, visibility, present weather, and obstructions to vision, pressure, temperature, dewpoint, wind speed, direction, and character, altimeter setting, and runway visual range. Basic observations are made at hourly intervals with special reports during the intervening periods when special weather events occur.

Basic observations are made at 63 stations, synoptic observations are made at 7 stations, and combined basic and synoptic observations are made at 208 stations.

METHOD OF MEASUREMENT: The measurements are made manually except at automatic observing stations.

DATA RELAY METHOD: Data is relayed by teletypewriter transmission over several FAA communications circuits for weather data and aviation information

FREQUENCY OF DATA RELAY: Same as frequency of measurement.

LOCATION OF USERS: Forecasting offices of NWS including National Meteorological Center in Suitland, Md. that prepares synoptic material and long-range forecasts, other major forecasting centers concerned with severe weather forecasting, 52 Weather Service Forecast Offices that prepare statewide forecasts and warnings, 250 Weather Service Offices that prepare local forecasts, FAA Flight Service Stations, and a variety of other users including weathermen. Users of surface weather observations also include weather forecasting organizations and aviators in other countries.

ESTIMATED DATA DELAY: One to three hours

COMMENTS: Part of the NWS plan to automate its operations includes the development of automatic observing stations. Twenty-two NWS stations are unmanned Automatic Meteorological Observing Stations (AMOS) and nine stations are manned Automatic Meteorological Observing Stations.

Automatic Meteorological Observing Stations provide automatic collection of data for the Basic Weather Program at stations too remote for manned operations, at stations for which complete observations are not needed, at part-time manned stations during unmanned periods, and to facilitate the observing program at stations where personnel are busy with other duties.

The parameters measured at unmanned AMOS stations are temperature, dewpoint, wind speed and direction, altimeter setting, amount of precipitations and maximum wind speed. At manned AMOS stations the observer supplements the AMOS observations with sky cover and height of ceiling, visibility, present weather, and obstructions to vision, and sea level pressure.

Future plans call for 106 AMOS and 86 limited AMOS (wind data only).

REFERENCES: 1, 2, 3, 4, 7, 19, 63, 65, 79, 99

NETWORK IDENTIFICATION: Surface observations stations operated cooperatively by the National Weather Service and the Federal Aviation Administration

APPLICATION: Meteorology

PURPOSE: To provide surface observations for the Basic Weather Program, and for aviation operations.

NUMBER OF STATIONS: 24

LOCATION OF STATIONS: There are 17 stations in the 48 states, 6 in Alaska, and 1 in Hawaii.

PARMETERS MEASURED AND FREQUENCY OF MEASUREMENT: Basic observations are made hourly at 11 stations and combined basic and synoptic observations are made at 13 stations.

METHOD OF MEASUREMENT: Manually except at automatic observing stations

DATA RELAY METHOD: By teletypewriter

FREQUENCY OF DATA RELAY: Same as frequency of measurement

LOCATION OF USERS: NWS forecasting offices, and various other users of surface weather observations.

ESTIMATED DATA DELAY: One to three hours

COMMENT: Three stations are manned Automatic Meteorolocial Observing Stations.

REFERENCES: 1, 3

NETWORK IDENTIFICATION: Surface Observing Stations staffed by FAA

APPLICATION: Meteorology

PURPOSE: To provide surface observations primarily for aviation operations, and to augment efforts of the National Weather Service in data acquisition for the Basic Weather program.

NUMBER OF STATIONS: 200

LOCATION OF STATIONS: There are 188 stations in the 48 states, and 12 in Alaska.

PARAMETERS MEASURED: Basic Observations

METHOD OF MEASUREMENT: Manually

FREQUENCY OF MEASUREMENT: Measurements are made at hourly intervals for periods of 8 to 24 hours a day. Special reports are made during the intervening periods when significant weather events occur.

DATA RELAY METHOD: By teletypewriter

FREQUENCY OF DATA RELAY: Same as frequency of measurement

LOCATION OF USERS: NWS forecasting offices preparing aviation forecasts, FAA Flight Service Stations, and a variety of other users of aviation weather data.

ESTIMATED DATA DELAY: One to three hours

REFERENCES: 1, 2, 3, 5, 19, 64

NETWORK IDENTIFICATION:	Supplementary Aviation Weather Observation Program of The National Weather Service
APPLICATION:	Meteorology
PURPOSE:	To provide aircraft operators with the weather observations they require to meet Federal Air Regulations.
NUMBER OF STATIONS:	308 Supplementary Aviation Weather Reporting Stations 105 Limited Aviation Weather Reporting Stations
LOCATION OF STATIONS:	Throughout the U.S. at small airports
PARAMETERS MEASURED:	Basic Observations
METHOD OF MEASUREMENT:	Manually
FREQUENCY OF MEASUREMENT:	Some stations operate on a regular schedule making hourly observations during the time when an observer is on duty. Other stations make observations on an on-call basis when needed for local aircraft operations. Stations also make reports when changes in weather occur.
DATA RELAY METHOD:	Data is relayed to local users by voice transmission via radio or telephone. Some data is relayed by teletypewriter.
FREQUENCY OF DATA RELAY:	Same as frequency of measurement
LOCATION OF USERS:	Local users of the data are positions which control local air traffic that are within the service area of the station. Also, some observations are disseminated regionally and/or nationally.
ESTIMATED DATA DELAY:	One to three hours
REFERENCES:	1, 3, 5, 8

NETWORK IDENTIFICATION:	Contract observing stations of the National Weather Service
APPLICATION:	Meteorology
PURPOSE:	To supplement basic and synoptic observations in areas where data are not otherwise available.
NUMBER OF STATIONS:	185
LOCATION OF STATIONS:	There are 120 stations in the 48 states, 28 in Alaska, 13 in Hawaii, 20 in the Pacific, and 4 in the Caribbean.
PARAMETERS MEASURED AND FREQUENCY OF MEASUREMENT:	Basic observations are made hourly at 123 stations, for 5 to 10 hours per day. Synoptic observations are made 4 times a day at 49 stations. Combined synoptic and basic observation are made at 13 stations.
METHOD OF MEASUREMENT:	Manually
DATA RELAY METHOD:	By teletypewriter
FREQUENCY OF DATA RELAY:	Same as frequency of measurement
LOCATION OF USERS:	NWS forecasting offices, and a variety of other users of surface weather observations.
ESTIMATED DATA DELAY:	One to three hours
REFERENCES:	1, 2, 3, 5

NETWORK IDENTIFICATION:	Military aviation weather observing network
APPLICATION:	Meteorology
PURPOSE:	To provide aviation weather data in support of military aviation operations and military aviation weather forecasting.
NUMBER OF STATIONS:	There are 74 Naval Air stations, 82 Army Air Fields, and 130 Air Force Bases where aviation weather observations are being made.
LOCATION OF STATIONS:	Throughout the U.S.
PARAMETERS MEASURED:	Basic observations
METHOD OF MEASUREMENT:	Manually
FREQUENCY OF MEASUREMENT:	Observations are made at hourly intervals for all or a portion of each day and special reports are made when significant weather events occur.
DATA RELAY METHOD:	By COMET, the military teletypewriter communications circuits for meteorological data.
FREQUENCY OF DATA RELAY:	Same as frequency of measurement
LOCATION OF USERS:	Military airfields and forecasting centers, and occasionally NWS when they require additional data.
ESTIMATED DATA DELAY:	One to three hours
REFERENCES:	2, 100

NETWORK IDENTIFICATION:	Marine Reporting Station Network of NWS
APPLICATION:	Meteorology
PURPOSE:	To provide observations for coastal marine weather services, including marine weather broadcasts.
NUMBER OF STATIONS:	202
LOCATION OF STATIONS:	Primarily at Coast Guard stations in Atlantic, Pacific, Great Lakes, and Gulf coastal areas
PARAMETERS MEASURED:	Sky condition, present weather, visibility, wind speed and direction, state of sea (sea height and sea period), sea water temperature, air temperature, and sea level pressure.
METHOD OF MEASUREMENT:	Manually
FREQUENCY OF MEASUREMENT:	Every 2, 3, or 6 hours with every 3 hours being the most common, and hourly upon request.
DATA RELAY METHOD:	By teletype from Coast Guard stations to Coast Guard Districts and from there by teletype to NWS.
FREQUENCY OF DATA RELAY:	Same as frequency of measurement
LOCATION OF USERS:	24 Weather Service Forecast Offices near coastal areas of the U.S. and possibly other NWS forecasting offices.
ESTIMATED DATA DELAY:	One to three hours
COMMENT:	Most Marine Reporting Stations are Coast Guard Stations.
REFERENCES:	1, 3, 6, 7

NETWORK IDENTIFICATION:	Coastal Ships of the U.S. Cooperative Ship Program of the National Weather Service
APPLICATION:	Meteorology
PURPOSE:	To obtain weather reports from U.S. coastal areas
NUMBER OF SHIPS:	100 at present (mostly tug boats) with a planned increase to 300 over the next 5 years
LOCATION OF SHIPS:	Atlantic, Pacific, and Gulf coastal waters
PARAMETERS MEASURED:	Present weather, visibility, wind speed and direction, wave height, swell direction and height, sea water temperature, air temperature, and pressure.
METHOD OF MEASUREMENT:	Manually
FREQUENCY OF MEASUREMENT:	Every 6 hours at standard synoptic times, and hourly upon request
DATA RELAY METHOD:	By radio to a number of land radio stations (probably Coast Guard Stations) and then by teletype to NMC and 19 WSFO's preparing coastal marine forecasts.
FREQUENCY OF DATA RELAY:	Same as frequency of measurement
LOCATION OF USERS:	NMC, and other NWS forecasting offices
ESTIMATED DATA DELAY:	One to three hours
REFERENCES:	1, 6, 7

NETWORK IDENTIFICATION: Great Lakes Ships of the U.S. Cooperative Ship Program of the National Weather Service

APPLICATION: Meteorology

PURPOSE: To obtain synoptic weather reports from the Great Lakes areas.

NUMBER OF SHIPS: 50 at present with a planned increase to 200 over the next 5 years

LOCATION OF SHIPS: Great Lakes

PARAMETERS MEASURED: Apparent wind speed and direction, visibility, present and past weather, air temperature, water temperature, ice accretion, wave period and height, and total cloud amount.

METHOD OF MEASUREMENT: Manually

FREQUENCY OF MEASUREMENT: Every 6 hours at world standard synoptic times, and hourly upon request

DATA RELAY METHOD: Data are relayed by radio to Great Lakes Commercial and Coast Guard Stations and then presumably by teletype to WSFO Cleveland, and possibly other NWS forecasting offices.

FREQUENCY OF DATA RELAY: Same as frequency of measurement

LOCATION OF USERS: WSFO Cleveland and possibly other NWS forecasting offices

ESTIMATED DATA DELAY: One to three hours

COMMENT: Canada cooperates in this program

REFERENCES: 1, 6, 7

NETWORK IDENTIFICATION:	Marine weather observations of Navy and Coast Guard ships on the high seas
APPLICATION:	Meteorology
PURPOSE:	This is part of an international program to obtain synoptic weather reports from the high seas.
NUMBER OF SHIPS:	There are 87 Coast Guard ships and approximately 300 Navy ships.
LOCATION OF SHIPS:	Worldwide
PARAMETERS MEASURED:	All these ships make marine surface observations. Twenty-two Navy ships make rawinsonde observations also.
METHOD OF MEASUREMENT:	The marine surface observations are made manually and the rawinsonde observations are made automatically.
FREQUENCY OF MEASUREMENT:	Marine surface observations are made every 6 hours at world standard synoptic times, and hourly upon request. Rawinsonde observations are made twice a day at 0000 and 1200 GMT.
DATA RELAY METHOD:	Presumably by ship-to-shore military radio teletype to military teletype circuits, and then to FAA teletype circuits and international teletype circuits for exchange of meteorological data.
FREQUENCY OF DATA RELAY:	Same as frequency of measurement
LOCATION OF USERS:	Military marine weather users, NWS offices preparing high seas marine forecasts, and worldwide users of marine weather observations.
ESTIMATED DATA DELAY:	One to six hours
COMMENT:	Navy ships on classified missions make weather observations but do not relay them. There are 23 Coast Guard ships that have the capability of making rawinsonde observations.
REFERENCES:	2, 9, 96

NETWORK IDENTIFICATION:	High Seas Ships of the U.S. Cooperative Ship Program (ships of opportunity) of the National Weather Service
APPLICATION:	Meteorology
PURPOSE:	This is part of an international program to obtain synoptic weather reports from the high seas.
NUMBER OF SHIPS:	1700 U.S. ships at present with a planned increase to 2000 over the next 5 years.
LOCATION OF SHIPS:	Worldwide, however, ships relay observations to NWS only when they are in the North Atlantic and North Pacific Oceans.
PARAMETERS MEASURED:	Marine surface observations of ships on the high seas include wind speed and direction, visibility, present and past weather, sea level pressure, dry bulb and wet bulb air temperature, clouds, 3-hr pressure change, air-sea temperature difference, dew point, water temperature, wave height and period, swell height, period, and direction.
METHOD OF MEASUREMENT:	Manually
FREQUENCY OF MEASUREMENT:	Every 6 hours at world standard synoptic times, and hourly upon request.
DATA RELAY METHOD:	By ship-to-ship radio teletype to a coastal radio station accepting ships weather observations, and then by teletype to NMC, where it is relayed on domestic and international data circuits.
FREQUENCY OF DATA RELAY:	Same as frequency of measurement
LOCATION OF USERS:	NMC, 4 WSFO's preparing high-seas marine forecasts, and international users.
ESTIMATED DATA DELAY:	One to six hours
COMMENT:	Approximately 7000 ships worldwide participate in this type of program.
REFERENCES:	1, 2, 6, 7, 9, 10

NETWORK IDENTIFICATION: Upper-Air Observational Network of the National Weather Service

APPLICATION: Meteorology

PURPOSE: To obtain basic data on the vertical and horizontal distribution of pressure, temperature, water vapor, and wind to provide forecasters with a three-dimensional picture of the atmosphere.

NUMBER OF STATIONS: 175

LOCATION OF STATIONS: There are 110 stations in the 48 states, 14 in Alaska, 5 in Hawaii, and 46 outside the U.S.

PARAMETERS MEASURED, METHOD, AND FREQUENCY OF MEASUREMENTS: Pilot balloons are free-rising balloons inflated to a predetermined lift. They are tracked visually. Their height is determined by timing the ascent and winds aloft are calculated using graphical techniques. Pibal observations are taken one to four times a day at 69 locations.

Rawinsonde observations are taken by sending aloft by balloon an instrument that senses temperature, pressure, and humidity and telemeters these parameters back to a ground station. Electronic tracking equipment at the ground station is used to determine winds aloft. Rawinsonde observations are taken one or two times a day at 0000 and 1200 GMT at 132 locations.

Low level soundings use slow-ascent balloons carrying temperature and relative humidity sensors. Wind data is obtained by electronic and visual tracking. Low level soundings are taken once or twice a day at 9 locations.

High altitude balloons sample rawinsonde data up to 100,000 feet. Observations are normally taken once a day at 25 upper-air stations.

Transponder radiosondes permit very accurate measurement of strong winds aloft, and are used at 33 locations taking rawinsondes.

DATA RELAY METHOD: By teletypewriter

FREQUENCY OF DATA RELAY: Same as frequency of measurement

LOCATION OF USER: NMC and possibly other NWS forecasting offices, and international users.

ESTIMATED DATA DELAY: One to four hours

COMMENT: This includes upper-air observations at 32 cooperative upper-air stations.

REFERENCES: 1, 2, 3, 62, 80, 81

NETWORK IDENTIFICATION:	Upper-air observations of the Department of Defense and other Federal Agencies.
APPLICATION:	Meteorology
PURPOSE:	To provide upper-air data in support of activities of each agency.
NUMBER OF STATIONS:	Upper-air observations are made at 6 stations by the Army, at 2 stations by the Navy, at 5 stations by the Air Force and at 1 station by NASA.
LOCATION OF STATIONS:	Throughout the 48 states
PARAMETERS MEASURED:	Rawinsonde observations
METHOD OF MEASUREMENT:	Automatically
FREQUENCY OF MEASUREMENT:	The majority of these observations are unscheduled, and are made according to data requirements of agency activities.
DATA RELAY METHOD:	The majority of observations are relayed by teletype on COMET, the military meteorological communications network.
FREQUENCY OF DATA RELAY:	Same as frequency of measurement
LOCATION OF USERS:	Military forecasting offices and occasionally NWS forecasting offices.
ESTIMATED DATA DELAY:	One to four hours
COMMENT:	The Department of Defense also takes irregular unscheduled upper-air observations at a number of schools, at mobile locations, and at research, development, test, and evaluation facilities.
REFERENCES:	2, 96, 97

NETWORK IDENTIFICATION: Meteorological rocket soundings of the Department of Defense, NASA, and other agencies.

APPLICATION: Meteorological

PURPOSE: To provide meteorological data from the upper atmosphere as part of a coordinated program of meteorological data acquisition, for meteorological research, for concurrent mission support, and for rocket research and development.

NUMBER OF STATIONS: 24

LOCATION OF STATIONS: Throughout the western hemisphere

PARAMETERS MEASURED: Wind speed and direction, temperature, density, and/or pressure, depending upon the rocket payload.

METHOD OF MEASUREMENT: Automatically

FREQUENCY OF MEASUREMENTS: Several launches per week at 1200 GMT

DATA RELAY METHOD: The stations that are part of the Cooperative Meteorological Rocket Network transmit observations on available weather communications circuits.

FREQUENCY OF DATA RELAY: Same as frequency of measurement

ESTIMATED DATA DELAY: Four to eight hours

COMMENT: Rocketsonde data reduction is performed by computer.

REFERENCES: 2, 82, 101

NETWORK IDENTIFICATION:	Meteorological Radar Observation Network of National Weather Service
APPLICATION:	Meteorology
PURPOSE:	To observe precipitation patterns as depicted by radar, and provide areal coverage, height, intensity, and precipitation movement information.
NUMBER OF STATIONS:	126
	There are 56 weather radars, and 70 local warning radars.
LOCATION OF STATIONS:	Throughout the 48 states
PARAMETERS MEASURED:	Radar echoes of precipitation patterns
METHOD OF MEASUREMENT:	Manually
FREQUENCY OF MEASUREMENT:	Hourly and more frequently when significant weather events are occurring.
DATA RELAY METHOD:	Radar reports are relayed on the RAWARC teletypewriter network.
FREQUENCY OF DATA RELAY:	Same as frequency of measurement
LOCATION OF USERS:	NWS forecasting offices, and the Radar Analysis and Development Unit in Kansas City.
ESTIMATED DATA DELAY:	One to three hours
COMMENT:	There are 32 radar stations with radar remoting equipment that transmits radarscope images to locations remote from the radar site.
REFERENCES:	1, 2, 3, 19, 83, 94, 95

NETWORK IDENTIFICATION: FAA Air Traffic Control Radars in the basic weather radar network

APPLICATION: Meteorology

PURPOSE: To provide weather data from the mountainous regions of the west where the expense of installation prevents placement of weather radars.

NUMBER OF STATIONS: 22

LOCATION OF STATIONS: Western U.S. and Alaska

PARAMETERS MEASURED: Echoes of precipitation patterns occurring on air traffic control radars.

METHOD OF MEASUREMENT: Manually

FREQUENCY OF MEASUREMENT: Continuously

METHOD OF DATA RELAY: Radarscope images are transmitted via microwave links.

FREQUENCY OF DATA RELAY: Continuously

LOCATION OF USERS: 5 Air Route Traffic Control Centers

ESTIMATED DATA DELAY: Real-time

COMMENT: Air Route Traffic Control Centers extract information from the air traffic control radarscope images for radar messages and composites which are relayed by a facsimile circuit to Salt Lake City ARTCC where a final composite is prepared and relayed by a telephone data link to the National Severe Storms Forecast Center, and other users of weather radar data.

REFERENCES: 1, 2, 19, 95

NETWORK IDENTIFICATION: Air Force Weather Radar Observation Network

APPLICATION: Meteorology

PURPOSE: To observe precipitation patterns as depicted by radar, and provide area coverage, height, intensity, and precipitation movement information in support of military operations.

NUMBER OF STATIONS: 83

LOCATION OF STATIONS: Throughout the 48 states

PARAMETERS MEASURED: Radar echoes of precipitation patterns

METHOD OF MEASUREMENT: Manually

FREQUENCY OF MEASUREMENT: Hourly and more frequently when significant weather events are occurring.

DATA RELAY METHOD: Radar reports are relayed on COMET, the military meteorological teletypewriter communications network.

FREQUENCY OF DATA RELAY: Same as frequency of measurement

LOCATION OF USERS: Military weather users throughout the U.S. and NWS

ESTIMATED DATA DELAY: One to three hours

REFERENCES: 2, 95, 97

NETWORK IDENTIFICATION: Substation Network of the National Weather Service

APPLICATION: Hydrology, Climatology, Meteorology, Agriculture

DESCRIPTION: The National Substation Program provides data for climatic, hydrologic, agricultural, and other local service programs. The distinctive feature of this program is that the observations are taken by lay persons. Basic data from this network is used in connection with climate studies, and some reports serve operational purposes to meet the needs of hydrologic and agricultural forecasting. Some stations are operated cooperatively with other agencies whose needs are beyond those normally provided by NWS.

NUMBER OF STATIONS: 9,445

LOCATION OF STATIONS: Throughout the 50 states, Puerto Rico, and several Pacific islands

PARAMETERS MEASURED AND FREQUENCY OF MEASUREMENT: Hourly measurements of precipitation are made at stations having recording precipitation gauges. Daily precipitation measurements are made at stations having non-recording gauges. Cumulative precipitation during irregular intervals is measured at stations having storage precipitation gauges. Some stations make daily measurements of maximum and minimum air temperature, evaporation and wind, and soil temperature.

METHOD OF MEASUREMENT: Manually except for automatic recording precipitation gauges.

DATA RELAY METHOD, FREQUENCY OF DATA RELAY, AND LOCATION OF USER: Data that are used for climate studies are mailed monthly to a regional substation, and eventually mailed to the National Climate Center in Ashville, N.C. Data that are used operationally for agricultural and hydrologic forecasting are relayed verbally by telephone and radio daily and more frequently if needed to the appropriate NWS forecasting office.

ESTIMATED DATA DELAY: One to two months for data used for climate studies, and one to three hours for data used for forecasting.

COMMENT: All 9,445 stations provide data for climate studies and 1,726 of these stations also provide data for agricultural and hydrologic forecasting.

In addition to these 9,445 stations, the substation network has 1,090 NWS river reporting stations, and approximately 750 river gauging stations operated by the Corps of Engineers and the Geological Survey that provide NWS with river stage and precipitation data for hydrological forecasting. These stations are described separately.

In addition to the 9,445 stations, the substation network has 356 stations operated by the Corps of Engineers, 28 stations operated by Tennessee Valley Authority, and 481 stations operated by various forestry and fire-control agencies that also provide NWS with data for climate studies and for agricultural, hydrologic, and fire-weather forecasting. These stations are described separately.

REFERENCES: 1, 13, 14, 15, 16, 17, 61, 69, 92, 98

NETWORK IDENTIFICATION: Surface Water Network of the Water Resources Division of the U.S. Geological Survey

APPLICATION: Hydrology

DESCRIPTION: The main objective of the Water Resources Division is to provide a continuing inventory of the nation's water resources. To meet part of this objective they have developed a hydrologic data network to measure stream flow. Most of the data collected from this network is published in the Geological Survey's Water Supply Papers, and provides a basis for the development, conservation, and management of water resources.

NUMBER OF STATIONS: 18,244

LOCATION OF STATIONS: There are 17,481 stations in the 48 states, 14 in a small portion of Canada, 199 in Alaska, 238 in Hawaii, and 312 outside the U.S.

PARAMETERS MEASURED: Surface water stage (height of water level in streams, rivers, lakes, and estuaries).

Some stations also measure precipitation.

The Geological Survey also makes discharge measurements at many gauging stations. Discharge is a measure of the volume of water which flows past a given point in a stream during a given amount of time. Discharge measurements are made by measuring the flow rate of water at various locations throughout the cross-section of a stream. Discharge measurements are made for various stages of a stream and a stage-discharge relationship is determined. This relationship is used to compute the daily discharge from stage data. Discharge measurements are made periodically to verify the existing stage-discharge relationship and to incorporate any changes that may occur due to natural or man-made causes. Current methods for making discharge measurements are not considered applicable to satellite data collection.

METHOD OF MEASUREMENT: Many measurements are made and recorded automatically, but some measurements are made manually.

FREQUENCY OF MEASUREMENT: Continuously to annually including monthly, weekly, daily, hourly, and every 5 and 15 minutes.

DATA RELAY METHOD AND FREQUENCY OF DATA RELAY: Stage data that is automatically recorded at gauging stations is relayed by courier and sometimes by mail from once a week to every six weeks.

Some data is relayed by telemetry by landlines and by the LANDSAT satellite, and probably verbally by telephone also. This data is relayed on-demand to once a day.

LOCATION OF USERS: U.S.G.S. field offices throughout the U.S. and U.S.G.S. headquarters in Reston, Virginia, and other users of hydrologic data including NWS and the Corps of Engineers.

ESTIMATED DATA DELAY: One to four months, and real-time to three hours

COMMENTS: Geological Survey personnel collect the recorded stage data from a gauging station when they attend the station to perform routine maintenance and/or make discharge measurements.

REFERENCES: 21, 24, 25, 26, 27, 28, 31, 32, 33, 102, 103, 104

NETWORK IDENTIFICATION:	Water quality observing stations of the U.S. Geological Survey
APPLICATION:	Hydrology
PURPOSE:	To provide an inventory of the quality of the nation's water resources that can be used to determine the suitability of water for various uses.
NUMBER OF STATIONS:	There are 8,453 water quality stations. These stations may monitor water quality parameters that can be measured by sensors as well as parameters that can only be measured by laboratory analysis of a collected sample. Measurements of those parameters which require laboratory analysis are not considered applicable to satellite data collection at this time. There are 7,826 stations that monitor one or more of the water quality parameters that can be measured by sensors.
LOCATION OF STATIONS:	There are 7,407 stations in the 48 states, 177 in Alaska, 154 in Hawaii, and 88 outside the U.S.
PARAMETERS MEASURED:	Water temperature, specific conductance, pH, turbidity, dissolved oxygen, and chloride can be measured operationally by sensors.
METHOD OF MEASUREMENT:	These parameters are currently being measured manually and automatically by sensor and by laboratory analysis of a collected sample.
FREQUENCY OF MEASUREMENT:	The frequency of measurement ranges from continuously to annually including hourly, daily, and monthly. A single station may monitor several water quality parameters each with a different frequency of measurement.
DATA RELAY METHOD:	By courier and by mail
FREQUENCY OF DATA RELAY:	Daily to annually
LOCATION OF USERS:	U.S.G.S. field offices throughout the U.S. and the U.S.G.S. headquarters in Reston, Virginia
ESTIMATED DATA DELAY:	One to four months
COMMENT:	Many water quality stations are located at surface water and ground water stations.
REFERENCES:	22, 25, 26, 30, 31, 32, 33, 70, 75, 105, 106, 107

NETWORK IDENTIFICATION:	Ground water observing stations of the U.S. Geological Survey
APPLICATION:	Hydrology
PURPOSE:	To assess changes in ground-water conditions.
NUMBER OF STATIONS:	18,268
LOCATION OF STATIONS:	There are 17,882 stations in the 48 states, 78 in Alaska, 165 in Hawaii, and 143 outside the U.S.
PARAMETER MEASURED:	Ground water level
METHOD OF MEASUREMENT:	Most measurements are made manually, but some wells have automatic recording gauges.
FREQUENCY OF MEASUREMENT:	Continuously to annually
DATA RELAY METHOD:	By courier and by mail
FREQUENCY OF DATA RELAY:	Daily to annually
LOCATION OF USERS:	U.S.G.S. field offices throughout the U.S. and the U.S.G.S. headquarters in Reston, Va.
ESTIMATED DATA RELAY:	One to four months
REFERENCES:	23, 25, 26, 29, 31, 33, 108

NETWORK IDENTIFICATION: Data Collection Network of the U.S. Army Corps of Engineers

APPLICATION: Hydrology

DESCRIPTION: The primary responsibilities of the Corps of Engineers involves flood control and navigation. As part of these responsibilities they also address the water resource objectives of hydroelectric power generation, municipal and industrial water supply, water quality, recreation, fish and wildlife conservation, irrigation, and preservation of ecological resources. The Corps of Engineers constructs and operates many projects such as dams and reservoirs. Operation of these structures to regulate flood waters and manage water resources requires a variety of hydrological and meteorological data.

NUMBER OF STATIONS: Approximately 5,500, some of which are part of a 5 year plan.

LOCATION OF STATIONS: Throughout the U.S.

PARAMETERS MEASURED: River or lake stage, precipitation, snow cover, wind speed and direction, barometric pressure, tide levels and other oceanographic data, air temperature, soil temperature, air moisture, soil moisture, water quality data, evaporation, spillway gate opening, solar radiation, and ground water level.

Each station measures only a few of these parameters.

METHOD OF MEASUREMENT: Manually, automatically, and by laboratory analysis of collected samples.

FREQUENY OF MEASUREMENT: Continuously to annually

DATA RELAY METHOD: A variety of methods of relaying data in near real time are used including voice relay by telephone and radio, teletype, telemark, microwave relay networks, and experimentally by the LANDSAT satellite. Data not required in real time is relayed by courier, and possibly by mail.

FREQUENCY OF DATA RELAY: On-demand to annually

LOCATION OF USERS: 10 Division offices and/or 35 District offices throughout the U.S. and other users of hydrologic data including NWS.

ESTIMATED DATA DELAY: Ranges from real time to one month depending upon the application of the data.

COMMENT: The Corps of Engineers has a 5-year plan for near real time data collection from the majority of its stations.

REFERENCES: 29, 32, 34, 35, 36

NETWORK IDENTIFICATION:	River Reporting Stations of the Substation Network of the National Weather Service
APPLICATION:	Hydrology
DESCRIPTION:	The NWS collects hydrologic data in conjunction with meteorological data for use in river and flood forecasting and to support water management.
NUMBER OF STATIONS:	1,090
LOCATION OF STATIONS:	Throughout the U.S.
PARAMETERS MEASURED:	River stage Precipitation measurements are made at some stations.
METHOD OF MEASUREMENT:	Manually and automatically
FREQUENCY OF MEASUREMENT:	Continuously to daily
DATA RELAY METHOD AND FREQUENCY OF DATA RELAY:	There are 117 Automatic Hydrologic Observing Systems which provide automatic collection of river stage and rainfall data by land line when interrogated from a distant station. At other stations an observer transmits the data verbally by telephone or radio. These observers may make reports as often as 4 times a day during flood conditions.
LOCATION OF USERS:	12 River Forecast Centers and 69 River District Offices throughout the U.S. and other users of hydrologic data including the Corps of Engineers.
ESTIMATED DATA DELAY:	Real-time to three hours
COMMENTS:	Automatic Hydrologic Observing Stations using radio and satellite communication links are planned . The Geological Survey and the Corps of Engineers provide the NWS Hydrologic Forecasting Program with stage data from approximately 750 stations which are considered part of the NWS Substation Network.
REFERENCES:	1, 11, 12, 32, 90

NETWORK IDENTIFICATION:	Data Collection Network of the Tennessee Valley Authority
APPLICATION:	Hydrology
DESCRIPTION:	The Tennessee Valley Authority operates a system of dams and reservoirs on the navigable Tennessee Waterway to provide flood protection and hydroelectric power. This system also provides recreational opportunities, sustained water supplies for homes, farms, and factories. The operation of this system is governed by the annual pattern of runoff. Operating guides, showing the water levels to be maintained in each reservoir during the different seasons of the year have been developed from many decades of runoff records. The regulation of reservoir levels and stream flow also requires predictions of amounts of rainfall expected and reports of rainfall and stream stage.
NUMBER OF STATIONS:	1155 planned for 1978-1986
LOCATION OF STATIONS:	Tennessee River Valley
PARAMETERS MEASURED:	There are plans for 444 stations measuring precipitation, 180 stations measuring water stage, 30 stations measuring wind and temperature, 200 stations measuring water quality, 173 stations measuring ground water, and 128 air qualtiy monitors.
METHOD OF MEASUREMENT:	Manually, automatically, and by laboratory analysis of collected samples.
FREQUENCY OF MEASUREMENT:	Continuously to annually, and on-demand at some stations.
DATA RELAY METHOD AND FREQUENCY OF DATA RELAY:	Data is telemetered on-demand at some stations. At other stations data is recorded, and relayed upon request by an observer by telephone. At other stations data is recorded and relayed every few weeks by courier. At stations where measurements are made infrequently, data is relayed by courier at the same frequency as the measurements.
ESTIMATED DATA DELAY:	Real-time to one month
COMMENT:	The Tennessee Valley Authority currently has plans to install telemetry at more of its stations.
REFERENCES:	29, 32, 37, 39, 39, 91

NETWORK IDENTIFICATION:	Hydrologic Network of the Bureau of Reclamation
APPLICATION:	Hydrology, Agriculture
DESCRIPTION:	The Bureau of Reclamation assists in managing the water resources of the 17 western states. Reclamation projects provide water for irrigation, hydroelectric power generation, municipal and industrial use and recreation, as well as providng flood control. The Bureau of Reclamation operates a monitoring network to provide the hydrologic and meteorological data that are needed to effectively operate these projects.
NUMBER OF STATIONS:	199 surface water stations, 4920 ground water stations, 334 water quality stations, of which 282 monitor parameters that can be measured by sensors.
LOCATION OF STATIONS:	17 western states
PARAMETERS MEASURED:	Surface and ground water level, water quality, and precipitation
METHOD OF MEASUREMENTS:	Measurements are made manually, automatically, and by laboratory analysis of collected samples.
FREQUENCY OF MEASUREMENT:	Continuously to annually
METHOD OF DATA RELAY:	Some of the data is probably relayed by courier and by mail, some data is telemetered, and some data is probably relayed verbally by telephone.
FREQUENCY OF DATA RELAY:	Hourly to annually
ESTIMATED DATA DELAY:	Real-time to three months
COMMENTS:	The Bureau of Reclamation also operates a network of meteorological observing stations, 49 of which are included in the NWS substation network. Seven data collection platforms that relay meteorological and hydrologic data via the LANDSAT satellite have been installed in southwestern Colorado.
REFERENCES:	29, 32, 40

NETWORK IDENTIFICATION:	Tide Network of the National Ocean Survey
APPLICATION:	Oceanography
PURPOSE:	To provide the data used to predict the tides and provide data for coastal flood warnings.
NUMBER OF STATIONS:	139
LOCATION OF STATIONS:	On the East Coast, Gulf Coast, West Coast, Alaskan Coast, and in the Pacific Ocean.
PARAMETERS MEASURED:	Tidal variations in water level.
METHOD OF MEASUREMENT:	Automatically
FREQUENCY OF MEASUREMENT:	The tide gauges continuously record the water level.
DATA RELAY METHOD:	Data used to predict the tides is probably relayed by courier and by mail. Some data for coastal flood warnings is telemetered, and some is probably telephoned.
FREQUENCY OF DATA RELAY:	Data used to predict tides is probably relayed weekly and data for coastal flood warnings is probably relayed every half hour to daily.
LOCATION OF USER:	National Ocean Survey and National Weather Service offices participating in the coastal flood warning program.
ESTIMATED DATA DELAY:	Real-time to two months
COMMENT:	Several of these stations may be part of the Tsunami Warning Systems in the Pacific and in Alaska. Observations of surface water temperature and density and measurements of tidal currents are made at some tide stations.
REFERENCES:	32, 41, 42, 43, 44, 45, 65, 71

NETWORK IDENTIFICATION: Hydrologic Networks of other Federal and Non-Federal agencies (see comment below)

APPLICATION: Hydrology, Environmental Quality, Forestry

PURPOSE: Hydrologic data are collected for a wide variety of reasons, including those which have already been mentioned for other agencies.

NUMBER OF STATIONS: 19,014

There are 3,029 surface water stations, 10,806 water quality stations of which 10,168 monitor at least one of six parameters that can be measured operationally by sensors, and 5,179 ground water stations.

Surface Water Stations

Federal

165 - Forest Service
123 - International Boundary and Water Commission
197 - Remaining Federal Agencies
185 - Total Stations

Non-Federal

333 - Minnesota Department of Natural Resources
245 - Illinois Department of Public Works and Buildings
214 - California Department of Natural Resources
176 - Los Angeles County Flood Control District
173 - City of Los Angeles, Department of Water and Power
156 - Oregon State Engineer
1,247 - Remaining Non-Federal Agencies
2,544 - Total Non-Federal Stations

Ground Water Stations

Federal

683 - Atomic Energy Commission
169 - Naval Facilities Engineering Command
143 - Bureau of Indian Affairs
995 - Total Federal Stations

Non-Federal

3,796 - Texas Water Development Board
157 - North Carolina Department of Natural and Economic Resources
91 - Ohio Department of Natural Resources
77 - Memphis Light, Gas, and Water Division
63 - Remaining Non-Federal Agencies
4,184 - Total Non-Federal Stations

Water Quality Stations (making measurements of one or more water quality parameters that can be measured operationally by sensors)

Federal

270 - Naval Facilities Engineering Command
212 - Forest Service
80 - Energy Research and Development Agency
164 - Remaining Federal Agencies
726 - Total Federal Agencies

Non-Federal

1,422 - South Carolina Department of Health and Environmental Control
816 - California Department of Water Resources
637 - Idaho Department of Environmental and Community Services
614 - Illinois Department of Public Health
509 - Division of Health of Missouri
471 - Bureau of Environmental Engineering, Arkansas State Department of Health
432 - Mississippi State Board of Health
4,781 - Remaining Non-Federal Agencies
9,682 - Total Non-Federal Stations

LOCATION OF STATIONS: Throughout the U.S.

PARAMETERS MEASURED: Surface and ground water level, precipitation, and the six water quality parameters for which operational sensors are available.

METHOD OF MEASUREMENT: Manually, automatically, and by laboratory analysis of collected samples.

FREQUENCY OF MEASUREMENT: Continuously to annually

DATA RELAY METHOD: Any of the previously mentioned data relay methods may be used by a particular user.

FREQUENCY OF DATA RELAY: Probably on-demand to annually

ESTIMATED DATA DELAY: Real-time to two months

COMMENT:	Federal agencies not mentioned specifically include Army Health Services Command, Bonneville Power Administration, Bureau of Land Management, Fish-Wildlife Service, Marine Corps, National Marine Fisheries Service, Soil Conservation Service, Environment Canada, Water Quality Branch, and Environment Canada, Water Resources.
REFERENCES:	29, 32

NETWORK IDENTIFICATION:	National Air Surveillance Network and Continuous Air Monitoring Program of the Environmental Protection Agency
APPLICATION:	Environmental Quality
PURPOSE:	These networks provide the air quality data necessary to evaluate the state of the environment and to make management decisions on controlling pollution. More specifically, the data are needed to determine the current state of pollution, to establish standards for pollutant concentrations, to determine trends in environmental quality, and to determine the degree of compliance with standards.
NUMBER OF STATIONS:	320
LOCATION OF STATIONS:	Throughout the U.S.
PARAMETERS MEASURED:	There are 322 total suspended particulate monitors, 261 sulfer dioxide monitors, 292 nitrogen dioxide monitors, 44 carbon monoxide monitors, 40 photochemical oxidant monitors, and 7 hydrocarbon monitors.
METHOD OF MEASUREMENT:	Some monitors have sensors to detect air pollutants and automatic recording devices, while other monitors semi-automatically sample the air and the pollutants are detected by laboratory analysis of the collected sample. There are operational sensors to detect all of the above parameters.
FREQUENCY OF MEASUREMENT:	The monitors with sensors operate continuously providing a record of instantaneous concentration, or frequent integrals of concentration of the pollutant which are used to determine hourly and daily averages of concentration. Monitors that sample the air for a period of time also produce hourly and daily values of concentration.
DATA RELAY METHOD:	Probably by courier and by mail
FREQUENCY OF DATA RELAY:	Probably ranges from one or more times daily to weekly.
LOCATION OF USERS:	Various EPA laboratories and offices, including the 20 regional offices.

ESTIMATED DATA DELAY: One to four months.

COMMENT: In many cases these stations serve as an element in a state or local network.

REFERENCES: 46, 48, 49, 70, 85, 86

NETWORK IDENTIFICATION: State and local air quality monitoring networks (state operated and EPA supervised)

APPLICATION: Environmental Quality

PURPOSE: To evaluate the state of the environment, to support legislative requirements and to access compliance with air quality standards.

NUMBER OF STATIONS: 4785

LOCATION OF STATIONS: Throughout the 50 states, Puerto Rico, and several Pacific Islands.

PARAMETERS MEASURED: There are 3841 total suspended particulate monitors, 2297 sulfer dioxide monitors, 1315 nitrogen dioxide monitors, 454 carbon monoxide monitors, and 451 photochemical oxidant monitors.

METHOD OF MEASUREMENT: Some monitors have sensors to detect air pollutants and automatic recording devices, while other monitors semi-automatically sample the air and the pollutants are detected by laboratory analysis of the collected sample.

FREQUENCY OF MEASUREMENT: Continuous sampling or sensing to determine hourly and daily averages.

DATA RELAY METHOD: Generally by courier, although some stations, generally in areas with poor air quality, are equipped with telemetry, usually by telephone lines.

FREQUENCY OF DATA RELAY: On-demand to daily

LOCATION OF USERS: Users include many local agencies, the state agencies responsible for environmental protection, and EPA.

ESTIMATED DATA DELAY: Real-time to one day

COMMENT: The number of stations indicated above is the number proposed by each state in its implementation plan.

REFERENCES: 46, 49, 50, 84, 86, 87, 88

NETWORK IDENTIFICATION:	Particle Size Network, Membrane Filter Network, and Precipitation Network of the Environmental Protection Agency
APPLICATION:	Environmental Quality
NUMBER OF STATIONS:	10 particle size fractionation stations, 50 membrane filter stations, and 17 precipitation stations.
PARAMETERS MEASURED:	Particle size fractionation and trace metal analysis of particles, trace metal analysis of membrane filters, and precipitation.
COMMENT:	Present methods for these types of monitoring are not considered applicable to satellite data collection.
REFERENCES:	46, 49

NETWORK IDENTIFICATION:	Regional Air Monitoring System of Regional Air Pollution Study of the Environmental Protection Agency
APPLICATION:	Environmental Quality, Meteorology
PURPOSE:	The system was designed to be a research tool to develop mathematical simulation models of atmospheric models affecting the transport and concentration of air pollutants.
NUMBER OF STATIONS:	25
LOCATION OF STATIONS:	These stations are arranged to form four concentric circles at distances of 4, 9, 20 and 40 kilometers from the center of St. Louis, Missouri.
PARAMETERS MEASURED:	Ozone, nitrogen monoxide, nitrogen oxides, and nitrogen dioxide inference, total hydrocarbons, methane, carbon monoxide, total sulfur, hydrogen sulfide, sulfur dioxide, visibility, fine particulates, wind speed and direction, ambient temperature, temperature differential between ground level and 30 meters, barometric pressure, dewpoint, total incident solar radiation, 300-395 nm radiation, and 300-695 nm radiation.
METHOD OF MEASUREMENT:	Automatically
FREQUENCY OF MEASUREMENT:	Every half second to produce one-minute and hourly averages.
DATA RELAY METHOD:	Telephone
FREQUENCY OF DATA RELAY:	Every minute
LOCATION OF USER:	Central Facility in St. Louis, Missouri.
ESTIMATED DATA DELAY:	Real-time
REFERENCES:	46, 47

NETWORK IDENTIFICATION: Water Quality Network of the Environmental Protection Agency

APPLICATION: Environmental Quality

PURPOSE: To establish water quality and effluent standards for fresh and marine waters, and to provide surveillance of water quality.

NUMBER OF STATIONS: There are 535 water quality stations. Parameters that can be measured operationally by sensors are monitored at 432 stations.

LOCATION OF STATIONS: Throughout the U.S.

PARAMETERS MEASURED: Water temperature, specific conductance, pH, turbidity, dissolved oxygen and chloride.

METHOD OF MEASUREMENT: These parameters are currently being measured manually and automatically by sensors, and by laboratory analysis of collected samples.

FREQUENCY OF MEASUREMENT: Continuously to annually

DATA RELAY METHOD: Probably by courier and by mail

FREQUENCY OF DATA RELAY: Probably ranges from every one or two weeks to annually.

LOCATION OF USERS: 10 Regional Offices and Office of Water Programs.

ESTIMATED DATA DELAY: One to four months

COMMENT: Many Federal and State agencies monitoring water quality send data to EPA.

REFERENCES: 32, 46

NETWORK IDENTIFICATION:	Federal and State Pesticide Monitoring Activities
APPLICATION:	Environmental Quality
PURPOSE:	To characterize and quantify levels of pesticides and their residues throughout the environment.
MONITORING ACTIVITIES:	Pesticide monitoring involves collecting samples of soil, air, water, food, fish, birds, and human tissue, and analyzing them in a laboratory for pesticides and pesticide residues.
NUMBER OF STATIONS:	16,361
COMMENT:	Present methods of pesticide monitoring are not considered applicable to satellite data collection. Federal agencies involved in pesticide monitoring activities include Environmental Protection Agency, Animal and Plant Health Inspection Service, Fish and Wildlife Service, Department of the Army, U.S. Geological Survey, U.S. Air Force, Food and Drug Administration, Atomic Energy Commission, Bonneville Power Administration, National Aeronautics and Space Administration, National Oceanic and Atmospheric Administration, and Panama Canal Company.
REFERENCES:	46, 51

NETWORK IDENTIFICATION:	Environmental Radiation Ambient Monitoring System (ERAMS) of the Environmental Protection Agency and State Environmental Radioactivity Surveillance Programs
APPLICATION:	Environmental Quality
PURPOSE:	To establish radiation standards and to quantify emissions from ionizing and non-ionizing radiation sources.
ACTIVITIES:	Radiation monitoring involves the collection and laboratory analysis of samples of air, water, milk, human bone, and other biological matter to identify the levels of radioactivity throughout the environment.
NUMBER OF STATIONS:	There are 503 stations operated by EPA and 7,767 stations that are state operated.
COMMENTS:	Present methods of radiation monitoring are not considered applicable to satellite data collection.
REFERENCES:	46, 52

NETWORK IDENTIFICATION:	Snow courses and soil moisture measurements conducted by the Soil Conservation Service in cooperation with other agencies
APPLICATION:	Hydrology
PURPOSE:	Water supply forecasting and the preparation of water supply outlook reports.
NUMBER OF STATIONS:	1704 There are 1505 snow courses, 58 soil moisture stations, and 141 snow course and soil moisture stations.
LOCATION OF STATIONS:	Western United States and the Columbia River Basin in British Columbia.
PARAMETERS MEASURED AT SNOW COURSES:	Snow depth and water equivalent. Approximately ten samples are taken at each location and measurements of snow depth and water equivalent of each sample are made. The average of these values is reported.
FREQUENCY OF MEASUREMENTS AT SNOW COURSES:	Monthly or semi-monthly from January 1 through June 1.
PARAMETERS MEASURED AT SOIL MOISTURE STATIONS:	Soil moisture and depth
FREQUENCY OF MEASUREMENTS AT SOIL MOISTURE STATIONS:	Once in the Fall and monthly from February 1 through June 1.
METHOD OF MEASUREMENT:	Manually
DATA RELAY METHOD:	By courier, and possibly by mail
FREQUENCY OF DATA RELAY:	Same as frequency of measurement
LOCATION OF USERS:	Water supply outlook reports are prepared by State offices of the Soil Conservation Service in ten states, the California Department of Water Resources, and the British Columbia Department of Lands, Forests, and Water Resources.

ESTIMATED DATA DELAY:	One to three weeks
COMMENTS:	The Soil Conservation Service anticipates that in the near future automatic snow water equivalent sensing devices along with radio telemetry will provide a continuous record of snow water equivalent at key locations. Cooperating agencies include the Bureau of Reclamation, Corps of Engineers, Forest Service, National Park Service, Weather Service, Geological Survey, Department of Water Resources of California, Department of Lands, Forests, and Water Resources of British Columbia, and other Federal Agencies, Departments of State Government, Irrigation Districts, Power Companies, and others.
REFERENCES:	53, 54

NETWORK IDENTIFICATION:	Fire Weather Observing Stations of the Forest Service, the Bureau of Land Management, State forestry agencies, and local fire-control organizations
APPLICATION:	Meteorology, Forestry
PURPOSE:	To collect the data needed to provide warnings of unusually high fire-danger, and to provide fire-weather forecasts, including special forecasts to support fire control and forest and range management activities.
NUMBER OF STATIONS:	2000
LOCATION OF STATIONS:	At ranger stations and fire look-outs throughout the U.S.
BASIC PARAMETERS MEASURED:	Wind speed and direction, temperature, humidity, and fuel moisture.
OTHER PARAMETERS MEASURED:	Precipitation, cloud types, visibility, and occurrence of thunderstorms.
METHOD OF MEASUREMENT:	The majority of measurements are made manually, however, an automatic fire-weather observing station has been developed.
FREQUENCY OF MEASUREMENT:	Once or twice per day during the fire-weather season; more frequently when the fire-danger is high.
DATA RELAY METHOD:	Voice transmissions by radio and telephone are used to relay data from fire-weather stations to a ranger unit and then to a National Weather Service Forecast Office.
FREQUENCY OF DATA RELAY:	Same as frequency of measurement
LOCATION OF USERS:	Ranger Units and 52 National Weather Service Offices throughout the U.S.
ESTIMATED DATA DELAY:	Two to three hours.
COMMENTS:	481 of these stations are part of the NWS Substation network.
REFERENCES:	2, 55, 56, 57, 60, 68, 93

NETWORK IDENTIFICATION:	Gamma Radiation Program of the National Weather Service
APPLICATION:	Environmental Quality
PURPOSE:	To provide gamma radiation level data to the Defense Civil Preparedness Agency during national emergencies.
NUMBER OF STATIONS:	140
LOCATION OF STATIONS:	At NWS stations throughout the U.S.
PARAMETERS MEASURED:	Gamma radiation
METHOD OF MEASUREMENT:	Manually
FREQUENCY OF MEASUREMENT:	Twice-monthly observations are taken as an instrument check and to provide basic data for background levels.
DATA RELAY METHOD:	The twice-monthly observations are probably sent by mail.
FREQUENCY OF DATA RELAY:	Same as frequency of measurement
LOCATION OF USER:	Defense Civil Preparedness Agency Offices.
ESTIMATED DATA DELAY:	One month
REFERENCES:	1

NETWORK IDENTIFICATION:	Atmospheric Turbidity and Precipitation Sampling Program of the National Weather Service
APPLICATION:	Environmental Quality
PURPOSE:	To provide the Environmental Protection Agency with data that will enable them to determine long-term global trends in atmospheric constituents and properties that are likely to produce climate change. This environmental monitoring network is part of a new program initiated by the World Meteorological Organization. This program is also part of the National Oceanic and Atmospheric Administration's effort to establish a geophysical monitoring network for climate change.
NUMBER OF STATIONS:	10 Regional Air Pollution Stations 15 Turbidity Monitoring Stations
LOCATION OF STATIONS:	At NWS stations throughout the U.S.
PARAMETERS MEASURED AND FREQUENCY OF MEASUREMENT:	Regional Air Pollution stations make turbidity measurements at two wavelengths three times a day on cloudless days and collect precipitation for each period of occurrence. Turbidity monitoring stations make turbidity measurements at one wavelength.
METHOD OF MEASUREMENT:	Probably manually
DATA RELAY METHOD:	By mail
FREQUENCY OF DATA RELAY:	Once a month
LOCATION OF USER:	EPA Laboratories
ESTIMATED DATA DELAY:	One to three months
COMMENT:	Turbidity data and precipitation samples are sent to EPA for analysis. Satellite data collection is not applicable for the precipitation sampling portion of this network.
REFERENCES:	1

NETWORK IDENTIFICATION: Ozone Monitoring Program of the National Weather Service; part of a worldwide ozone monitoring network established by the World Meteorological Organization

APPLICATION: Climatology

PURPOSE: To establish long-term trends in the ozone content of the atmosphere to determine if man's activities are causing any changes in the total ozone content of the atmosphere.

NUMBER OF STATIONS: 6

LOCATION OF STATIONS: At NWS stations throughout the U.S.

PARAMETERS MEASURED: Ultra-violet radiation.

METHOD OF MEASUREMENT: Dobson spectrophotometer

FREQUENCY OF MEASUREMENT: 3 per day

LOCATION OF USER: Canada

METHOD OF DATA RELAY: By mail

FREQUENCY OF DATA RELAY: Twice a month

ESTIMATED DATA DELAY: One month

COMMENT: Ozonesondes are taken at one station.

REFERENCES: 1

NETWORK IDENTIFICATION:	Solar Radiation Program of the National Weather Service
APPLICATION:	Climatology
PURPOSE:	To furnish knowledge of the amount and distribution of solar radiation received at the earth's surface. This data is used to document climatological history.
NUMBER OF STATIONS:	92 NWS operates 62 stations and there are 30 cooperative stations.
LOCATION OF STATIONS:	At NWS stations throughout the U.S.
PARAMETERS MEASURED:	Global radiation, direct radiation, and true solar noon readings.
FREQUENCY OF MEASUREMENT:	Daily
DATA RELAY METHOD:	By mail
FREQUENCY OF DATA RELAY:	Once a month
LOCATION OF USER:	National Climatological Center, Asheville, N. Carolina
ESTIMATED DATA DELAY:	One to two months
COMMENT:	Data recording systems are planned for this network.
REFERENCES:	1

NETWORK IDENTIFICATION:	Ion Exchange Program of the National Weather Service in cooperation with the Atomic Energy Commission
APPLICATION:	Environmental Quality
PURPOSE:	To provide AEC with radioactive fallout data produced by nuclear testing. This network enables AEC to monitor the amounts of SR^{90} and SR^{89} fallout from nuclear testing and usage of nuclear weapons.
NUMBER OF STATIONS:	32
METHOD OF MEASUREMENT:	A column-type collector is exposed to the elements for one month. The column collector is then replaced by a new one. The exposed one is sent to the Health and Safety Laboratory in New York City for analysis.
COMMENT:	Present methods used for this type of monitoring are not considered applicable to satellite data collection.
REFERENCES:	1

NETWORK IDENTIFICATION:	NOAA data buoy network for basic monitoring
APPLICATION:	Meteorology, Oceanography
PURPOSE:	To provide the data needed for oceanic weather forecasting.
NUMBER OF BUOYS:	Presently there are 8 and plans call for 36 buoys.
LOCATION OF BUOYS:	Northern Pacific Ocean, Northern Atlantic Ocean, and Gulf of Mexico.
PARAMETERS MEASURED:	Surface water temperature, and salinity,wave height and period, air temperature and pressure, and wind speed and direction.
METHOD OF MEASUREMENT:	Automatically
FREQUENCY OF MEASUREMENT:	Every 3 or 6 hours and hourly when needed.
DATA RELAY METHOD:	Data is presently telemetered by high frequency radio, and may be telemetered by satellite at some time in the future.
FREQUENCY OF DATA RELAY:	Same as frequency of measurement
ESTIMATED DATA DELAY:	One to six hours
COMMENT:	Several buoys are also needed in the Great Lakes.
REFERENCES:	2, 6, 18, 89

NETWORK IDENTIFICATION:	Ocean buoys for specialized monitoring activities of various programs and experiments
APPLICATION:	Oceanography, Meteorology, Climatology
PURPOSE:	To provide data for oceanographic research, and for development of buoy technology.
NUMBER OF BUOYS:	The various experiments use approximately 350 buoys.
LOCATION OF BUOYS:	North Atlantic Ocean, North Pacific Ocean, Arctic Ocean, and in the Antarctic. Some of the buoys are moored, and others are free drifting.
PARAMETERS MEASURED:	Buoys are currently being used to measure wind speed and direction, air temperature and pressure, dewpoint, precipitation, global radiation, wave height and period, surface water temperature and salinity, subsurface water temperature, current speed and direction, and the location of drifting buoys. Plans call for the development of buoys which are capable of monitoring water quality.
METHOD OF MEASUREMENT:	Automatically
FREQUENCY OF MEASUREMENT:	Ranges from once every 15 minutes to once every 12 hours depending upon the buoy, the experiment, and the method of data relay.
DATA RELAY METHOD:	By satellite and high-frequency radio
FREQUENCY OF DATA RELAY:	Every 3 to 12 hours
LOCATION OF USERS:	Various primary and secondary scientists and researchers who require marine data. Synoptic meteorological data are distributed to national and international users of marine weather data for weather forecasting.
COMMENT:	The Coast Guard, Department of Defense, National Science Foundation, and NOAA cooperate in the development of environmental data buoys.

Experiments and programs involving buoys are the Northern Pacific Experiment, the First GARP Global Experiment, the Arctic Ice Dynamics Joint Experiment, the Polar Experiment, and NWS program to develop an expendable meteorological drifting buoy.

REFERENCES: 18, 76, 77, 78, 89

NETWORK IDENTIFICATION:	Volcano Surveillance Network of the U.S. Geological Survey
APPLICATION:	Geology
PURPOSE:	To establish, test, and evaluate a prototype volcano-surveillance system. The long-range objective of this project is to develop an automated volcano-surveillance system to detect which volcanoes are undergoing rapid internal changes and should be studied to predict eruptions and assess the danger of eruptions. There are more than 500 historically active volcanoes throughout the world that could be monitored by this system.
NUMBER OF STATIONS:	29
LOCATION OF STATIONS:	15 volcanoes in Alaska, California, Hawaii, and Washington, and in Iceland, El Salvador, Guatemala, and Nicaragua.
PARAMETERS MEASURED:	There are 23 stations equipped with multilevel seismic event counters and 6 stations with braxial tiltmeters.
METHOD OF MEASUREMENT:	The multilevel seismic event counters count earthquakes of four different amplitudes. An earthquake is assumed if 10 peaks of a rectified seismic signal exceed a given threshold in 1.2 seconds and no peaks and exceeded the threshold in the previous 15 seconds. Each instrument contains 4 counters separated in threshold level by factors of four. Tiltmeters measure tilt by electronically monitoring a level bubble.
FREQUENCY OF MEASUREMENT:	Continuous
DATA RELAY METHOD AND LOCATION OF USERS:	By the LANDSAT satellite to Goddard Space Flight Center, and by teletype to the National Center for Earthquake Research in Menlo Park, California.
FREQUENCY OF DATA RELAY:	6 to 10 times a day
ESTIMATED DATA DELAY:	One to two hours
REFERENCES:	58, 59

NETWORK IDENTIFICATION:	Seismotology Program of the Geological Survey and the National Oceanic and Atmospheric Administration
APPLICATION:	Geology
PURPOSE:	To develop earthquake prediction techniques by monitoring and analyzing the changes in various parameters that currently appear to be premonitory of earthquakes.
NUMBER OF STATIONS:	45
LOCATION OF STATIONS:	California
PARAMETERS MEASURED:	There are 22 creepmeters that measure the distance that the ground on one side of a fault has slipped in relation to the ground on the other side of the fault. There are 15 tiltmeters that monitor the tilt of the earth's surface near a fault. There are 8 magnetometers that monitor the earth's magnetic field.
METHOD OF MEASUREMENT:	Automatically
FREQUENCY OF MEASUREMENT:	Continuously
METHOD OF DATA RELAY:	Some stations telemeter data, and at other stations data is recorded and presumably is retrieved by courier.
LOCATION OF USERS:	The Geological Survey at Menlo Park, California, the Earthquake Mechanism Laboratory of NOAA in San Francisco, California.
REFERENCES:	66, 74

NETWORK IDENTIFICATION:	Seismograph Networks in the U.S.
APPLICATION:	Geology
PURPOSE:	To provide the seismic data needed to locate earthquake epicenters, and for earthquake research and earthquake prediction.
NUMBER OF STATIONS:	635
LOCATION OF STATIONS:	There are 562 in the 48 states, 13 in Alaska, 44 in Hawaii, and 16 in Puerto Rico.
PARAMETERS MEASURED:	Seismic activity, the motion and vibration of the earth's crust.
METHOD OF MEASUREMENT:	Automatically
FREQUENCY OF MEASUREMENT:	Continuously
METHOD AND FREQUENCY OF DATA RELAY:	Some stations continuously telemeter seismic data to the user. At other stations, the seismic data are interpreted and reports are sent to the user by a variety of methods when significant seismic events occur.
LOCATION OF USERS:	National Earthquake Information Service of the U.S. Geological Survey in Golden, Colorado, and other users of seismic data including the U.S. Geological Survey in Menlo Park, California and many universities.
ESTIMATED DATA DELAY:	Real-time to several days.
COMMENT:	A variety of agencies and organizations participate in this program including U.S. Geological Survey, NOAA, and many universities.
REFERENCES:	66, 67, 74

NETWORK IDENTIFICATION:	Alaska Cooperative Seismic Recording Program
APPLICATION:	Geology
PURPOSE:	To study Alaska seismicity and to provide secondary seismic data for natural disasters.
NUMBER OF STATIONS:	48
LOCATION OF STATIONS:	Alaska
PARAMETERS MEASURED:	Seismic activity
METHOD OF MEASUREMENT:	Automatically
FREQUENCY OF MEASUREMENT:	Continuously
DATA RELAY METHOD:	Data is telemetered by land lines, VHF radio, and by satellite.
FREQUENCY OF DATA RELAY:	Continuously
LOCATION OF USERS:	Palmer Observatory in Alaska
ESTIMATED DATA DELAY:	Real-time
REFERENCES:	19, 74

NETWORK IDENTIFICATION: Tsunami Warning System of the National Weather Service

APPLICATION: Geology, Oceanography

PURPOSE: To detect and locate major earthquakes in the Pacific region, to determine whether they have generated tsunamis, and to provide timely and effective tsunami information and warnings to the population of the Pacific.

NUMBER OF STATIONS: 93

There are 23 seismograph stations and 70 tide stations.

LOCATION OF STATIONS: Throughout the Pacific, excluding Alaska

PARAMETERS MEASURED: Seismic activity and tides

FUNCTIONING OF TSUNAMI WARNING SYSTEM: When an earthquake of magnitude 6½ or greater occurs anywhere in the Pacific region, alarms attached to seismograph stations are triggered. This alerts personnel at the stations and they immediately interpret their seismograms and send their readings to Honolulu Observatory (HO). Upon receipt of a report of an earthquake, HO may request data from other seismograph stations in the TWS to receive sufficient data to locate the earthquake and determine its size. If the earthquake is strong enough to cause a tsunami, HO requests tide stations in the area to monitor their gauges. The tide stations send reports to HO where the tsunami's threat to the Pacific population is determined.

DATA RELAY METHOD: By radio and by land line including communication channels of the Army, Air Force, Navy, Coast Guard, NASA, FAA, foreign agencies, and private companies.

ESTIMATED DATA DELAY: Fifteen minutes to one hour

COMMENT: Studies are being made of ways to telemeter data directly to HO in real-time either continuously or on an as-needed basis. Various types of transmission are being considered including satellite relay, cable, and radio.

This does not include the stations in the Regional Tsunami Warning System in Alaska which participates in this program.

REFERENCES: 1, 20, 60, 72

NETWORK IDENTIFICATION:	Regional Tsunami Warning System in Alaska
APPLICATION:	Geology, Oceanography
PURPOSE:	To detect and locate major earthquakes in the Aleutian-Alaskan region and to provide resulting tsunami information and warnings to people in that region.
DESCRIPTION:	Seismograph and tide data are continuously telemetered to Palmer Observatory.
NUMBER OF STATIONS:	24
LOCATION OF STATIONS:	Alaska
PARAMETERS MEASURED:	Seismic activity and tides
METHOD OF MEASUREMENT:	Automatically
FREQUENCY OF MEASUREMENT:	Continuously
DATA RELAY METHOD:	Telemetered by land lines and VHF radio
FREQUENCY OF DATA RELAY:	Continuously
LOCATION OF USERS:	Palmer Observatory in Alaska
ESTIMATED DATA DELAY:	Real-time
COMMENT:	Palmer Observatory and Honolulu Observatory work closely and exchange significant information.
REFERENCES:	19, 20, 73

NETWORK IDENTIFICATION:	The National Strong-Motion Instrumentation Network
APPLICATION:	Geology
PURPOSE:	To measure the motion of the ground near an earthquake's epicenter to provide information about the type and degree of ground motion during an earthquake. This information is being used to design buildings that are resistant to earthquake damage.
NUMBER OF STATIONS:	1,300
LOCATION OF STATIONS:	Throughout the United States, primarily where earthquakes are likely to occur, with the greatest concentration being in California.
PARAMETERS MEASURED:	Strong motion instruments may contain three accelerators to measure acceleration in each of three principle directions of motion, and two displacement meters to measure the amplitude of displacement in the horizontal directions.
METHOD OF MEASUREMENT:	Automatically
FREQUENCY OF MEASUREMENT:	Strong motion instruments monitor continuously after being started by the occurrence of an earthquake of sufficient magnitude.
DATA RELAY METHOD:	By courier and/or by mail
FREQUENCY OF DATA RELAY:	After an earthquake
ESTIMATED DATA DELAY:	One to four weeks
COMMENT:	The data from the strong-motion network are being used to develop building standards, construction codes, and safety regulations for earthquake prone areas.
REFERENCES:	66, 74

CONDENSED USER DATA BASE (APPLICABLE TO SATELLITE RELAY)

For convenience, the information in the user data base was condensed and is presented in Table 4.1. It should be noted that 26,260 stations where monitoring activities involve collecting samples for laboratory analysis were not considered applicable to satellite data collection, and have not been included in this table. It contains condensed information about 47 data collection networks and 102,474 data collection stations. It should also be noted that the data collection station data base (discussed in Sections 5,6, and 7) contains 107,407 stations. The difference of 4,933 stations results from entering air quality monitors in the data base rather than the number of stations (discussed in Section 5), and considering multiple observations of single stations as single observations of several stations (discussed in Section 6).

OTHER DATA COLLECTION USERS

Only minimal information was available about some data collection users, and a detailed description similar to the previous pages could not be completed. A brief summary of each of these users is given below.

- Surface weather observations are made at 13 island stations in the Bahamas. These stations form the Bahamas Cooperative Hurricane Warning Network.
- Aircraft reconnaissance to acquire essential storm data from tropical cyclones and East Coast winter storms, and to satisfy military requirements are provided by Department of Defense aircraft and NOAA research aircraft.
- The IGOSS Marine Pollution Monitoring Pilot Project involves the observation and reporting of oil slicks and other floating pollutants to provide information that can be used to appraise the quantity and distribution of these pollutants, and the manner in which they are transported and dispersed.
- Special areal investigations of water supply of areas ranging in size from a few square miles to an entire state, to determine how the water supply can best be developed, are made by many Federal and non-Federal agencies. These studies involve the collection of water level and water quality data.

TABLE 4.1
USER DATA BASE

NETWORK IDENTIFICATION	NUMBER OF STATIONS	PARAMETERS MEASURED	METHOD OF MEASUREMENT	FREQUENCY OF MEASUREMENT	METHOD OF DATA RELAY	FREQUENCY OF DATA RELAY	ESTIMATED DATA DELAY
1 Surface observation stations of NWS	278	synoptic observations consisting of amount of sky cover, wind speed, direction, and character, type and amount of clouds, visibility, present and past weather, temperature, precipitation, dewpoint, pressure, pressure tendency, and occurance of special phenomena, and/or basic observations consisting of amount of sky cover, height of ceiling, visibility, present weather and obstructions to vision, pressure, temperature, dewpoint, wind speed, direction and character, altimeter setting, and runway visual range	manually and automatically at AMOS	hourly, when special weather events occur, and four or eight times a day at standard synoptic times	by teletype	same as frequency of measurement	one to three hours
2. Surface observation stations operated cooperatively by NWS and FAA	24	basic observations and/or synoptic observations	manually and automatically at AMOS	hourly, when special weather events occur, and at standard synoptic times	by teletype	same as frequency of measurement	one to three hours
3. Surface observing stations staffed by FAA	200	basic observations	manually	hourly for all or part of the day, and when special weather events occur	by teletype	same as frequency of measurement	one to three hours
4 Supplementary aviation weather observing program of NWS	413	basic observations	manually	hourly for a portion of the day or on an on-call basis, and when special weather events occur	verbally by telephone and radio, and also by teletype	same as frequency of measurement	one to three hours
5 Contract observing stations of NWS	185	basic observations and/or synoptic observations	manually	hourly for a portion of the day, when special weather events occur, and at world standard synoptic times	by teletype	same as frequency of measurement	one to three hours
6. Military aviation weather observing network	286	basic observations	manually	hourly, and when special weather events occur	by teletype	same as frequency of measurement	one to three hours

TABLE 4.1 (continued)

NETWORK IDENTIFICATION	NUMBER OF STATIONS	PARAMETERS MEASURED	METHOD OF MEASUREMENT	FREQUENCY OF MEASUREMENT	METHOD OF DATA RELAY	FREQUENCY OF DATA RELAY	ESTIMATED DATA DELAY
7. Marine reporting stations of NWS	202	sky condition, present weather, visibility, wind speed and direction, wave height and period, water temperature, air temperature, and sea level pressure	manually	every two, three, or six hours, and hourly upon request	by teletype	same as frequency of measurement	one to three hours
8. Coastal ships of the U.S. Cooperative Ship Program of NWS	100 at present 300 planned	present weather, visibility, wind speed and direction, wave height, swell height and direction, sea water temperature, air pressure and temperature	manually	every six hours at synoptic times, and hourly upon request	by radio and teletype	same as frequency of measurement	one to three hours
9 Great Lakes Ships of the U.S. Cooperative Ship Program	50 at present 200 planned	apparent wind speed and direction, visibility, present weather, past weather, air temperature, water temperature, ice acretion, wave height and period	manually	every six hours at synoptic times, and hourly upon request	by radio and teletype	same as frequency of measurement	one to three hours
10. High seas ships of the U S Cooperative Ship Program	1,700 at present 2,000 planned	marine surface observations consisting of wind speed and direction, visibility, present and past weather, sea level pressure, dry and wet bulb temperature, clouds, three-hour pressure change, air-sea temperature difference, dewpoint, water temperature, wave height and period, swell height, period, and direction	manually	every six hours synoptic times, and hourly upon request	by radio-teletype and by teletype	same as frequency of measurement	one to six hours
11. Marine surface observations of Navy and Coast Guard Ships on the high-seas	387	marine surface observations	manually	every six hours at synoptic times, and hourly upon request	by radio-teletype and by teletype	same as frequency of measurement	one to six hours
12. Upper-air observing stations of NWS	175 stations 210 obs *	temperature, pressure, and humidity of upper atmosphere, and wind speed and direction	manually and automatically	one to four times a day at synoptic times	by teletype	same as frequency of measurement	one to four hours
13 Marine upper-air observations of Navy ships	22	temperature, pressure, and humidity of upper atmosphere, and wind speed and direction	automatically	twice a day at synoptic times	by radio-teletype and by teletype	same as frequency of measurement	one to six hours
14. Upper-air observing stations of Department of Defense and other Federal agencies	14	temperature, pressure, and humidity of upper atmosphere, and wind speed and direction	automatically	unscheduled	by teletype	same as frequency of measurement	one to four hours

*The number of observations rather than the number of stations was used in the data collection stations data base.

TABLE 4.1 (continued)

	NETWORK IDENTIFICATION	NUMBER OF STATIONS	PARAMETERS MEASURED	METHOD OF MEASUREMENT	FREQUENCY OF MEASUREMENT	METHOD OF DATA RELAY	FREQUENCY OF DATA RELAY	ESTIMATED DATA DELAY
15	Meteorological rocket soundings	24	temperature, pressure, and density of upper atmosphere, and wind speed and direction	automatically	several per week at 1200 GMT	by teletype	same as frequency of measurement	four to eight hours
16	Meteorological radar network of NWS	126	radar echos of precipitation	manually	hourly, and more frequently when severe weather occurs	by teletype	same as frequency of measurement	one to three hours
17	FAA air traffic control radars of the basic radar network	22	air traffic control radar echos of precipitation patterns	manually	continuously	by microwave transmission	continuously	real-time
18.	Air Force weather radar observation network	83	radar echos of precipitation patterns	manually	hourly, and more frequently when severe weather occurs	by teletype	same as frequency of measurement	one to three hours
19.	Substation network of NWS	9,445 excluding stations described elsewhere	precipitation, maximum and minimum air temperature, evaporation including wind and water temperature data, snowfall, snowdepth, and soil temperature	manually and automatically	hourly, daily, more frequently than daily if needed, and irregularly	verbally by telephone and radio, by telemetry, and by mail	daily and more frequently if needed, and monthly	one to three hours, and one to two months
20	Surface water network of the U S. Geological Survey	18,244	surface water level	manually and automatically	continuously to annually, including every fifteen minutes, hourly, daily, and monthly	by courier and by mail	on-demand to annually with one to six weeks most common	real-time to three hours and one to four months
21.	Water quality network of the U S Geological Survey	7,826	water temperature, specific conductance, pH, turbidity dissolved oxygen, and chloride	manually, automatically, and by laboratory analysis of samples	continuously to annually including hourly, daily, and monthly	by courier and by mail	daily to annually	one to four months
22.	Ground water network of the U S Geological Survey	18,268	ground water level	manually and automatically	continuously to annually	by courier and by mail	daily to annually	one to four months
23.	Data collection network of the Corps of Engineers	approx. 5,500	surface water level, precipitation, snow cover, wind speed and direction, pressure, tides, air temperature soil temperature, soil moisture water quality, evaporation, solar radiation, and ground water level	manually, automatically, and by laboratory analysis of samples	continuously to annually	verbally by telephone and radio, telemetry by microwave relay, telemark, and LANDSAT satellite, by teletype, by courier, and by mail	on-demand to annually	real-time to one month

TABLE 4.1 (continued)

NETWORK IDENTIFICATION	NUMBER OF STATIONS	PARAMETERS MEASURED	METHOD OF MEASUREMENT	FREQUENCY OF MEASUREMENT	METHOD OF DATA RELAY	FREQUENCY OF DATA RELAY	ESTIMATED DATA DELAY
24. River reporting stations of NWS	1,090	river stage and precipitation	manually and automatically	continuously to daily	verbally by telephone and radio, and telemetry by landline	on-demand, daily, and every six hours or more often if needed	real-time to three hours
25. Data collection network of the Tennessee Valley Authority	1,155 planned	surface water level, precipitation, temperature, wind, water quality, air quality, and ground water level	manually, automatically, and by laboratory analysis of samples	continuously to annually	verbally by telephone, telemetry by landline, and by courier	on-demand to annually	real-time to one month
26. Hydrologic network of the Bureau of Reclamation	5,401	surface water level, ground water level, water quality, and precipitation	manually, automatically, and by laboratory analysis of samples	continuously to annually	probably by courier, by mail, by telemetry, and verbally by telephone	probably hourly to annually	real-time to three months
27 Tide network of the National Ocean Survey	139	tidal variations in water level	automatically	continuously	by courier and by mail, by telemetry, and probably verbally by telephone	every half hour to daily, and weekly	real-time to two months
28. Hydrologic networks of other Federal and Non-Federal agencies	18,376	surface water level, ground water level, water quality, and precipitation	manually, automatically, and by laboratory analysis of samples	continuously to annually	various	on-demand to annually	real-time to two months
29. NASN and CAMP air quality stations of EPA	320 stations 966 monitors*	total suspended particulates, sulfur dioxide, nitrogen dioxide, carbon monoxide, photochemical oxidants, and hydrocarbons	automatically, and semi-automatically with laboratory analysis of samples	continuously	probably by courier and by mail	probably one or more times daily, to weekly	one to four months
30. State and local air quality monitoring networks	4,785 stations 8,358 monitors*	total suspended particulates, sulfur dioxide, nitrogen dioxide, carbon monoxide, and photochemical oxidants	automatically, and semi-automatically with laboratory analysis of samples	continuously	by courier, and by telemetry by landlines	on-demand to daily	real-time to one day

*The number of monitors rather than the number of stations was used in the data collection station data base.

C-2

TABLE 4.1 (continued)

NETWORK IDENTIFICATION	NUMBER OF STATIONS	PARAMETERS MEASURED	METHOD OF MEASUREMENT	FREQUENCY OF MEASUREMENT	METHOD OF DATA RELAY	FREQUENCY OF DATA RELAY	ESTIMATED DATA DELAY
31 Regional Air Monitoring System of EPA	25	ozone, nitrogen monozide, nitrogen oxides, nitrogen dioxide inference, total hydrocarbons, methane, carbon monoxide, total sulfur, hydrogen sulfide, sulfur dioxide, visibility, fine particulates, wind speed and direction, ambient termperature, temperature differential, pressure, dewpoint, total incident solar radiation, and 300-395 and 300-695 nm radiation	automatically	every half second	telemetry by landlines	every minute	real-time
32. Water quality network of EPA	432	water temperature, specific conductance, pH, turbidity, dissolved oxygen, and chloride	manually, automatically, and by laboratory analysis of samples	continuously to annually	by courier and by mail	weekly to annually	one to four months
33. Snow courses and soil moisture stations of Soil Conservation Service and others	1,704	snow depth and water equivalent, and soil moisture and depth	manually	monthly and semi-monthly	by courier and by mail	same as frequency of measurements	one to three weeks
34. Fire-weather observing stations of Forest Service, state forestry agencies, and others	2,000	wind speed and direction, temperature, humidity, fuel moisture, precipitation, cloud types, visibility, and occurance of thunderstorms	manually	once or twice per day and more frequently is needed	verbally by radio and telephone	same as frequency of measurement	two to three hours
35. Gamma radiation program of NWS	140	gamma radiation	manually	twice a month	by mail	same as frequency of measurement	one month
36. Atmospheric turbidity and precipitation sampling program of NWS	25	atmospheric turbidity at one or two wavelengths	manually	three times a day	by mail	monthly	one to three months
37. Ozone monitoring program of NWS	6	ultraviolet radiation	probably manually	three per day	by mail	twice a month	one month
38. Solar radiation program of NWS	92	global radiation, direct radiation, and true solar noon readings	probably manually	daily	by mail	monthly	one to two months
39 NOAA data buoy network for basic monitoring	36	surface water temperature and salinity, wave height and period, air temperature and pressure, and wind speed and direction	automatically	every three or six hours and hourly when needed	telemetered by HF radio	same as frequency of measurement	one to six hours

TABLE 4.1 (continued)

NETWORK IDENTIFICATION	NUMBER OF STATIONS	PARAMETERS MEASURED	METHOD OF MEASUREMENT	FREQUENCY OF MEASUREMENT	METHOD OF DATA RELAY	FREQUENCY OF DATA RELAY	ESTIMATED DATA DELAY
40 Ocean buoys for specialized monitoring	350	wind speed and direction, air temperature and pressure, dewpoint, precipitation, global radiation, wave height and period, surface water temperature and salinity, subsurface water temperature, current speed and direction, and location of buoy	automatically	every fifteen minutes to every twelve hours	telemetered by satellite and by HF radio	every three to twelve hours	
41 Volcano surveillance network of the U S Geological Survey	29	multi-level detection of occurrence of seismic events, and biaxial tilt	automatically	continuously	telemetered by LANDSAT satellite	six to ten times a day	one to two hours
42 Seismotology program of the Geological Survey and NOAA	45	tilt, creep, and magnetic field	automatically	continuously	telemetered, and by courier		
43 Seismograph networks in the U S	635	seismic activity	automatically	continuously	telemetered, and by a variety of other methods	continuously, and when significant seismic events occur	real-time to several days
44 Alaska cooperative seismic recording program	48	seismic activity	automatically	continuously	telemetered, by landlines, VHF radio, and by satellite	continuously	real-time
45. Tsunami warning system of NWS	93	seismic activity and tides	automatically	continuously	by radio and landlines	when tsunamis and earthquakes occur	fifteen minutes to one hour
46 Regional tsunami warning system in Alaska	24	seismic activity and tides	automatically	continuously	telemetered by VHF radio and landlines	continusously	real-time
47 National strong-motion instrumentation network	1,300	ground acceleration and displacement during earthquakes	automatically	continuously during earthquakes	by courier and by mail	after each earthquake	one to four weeks

- The five-year plan of the Tennessee Valley Authority for monitoring the atmosphere consists of 67 atmospheric radioactivity monitors, 10 ambient fluoride monitors, 11 ambient ozone monitors, 105 ambient sulfur dioxide monitors, and 12 ambient nitrogen dioxide monitors.
- Pilots report the existence of various weather conditions during flights. There are approximately 2,500 pilot reports per day.

OTHER APPLICATIONS OF SATELLITE DATA COLLECTION

During the course of a recently concluded study (Reference 109), a wide variety of users have been identified as part of a transportation application in the form of vehicle monitoring. These users desire position location and may be applicable to satellite data relay. Some of these users have developed costly systems that provide this information with varying degrees of success. These users include the following:

- Railroads: Car inventory, assignment monitoring on a regional or commodity basis, train makeup.

  Location of cars and monitoring hazardous or perishable cargo.
- Interstate trucking: Pick up assignment, route monitoring, hijack prevention.

  Location of trailers for monitoring high value, perishable, or hazardous cargo.
- Police Department: Urban and rural patrol monitoring, emergency equipment assignment and response monitoring.
- State Police: Patrol locations, assignment monitoring, isolated trooper safety.
- General Aviation: Search and rescue enhancement for commercial and private aircraft.

- General Aviation: Search and rescue enhancement for commercial and private aircraft.

- Coast Guard: Patrol location monitoring, such as search aircraft and surface ships.
- Recreational Boating: Distress alerting and location and rescue.

Some of these users may desire or find useful a wide variety of sensor information in addition to position location information.

This vehicle monitoring area represents a new application that has not been examined to any extent with regard to satellite data transfer. An example of the user market includes the nearly 2 million North American freight car fleet. A ten percent improvement in utilization would represent a savings of $5.8 billion in equipment costs (Reference 110).

V. DEVELOPMENT OF THE DATA COLLECTION STATION DATA BASE

Our approach to the tasks of gathering the information about the data collection stations,and the synthesis of this information into a computerized data base are presented in this section. The development of the station data base involved: (1) identifying all of the data collection stations in the data base; (2) defining the specific information about data collection station activities to be gathered; (3) gathering as many documents as possible that contain the required information; and (4) interpreting and synthesizing the gathered information into a data base. Each of these steps in the development of the station data base is discussed individually in the subsequent paragraphs.

IDENTIFICATION OF STATIONS IN DATA BASE

All of the data collection stations, that are characterized in the data collection station data base have been identified and described in the user data base presented in Section IV. There are 128,734 stations in the user data base. Of these stations 102,474 are potentially applicable to satellite data collection and 26,260 are not. The stations that are not applicable to satellite data collection include pesticide monitoring stations, radiation monitoring stations, and a few water quality monitoring stations that measure parameters that can only be determined by laboratory analysis of a collected sample. This aspect of the user data base is discussed in Section III. In the station data base there are 107,407 stations. There are two reasons for this difference of 4,933 stations. One is that individual air quality monitors were identified in the station data base while air quality stations were identified in the user data base. This is discussed in more detail in this section. The other reason for the difference is that some of the stations that monitor several parameters were considered as several stations each monitoring only a few of the parameters. This aspect of the station data base is discussed in more detail in Section VI.

DEFINITION OF STATION PARAMETERS

The next task in the development of the data collection station data base is defining the information it will contain to describe each station. The data base was originally envisioned containing the information given below.

- Location
  - The state, foreign country, or other region in which the station is located.
- Message Size
  - The size (number of bits) of messages that the station relays.
- Collection Interval
  - The most frequent interval at which messages are relayed from the station to the user.

It was felt that a data base containing only this information would have limited use, therefore, the additional information given below was included in the data base.

- Measurement Interval
  - The most frequent interval at which parameters are measured.

- Fixed/Mobile Type
  - Indicates whether a station has a fixed location or is mobile, and if mobile,whether or not it can locate itself; each fixed/mobile type corresponds to a particular communications requirement.
- Record/Telemeter Devices
  - Indicates whether or not there is automatic recording and telemetering equipment at the station.
- Network/Agency Identification
  - Identifies the agency that operates the station or the network of which the station is a part.

Initial attempts to produce a sample data base containing stations from a variety of users quickly indicated that a data base containing only these seven pieces of information could not describe many data collection stations without oversimplifying the activities of these stations to the extent that the description became substancially inaccurate. The following description of a typical data collection station monitoring water quality exemplifies the situation. The station monitors four water quality parameters. Hourly values of one water quality parameter are automatically measured by a sensor,and recorded on a paper tape which is collected every other week. The three other water quality parameters measured at this station are measured manually and collected once a year. The difficulty in describing this station arises when trying to choose a single measurement interval, message size, and collection interval that describes the activities of this station. Rather than developing a method of determining a single value for each of these parameters, it was concluded that the data base should be capable of describing the multiple observations of data collection stations as accurately as possible. This would ensure the usefulness of the data base.

With this in mind, the seven pieces of information to be contained in the data were separated into two catagories: station information and observation information. The <u>station information</u> contains the parameters that do not describe any aspect of the data collection activities at the station. The station information consists of:

- Location of the station
- Fixed/mobile type
- Identification of the agency or network.

The observation information contains the parameters that describe the data collection activities of a station. They consist of:

- Message size
- Collection interval
- Measurement interval
- Use of record/telemeter equipment.

These two types of information were used to define the information contained in the data base. It consists of a single set of station information and as many sets of observation information as are necessary to accurately describe the data collection activities of the station. Generally, observations that are either measured or collected at different intervals were described with different sets of observation information. Henceforth, this set of station and observation information to be gathered shall be referred to as the station parameters. This aspect of the data base is discussed in more detail in Appendix B.

Further attempts to produce a sample data base resulted in two additional changes in the set of station parameters. The parameter "message size" was replaced by a more suitable parameter, the amount of data produced by a single measurement. This was done because the amount of data per measurement is the fundamental parameter from which message size is determined. Substituting the amount of data per measurement for message size means that the message size must be computed during the analysis of the data base. Computing message size automatically instead of determining it manually and entering it in the data base also reduced the amount of effort required to develop the data base.

The other change in the data base is due to a large group of stations (weather stations) where the data from measurements are encoded into messages of alphanumeric characters rather than binary digits (bits). Attempts to convert messages of characters into an equivalent amount of bits produced substancially different results, depending upon the particular coding scheme used. Rather than assume a coding scheme and use it to convert characters to bits, the data base was modified to permit entering the parameter amount of data per measurement, as a quantity of bits or characters. This means that the conversion from characters to bits can be performed during the analysis of the data base, and that any coding scheme desired can be used. The scheme that was used during our analysis consisted of converting characters to bits using the simple conversion factor of 8 bits per character.

During the initial attempts to produce a sample data base, two different types of stations were found that needed to be treated as special cases. They are the stations that relay data only after a specific event has occured, henceforth called event stations, and the stations that relay data continuously, henceforth called continuous stations.

The event stations transmit messages only after the event of interest occurs. The messages vary widely in size, and are transmitted at erratic intervals. Being able to transmit messages of any size at any time is a unique communications requirement. Since each fixed/mobile type corresponds to a particular communications requirement, these stations were given a unique fixed/mobile type classification called event.

The various sizes of messages of these stations, and the erratic collection intervals make these stations difficult to describe in terms of the data base parameters measurement interval, amount of data per measurement, and collection interval. Hence, values for these parameters were not specified (left blank) in the data base. During the analysis of the data base, these stations were identified by their fixed/mobile type and were assigned special message size and collection interval catagories called event. These catagories represent message sizes and collection intervals that vary widely.

The continuous stations were treated as a special case because they collect amounts of data that are several orders of magnitude larger than the quantities of data collected by the other stations in the data base. When these stations were entered in the data base they were assigned measurement and collection intervals of zero. These values correspond to continuous measurement and collection intervals. For convenience, these stations were also assigned a value of zero for the amount of data per measurement.

During the analysis these stations were identified by the zero values of these three parameters, and were assigned special message size and collection interval catagories called continuous.

One additional parameter was included in the data base, primarily to increase its usefulness. This parameter is called the observation identification. It indicates the specific environmental parameters (i.e., water stage, precipitation, etc.) that each set of observation information describes.

The development of the sample data base also showed that many stations had identical descriptions. To reduce the size of the data base, the parameter "number of stations" was added to the data base. This eliminates the need for an individual description of each station in the data base. This means that several stations with identical descriptions can be entered in the data base by a single description, and the number of stations to which the description applies. By choosing this approach, instead of requiring one data card for each of 107,407 stations, only approximately 11,000 data cards were necessary to characterize the station data base.

INFORMATION ACQUISITION

The information acquisition phase of the development of the data collection station data base consisted of gathering the information defined by the station parameters for each of the data collection stations that were identified in the user data base. Most of the information in the station data base was found in a variety of government publications. Some of the information was available in the form of lists of stations. These lists generally contained information such as the location of the station, parameters measured, frequency of measurement, and occasionally some information about the method of measurement. Other information was available in documents that contain descriptions of data collection networks, descriptions of data collection equipment, manuals containing observing procedures, descriptions of communications networks that collect data, published data, and descriptions of the activities at large centralized facilities that use and analyze the collected data. Information such as measurement interval, method of measurement, amount of data produced by a single measurement, and collection interval could be found in documents of this type. All of the documents used to develop the data collection station data base are given in the list of references and in the bibliography which is Appendix C.

DATA BASE SYNTHESIS

The development of the data collection station data base required a substancial amount of interpretation and synthesis of the gathered information. This was due to the fact that only a small part of the information that was gathered was in a form that could be used in the data base. An example of some simple interpretation and synthesis involves the parameter amount of data per measurement. Many documents are published that describe the instruments that are used to measure specific environmental parameters. However, very few documents indicate the amount of data produced by a single measurement. When these documents indicate the range and resolution of a particular instrument,this information was used to determine the amount of data per measurement. Sometimes documents contain information that imply the range and resolution of the measurements of a particular parameter. An example of this is an observing instruction to report wind direction to the nearest ten degrees. Information like this that implies range and resolution of a measurement was often used to determine the amount of data per measurement. There were many instances during the development of the station data base when this type of simple interpretation and synthesis of the gathered information was required.

The development of the station data base also involved some interpretation and synthesis of the gathered information that is more complex in nature. Several examples of this are described in the following paragraphs.

A substancial amount of information about the data collection stations that measure water data was available. This information consisted of location of station, parameters measured, frequency of measurement, and for some stations, information about whether or not the data is recorded or telemetered. Close examination of this data revealed that stations were assigned measurement frequencies that were equal to or less frequent that the actual measurement interval. For example, stations that make measurements every two to seven days were assigned a measurement frequency of weekly. Since a large number of stations were described in this manner, simply entering in the data base the assigned frequency of measurement would distort the parameter message size that is computed using the frequency of measurement. The following scheme was developed to deal with this situation. The frequency of measurement that was entered in the data base for a portion of these stations was more frequent than that given in the reference. For example, a portion of the stations that had a measurement frequency of monthly in the reference were given a frequency of measurement in the data base of once every two weeks.

A similar situation existed with the stations that a documented reference indicated as making measurements continuously. In fact, these stations have a frequency of measurement that ranges from once every four hours to continuously. In the same manner just mentioned, the frequencies of measurement entered in the data base for portions of these stations ranged from once every five minutes to once every three hours. It should be noted that a few of these stations actually measure continuously. Since this appeared to be done for convenience rather than because of the need for data that frequently, none of these station were entered in the data base with a continuous frequency of measurement. The specific portions of stations entered in the data base with frequencies of measurement different from that given in the reference were estimated based on information available from other references. These references were also used to assign each station an accurate collection interval.

A special situation involving air quality monitoring was encountered that resulted in entering the air quality stations in the data base differently from other stations. The interpretation of gathered information that lead to this result requires some explanation. The information that was available dealing with air quality monitoring networks consisted of lists of each type of monitor and the city or county in which it is located. Consequentially, this information was not sufficient to indicate when air quality monitors measuring different parameters were at the same location. The reason that the information on air quality monitoring activities is presented in this manner is probably due to the fact that air quality monitors are frequently moved from place to place within a city or county as the local air quality varies. This means that the number of each type of air quality monitor in each city or county remains constant while the total number of locations from which the data are measured, and the parameters measured at each location varies. Hence, each air quality monitor was entered in the data base individually.

Occasionally it was necessary to assign locations to stations for which this information was not specifically available. This was done when the activities of a particular group of stations were well documented, but their specific locations could not be obtained. In situations of this type, a variety of information was gathered that provided insight into the purpose and activities of the network. This permitted the assignment of reasonable locations for these stations.

These are some examples of the methods in which the gathered information was interpreted and synthesized to develop a data base that contained both meaningful and reasonable information.

DATA BASE CODING

Two methods for encoding the information contained in the data base were considered. One method for encoding the data was to use an entirely numeric code. This type of code can be easily handled by a computer, but makes encoding and reading the data very difficult. The other method for encoding the data was to use an alphanumeric code. This type of code is more cumbersome for the computer, but makes encoding and reading the data much easier. The alphanumeric code was selected because it simplified the enormous task of encoding the data for 107,407 data collection stations.

VI. COMPUTER PROGRAM

This section presents a description of the computer program used in the analysis of the station data base. Basic definitions, index assignments and selected computations are discussed. Typical program outputs are indicated as well as options for selected sample population tabulation.

GENERAL

The basic operations performed by the computer program are the following:

- Create arrays where the number of stations are to be tabulated
- Accept information about a number of data collection stations
- Perform computations on the information
- Assign indices
- Add the number of stations to the proper place in the arrays
- Add the various rows and columns of the arrays after all the data has been accepted
- Write the totals.

A flow chart of the program is provided in Figure 6.1, and a copy of the program can be found in Appendix A.

ARRAY DEFINITION

Five arrays are used to tabulate the information about data collection stations according to various parameters. The number of data collection stations is tabulated in four arrays, and the amount of data collected by these stations is tabulated in one array. An array called A is used to tabulate the number of data collection stations according to location, message size, and collection interval. An array called AFM is used to tabulate the number of stations according to location, and fixed/mobile type. An array called ART is used to tabulate the number of stations according to location, and the use of automatic recording and telemetering devices. An array called AMI is used to tabulate the number of stations according to location, and measurement interval. An array called ATLBTS is used to tabulate the total amount of data collected by the stations during a year according to location. These arrays are noted below.

- A (location, message size, collection interval)
- AFM (location, fixed/mobile type)
- ART (location, record/telemeter device)
- AMI (location, measurement interval)
- ATLBTS (location)

There are 69 different locations which include the 50 states and various regions outside the United States, 19 collection and measurement intervals which range from continuous to annual, 13 message sizes which range from 20 to 200,000 bits, 4 fixed/mobile types and 4 record/telemeter options. The locations, fixed/mobile types and record/telemeter options are defined in portions of Appendix B. The measurement and collection intervals and message sizes used are discussed on pages 6-10 and 6-11.

DATA DESCRIPTION

The data cards contain information that describes a data collection station and the number of stations to which this description applies. The description includes station information such as location, and observation

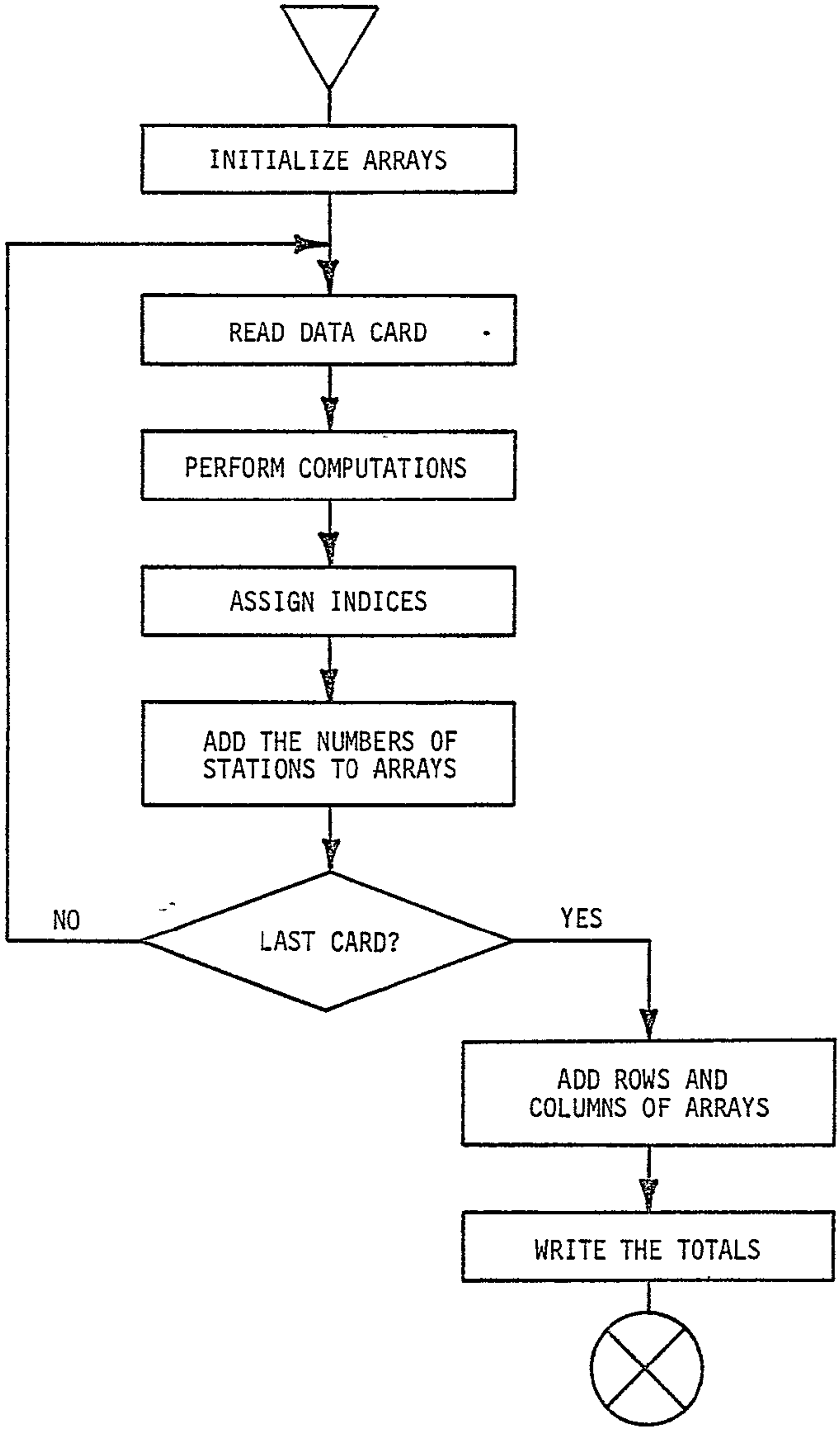


FIGURE 6.1. COMPUTER PROGRAM FLOWCHART

information such as measurement and collection interval. More specifically, this information includes:

- Number of data collection stations
- Data collection station description
  --Station information
    a. location
    b. fixed/mobile type
    c. identification of the agency that operates the station or the network of which the station is a part
  --Observation information
    a. observation identification
    b. indicator of whether the amount of data is a quantity of bits or characters
    c. indicator of usage of automatic recording and telemetering equipment
    d. the amount of data produced as the result of a single measurement
    e. measurement interval
    f. collection interval.

The data collection station description may include as many as four sets of observation information. This option was provided to handle the capability for multiple observations of many stations. For example, a station that monitors several parameters may have different measurement and collection intervals for each parameter. This can be described by several sets of observation information. When the measurement and collection intervals of each parameter are identical, they are considered as a single observation and the amount of data produced is the sum of a single measurement of each parameter. Sample data, the data card format, and the codes used to encode the data are contained in Appendix B.

COMPUTATIONS PERFORMED

The computations that are performed are for the most part straightforward. They involve simple calculations such as message size, B,

$$B = B_m \cdot T_c/T_m$$

where B_m is the number of bits required for the measurement

T_m is the measurement interval (frequency of measurement)

T_c is the collection interval of the data constituting the message size, B.

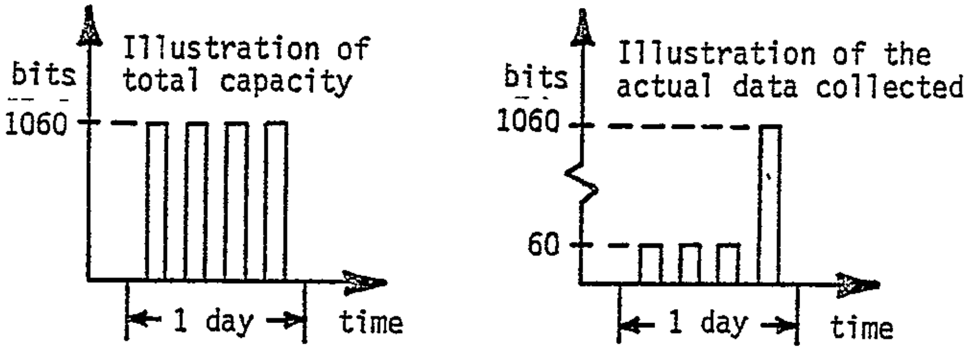
The procedure for handling multiple observations with a single platform is somewhat more complicated and requires a detailed explanation. The problems encountered as a result of multiple observations are discussed in the following paragraphs.

Consider a data collection station that makes two distinct observations. One observation consists of measurements once an hour that produce 10 bits of data that are collected once every 6 hours. The second observation consists of measurements once a day that produce 1,000 bits of data that are collected once a day. The first observation has a message size of B = 60 bits with a collection interval of T_c = 6 hours. The second observation has a message size of B = 1,000 bits and a collection interval of T_c = 1 day.

Two simple methods of handling this situation were considered. One method was to consider this station as if it were in fact two stations, each making a single observation. A second method was to combine the observations to produce a single message size of 1,060 bits, equal to the sum of the two message sizes, and a collection interval of 6 hours, which is equal to the minimum value of the two collection intervals. Observations were combined in this manner rather than by dividing the infrequent message into smaller pieces and collecting one piece at a time because this technique did not seem acceptable in many data collection situations.

The method of separating multiple observations was considered somewhat inadequate when applied to all cases, and likely to produce distortion in the total number of data collection stations. Yet this method seemed quite applicable when a data collection station made two observations that were very different. The method of combining multiple observations was considered inadequate when applied to all cases, and likely to produce a distortion in the resultant message size and collection interval. Yet this method seemed quite applicable when a data collection station made observations that were very similar. It was found that the distorting effects of each method could be reduced to an insignificant level by using each method when it was appropriate.

The criteria for determining which method to use is based on the amount of unused capacity that is the result of combining observations. In the above example, over the period of a day, the combination of the observations provides a capacity to collect 4,240 bits of information, while only 1,240 bits are actually collected, leaving 3,000 bits left unused. This is illustrated in Figure 6.2.



total capacity = 4240 bits

actual data collected = 1240 bits

FIGURE 6.2. SIMPLE CAPACITY EXAMPLE

The criteria for determining whether or not to combine multiple observations is the efficiency ratio, η, of the actual bits collected to the total capacity. Multiple observations were combined when this ratio was less than 0.5.

The following example has been selected to demonstrate how the computer program handles multiple observations. Consider a single station that makes these three observations.

- Observation 1:
  message size = 10 bits
  collection interval = 1 day
- Observation 2:
  message size = 1,000 bits
  collection interval = 2 days

- Observation 3:

  message size = 100 bits

  collection interval = 12 hours.

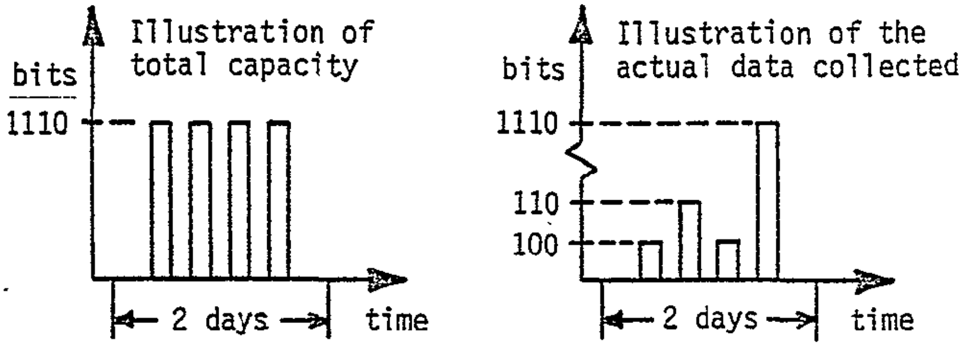
The program first combines the three observations into a single observation.

Observation 1+2+3:

message size = 1,110 bits

collection interval = 12 hours.

The program then computes the total capacity, the actual bits collected, and the ratio. This is illustrated in Figure 6.3.



Total capacity = 4440 bits
Actual data collected = 1420 bits
$\eta = 0.28$

FIGURE 6.3. CAPACITY OF THE COMBINATION OF THREE OBSERVATIONS INTO ONE OBSERVATION

The result indicates that this combination is unsatisfactory.

The program then combines the three observations into two observations. It should be noted that there are three different ways of doing this. The program considers all three possibilities.

- Combination 1:

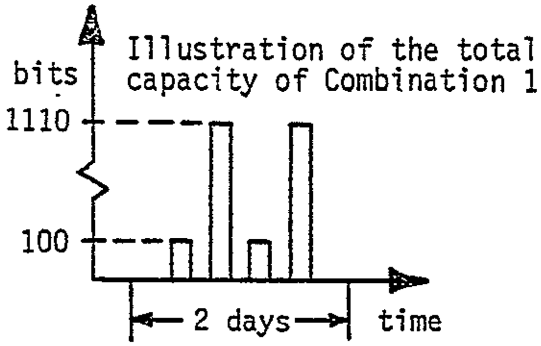
  observation 1+2:

  message size = 1,010 bits

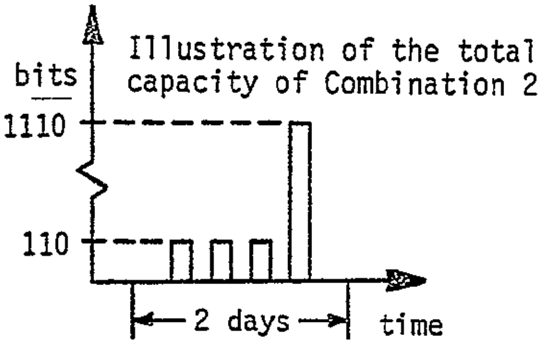
  collection interval = 1 day

    - observation 3:
        - message size = 100 bits
        - collection interval = 12 hours
- Combination 2
    - observation 1+3:
        - message size = 110 bits
        - collection interval = 12 hours
    - observation 2:
        - message size = 1,000 bits
        - collection interval = 2 days
- Combination 3
    - observation 2+3:
        - message size = 1,100 bits
        - collection interval = 12 hours
    - observation 1:
        - message size = 10 bits
        - collection interval = 1 day.

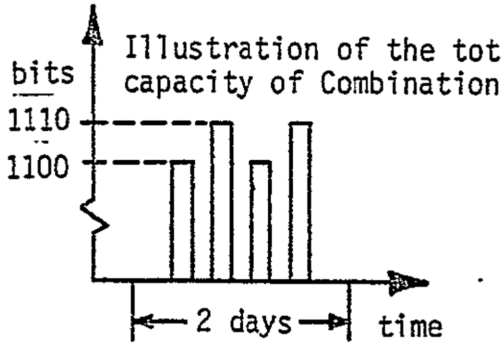
The program then computes the total capacity of each combination, and the efficiency ratio of the actual data collected to the total capacity. It should be noted that the actual data collected remains the same, regardless of how the observations are combined. This is illustrated in Figure 6.4, on page 6-9. The results of these computations indicate that an efficiency ratio greater than 0.5 can be achieved by combining the three observations into two, and that leaving the three observations separate is not necessary. The results also indicate that combination 2 is the best, and that this combination should be chosen. Based on these results, the computer program considers this single station with three observations as two stations, one having a message size of 110 bits and a collection interval of 12 hours, and another station having a message size of 1,000 bits and a collection interval of 2 days. This combination of the two methods originally proposed proved highly satisfactory and resulted in minimal distortion of the results.



Total capacity = 2420 bits
Actual data collected = 1420 bits
η = 0.59



Total capacity = 1440 bits
Actual data collected = 1420 bits
η = 0.99



Total capacity = 4410 bits
Actual data collected = 1420 bits
η = 0.32

FIGURE 6.4. CAPACITY OF THE COMBINATION OF THREE OBSERVATIONS INTO TWO OBSERVATIONS

The remaining computations to be performed involve determining the measurement interval and the record/telemeter code for combined observations. The measurement interval of a combined observation is the minimum value of the measurement intervals of each of the combined observations. The record/telemeter code of a combined observation is determined according to the following rules.

1. The combination of one observation that is recorded with another that is not recorded is defined as a single observation that is recorded.

2. The combination of one observation that is telemetered with another that is not telemetered is defined as a single observation that is telemetered.
3. The combination of one observation that is recorded with another that is telemetered is defined as a single observation that is both recorded and telemetered.

These combinations are performed by four function routines called FRT1, FRT2, FRT3, FRT4.

ASSIGNMENT OF INDICES AND TABULATION OF STATIONS

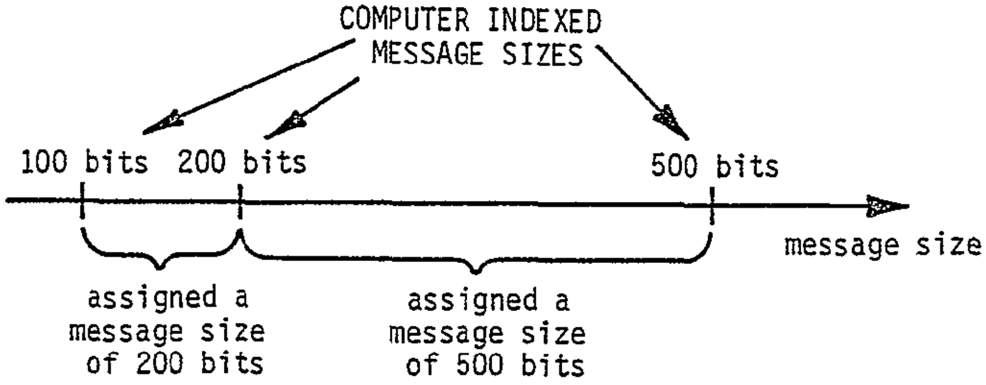
The tabulation of the data collection stations requires the assignment of these indices:

IST - location index
IMS - message size index
ICI - collection interval index
IFM - fixed/mobile index
IRT - record/telemeter index
IMI - measurement interval index.

The assignment of these indices is performed in two different places in the program. The location and fixed/mobile indices are determined from the station information, and do not depend upon any of the previously discussed calculations. The program assigns these indices before performing any of the calculations. The remaining indices are determined from the observation information and depend upon the calculations. The program assigns these indices after performing the calculations.

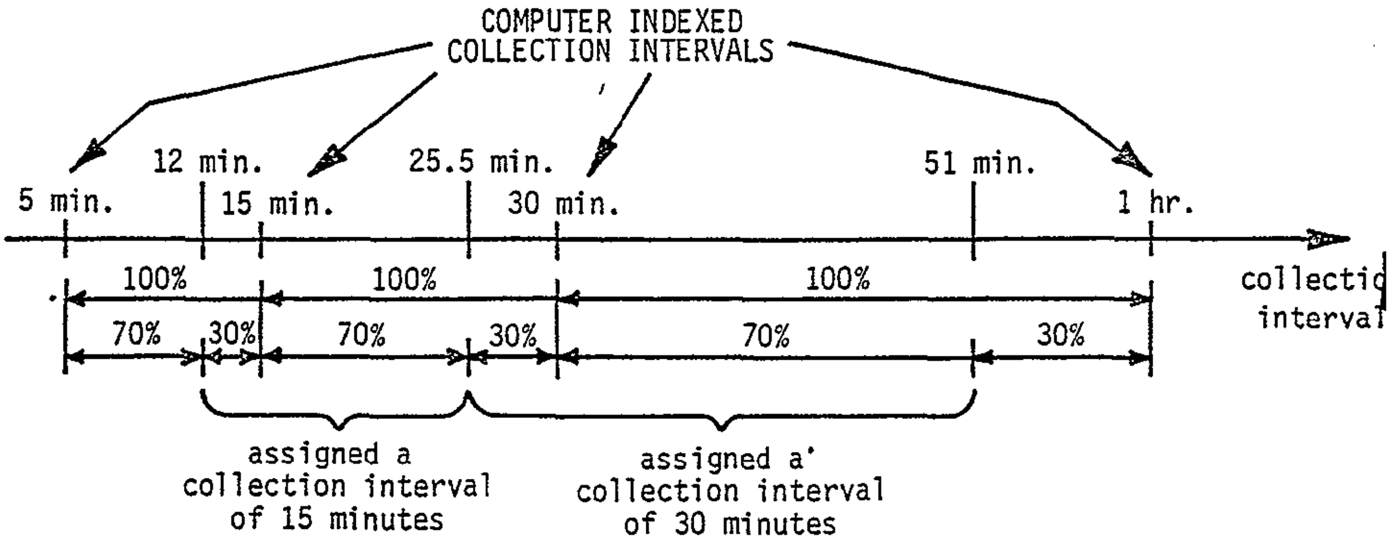
The location and fixed/mobile indices are assigned by simple matching where each different location and fixed/mobile type is assigned a different index.

The message size indices available in the computer program represent message sizes of 20, 50, 100, 200, 500, 1,000, 2,000, 5,000, 10,000, 20,000 50,000, 100,000, and 200,000 bits. Any message size in the data base that does not equal one of the above numbers is assigned the next larger computer indexed message size. For example, message sizes in the data base ranging from 101 bits to 200 bits are assigned the computer indexed message size of 200 bits, as indicated in the diagram below. A message size in the data base ranging from 201 bits to 500 bits is assigned the computer indexed message size of 500 bits, and so forth.



This method of assigning the message size index was chosen because the amount of data required by the majority of users was not considered flexible. Hence, it was assumed that their requirements could not be met by an amount of data less than what is currently being used.

The collection interval indices available in the computer program represent collection intervals of 1 minute, 5 minutes, 15 minutes, 30 minutes, 1 hour, 2 hours, 3 hours, 6 hours, 12 hours, 1 day, 2 days, 1 week, 2 weeks, 1 month, 2 months, 3 months, 6 months, and 1 year. Any collection interval in the data base that does not equal one of the above numbers will be assigned the next smaller computer indexed collection interval, with one exception. The exception is those data base collection intervals that are more than 70% of the distance to the next higher computer indexed collection interval. These are assigned the next higher computer indexed collection interval. For example, a collection interval in the data base ranging from 13 minutes to 25 minutes would be assigned the computer indexed collection interval of 15 minutes, as indicated in the diagram on page 6-12. A collection interval in the data base ranging from 26 minutes to 51 minutes would be assigned the computer indexed collection interval of 30 minutes, and so forth.



This method of assigning the collection interval index was chosen because the collection interval required by the majority of users was considered somewhat flexible. Thus, it was assumed that their requirements could be met in a few cases by collecting data just slightly less often than what they are presently doing. The extent to which the collection interval was considered to be flexible was 30%. In most circumstances, however, data is indexed to be collected in an interval equal to or more often than what is currently being done by the user. It should be noted that, except for the 6-day collection interval of some observations in the data base, all the collection intervals that were contained in the data base were explicitly indexed.

The record/telemeter index is assigned by simple matching where each different record/telemeter type is assigned a different index. The measurement interval index is assigned in the same manner as the collection interval index.

Two special cases, event type stations and stations that have continuous collection intervals, are indexed by a separate section of the program.

The tabulations that are performed involve adding the number of stations and the total amount of data to the element in each array that has been identified by the indices.

PROGRAM OUTPUT

The output that the computer program produces consists of the totals of the various rows and columns of the five arrays, and some of the individual elements of the arrays. The output portion of the program is performed in a subroutine called CWAB. There are two parts to the output: profiles of individual states, and more detailed profiles of regions consisting of groups of states.

The profiles of individual states contain the following information.

- Total number of data collection stations, number of stations per 1,000 square miles, and the total amount of data collected in a year.
- Breakdown according to fixed/mobile type.
- Breakdown according to record/telemeter type.
- Values for histograms of measurement interval and collection interval.
- Values for histogram of message size.
- Total number of stations and number of stations per 1,000 square miles for three ranges of collection intervals:
    - -- 1 minute $\leqslant$ collection interval $\leqslant$ 3 hours
    - -- 6 hours $\leqslant$ collection interval $\leqslant$ 2 months
    - -- 3 months $\leqslant$ collection interval $\leqslant$ 1 year
- Values for histograms of message size for the three ranges of collection interval.

The profile for a single state is shown in Figure 6.5.

The data for each region is tabulated in five arrays called B, BFM, BRT, BMI and BTLBTS, similar to the five arrays previously discussed. The regions are defined in Table 6.1.

The profiles of each of the regions include all of the information in the state profiles plus a complete table of message size versus collection interval. The profile of a single region is shown in Figure 6.6.

COMPLETE PRINTOUT OF STATE PROFILE

```
   26      MT          600         4.C778       0.1351765E 09
 ------FIXED------SHIP------ALFY------EVENT------TOTAL--------------------------------------
        580         0          0        20        600
 -- --NEITHER -  -RECORD TELEMETER        BOTH   REC+BOTH  TEL+BOTH      TOTAL
         0        6CC         0            0       6C0        0          600
 -
       EVNT  CCNT  1MIN  5MIN 15MIN 30MIN   1HR   2HR   3HR   6HR  12HR   1DA   2DA   1WK   2WK   1MC   6WK   2MC   3MC   6MC   1YR
  MI=   20    15     0    25    72    27   244    22     C     C     2     3     0     C     8   162     0     0     0     0     C
 -CI=----20-- -15--   0  -  0--    0     0    12     0     C    15     2    25     0     7    87   385    37     0     0     C     C
 _BITS=    EVNT      CCNT        20        50       100       20C       500      100C      2000      500C     10000     20000     50000    100000    20000C
 - 600             4.C7780
            2C        15        24       158         8         6        23         3         C        12        9C       125        88        18        1C
     12            C.38156
             0         0        12         0         C         C         C         C         0         C         0         C         0         0         C
    553            3.75838
 -----------0 ------0- -----12--       158        8--       6--     ---23         3         C        12        90       125        88        19        1C
      0            0.0
             0         0         0         0         C         C         C         C         C         C         C         0         0         0         C
```

IDENTIFICATION OF DATA IN STATE PROFILE

1) General data

	State	Number of stations	Number of Stations per 1,000 sq. miles	Amount of data collected by all stations per year (bits)
27	NB	353	4.5709	C.6429966E C8

2) Number of stations having each fixed/mobile type

```
            FIXED        SHIP        ALCY        EVENT        TOTAL
             349           C           0            5          353
```

3) Number of stations having automatic recording and/or telemetering devices

```
          NEITHER     RECORD TELEMETER       BOTH   REC+BOTH  TEL+BOTH      TOTAL
             0           353       0            C       353        0          353
```

4) Data for histogram of measurement interval (MI) and collection interval (CI)

Indexed measurement and collection intervals

Number of stations having each measurement interval

Number of stations having each collection interval

```
       EVNT  CONT  1MIN  5MIN 15MIN 30MIN   1HR   2HR   3HR   6HR  12HR   1DA   2DA   1WK   2WK   1MC   6WK   2MC   3MC   6MC   1YR
  MI=    5     1     0    10    39    12   216    14     C     0     2     1     0     3    10    43     0     0     0     0     C
  CI=    5     1     0     0     3     C    24     C     5    22     2    18     0     1    46   154    12     C     0     0     C
```

5) Data for histograms of message size

a) Data for histogram of message size of all stations

Indexed message sizes

Number of stations and stations per 1,000 sq. mi.

Number of stations having each message size

```
  -BITS=----EVNT    CCNT------20       50      1CC      2CC      500      1000     2000     5000    10000    20000    50000   100000   200000
      353          4.57094
            5         1       25       44       54        2       16        4        0        3       43       57       35        5        3
```

b) Data for histogram of message size of all stations with a collection interval of 1 minute to 3 hours

Number of stations and stations per 1,000 sq. mi.

Number of stations having each message size

```
       32          C.41436
            C         0        ,        5       13        2        1        C        0        0        0        0        0        0        C
```

c) Data for histogram of message size of all stations with a collection interval of 6 hours to 2 months

Number of stations and stations per 1,000 sq. mi.

Number of stations having each message size

```
      315          4.C7088
            0         0       14       39       81        C       15        4        C        3       63       53       35        5        3
```

d) Data for histogram of message size of stations with a collection interval of 3 months to 1 year

Number of stations and stations per 1,000 sq. mi.

Number of stations having each message size

```
        0          0.0
            0         0        0        0        C        0        0        0        0        0        0        0        0        0        C
```

FIGURE 6.5 SAMPLE STATE PROFILE

TABLE 6.1

DEFINITION OF REGIONS

Region	General Location	Component States
1	New England	Connecticut Maine Massachusetts New Hampshire Rhode Island Vermont
2	Mideast	Delaware Maryland New Jersey New York Pennsylvania
3	Great Lakes	Illinois Indiana Michigan Ohio Wisconsin
4	Plains	Iowa Kansas Minnesota Missouri Nebraska North Dakota South Dakota
5	Southeast	Alabama Arkansas Florida Georgia Kentucky Louisiana Mississippi North Carolina South Carolina Tennessee Virginia West Virginia
6	Southwest	Arizona New Mexico Oklahoma Texas

TABLE 6.1 (Cont)

Region	General Location	Component States
7	Rocky Mountain	Colorado Idaho Montana Utah Wyoming
8	Far West	California Nevada Oregon Washington
9	Alaska	Alaska
10	Hawaii	Hawaii
11	Remainder	All locations outside the 50 states
12	Far West 50	Alaska California Hawaii Nevada Oregon Washington
13	48 States	48 States
14	50 States	50 States
15	Total	All Locations

IDENTIFICATION OF DATA IN REGION PROFILE

1) Data identical to that in the state profile

```
       4     ELNS         2977          5.7555        0.67145535 09
        FIXED        SHIP        BUSY        EVENT       TOTAL
         2942           0           0           35        2977
  ---NEITHER----RECORD-TELEMETER-- --- BOTH --REC+BOTH  -TEL+BOTH       TOTAL
          0        2971          6          0      2971         6          2977
        EVNT  CONT  1MIN  5MIN 15MIN 30MIN   1HR   2HR   3HR   6HR  12HR    DA   2DA   1WK   2WK   1MO   6WK   2MO   3MO   6MO   1YR
  MI=     35    28     0   103   341   144  1368   113     0    22    16    14    14     9    16   754     0     0     0     0     2
  CI=     35    28     0     0    22     0   156     0     5   274    10   188     0   103   368  1689    97     0     0     0     2
  BITS=     EVNT     CONT       20       50      100      200      500     1000     2000     5000    10000    20000    50000   100000   200000
  ----2977--------0.15547------------------------------------------------------------------------------------------------------------
              35       28      158      777      297       11      147       55        0       78      491      453      358       60       25
      162          0.35380
               0        0      106       16       52        5        4        0        0        0        0        0        0        0        0
     2729          5.27601
               0        0       50      761      245        6      143       55        0       78      491      453      358       60       25
        2          0.00387
               0        0        2        0        0        0        0        0        0        0        0        0        0        0        0
  -----------------------------------------------------------------------------------------------------------------------------------
```

2) Table of message size versus collection interval for all stations

Indexed message sizes →

Indexed collection intervals

```
  BITS=     EVNT     CONT       20       50      100      200      500     1000     2000     5000    10000    20000    50000   100000   200000
   EVNT       35        0        0        0        0        0        0        0        0        0        0        0        0        0        0
   CONT        0       28        0        0        0        0        0        0        0        0        0        0        0        0        0
    1MN        0        0        0        0        0        0        0        0        0        0        0        0        0        0        0
    5MN        0        0        0        0        0        0        0        0        0        0        0        0        0        0        0
   15MN        0        0       13        9        0        0        0        0        0        0        0        0        0        0        0
   30MN        0        0        0        0        0        0        0        0        0        0        0        0        0        0        0
  --1HR--------0--------0-------91--------4-------52--------5--------4--------0--------0--------0--------0--------0--------0--------0--------0
    2HR        0        0        0        0        0        0        0        0        0        0        0        0        0        0        0
    3HR        0        0        0        3        0        0        2        0        0        0        0        0        0        0        0
    6HR        0        0       22        1      245        6        0        0        0        0        0        0        0        0        0
   12HR        0        0        0        0        0        0        0        0        0        0       10        0        0        0        0
    1DA        0        0        6        1        0        0      126       55        0        0        0        0        0        0        0
    2DA        0        0        0        0        0        0        0        0        0        0        0        0        0        0        0
    1WK        0        0        9        0        0        0        1        0        0       44       11       29        9        0        0
  --2WK--------0--------0-------10--------0--------0--------0--------0--------0--------0-------27------146-------25------111-------49--------0
    1MO        0        0        5      759        0        0       14        0        0        7      310      330      224       11       25
    6WK        0        0        0        0        0        0        0        0        0        0       14       65       14        0        0
    2MO        0        0        0        0        0        0        0        0        0        0        0        0        0        0        0
    3MO        0        0        0        0        0        0        0        0        0        0        0        0        0        0        0
    6MO        0        0        0        0        0        0        0        0        0        0        0        0        0        0        0
    1YR        0        0        2        0        0        0        0        0        0        0        0        0        0        0        0
```

FIGURE 6.6. SAMPLE REGION PROFILE

PROGRAM ALTERATIONS FOR TABULATION OF SELECTED STATIONS

The program can be altered in order to produce profiles of only selected groups of stations. These alterations involve inserting simple tests throughout the program that cause the program to tabulate only the selected stations, and to ignore the unwanted stations.

The simplest of these alterations is the selection of stations according to the indexed parameters. Examples of this include selecting only those stations that are fixed, selecting only those stations that have recording devices, or selecting only those stations that have a message size that is between 500 and 5,000. This type of selection can be performed by testing for the assigned index after the assignment of the index, but prior to the tabulation of the stations.

Selections can also be made using the remaining information on the data cards. Examples of this include selecting only those stations with a Federal network/agency identification code, or selecting only those stations that make water quality observations. This type of selection can be performed by testing for the desired information after reading the data card, but prior to any of the calculations.

VII. RESULTS OF COMPUTER ANALYSIS

This section presents the results of the computer analysis of the data collection station data base. These results are depicted by histograms of the various data collection parameters. For convenience, the results have been separated into three parts. Part I contains the results that describe the general characteristics of the stations in the data base. Part II contains the results that describe the characteristics of specific groups of stations. Part III contains the results of a variety of regression analyses that were performed on the number of data collection stations and on the amount of data collected by these stations.

PART I - GENERAL CHARACTERISTICS OF DATA COLLECTION STATIONS

The results discussed in this section describe the general characteristics of all the stations in the data base. They consist of five distinct sets of histograms with each set containing three. These three histograms show the total number of stations versus location, message size, and collection interval. The first set of results illustrates all the stations, while the second set illustrates the stations with and without automatic recording and telemetering devices. The third group illustrates the fixed stations and the mobile and event stations. The fourth group illustrates the stations in three ranges of collection intervals. Finally, the fifth set illustrates a breakdown of the Federal and non-Federal stations.

Histograms of Total Number of Stations

The most general results of the computer analysis of the station data base consist of histograms of the number of data collection stations versus location (Figure 7.1), message size (Figure 7.2), and collection interval (Figure 7.3). These histograms contain a total of 107,407 data collection stations. Hence, they illustrate the characteristics of all the data collection stations contained in the data base. A discussion of these histograms has not been included here, because these results are discussed when they are compared to many of the other histograms presented throughout this section.

The four remaining groups of histograms are identical to the three presented here except that each group illustrates the characteristics of specific types of stations, as compared to the characteristics of all of the stations in the data base. These four groups describe the characteristics of the following types of stations:

- Stations that have automatic recording and/or telemetering devices
- Stations that are fixed and mobile
- Stations in each of three broad ranges of collection interval (slow, medium, and fast)
- Stations operated by Federal and non-Federal agencies.

Subsequent paragraphs discuss each of the above data collection characteristics.

Histograms of Stations With and Without Automatic Recording and/or Telemetering Devices

The following histograms illustrate the number of data collection stations which either have or do not have automatic recording and/or telemetering (R/T) equipment. These histograms show the number of stations versus location (Figure 7.4), message size (Figure 7.5), and collection interval (Figure 7.6). Almost 30% of the stations have automatic recording and/or telemetering equipment.

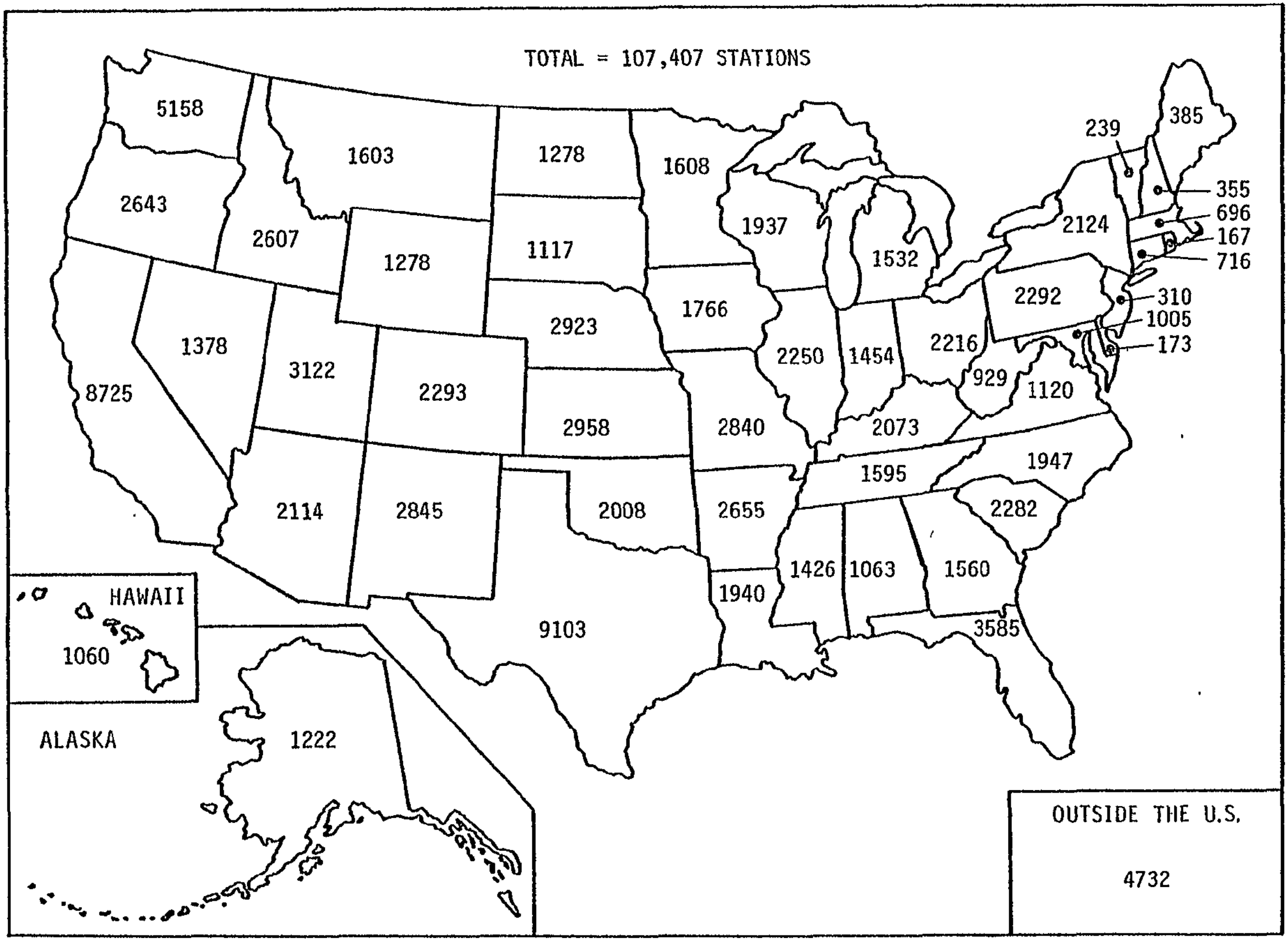


FIGURE 7.1. NUMBER OF DATA COLLECTION STATIONS VERSUS LOCATION

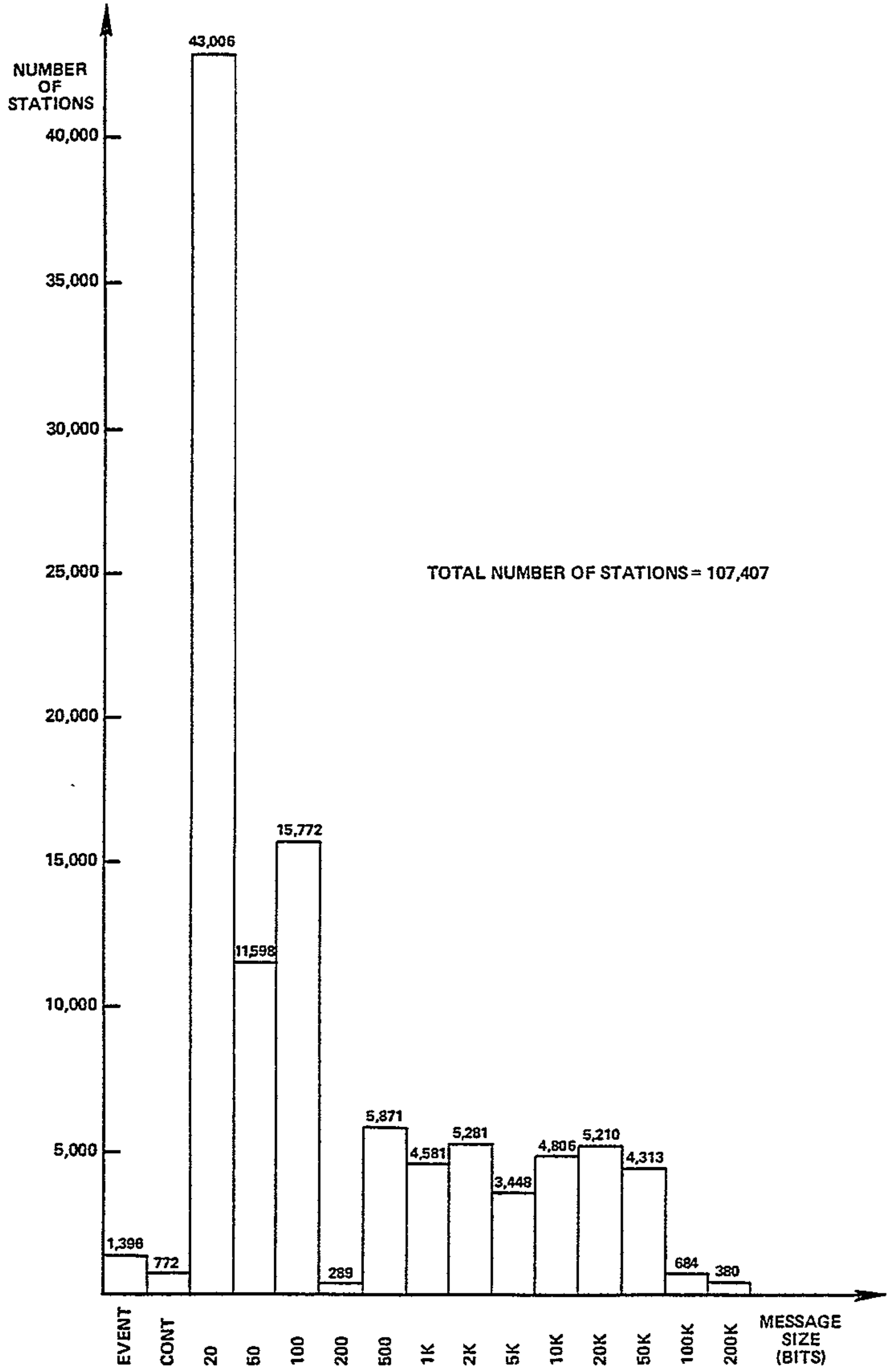


FIGURE 7.2. NUMBER OF DATA COLLECTION STATIONS VERSUS MESSAGE SIZE

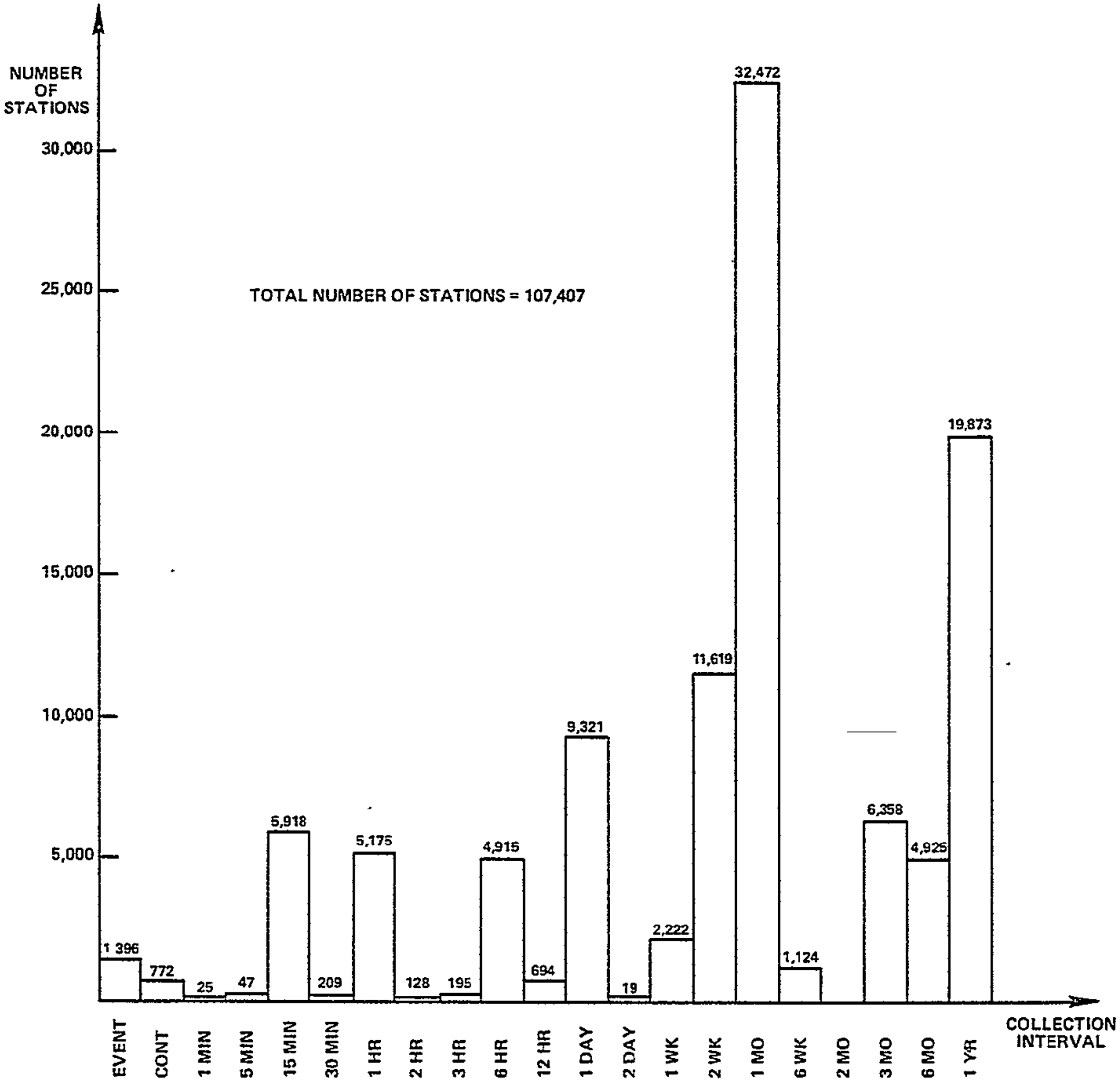


FIGURE 7.3. NUMBER OF DATA COLLECTION STATIONS VERSUS COLLECTION INTERVAL

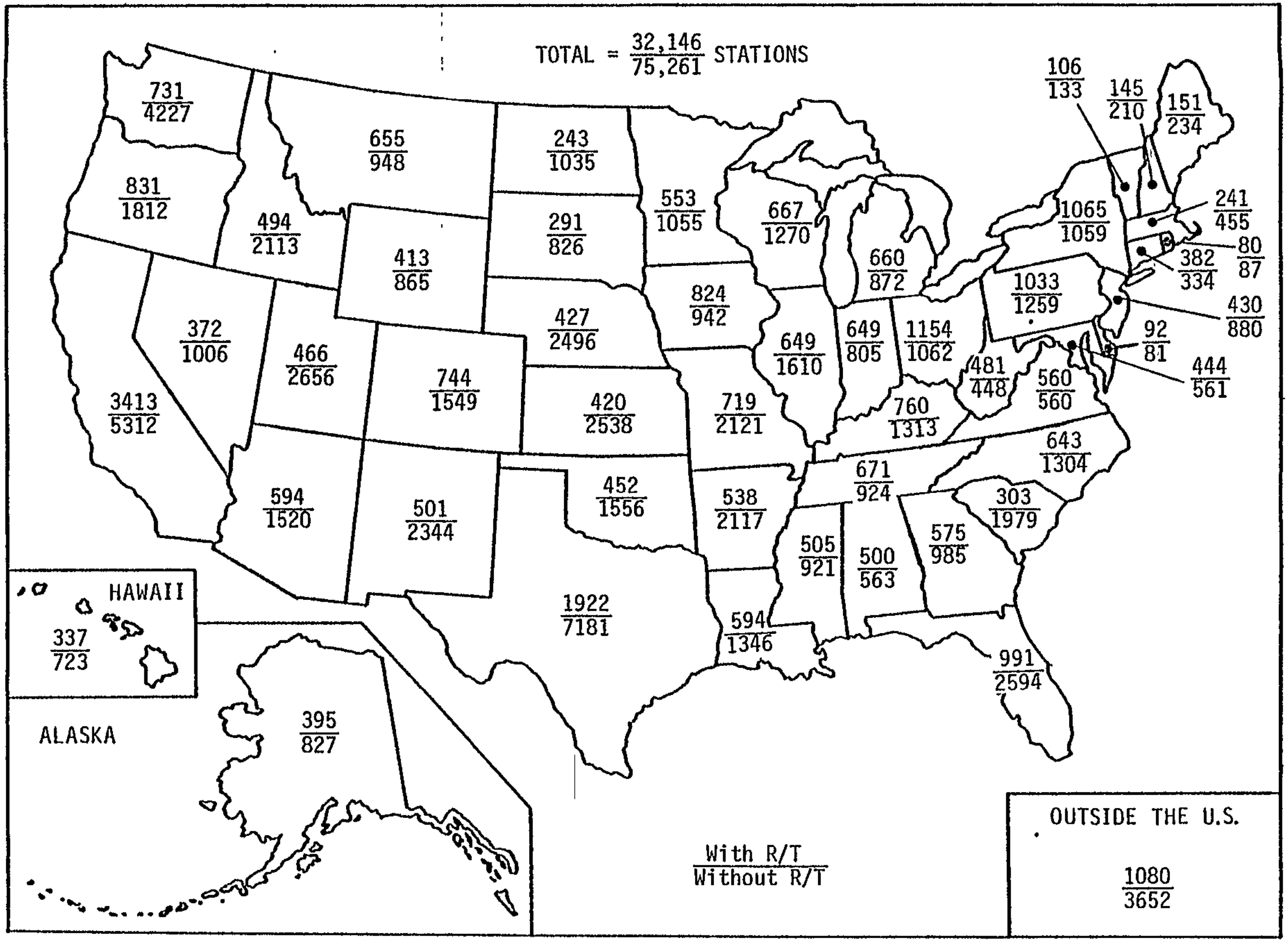


FIGURE 7.4. NUMBER OF STATIONS WITH AND WITHOUT AUTOMATIC RECORDING AND TELEMETERING (R/T) DEVICES VERSUS LOCATION

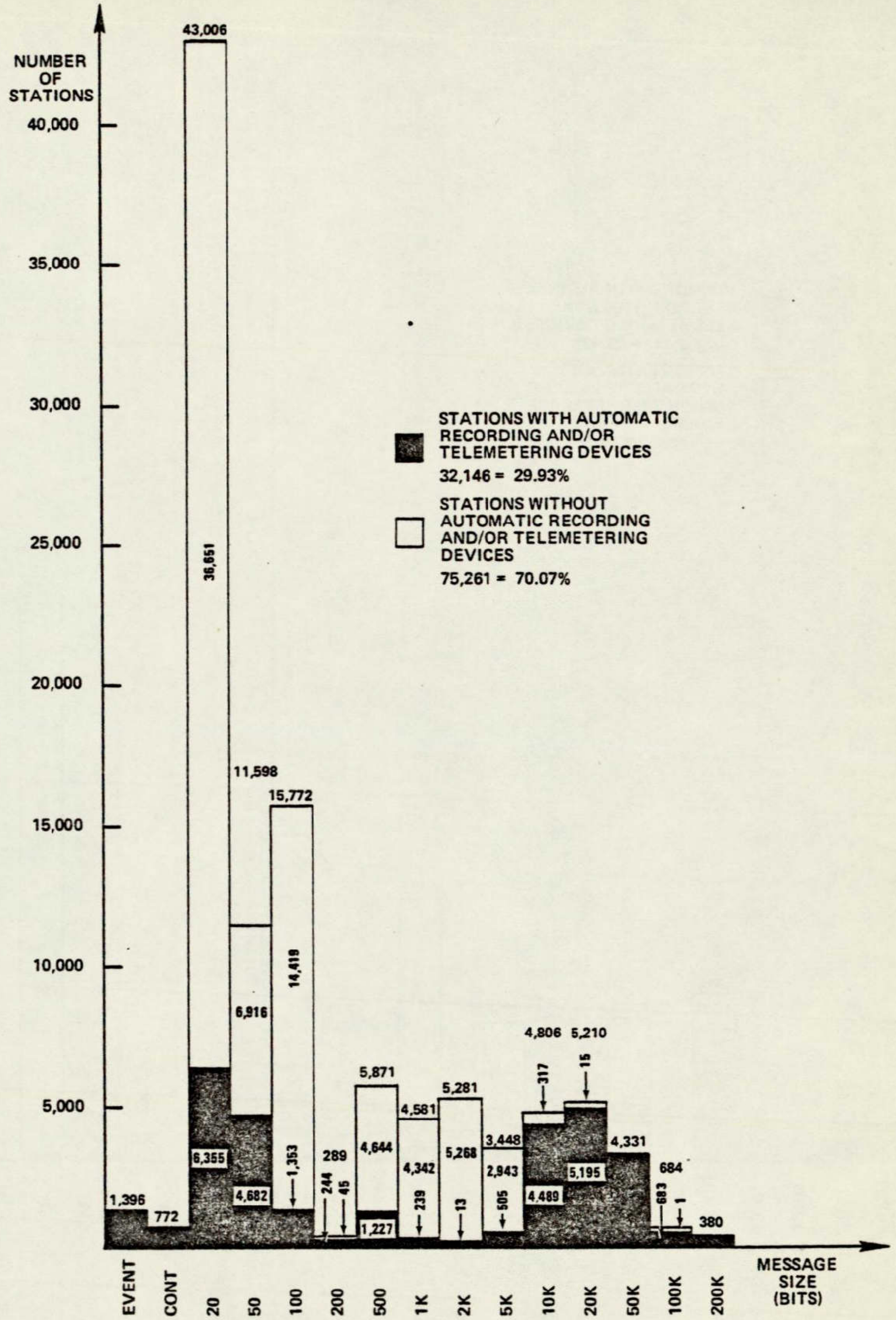


FIGURE 7.5. NUMBER OF STATIONS WITH AND WITHOUT AUTOMATIC RECORDING AND TELEMETERING DEVICES VERSUS MESSAGE SIZE

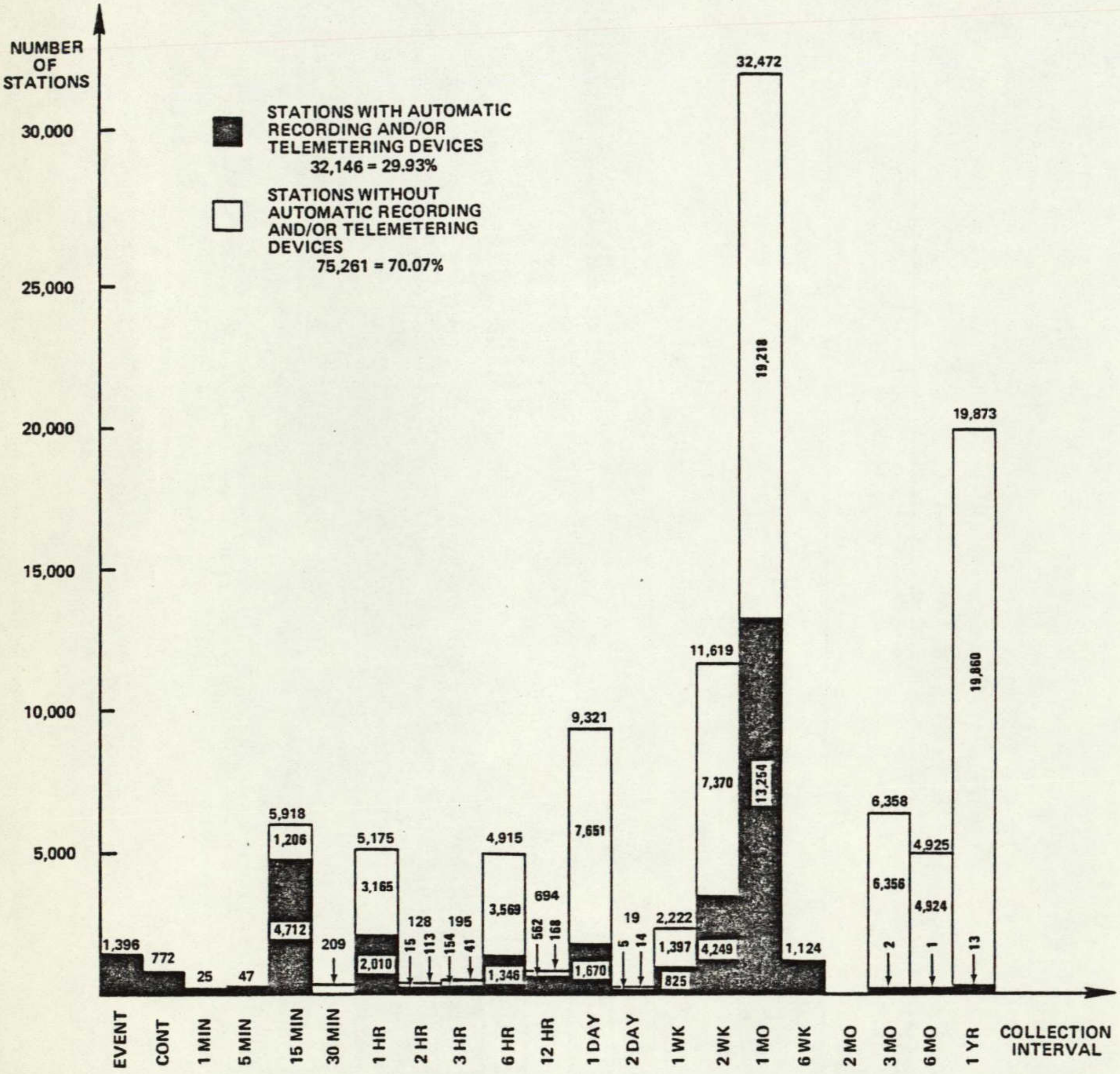


FIGURE 7.6. NUMBER OF STATIONS WITH AND WITHOUT AUTOMATIC RECORDING AND TELEMETERING DEVICES VERSUS COLLECTION INTERVAL

Figure 7.4 indicates that a relatively small percentage of the stations in the western part of the United States have automatic recording and/or telemetering equipment, as compared to a substantially larger percentage of the stations in the northeastern part of the United States.

Figure 7.5 indicates that a small percentage of the stations with message sizes of 5,000 bits or less have automatic recording and/or telemetering equipment, as compared to a substantially larger portion of the stations with message sizes of more than 5,000 bits. The obvious exception to this last general comment applies to stations which either monitor events or transmit data continuously.

Figure 7.6 indicates that a large percentage of the stations with frequent collection intervals have automatic recording and telemetering equipment. It also indicates that a medium percentage of the stations with medium collection intervals, and only a small percentage of the stations with infrequent collection intervals have automatic recording and/or telemetering equipment.

Histograms of Stations That Are Fixed or Mobile

The following histograms illustrate the number of data collection stations that are fixed or non-fixed (mobile and event) versus location (Figure 7.7), message size, (Figure 7.8), and collection interval (Figure 7.9). The stations that are non-fixed consist of: (1) the mobile stations that are capable of locating themselves; (2) the mobile stations that are not capable of locating themselves; and (3) the event stations that are not mobile but relay data only after a specific event has occurred. Only 4% of the total are mobile and event stations.

Figure 7.7 indicates that the largest portion of the stations that are not fixed are outside the 50 states. This result is expected because the mobile stations are ships and buoys in the ocean.

Figures 7.8 and 7.9 tend to indicate that the number of stations that are not fixed have random message sizes and collection intervals, spanning the entire range of these parameters.

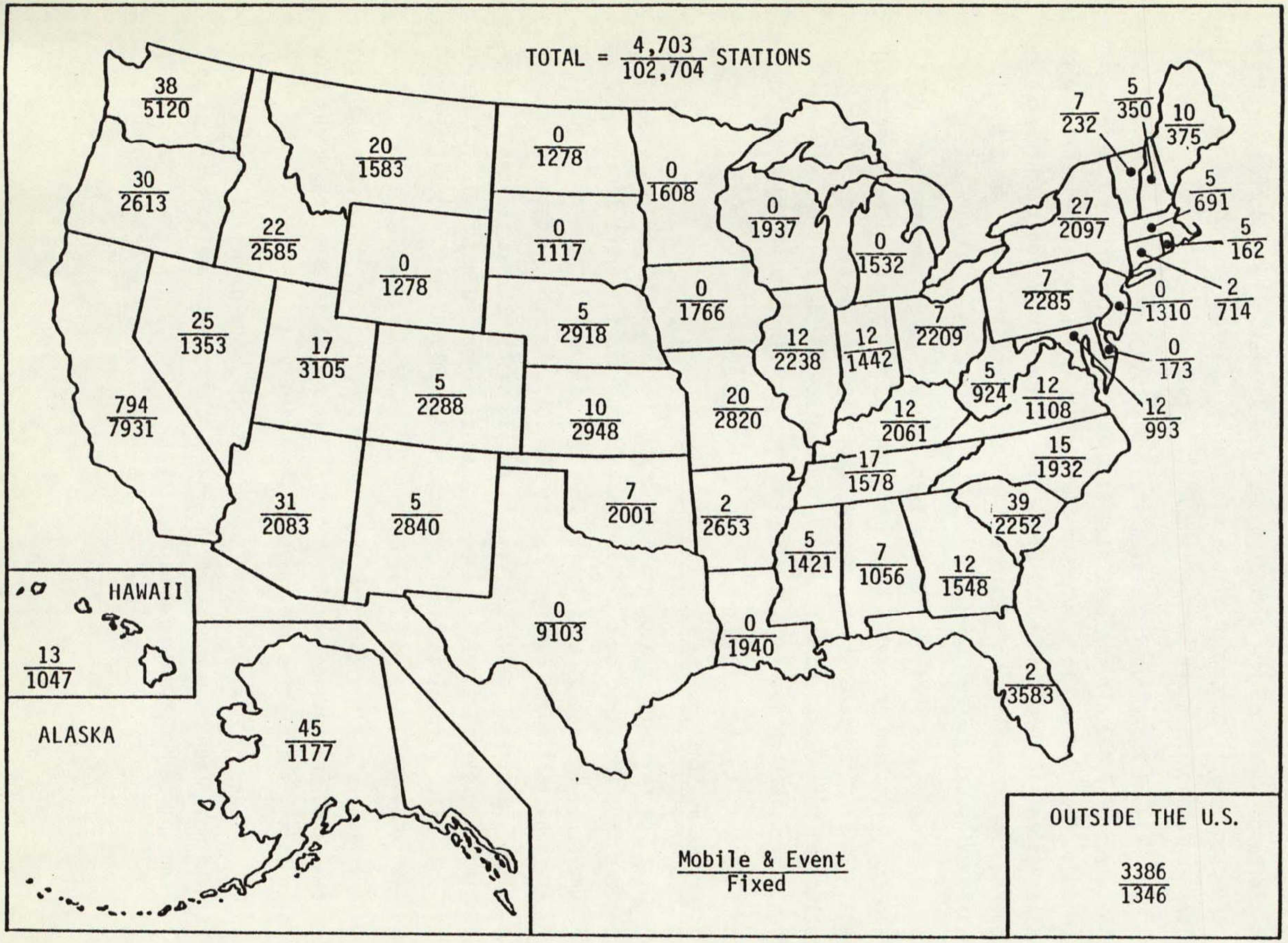


FIGURE 7.7. NUMBER OF FIXED STATIONS OR MOBILE AND EVENT STATIONS VERSUS LOCATION

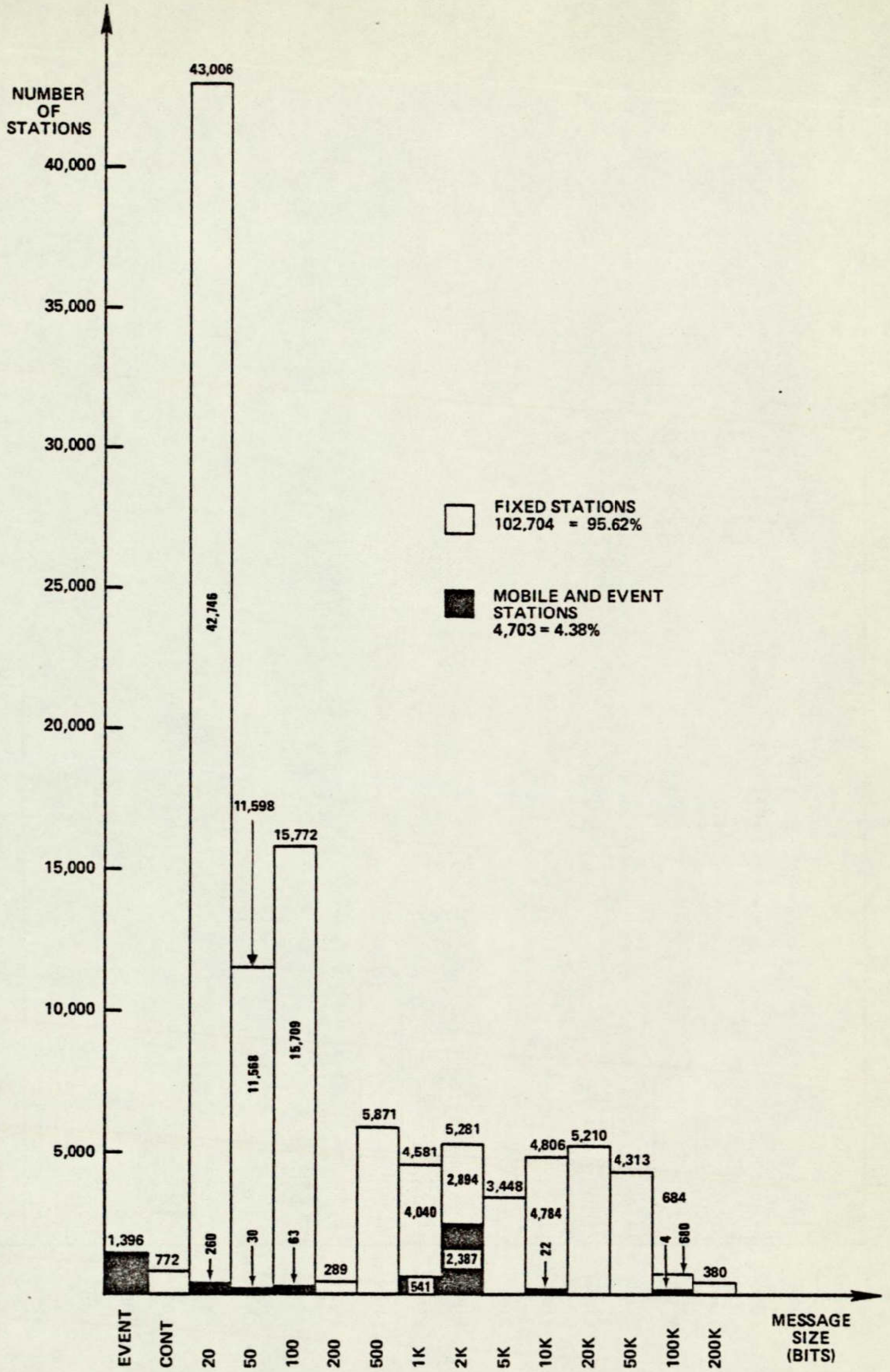


FIGURE 7.8. NUMBER OF FIXED STATIONS OR MOBILE AND EVENT STATIONS VERSUS MESSAGE SIZE

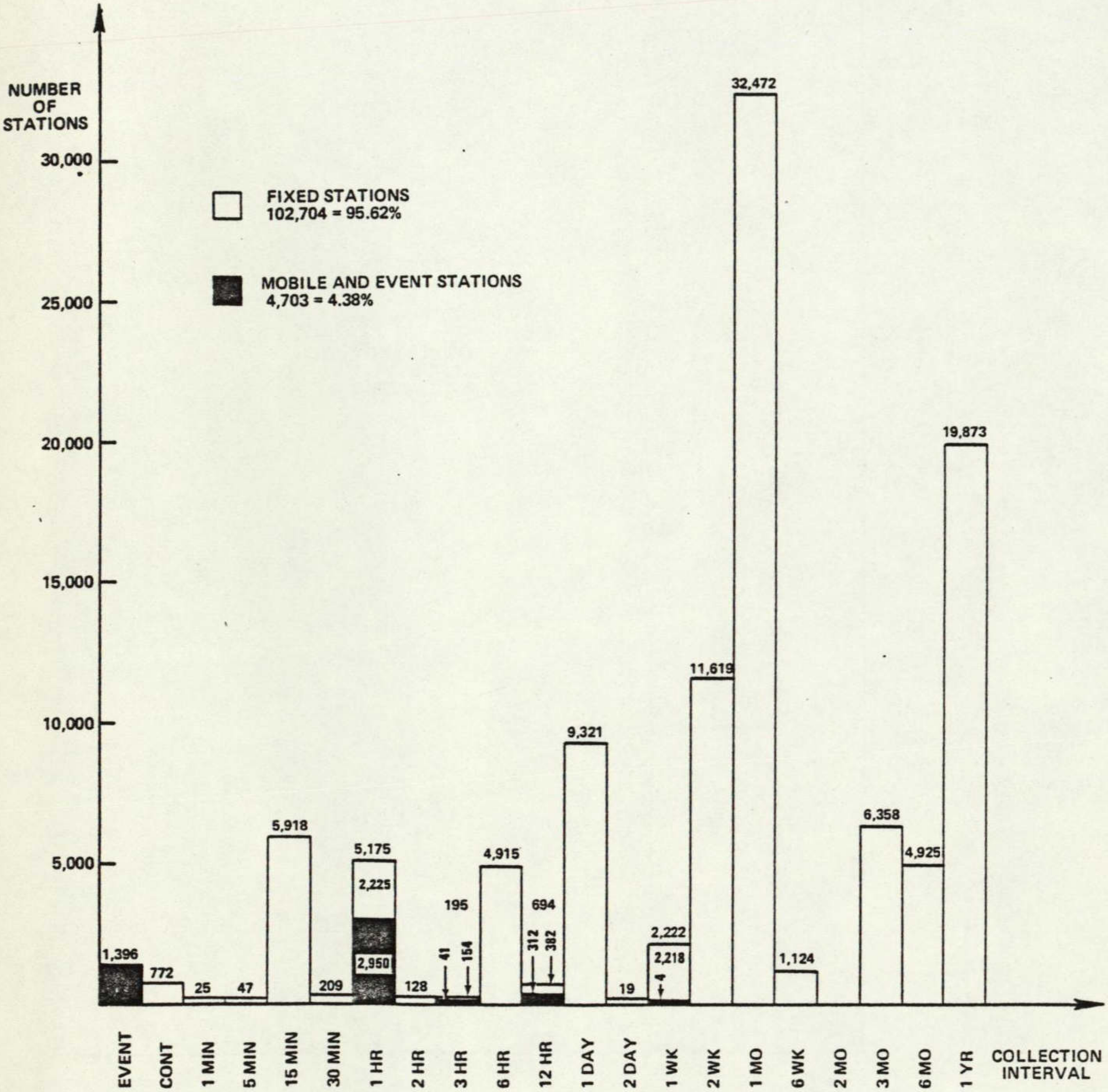


FIGURE 7.9. NUMBER OF FIXED STATIONS OR MOBILE AND EVENT STATIONS VERSUS COLLECTION INTERVAL

Histograms of Stations for Three Broad Ranges of Collection Interval

In this paragraph, the collection interval scale has been divided into the following three broad ranges:

- FAST - collection intervals ranging from 1 minute to 3 hours
- MEDIUM - collection intervals ranging from 6 hours to 2 months
- SLOW - collection intervals ranging from 3 months to 1 year.

The following histograms illustrate the number of data collection stations that are contained in each of these three ranges versus collection interval (Figure 7.10), message size (Figure 7.11), and location (Figure 7.12).

Figure 7.10 illustrates the three ranges of collection intervals and the number of stations contained in each. It should be noted that the stations that monitor events and the stations that collect data continuously are not contained in any of the three ranges of collection intervals.

Figure 7.11 indicates that all of the stations that have FAST collection intervals have messages that are 5 kilobits or less, and that more than half have messages that are 100 bits or less. The large messages being collected so frequently are weather observations for weather forecasting. This histogram also indicates that all of the stations that have SLOW collection intervals have message sizes of 100 bits or less.

Figure 7.12 indicates that the portion of stations in the western part of the United States that have SLOW collection intervals is significantly higher than average. This is due to the large number of ground water monitoring stations in this area.

Histograms of Stations Operated by Federal and Non-Federal Agencies

Data collection stations are operated by both Federal and non-Federal agencies. In the following three figures, the number of data collection stations that are operated by (or for) Federal and non-Federal agencies

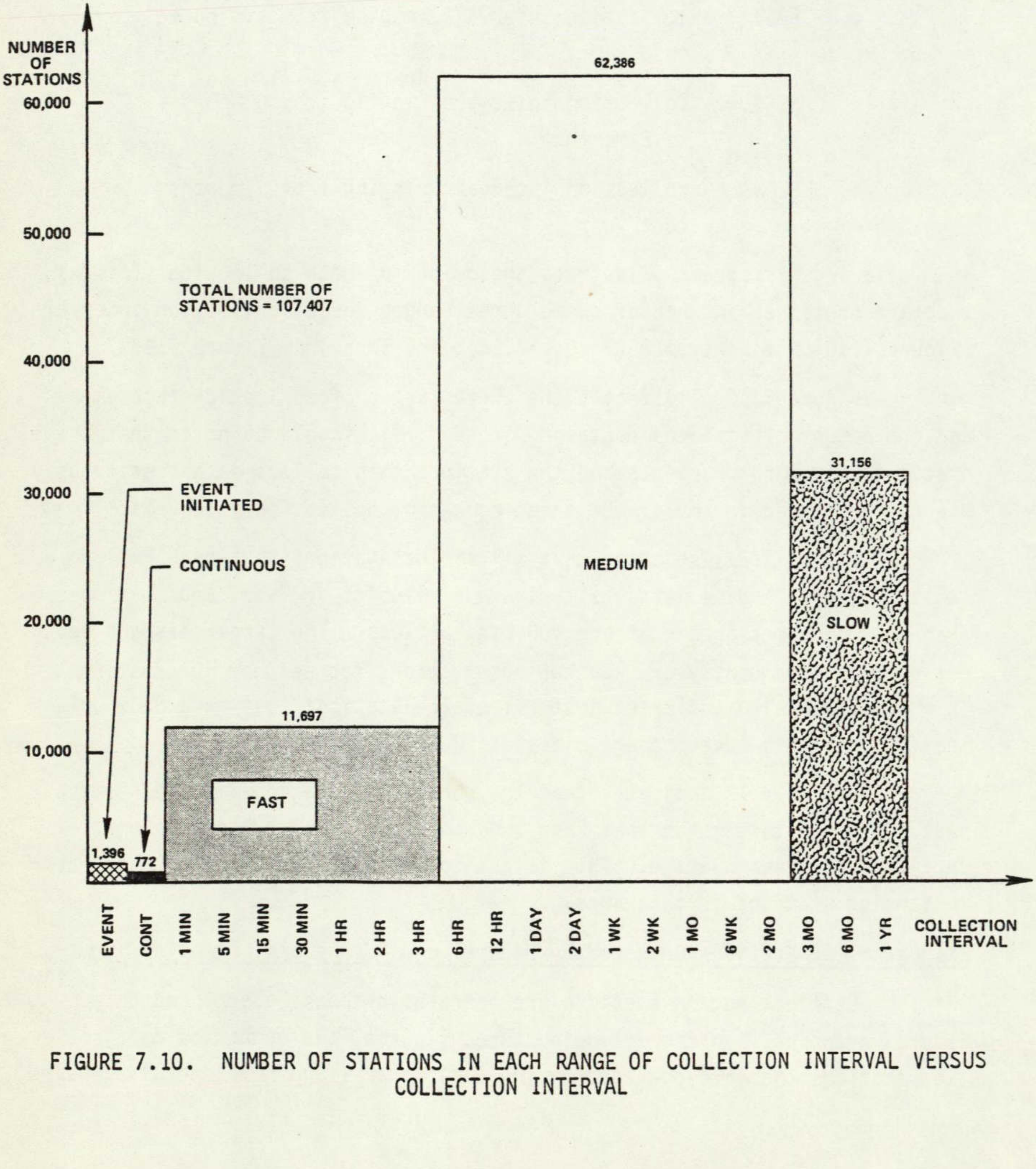


FIGURE 7.10. NUMBER OF STATIONS IN EACH RANGE OF COLLECTION INTERVAL VERSUS COLLECTION INTERVAL

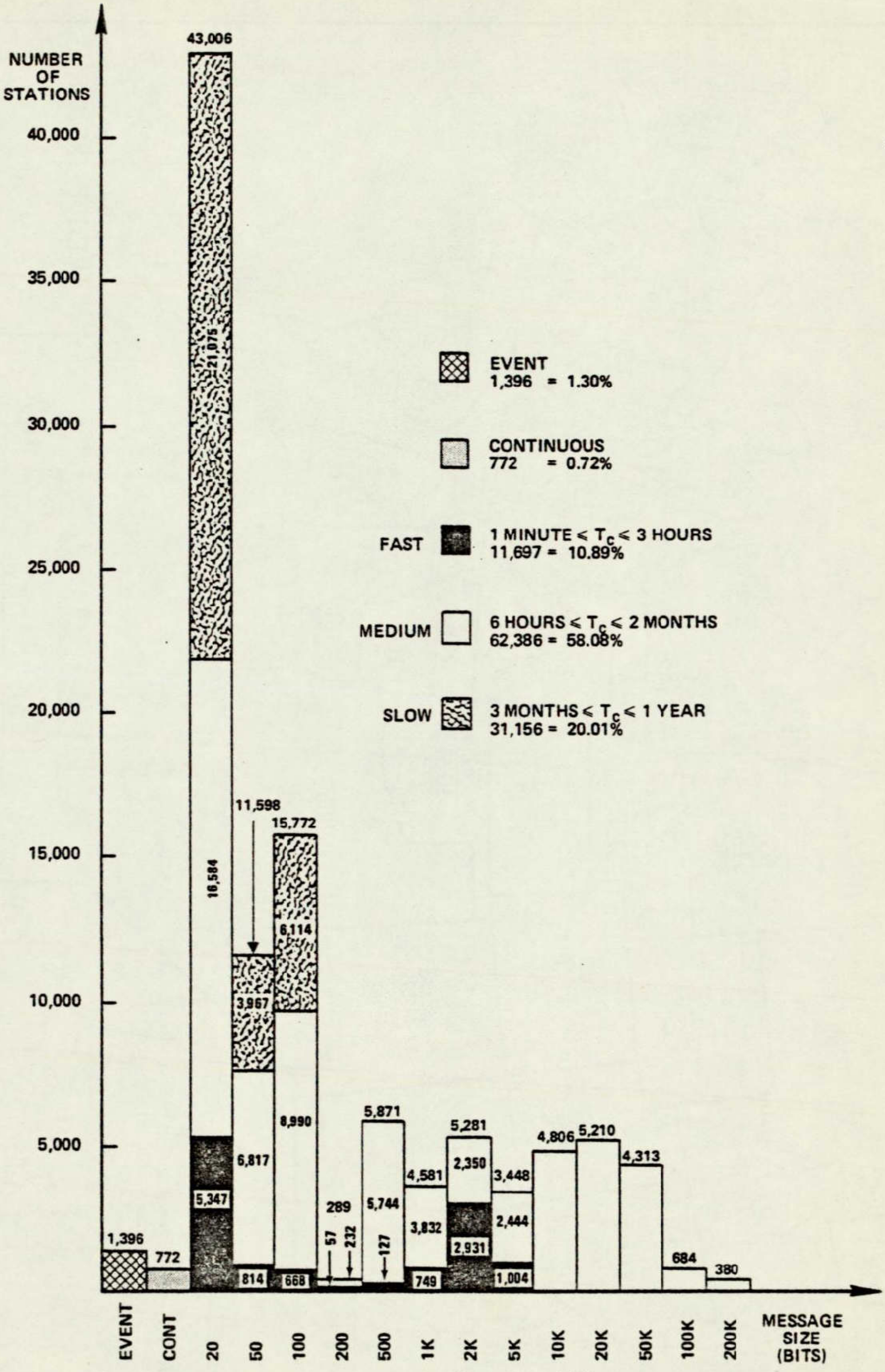


FIGURE 7.11. NUMBER OF STATIONS IN EACH RANGE OF COLLECTION INTERVAL VERSUS MESSAGE SIZE

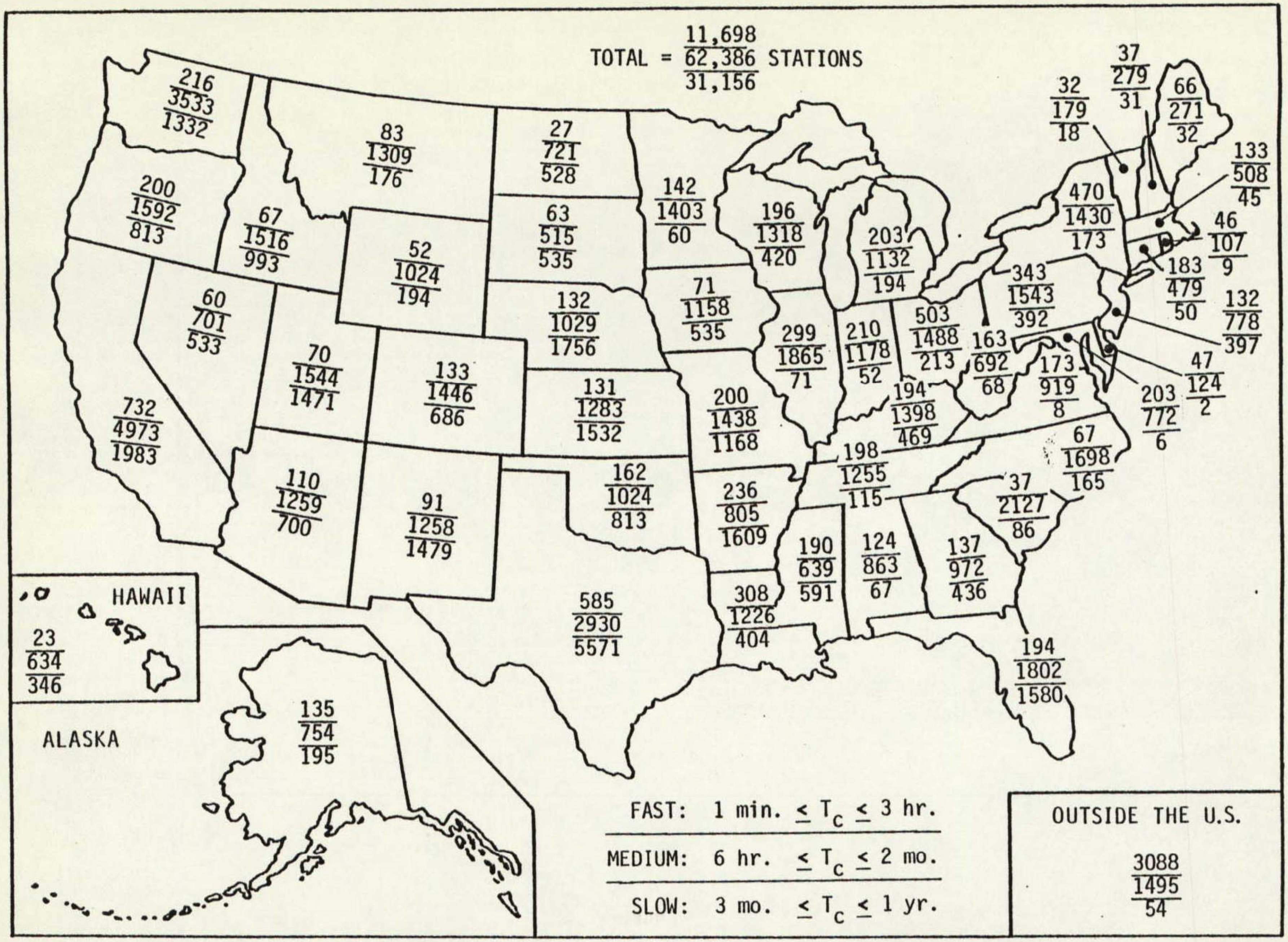


FIGURE 7.12. NUMBER OF STATIONS IN EACH RANGE OF COLLECTION INTERVAL VERSUS LOCATION

is shown. As before, these histograms illustrate the number of stations versus location (Figure 7.13), message size (Figure 7.14), and collection interval (Figure 7.15).

Figure 7.13 indicates that the percentage of stations in a state that are operated by non-Federal agencies may range from more than half, in the case of Delaware, to less than 10%, as occurs in the mid-western part of the United States.

Figure 7.14 indicates that a simple histogram of the number of Federal stations versus message size would look almost identical to a simple histogram of the number of non-Federal stations versus message size. Figure 7.15 indicates that the same is true for collection interval. This similarity is due to the fact that a large part of the monitoring that is done by non-Federal agencies is done in cooperation with Federal agencies.

PART II - CHARACTERISTICS OF SPECIFIC GROUPS OF STATIONS

Several distinct groups of stations that were discussed in general in Part I required more detailed descriptions. These groups of stations are:

- Stations that automatically record and telemeter data
- Mobile and event station
- Stations with FAST, MEDIUM, and SLOW collection intervals.

The Federal and Non-Federal stations are not discussed in more detail because this distinction between stations did not indicate any substantial difference in characteristics.

The description of the stations that have automatic recording and telemetering equipment include histograms of the number of stations and amount of data collected, and the densities of each. These parameters are discussed with respect to location, message size, and collection interval.

Two types of mobile stations and the event stations are described individually and are illustrated by histograms of the number of these stations versus location, message size and collection interval.

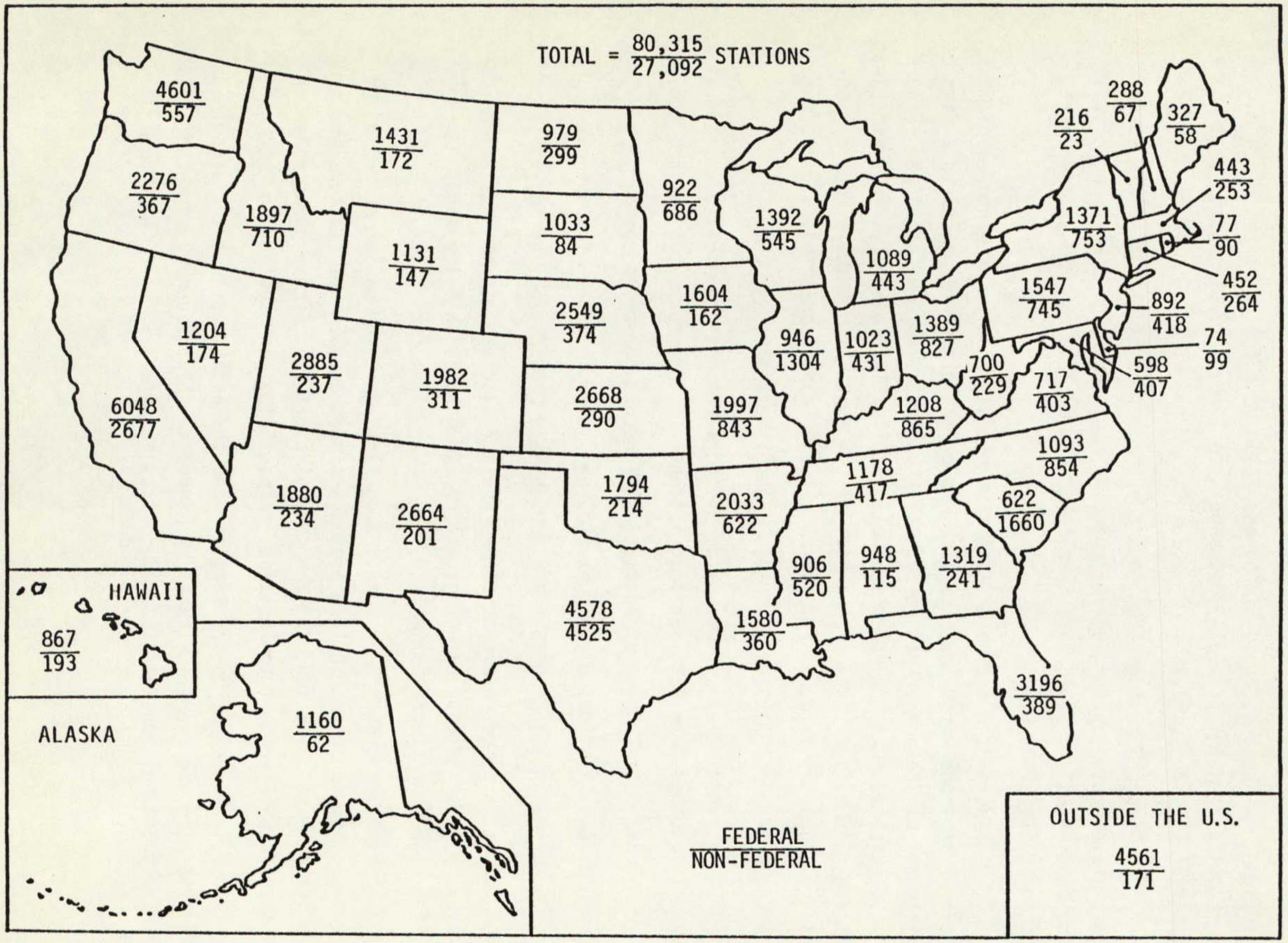


FIGURE 7.13. NUMBER OF FEDERAL AND NON-FEDERAL STATIONS VERSUS LOCATION

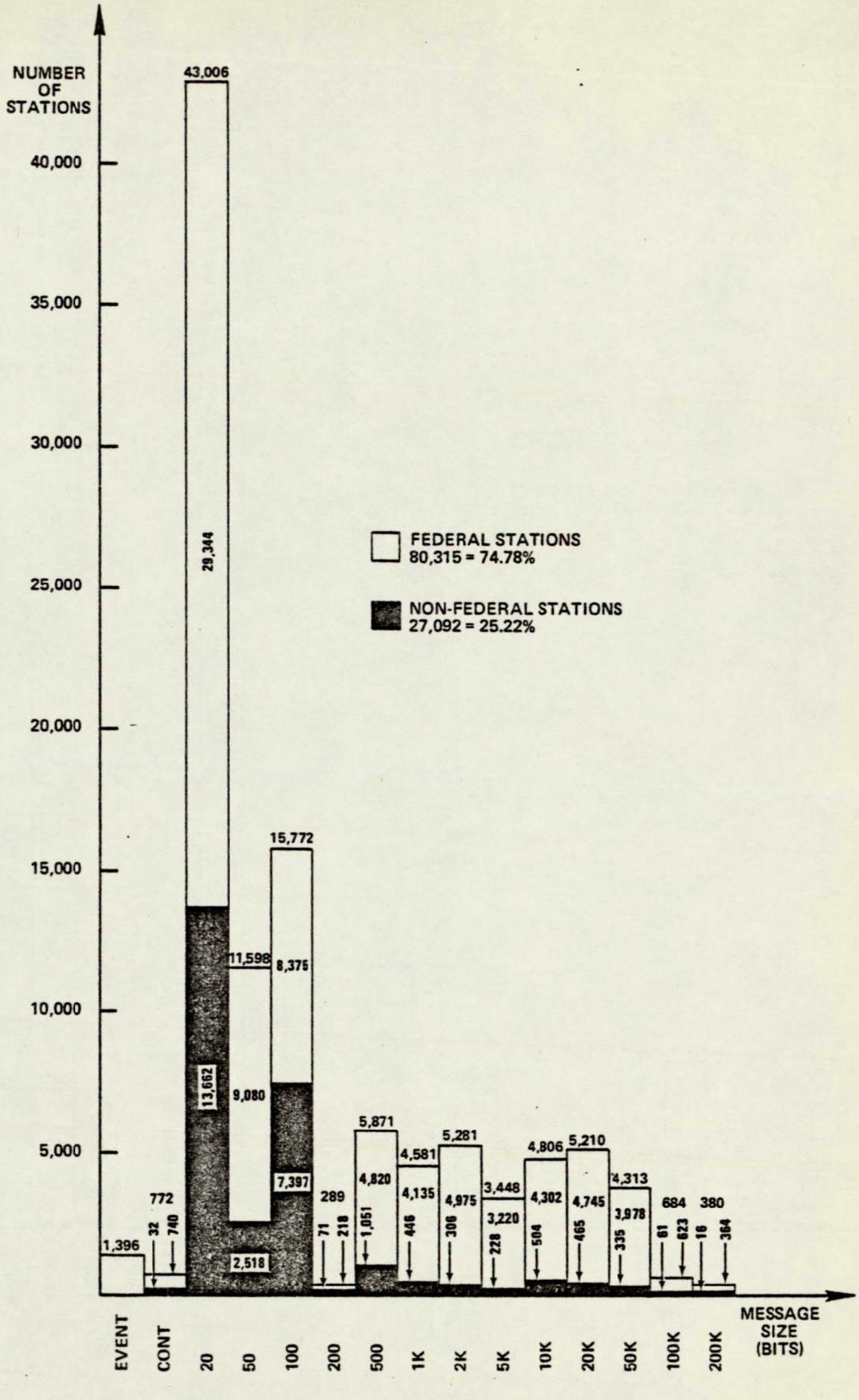


FIGURE 7.14. NUMBER OF FEDERAL AND NON-FEDERAL STATIONS VERSUS MESSAGE SIZE

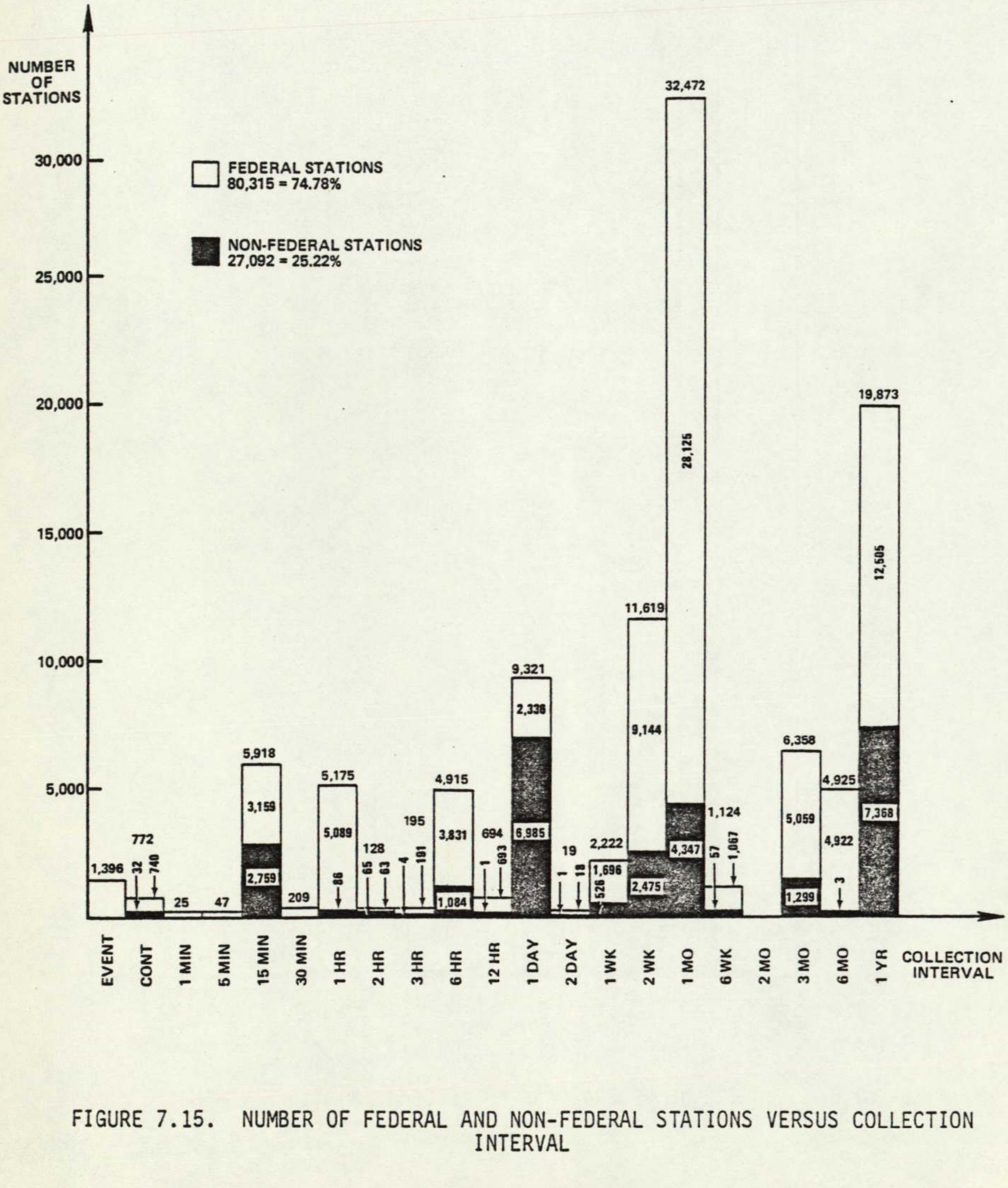


FIGURE 7.15. NUMBER OF FEDERAL AND NON-FEDERAL STATIONS VERSUS COLLECTION INTERVAL

The stations that have collection intervals in each of the three ranges, FAST, MEDIUM, and SLOW, are presented and discussed separately. The discussion includes histograms of the number and density of stations according to location.

In addition to the results that deal with the characteristics of these specific groups of stations, other histograms of interest are included. These histograms provide a more complete description of the total number of stations. They also illustrate the characteristics of the stations that collect data continuously, which, until this point, have not been discussed.

Histograms of Stations with Automatic Recording and Telemetering Devices

This section presents the characteristics of the stations that have automatic recording and/or telemetering equipment. It should be noted that some stations have both recording and telemetering devices. These stations are contained in the histograms of the stations that automatically record data, and in the histograms of the stations that automatically telemeter data. Two of the following histograms illustrate the number of data collection stations with automatic recording devices versus location (Figure 7.16), and the density* of these stations (Figure 7.17). Following this are two histograms that illustrate the number of stations with automatic telemetering devices versus location (Figure 7.18), and the density* of these stations (Figure 7.19). Finally, the last two histograms illustrate the number of stations with automatic recording and telemetering devices versus message size (Figure 7.20), and collection interval (Figure 7.21).

Figures 7.16 and 7.17 indicate that the highest density of stations with automatic recording devices occurs in the eastern half of the United States.

Figures 7.18 and 7.19 indicate that the highest density of stations with automatic telemetering devices occurs in the northeastern part of the United States.

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*Density of stations is defined as the number of stations per unit area. Typical units of the density of stations are number of stations per 1,000 square miles and number of stations per 10,000 square miles.

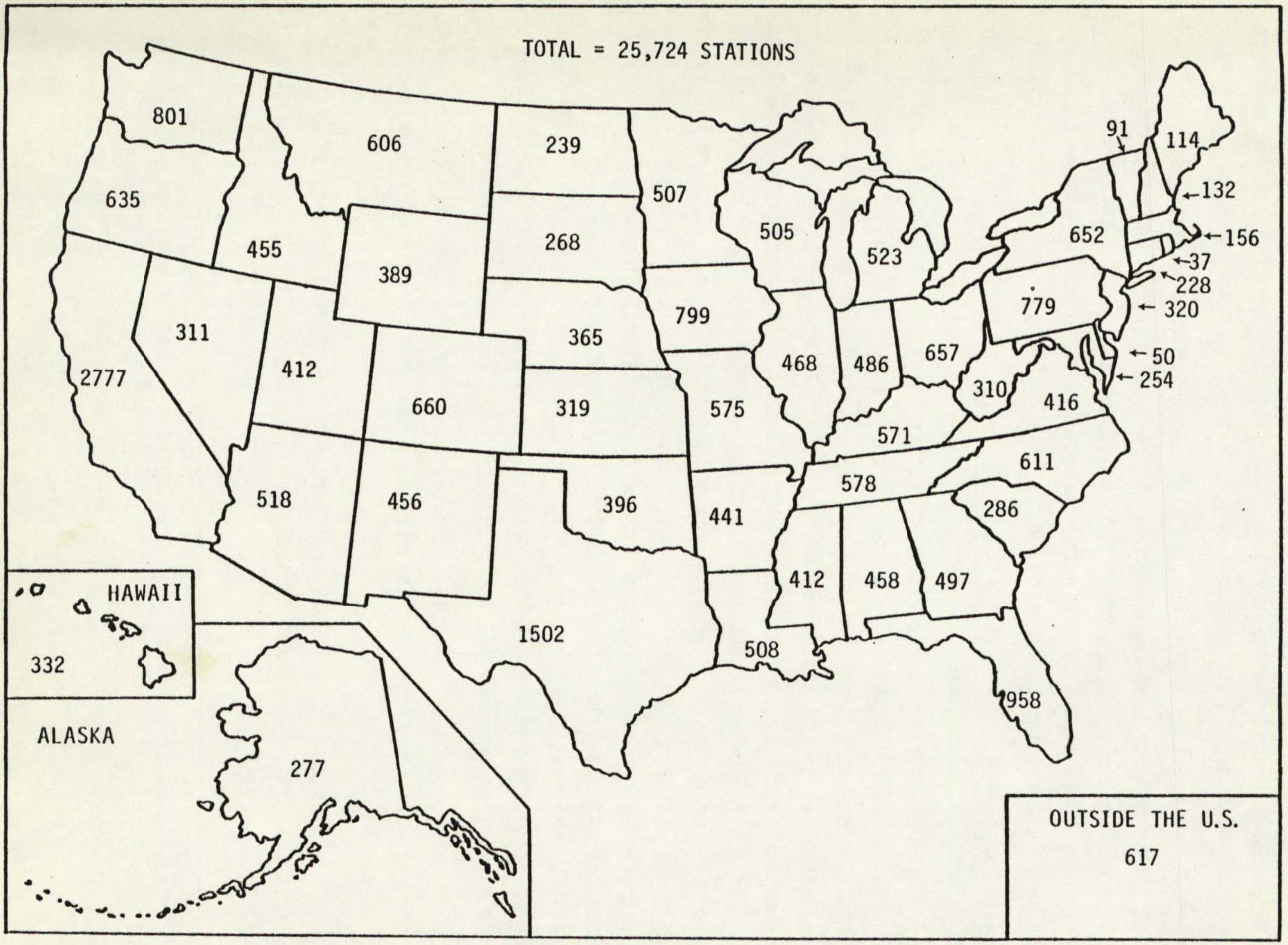

FIGURE 7.16. NUMBER OF DATA COLLECTION STATIONS WITH AUTOMATIC RECORDING DEVICES VERSUS LOCATION

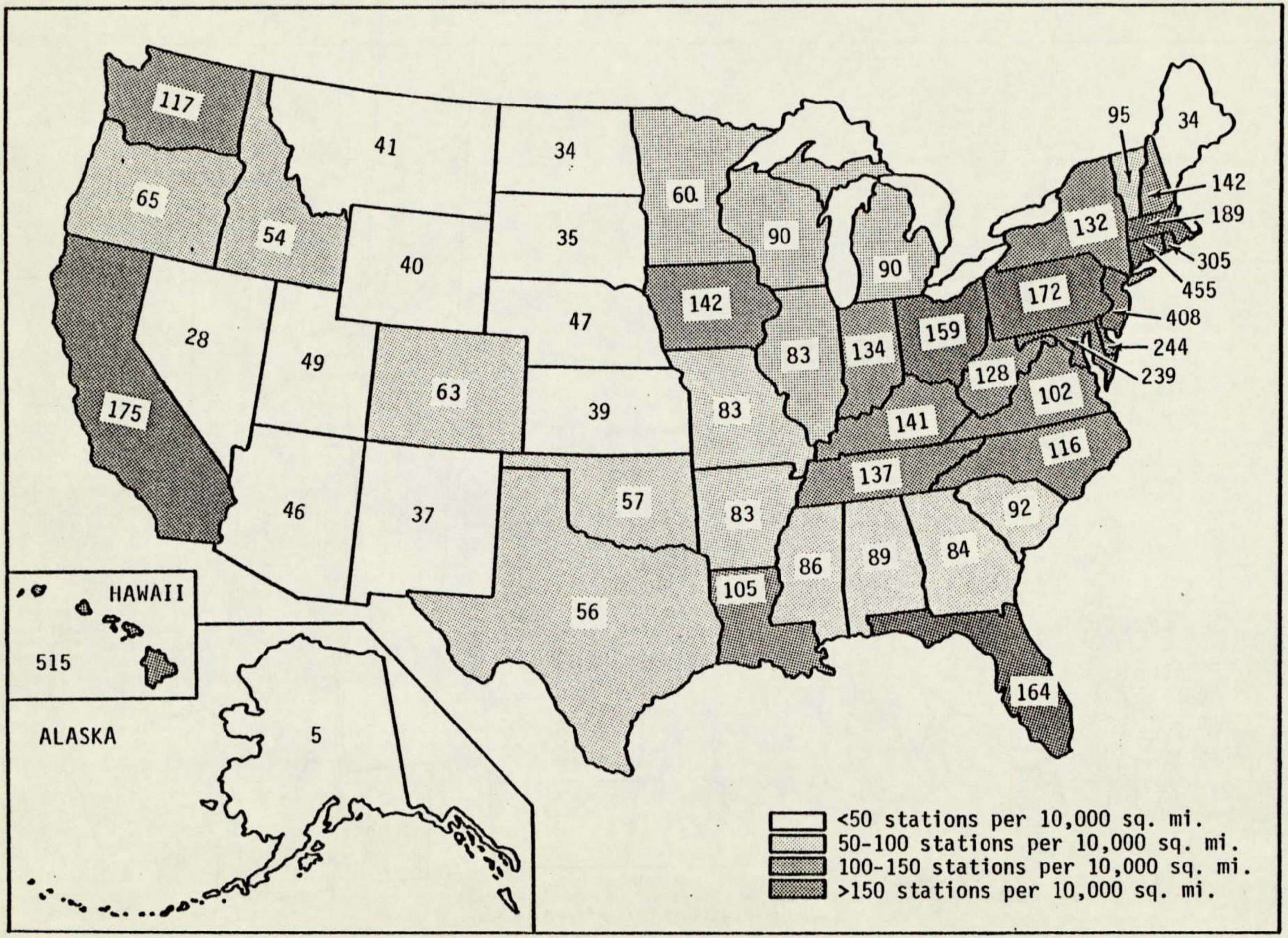

FIGURE 7.17. DENSITY OF DATA COLLECTION STATIONS WITH AUTOMATIC RECORDING DEVICES VERSUS LOCATION

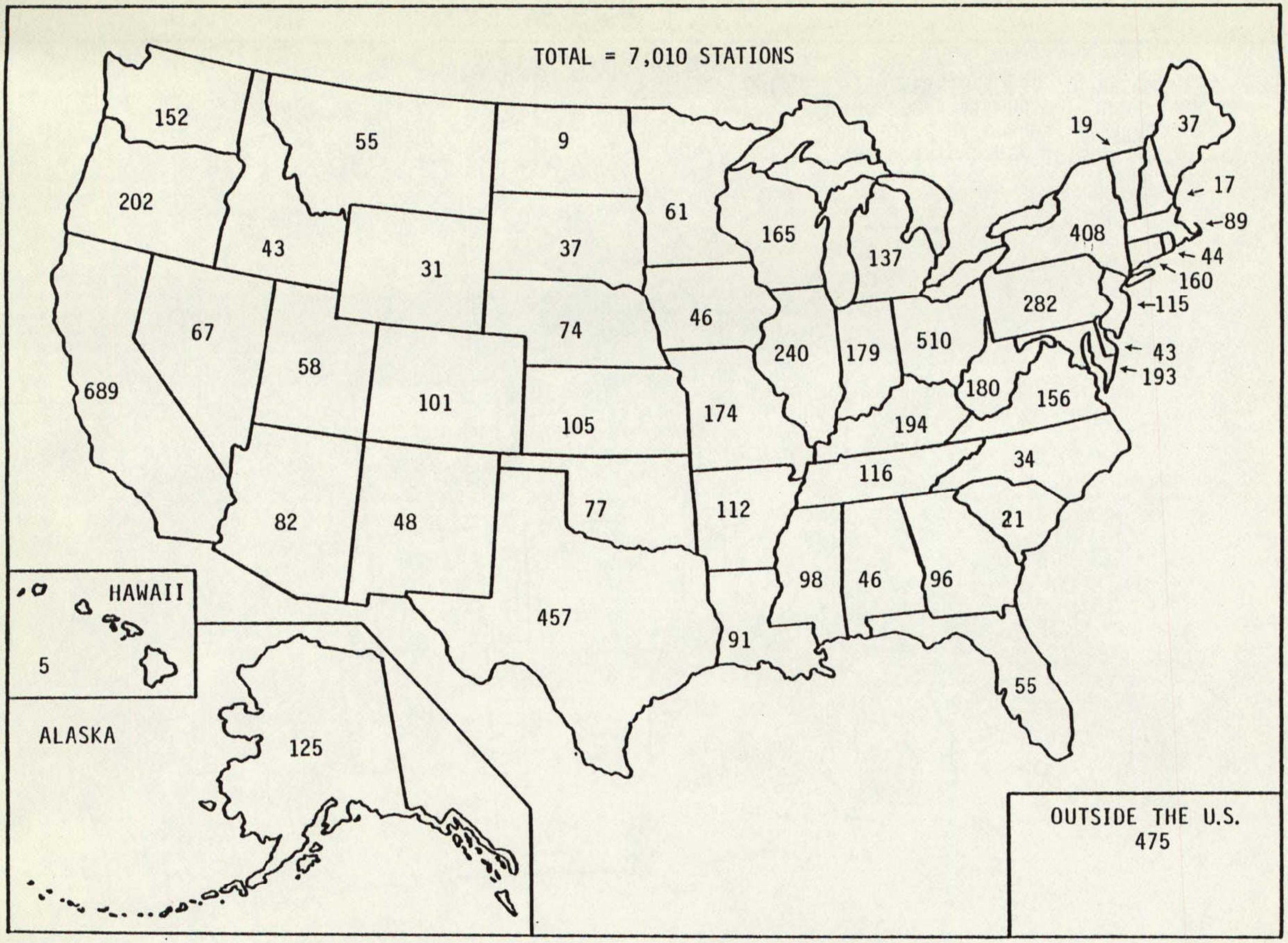

FIGURE 7.18. NUMBER OF DATA COLLECTION STATIONS WITH AUTOMATIC TELEMETERING DEVICES VERSUS LOCATION

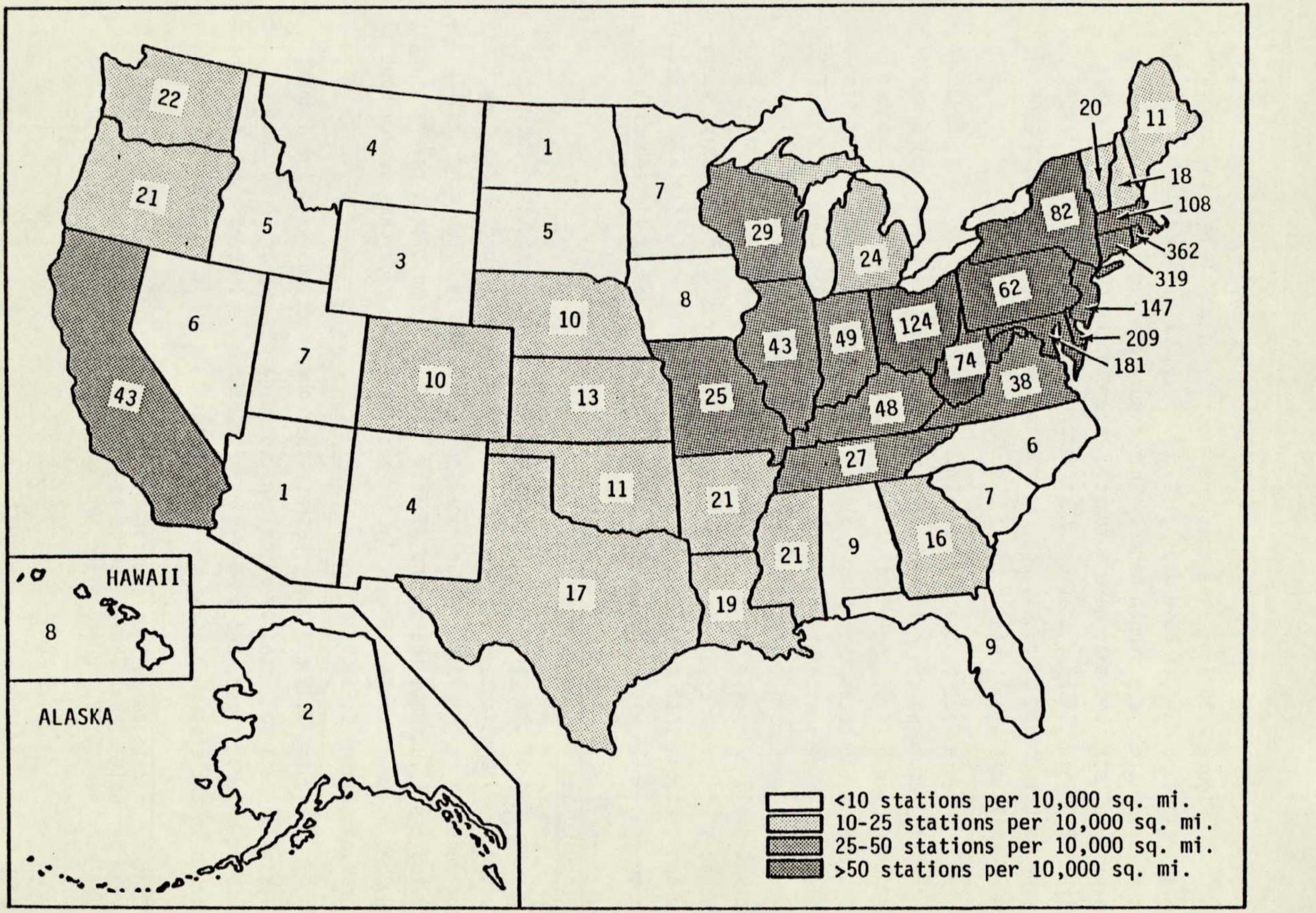

FIGURE 7.19. DENSITY OF DATA COLLECTION STATIONS WITH AUTOMATIC TELEMETERING DEVICES VERSUS LOCATION

Figure 7.20 indicates that the majority of stations that have automatic recording devices have message sizes of 10, 20, and 50 kilobits. Many of these stations are stream gages. This figure also indicates that the majority of stations that have automatic telemetering devices have message sizes of 20 bits. Thus, stations that record data tend to collect large messages (thousands of bits), whereas stations which telemeter data generally relay small messages (tens of bits).

Figure 7.21 indicates that almost three quarters of the stations having automatic recording devices have collection intervals between 2 and 6 weeks, and that over half of the stations have a collection interval of 1 month. This figure also indicates that nearly all of the stations that have automatic telemetering devices have collection intervals that range from continuous to 1 day, and that more than two thirds of these stations have a collection interval of 15 minutes. Hence, stations that record data tend to collect the messages of thousands of bits (see Figure 7.20) approximately monthly, whereas the stations that telemeter the messages of tens of bits (see Figure 7.21) do so frequently with a collection interval on the order of fifteen minutes.

Histograms of the Amount of Data Collected by Automatic Recording and Telemetering Devices

Two of the following histograms illustrate the amount of data collected by automatic recording devices versus location (Figure 7.22), and the density* of this data versus location (Figure 7.23). The other two histograms illustrate the amount of data collected by automatic telemetering devices versus location (Figure 7.24), and the density* of this data versus location (Figure 7.25).

Figures 7.22 and 7.23 indicate that the locations with the highest density of data collected by automatic recording devices are scattered throughout the United States, and that a generally higher density of these stations occurs in the eastern half of the United States.

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*Density of data collected is defined as the amount of data collected per year per unit area. Typical units of density of data collected are megabits per year per 10,000 square miles, and megabits per year per 100,000 square miles.

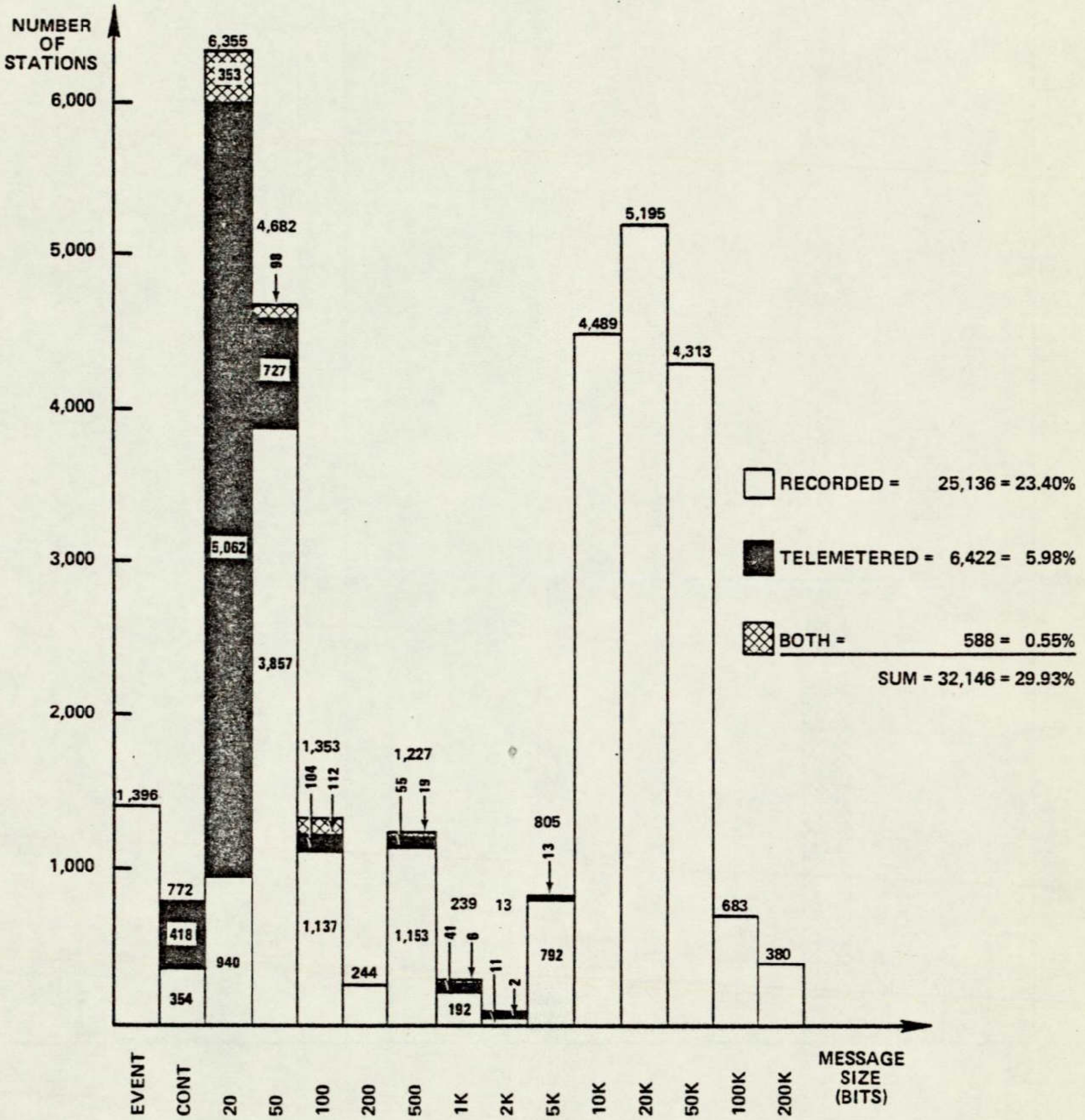


FIGURE 7.20. NUMBER OF STATIONS WITH AUTOMATIC RECORDING AND TELEMETERING DEVICES VERSUS MESSAGE SIZE

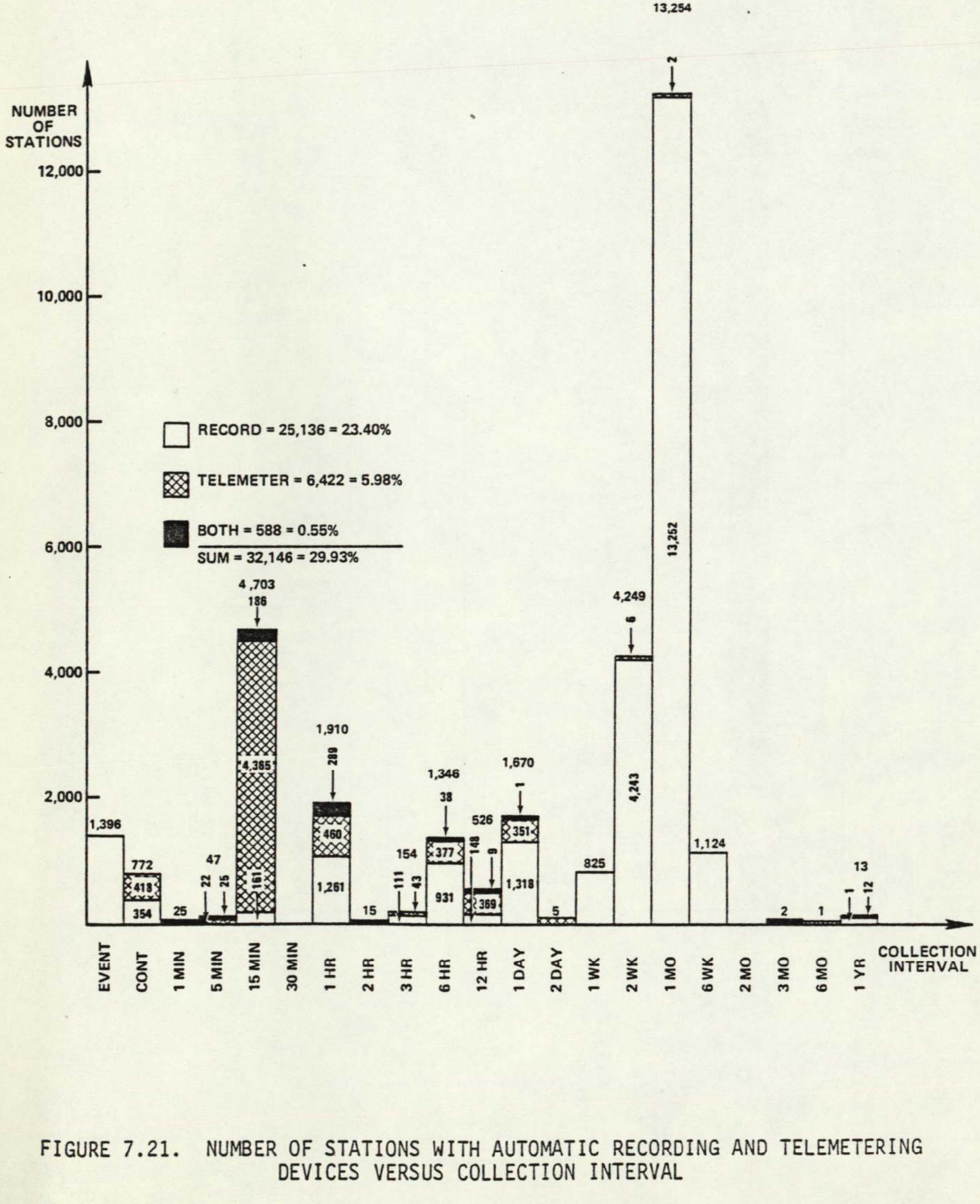


FIGURE 7.21. NUMBER OF STATIONS WITH AUTOMATIC RECORDING AND TELEMETERING DEVICES VERSUS COLLECTION INTERVAL

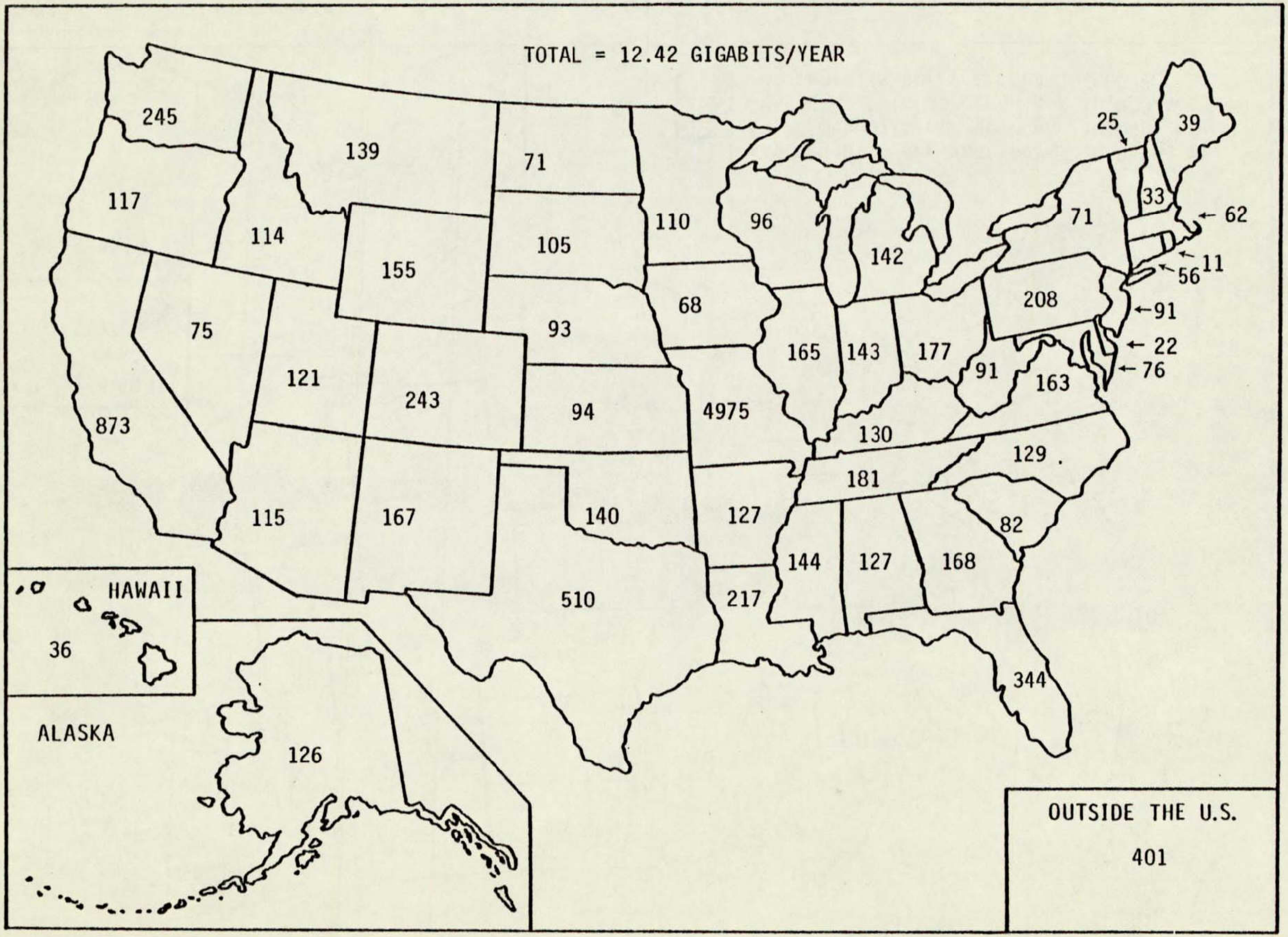


FIGURE 7.22. AMOUNT OF DATA COLLECTED (MEGABITS PER YEAR) BY AUTOMATIC RECORDING DEVICES VERSUS LOCATION

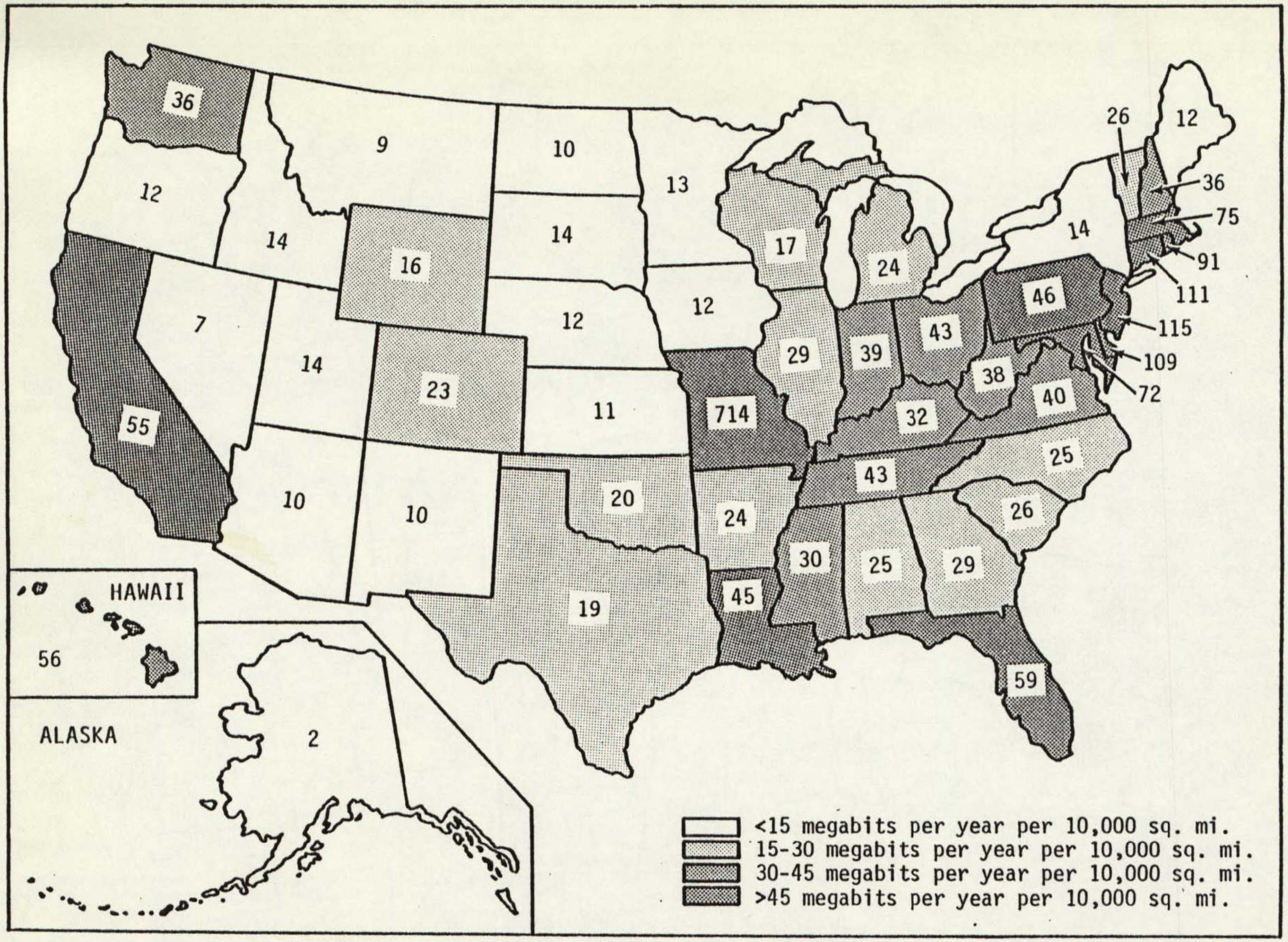


FIGURE 7.23. DENSITY OF DATA COLLECTED BY AUTOMATIC RECORDING DEVICES VERSUS LOCATION

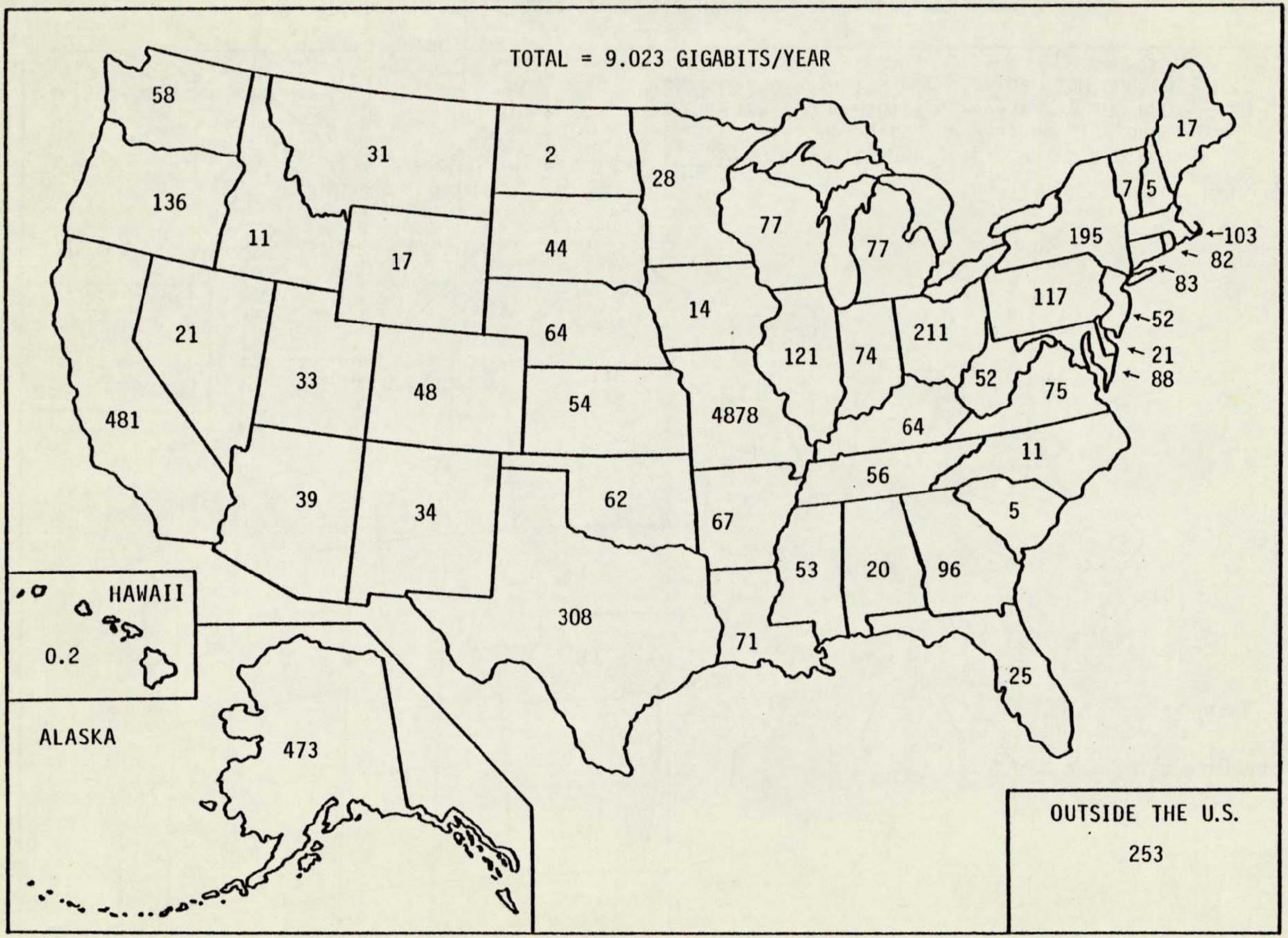


FIGURE 7.24. AMOUNT OF DATA COLLECTED (MEGABITS PER YEAR) BY AUTOMATIC TELEMETERING DEVICES VERSUS LOCATION

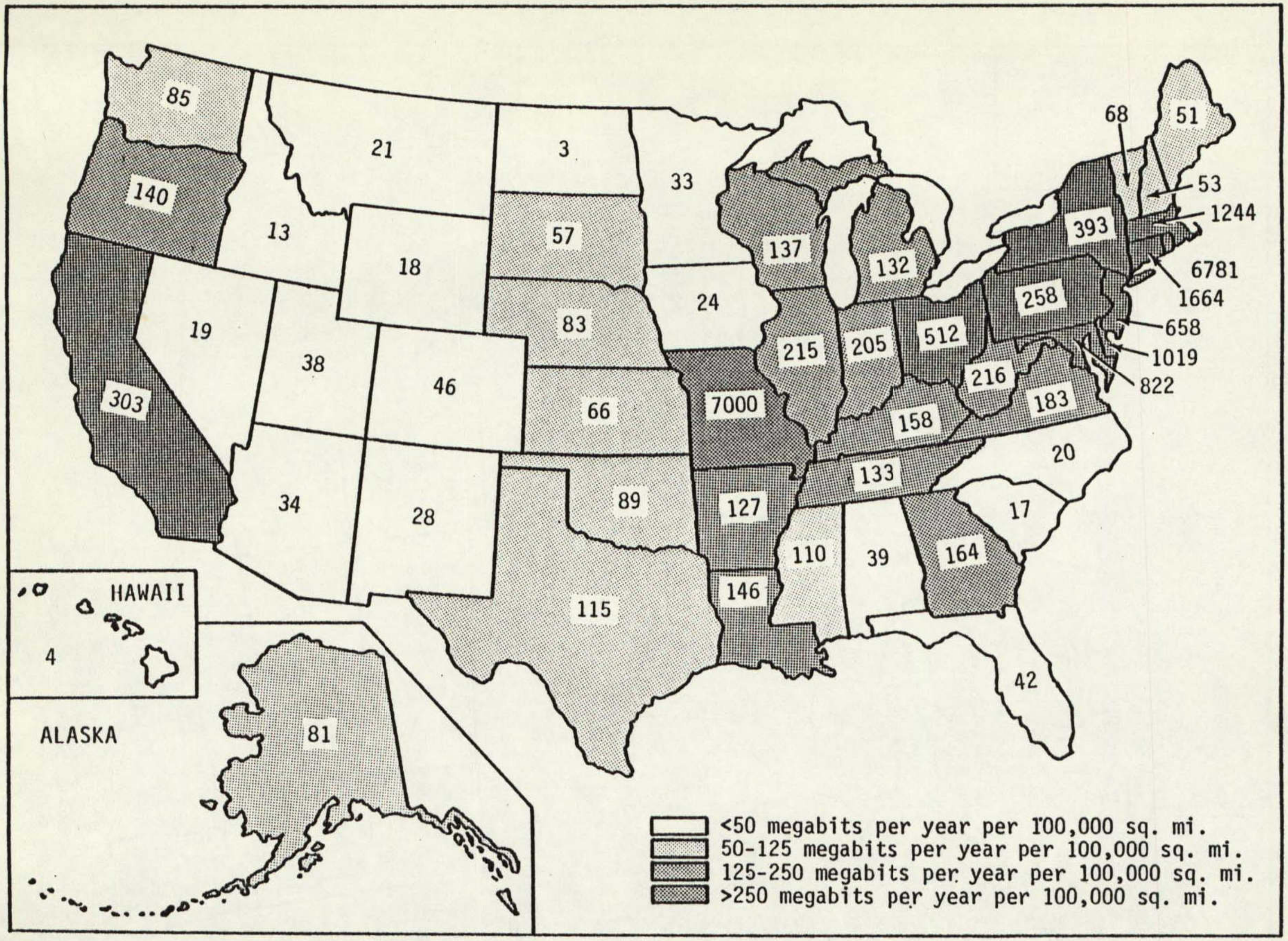


FIGURE 7.25. DENSITY OF DATA COLLECTED BY AUTOMATIC TELEMETERING DEVICES VERSUS LOCATION

Figures 7.24 and 7.25 indicate that the lowest density of data collected by automatic telemetering devices occurs in the Rocky Mountain states, and that the highest density of this data occurs in the northeastern part of the United States.

It should be noted that the amount and density of data collected by automatic recording and telemetering devices in the state of Missouri has been distorted by the data collected by the stations in the Regional Air Monitoring System. The stations in this network record and telemeter almost 4.8 gigabits of data per year. This network alone would produce a density of data collected in Missiouri of 680 megabits per year per 10,000 square miles, or 6800 megabits per year per 100,000 square miles. It should also be noted that this single network collects more than half of all the data that is collected by telemetry in the United States.

Histograms of the Mobile and Event Type Stations

The following histograms illustrate the number of event stations versus location (Figure 7.26), and the number of mobile and event stations versus message size (Figure 7.27) and collection interval (Figure 7.28).

The event stations illustrated in Figure 7.26 are stations that are in the Tusnami Warning System and the Strong Motion Network. For this reason, most of the stations occur in the parts of the United States where earthquakes are likely to occur, and outside the United States in the Pacific Ocean. It should be noted that a histogram of the mobile stations versus location has not been provided because all of the mobile stations are located outside the United States.

Figures 7.27 and 7.28 illustrate the number of each type of mobile station and the number of event stations versus message size, and collection interval. The two types of mobile stations are:

- Mobile S - Mobile stations that are capable of locating themselves
- Mobile B - Mobile stations that are not capable of locating themselves.

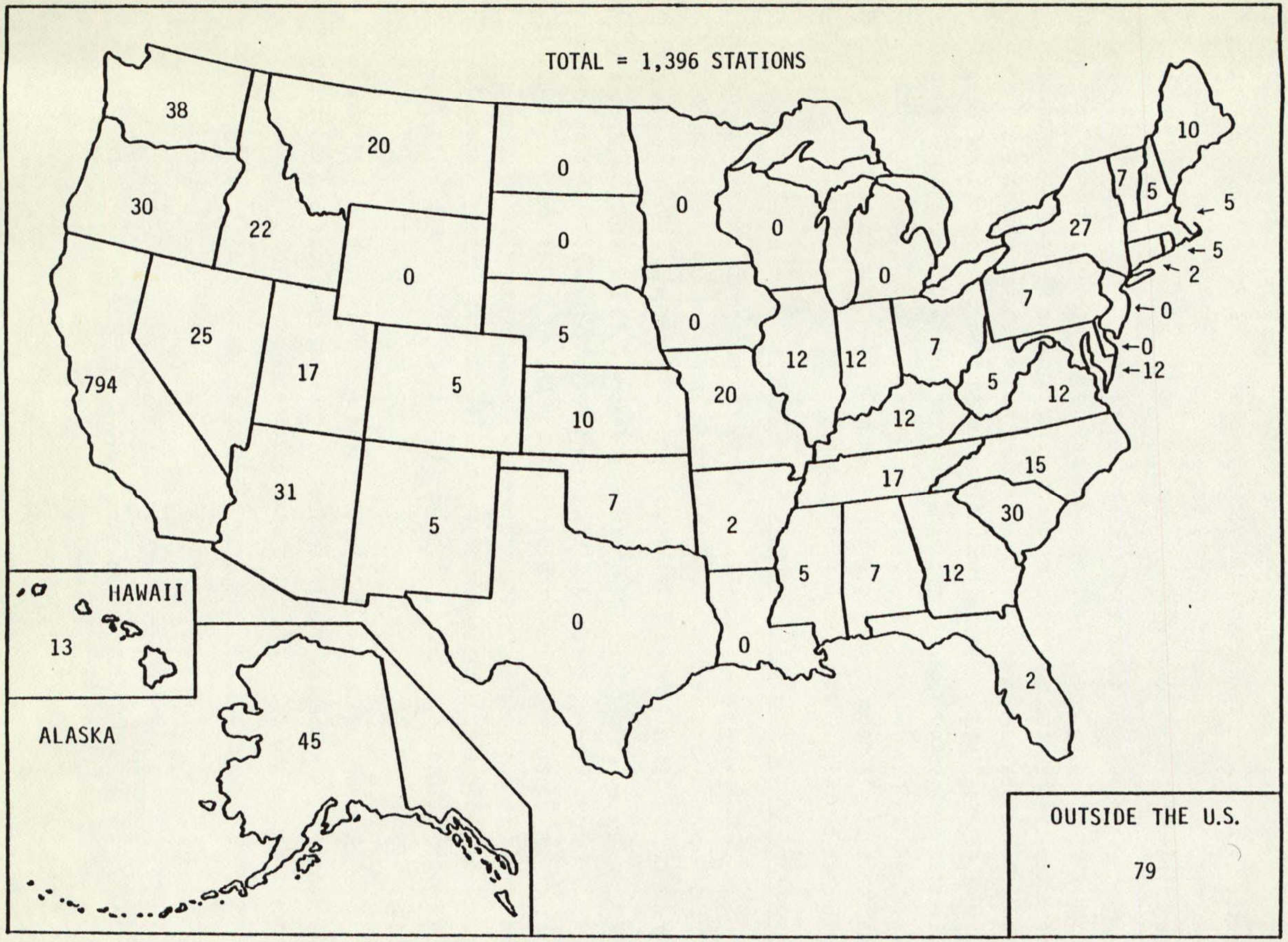


FIGURE 7.26. NUMBER OF EVENT STATIONS VERSUS LOCATION

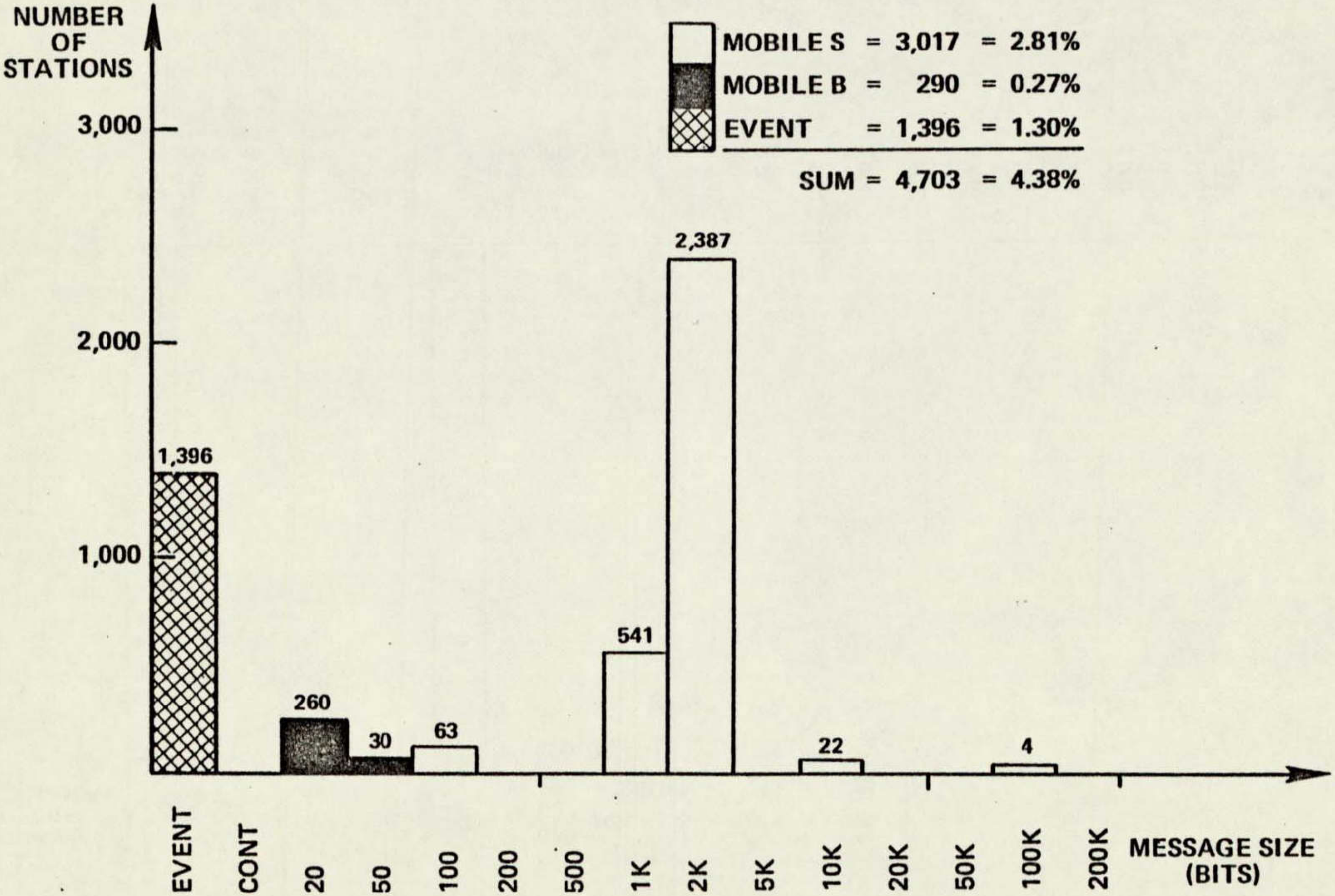


FIGURE 7.27. NUMBER OF MOBILE AND EVENT STATIONS VERSUS MESSAGE SIZE

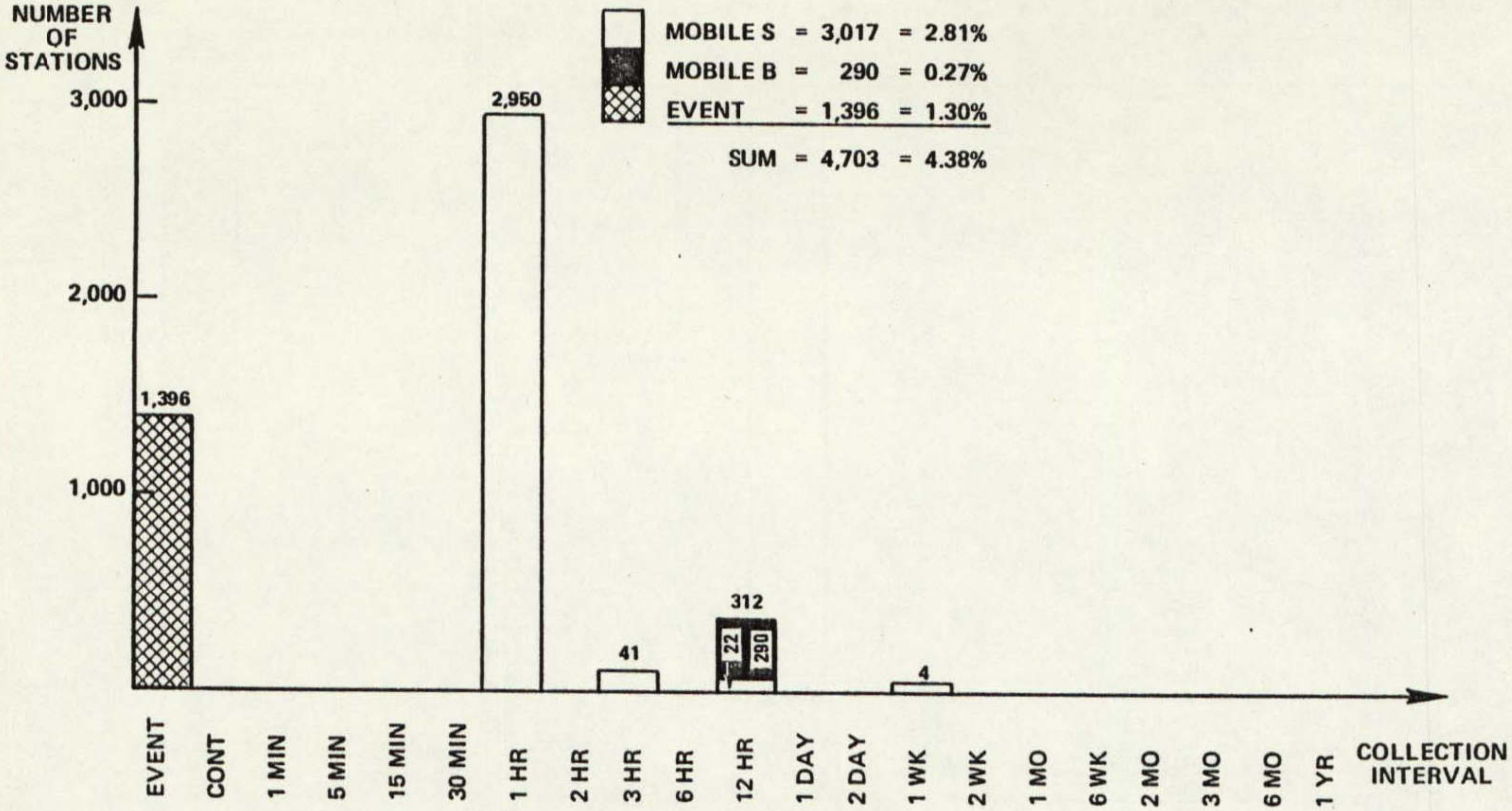


FIGURE 7.28. NUMBER OF MOBILE AND EVENT STATIONS VERSUS COLLECTION INTERVAL

These histograms indicate that the majority of the mobile stations are capable of locating themselves, have message sizes of 1 and 2 kilobits, and have a collection intervals of 1 hour. Most of these mobile stations are ships making weather observations.

Histograms of the Number and Density of Stations in the Three Ranges of Collection Intervals

The six histograms presented here illustrate the number and density of data collection stations in each of the three broad ranges of collection intervals discussed in Part I (SLOW, MEDIUM, and FAST).

Figures 7.29 and 7.30 illustrate the number and density of stations having FAST collection intervals (between 1 minute and 3 hours) versus location. These histograms indicate that the highest density of stations having FAST collection intervals occurs in the northeastern part of the United States. They also indicate that the lowest density of these stations occurs in the Rocky Mountain states.

Figures 7.31 and 7.32 illustrate the number and density of stations that have MEDIUM collection intervals (between 6 hours and 2 months) versus location. These histograms indicate that the higher densities of stations occur in the eastern half of the United States. It should also be noted that all of the states that have densities greater than 50 stations per 1,000 square miles are coastal states.

Figures 7.33 and 7.34 illustrate the number and density of stations having SLOW collection intervals (between 3 months to 1 year) versus location. These histograms indicate that the highest density of stations is in the south central part of the United States.

Additional Histograms of Interest

In addition to the results already presented in this section, the computer analysis provided the data for the following histograms of interest:

- Number of stations that measure and relay data continuously versus location
- Number of stations versus measurement interval
- Number of stations versus message size and collection interval.

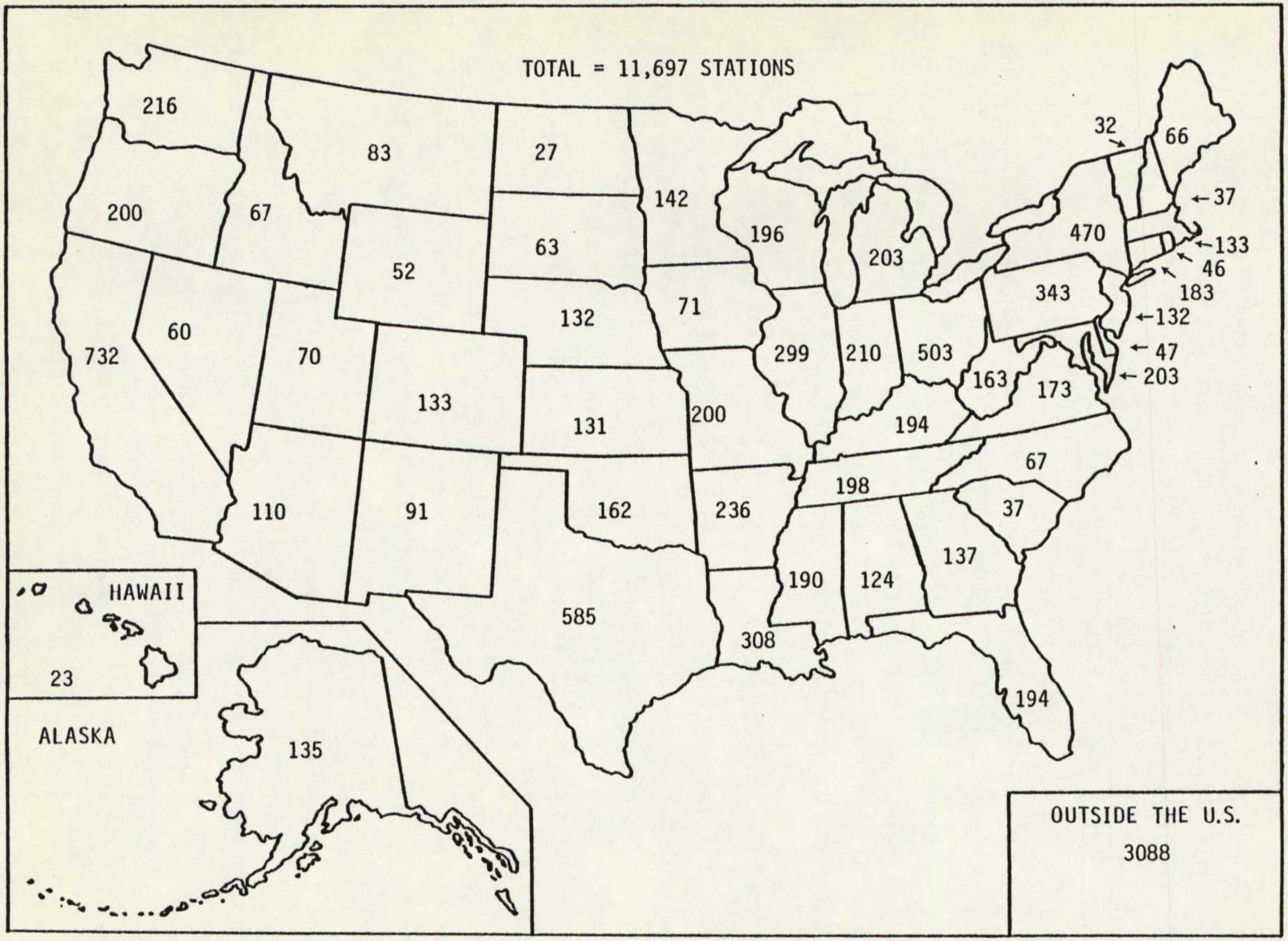


FIGURE 7.29. NUMBER OF DATA COLLECTION STATIONS WITH FAST COLLECTION INTERVALS (1 MINUTE TO 3 HOURS) VERSUS LOCATION

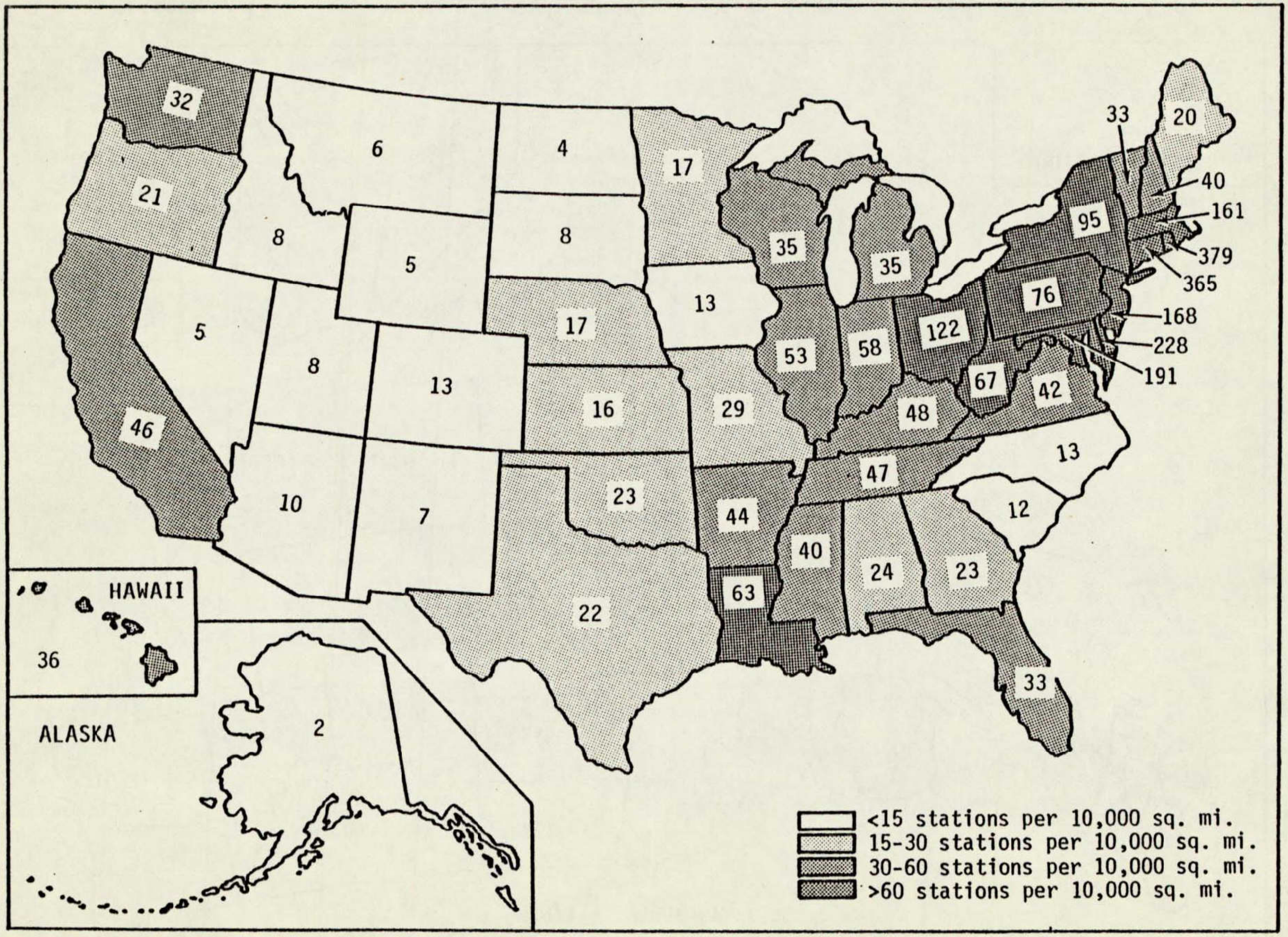


FIGURE 7.30. DENSITY OF DATA COLLECTION STATIONS WITH FAST COLLECTION INTERVALS (1 MINUTE TO 3 HOURS) VERSUS LOCATION

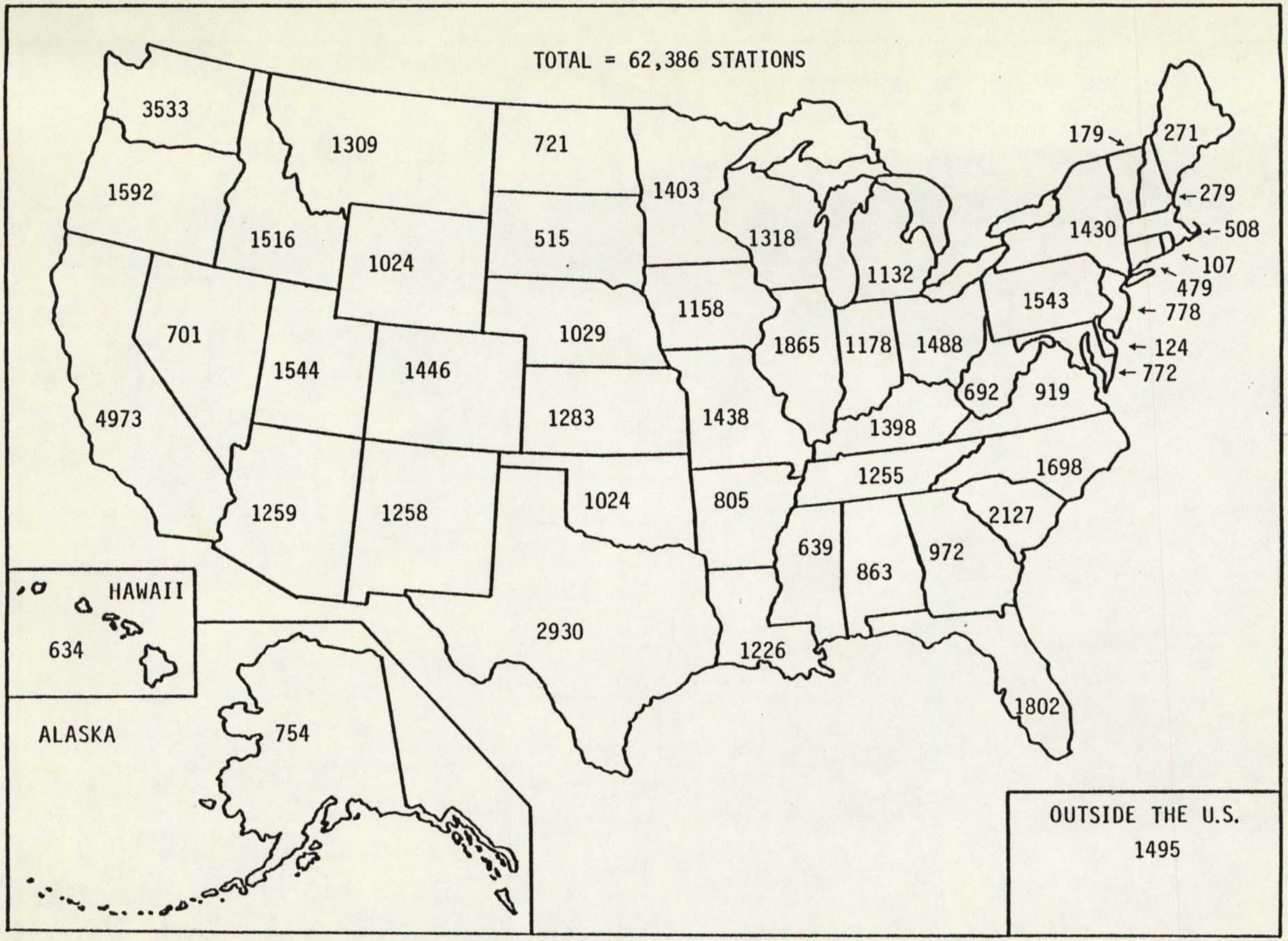


FIGURE 7.31. NUMBER OF DATA COLLECTION STATIONS WITH MEDIUM COLLECTION INTERVALS (6 HOURS TO 2 MONTHS) VERSUS LOCATION

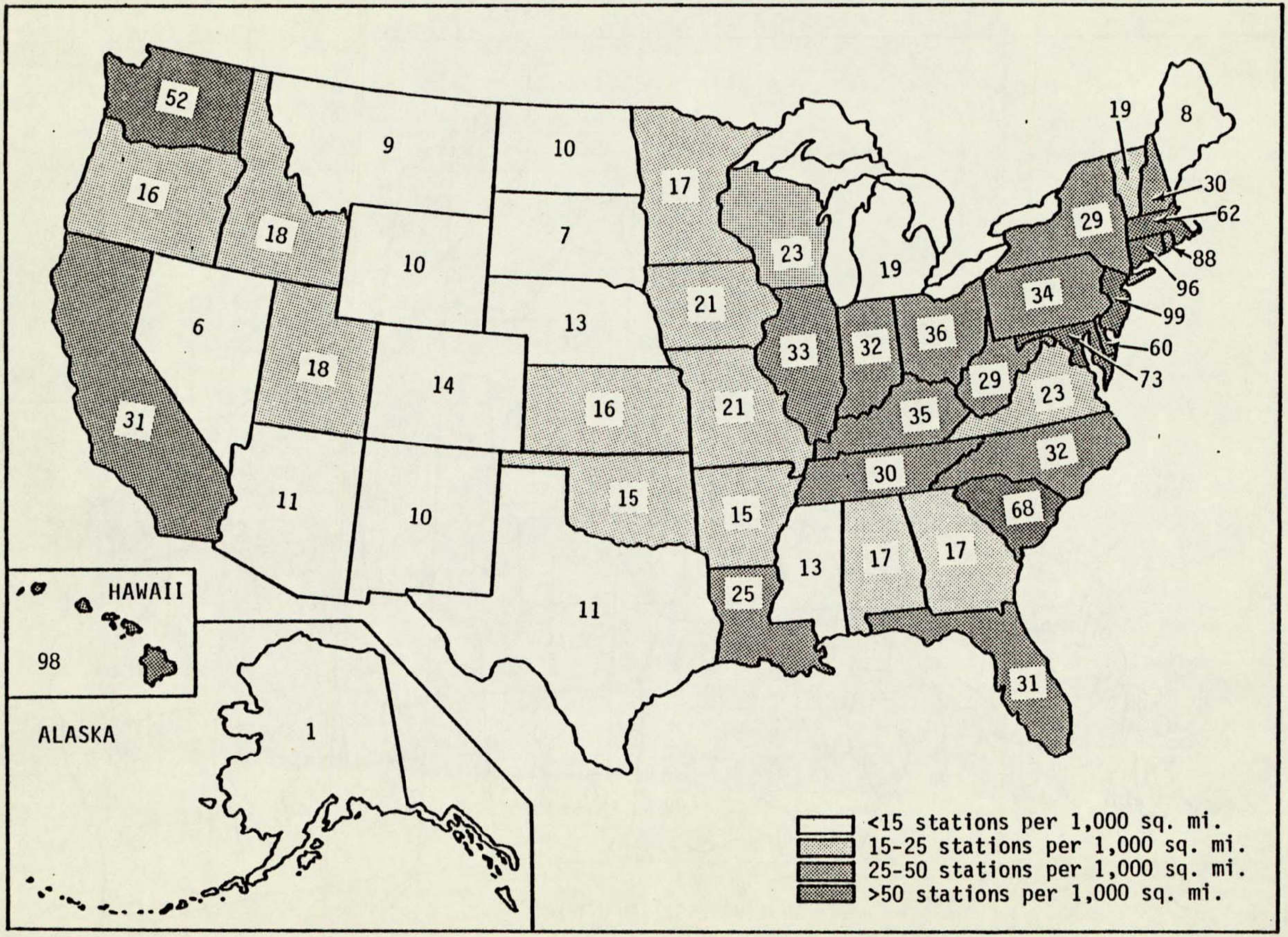


FIGURE 7.32. DENSITY OF DATA COLLECTION STATIONS WITH MEDIUM COLLECTION INTERVALS (6 HOURS TO 2 MONTHS) VERSUS LOCATION

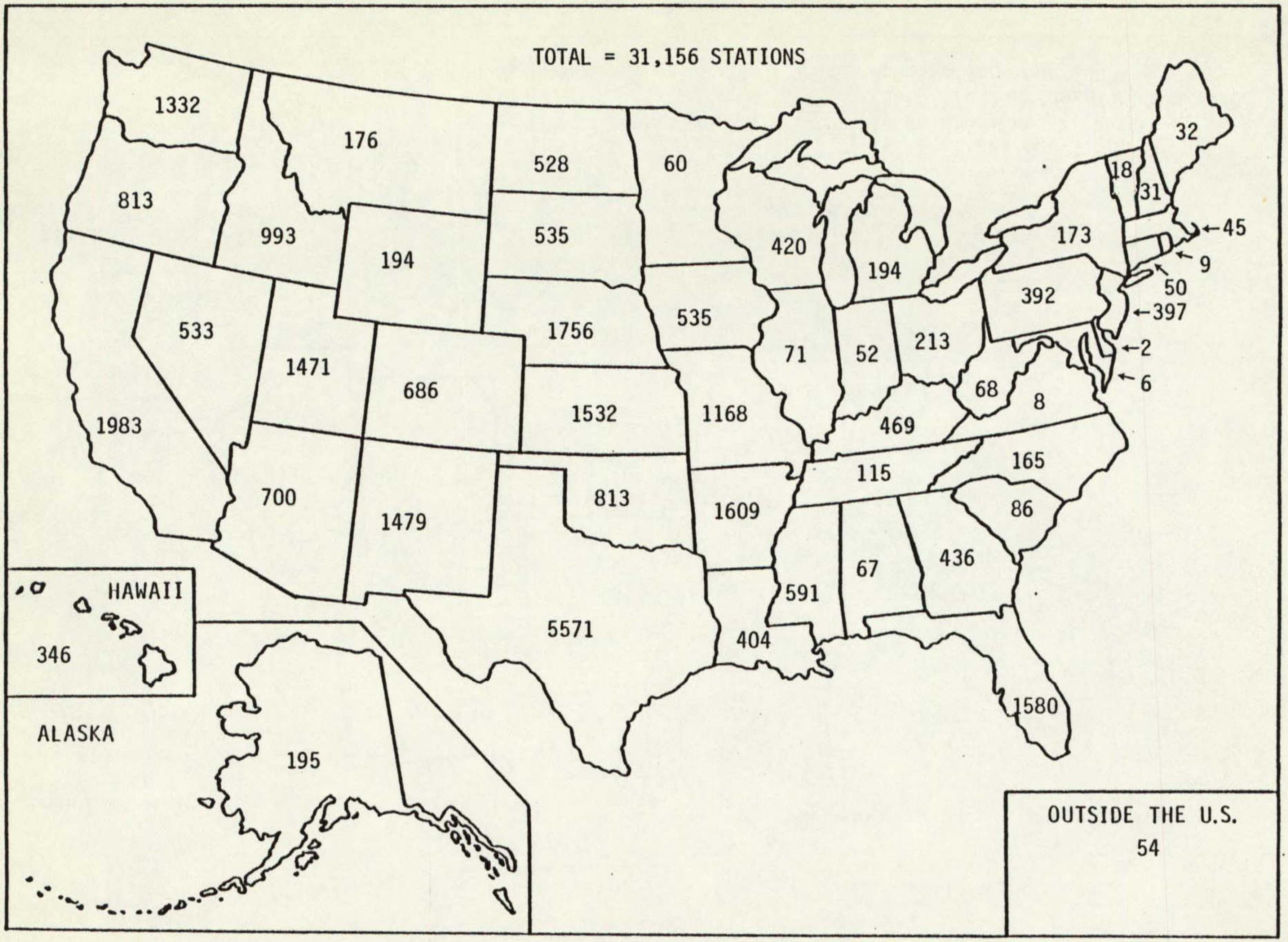


FIGURE 7.33. NUMBER OF DATA COLLECTION STATIONS WITH SLOW COLLECTION INTERVALS (3 MONTHS TO 1 YEAR) VERSUS LOCATION

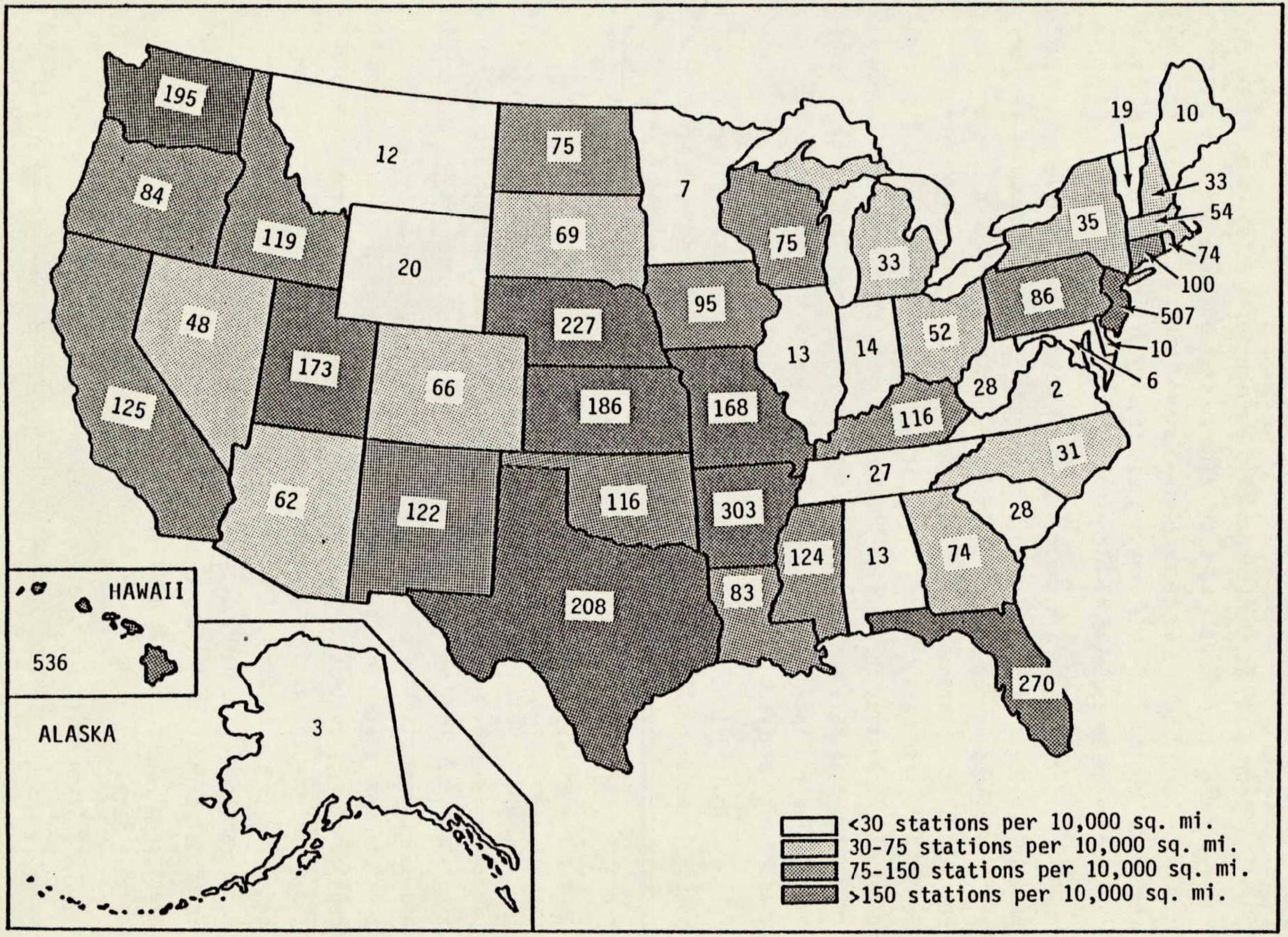


FIGURE 7.34. DENSITY OF DATA COLLECTION STATIONS WITH SLOW COLLECTION INTERVALS (3 MONTHS TO 1 YEAR) VERSUS LOCATION

Figure 7.35 is a histogram of the number of stations that measure and relay data continuously versus location. All of these stations are continuously recording and/or telemetering seismographs. This figure indicates the rather obvious fact that the highest density of stations occurs where the chances of earthquakes is highest.

Figure 7.36 is a histogram of the number of stations versus measurement interval. When comparing this histogram with the histogram of the number of stations versus collection interval (Figure 7.3) it can be seen that almost all of the stations that have a measurement interval ranging from 3 months to 1 year have the same collection interval. These figures also indicates that more stations have collection intervals that range from 1 week to 6 weeks than have measurement intervals in this range, and fewer stations have collection intervals that range from 5 minutes to 2 days than have measurement intervals in this range.

Table 7.1 is a complete table of the number of stations versus message size and collection interval. This table indicates that all of the message sizes larger than 10 kilobits have collection intervals from 1 to 6 weeks.

PART III - ANALYSIS OF NUMBER OF STATIONS AND AMOUNT OF DATA COLLECTED

The results presented in this section provide a detailed analysis of the number and density (number of stations per unit area) of data collection stations. Some of these results consist of histograms of the number and density of stations versus location. Also included are histograms of the number of states and the percent area of the United States versus the density of data collection stations. In addition, the results of an analysis of the number and density of stations in each state are described to determine if, and to what extent, any correlation exists between these parameters and the size, population, average annual rainfall, and per capita income of each state. The outputs of this analysis consist of a variety of scatter plots of the data and the results of regression analyses performed on this data.

After reviewing these results, the possibility that a similar analysis of the amount of data collected would also produce interesting

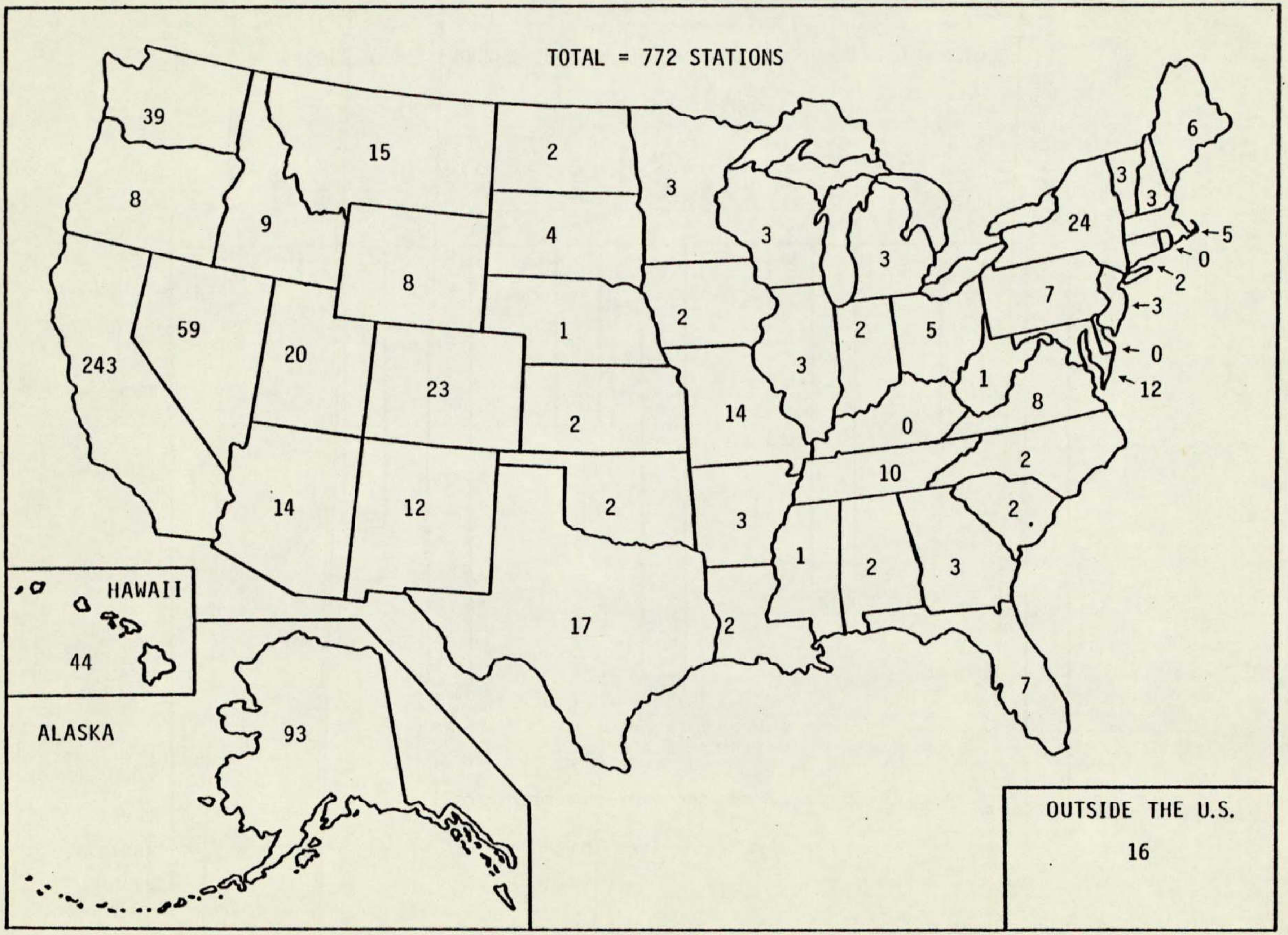


FIGURE 7.35. NUMBER OF CONTINUOUS STATIONS VERSUS LOCATION

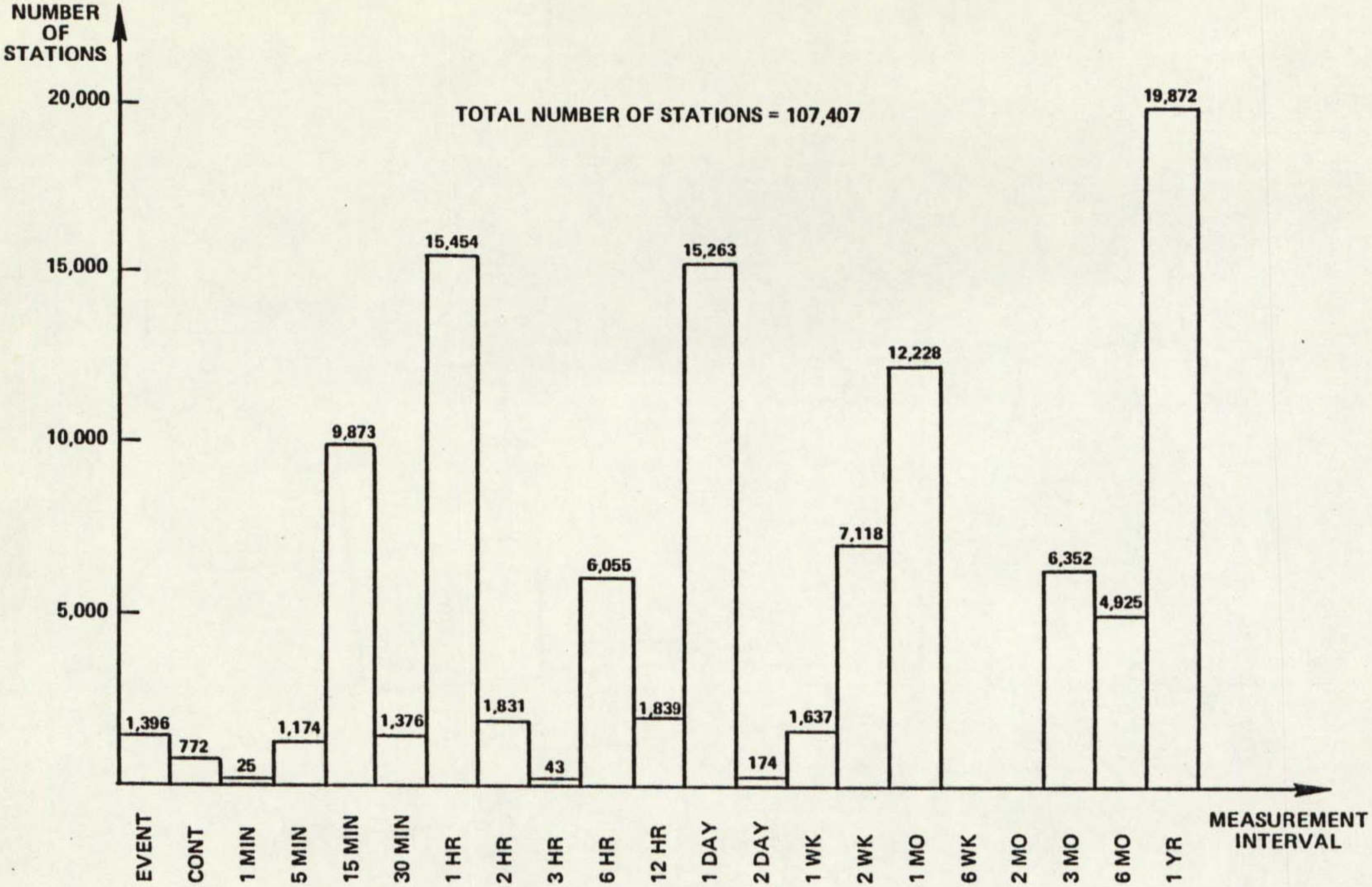


FIGURE 7.36. NUMBER OF STATIONS VERSUS MEASUREMENT INTERVAL

TABLE 7.1
TOTAL NUMBER OF STATIONS VERSUS MESSAGE SIZE AND COLLECTION INTERVAL

MS CI	EVENT	CONT	20 BITS	50 BITS	100 BITS	200 BITS	500 BITS	1 KBIT	2 KBITS	5 KBITS	10 KBITS	20 KBITS	50 KBITS	100 KBITS	200 KBITS	TOTAL
EVENT	1,396	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,396
CONT	0	772	0	0	0	0	0	0	0	0	0	0	0	0	0	772
1 MIN	0	0	0	0	0	0	19	6	0	0	0	0	0	0	0	25
5 MIN	0	0	32	0	15	0	0	0	0	0	0	0	0	0	0	47
15 MIN	0	0	4,009	667	0	0	12	0	469	751	0	0	0	0	0	5,918
30 MIN	0	0	0	0	0	0	0	0	0	209	0	0	0	0	0	209
1 HR	0	0	1,189	88	631	30	74	702	2,434	27	0	0	0	0	0	5,175
2 HR	0	0	117	7	0	0	0	0	0	4	0	0	0	0	0	128
3 HR	0	0	0	42	22	27	22	41	28	13	0	0	0	0	0	195
6 HR	0	0	1,280	766	2,617	194	11	0	35	11	1	0	0	0	0	4,915
12 HR	0	0	338	138	26	0	0	0	11	28	153	0	0	0	0	694
1 DAY	0	0	6,702	550	689	25	1,073	191	0	39	47	0	0	0	0	9,321
2 DAY	0	0	19	0	0	0	0	0	0	0	0	0	0	0	0	19
1 WK	0	0	850	220	220	3	75	0	40	381	88	230	81	4	30	2,222
2 WK	0	0	2,811	722	1,936	10	1,734	73	22	393	1,671	285	1,423	539	0	11,619
1 MO	0	0	4,584	4,416	3,502	0	2,851	3,568	2,242	1,592	2,691	3,881	2,654	141	350	32,472
6 WK	0	0	0	0	0	0	0	0	0	0	155	841	155	0	0	1,124
2 MO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3 MO	0	0	3,530	583	2,245	0	0	0	0	0	0	0	0	0	0	6,358
6 MO	0	0	4,925	0	0	0	0	0	0	0	0	0	0	0	0	4,925
1 YR	0	0	12,620	3,384	3,869	0	0	0	0	0	0	0	0	0	0	19,873
TOTAL	1,396	772	43,006	11,598	15,772	289	5,871	4,581	5,281	3,448	4,806	5,210	4,313	684	380	107,407

results seemed likely. Thus, an identical analysis of this data was performed, and these results are also presented in this section.

Histograms of the Number and Density of Stations Versus Location

In the forthcoming paragraphs, the total number of data collection stations is re-examined with regard to location, and the density of stations is discussed in detail. The discussion includes histograms of the number and density of stations versus location, and histograms that show how the states and the area of the United States are distributed with respect to the density of stations.

Figure 7.37 is a histogram of the number of stations versus location. This figure is identical to Figure 7.1, and is repeated here for the purpose of convenience when examining and comparing subsequent figures.

The density of stations in each state was determined by dividing the number of stations in each state by the area of the state. The results are shown in Figure 7.38 which is a histogram of the density of stations versus location. The values shown in this figure have been rounded to the nearest whole number. Several broad ranges of densities have been shaded to clearly identify the states that have densities of stations in each of these ranges. This figure clearly indicates that the density of stations varies widely from place to place, and that, for the most part, the stations seem to be concentrated in coastal areas, and in the Mississippi, Missouri, and Ohio River basins.

The data on the density of stations in each state was used to produce a histogram that shows how the number of states are distributed with respect to the density of stations. To do this, the entire range of the density of stations was divided into 17 intervals, that are 10 units wide and the number of states that have densities in each interval was determined. The results are shown in Figure 7.39a. The values above the histogram give the number of states that have a density of stations in each interval. The shading in this histogram corresponds to the shading in Figure 7.38, and indicates identical ranges of densities of stations. The number of states that have a density of stations in each of these ranges is shown within the shaded region of the histogram. It should be noted that a slight discrepancy exists

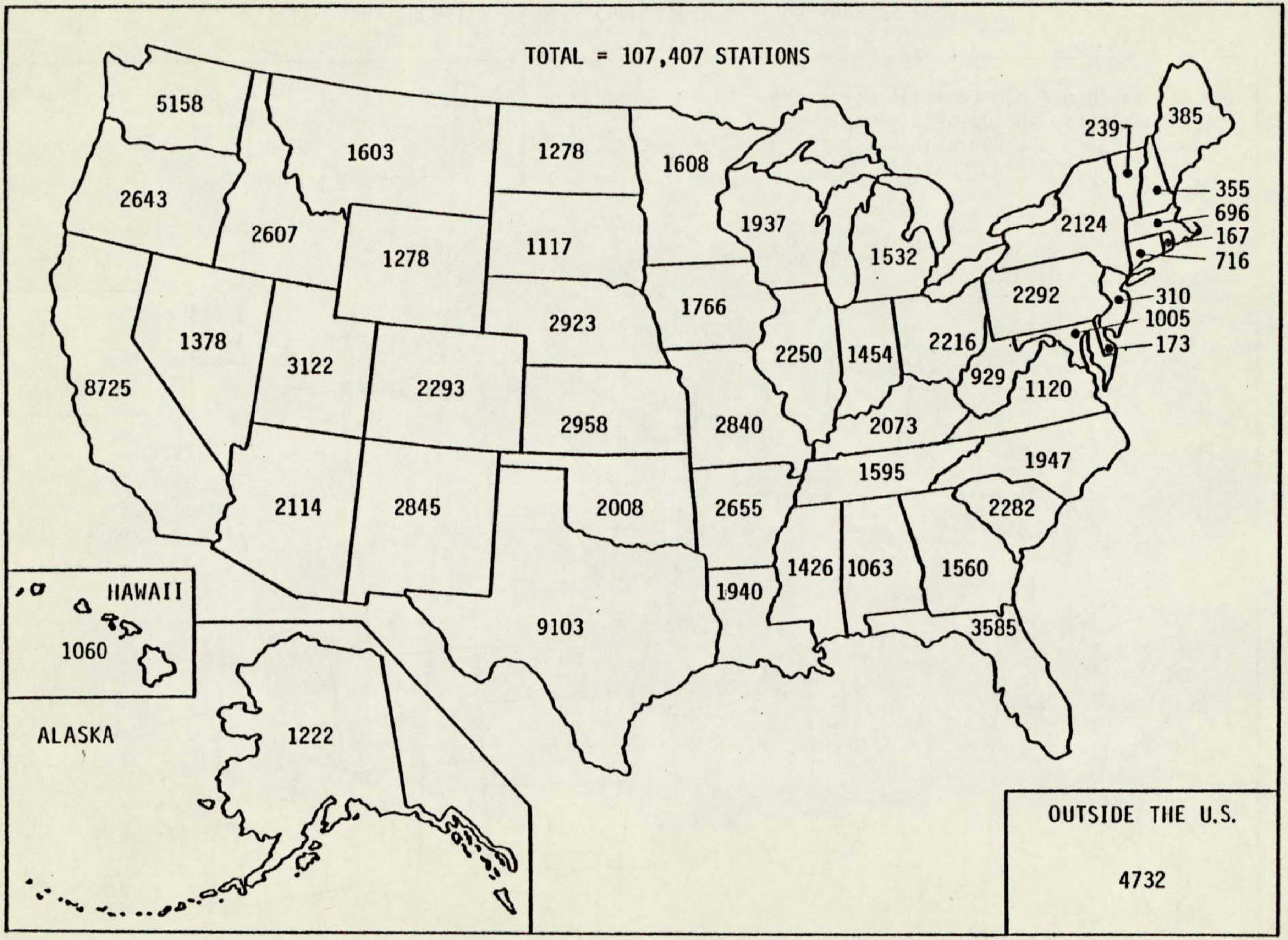


FIGURE 7.37. NUMBER OF DATA COLLECTION STATIONS VERSUS LOCATION

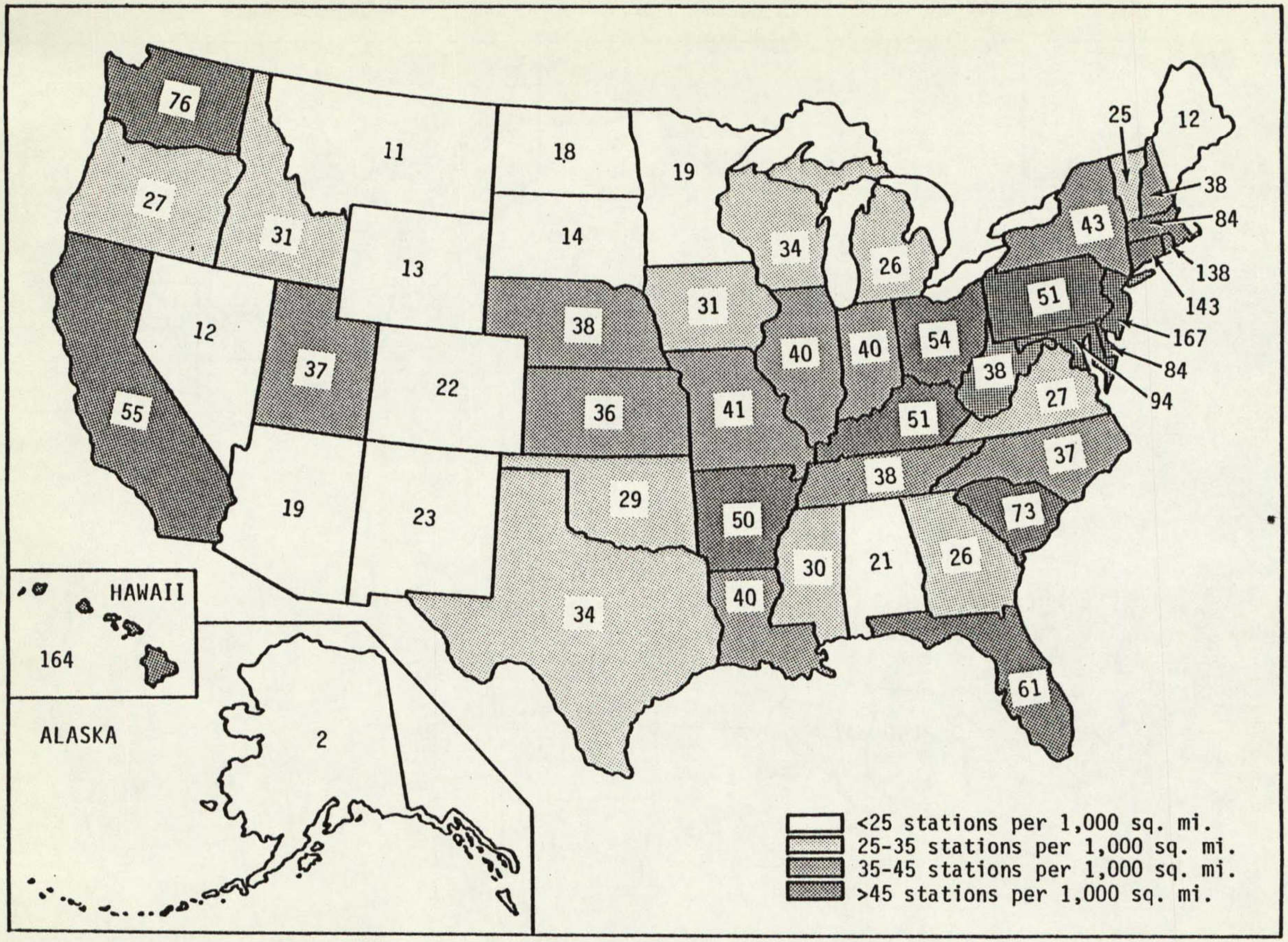


FIGURE 7.38. DENSITY OF DATA COLLECTION STATIONS VERSUS LOCATION

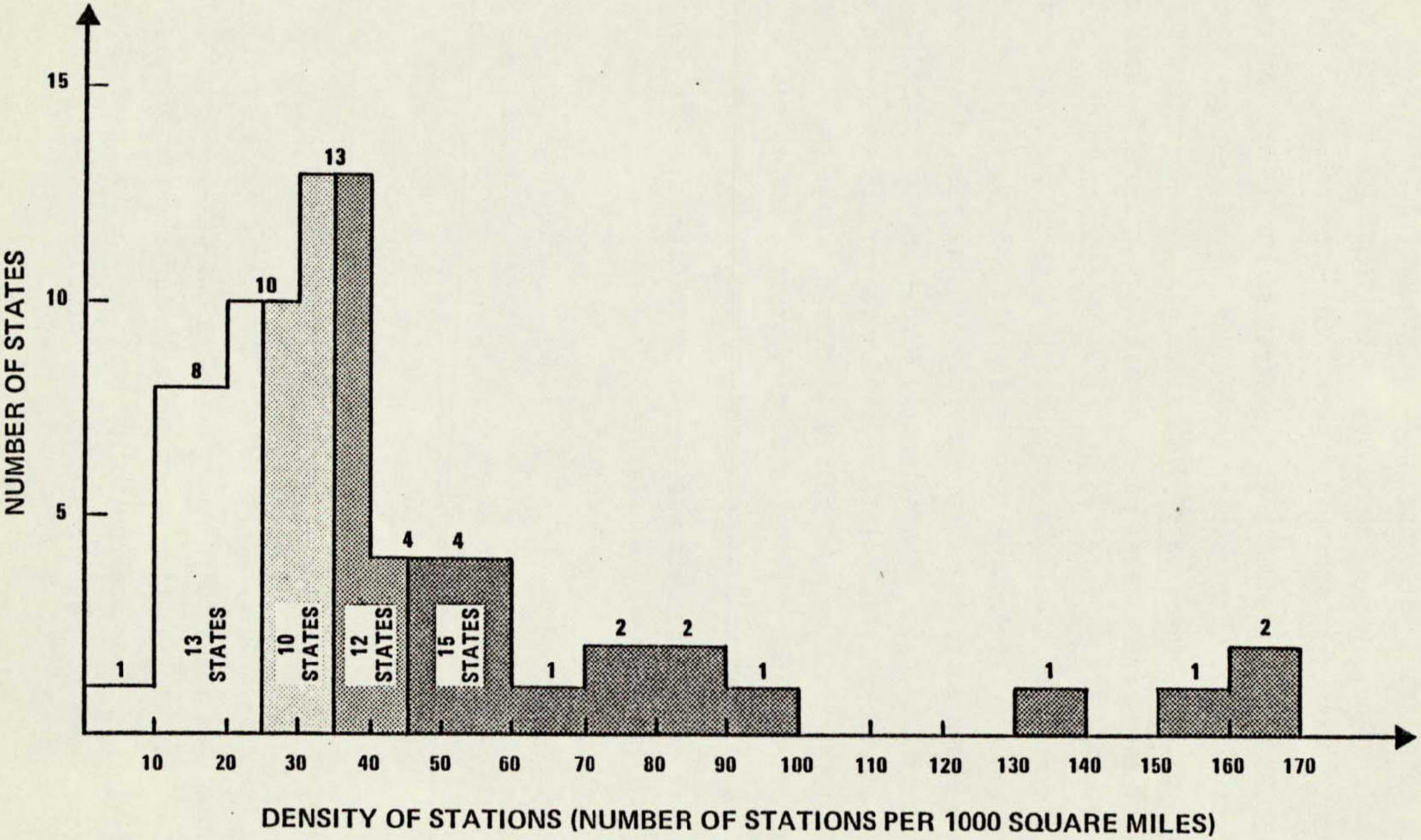


FIGURE 7.39a. DISTRIBUTION OF STATES ACCORDING TO THE DENSITY OF STATIONS

between the values in Figures 7.38 and 7.39a. This is due to the fact that the values of the densities of stations shown in Figure 7.38 have been rounded to the nearest whole number, while the values of the densities of stations used to determine the histogram shown in Figure 7.39a were not.

Figure 7.39b is a histogram that illustrates how the area of the United States is distributed with respect to the density of stations. The density of station data and the area of each state was used to determine how much of the area of the United States has a density of stations in each of the indicated intervals. To do this, it was necessary to assume that all of the stations in a state were equally distributed throughout the state, rather than being concentrated in various parts of the state and sparse in other parts. The values shown above the histogram indicate the percent area of the United States that has a density of stations in each interval, rather than the actual number of square miles. Intervals identical to those shaded in the two previous histograms have been shaded in this figure also. The percent area of the United States that has a density of stations in each of these shaded ranges is shown within the shaded region.

The density of station data was also used to determine the mean (average) density of stations in the United States using the equation given below,

$$\bar{d}_s = \frac{\sum_{i=1}^{50} A_i d_{s_i}}{\sum_{i=1}^{50} A_i} \qquad (7\text{-}1)$$

where d_{s_i} is the density of stations in each state, A_i is the area of each state, and $\bar{d}_s$ is the mean density of stations. The mean density of stations in the United States was found to be $\bar{d}_s = 28.4$ stations per 1000 square miles. It should be noted that the equation given above is for a weighted mean, and when reduced, is equal to the total number of stations in the United States divided by the total area of the United States.

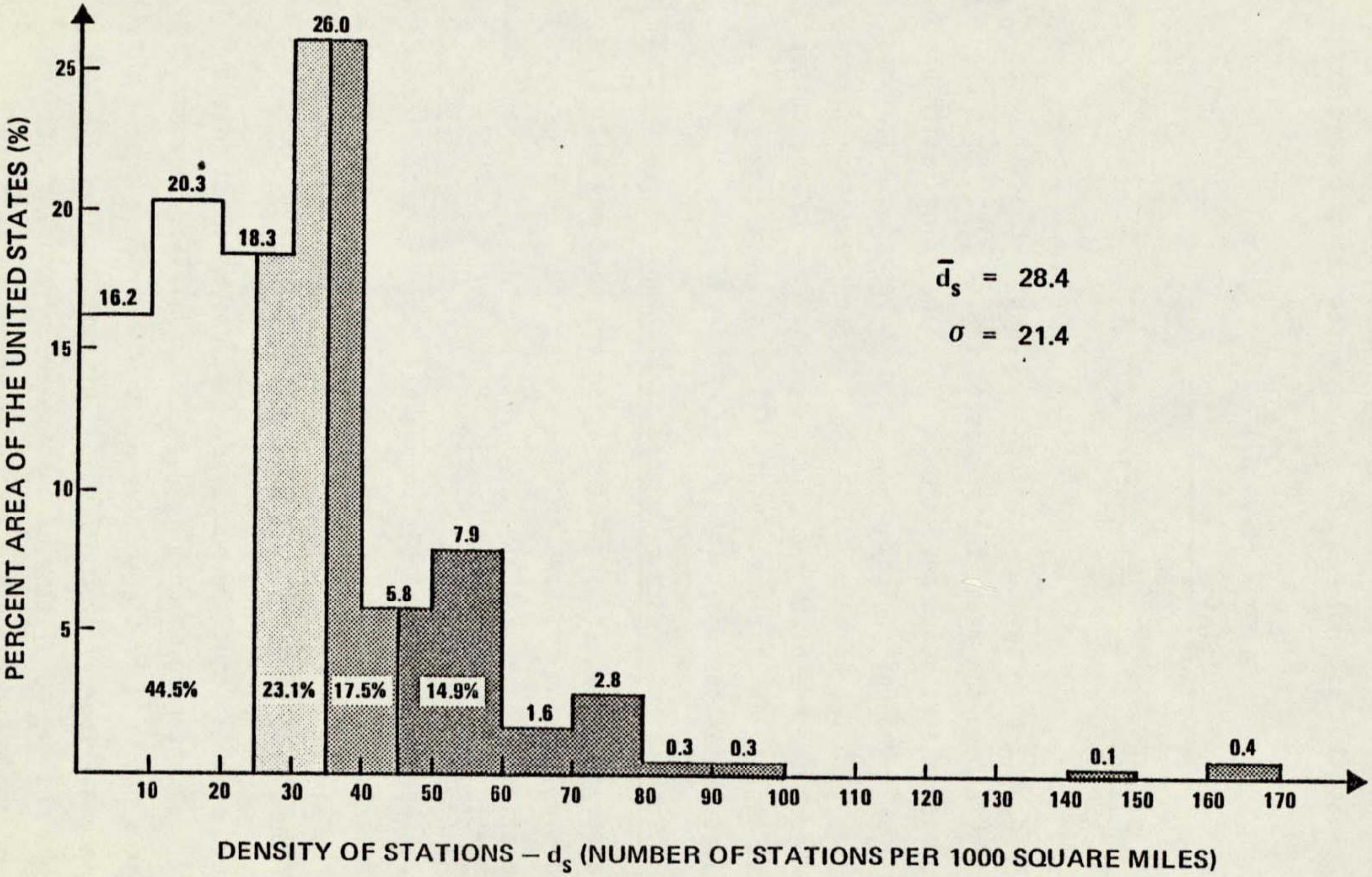


FIGURE 7.39b. DISTRIBUTION OF THE AREA OF THE UNITED STATES ACCORDING TO THE DENSITY OF STATIONS

The standard deviation, σ, of the density of stations throughout the United States was also determined. It was computed using the equation given below,

$$\sigma = \frac{\sum_{i=1}^{50} A_i(d_{s_i} - \bar{d}_s)^2}{\sum_{i=1}^{50} A_i - 1} \qquad (7\text{-}2)$$

where d_{s_i}, A_i, and $\bar{d}_s$ have been defined previously. Just as the values of d_{s_i} were weighted to determine the mean, the values of $(d_{s_i} - \bar{d}_s)^2$ have been weighted to determine the standard deviation. The standard deviation of the density of stations in the United States was found to be $\sigma = 21.4$ stations per 1000 square miles. Both the large value of the standard deviation (large compared to the mean) and the histogram of the percent area of the United States versus the density of stations vividly illustrate how widely the density of stations varies throughout the United States.

Scatter Plots and Regression Results of Number of Stations

In an attempt to identify some of the factors that may influence the number of data collection stations in each state, four variables were chosen for examination. These variables are area, population, average annual rainfall, and per capita income of each state.

The first part of this analysis represents a simple attempt to determine if any correlation exists between the number of stations and each of these variables by simply plotting the data. This produced four scatter plots shown in Figure 7.40 through 7.43.

It should be noted that the number of stations was used in the scatter plots of area and population (Figures 7.40 and 7.41). However, the density of stations was used in the scatter plots of average annual rainfall and per capita income (Figure 7.42 and 7.43). This was done because the number of stations and the population of a state are parameters that are usually thought of as dependent on the area of a state, while the density of stations, average annual rainfall, and per capita income of a state are parameters that are usually thought of as independent of the area of a state.

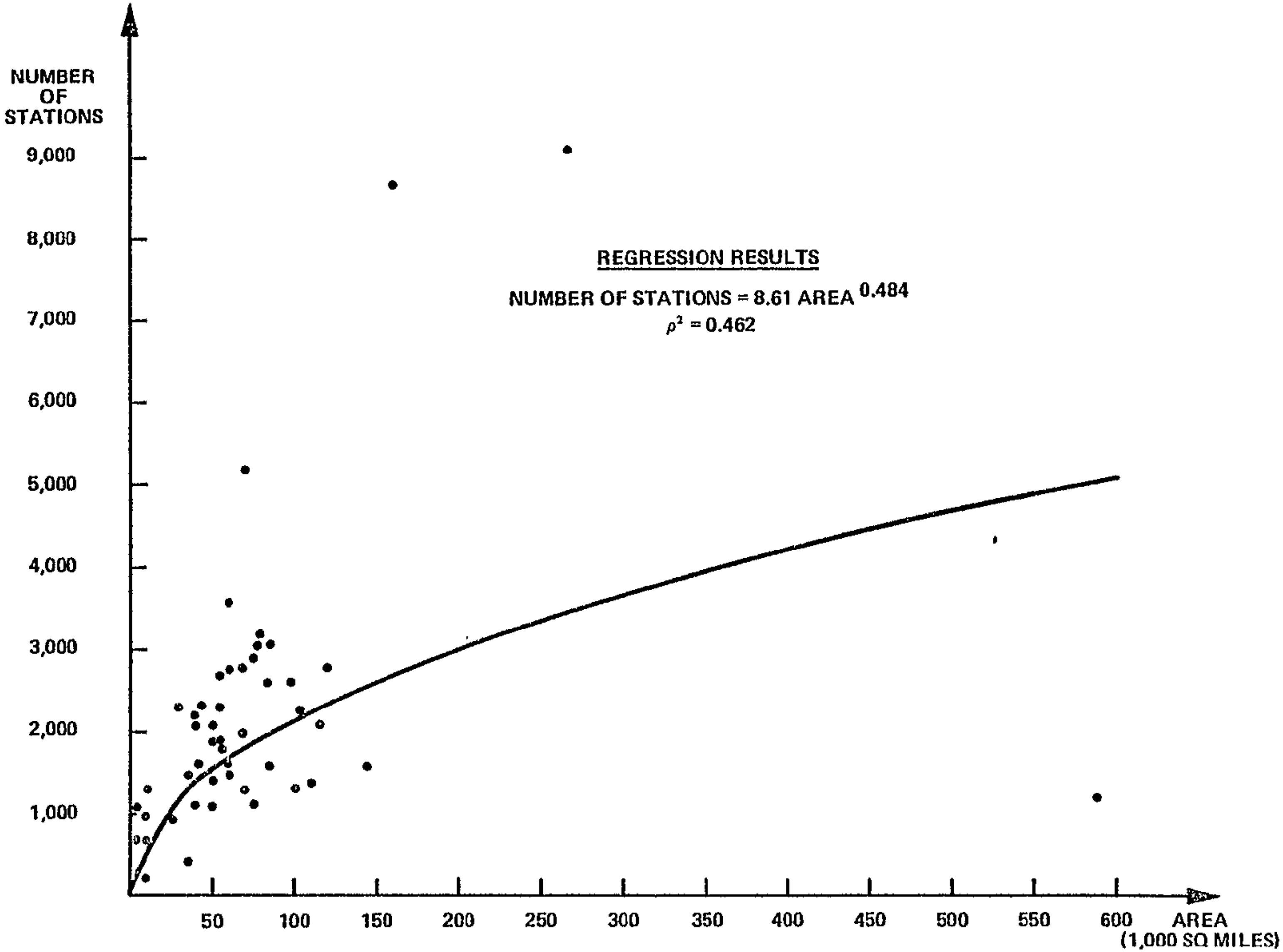


FIGURE 7.40. NUMBER OF STATIONS IN EACH STATE VERSUS AREA OF THAT STATE

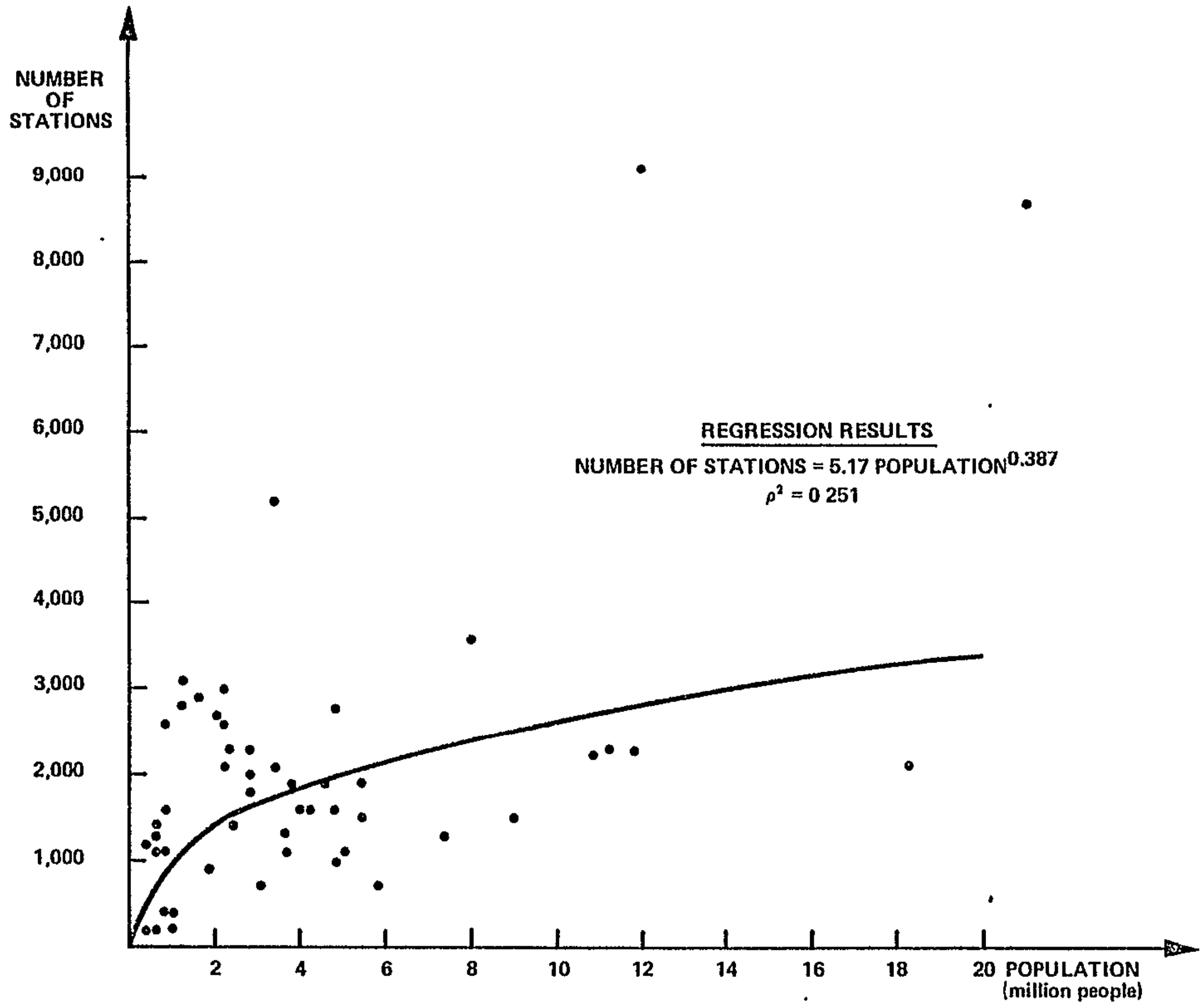


FIGURE 7.41. NUMBER OF STATIONS IN EACH STATE VERSUS POPULATION OF THAT STATE

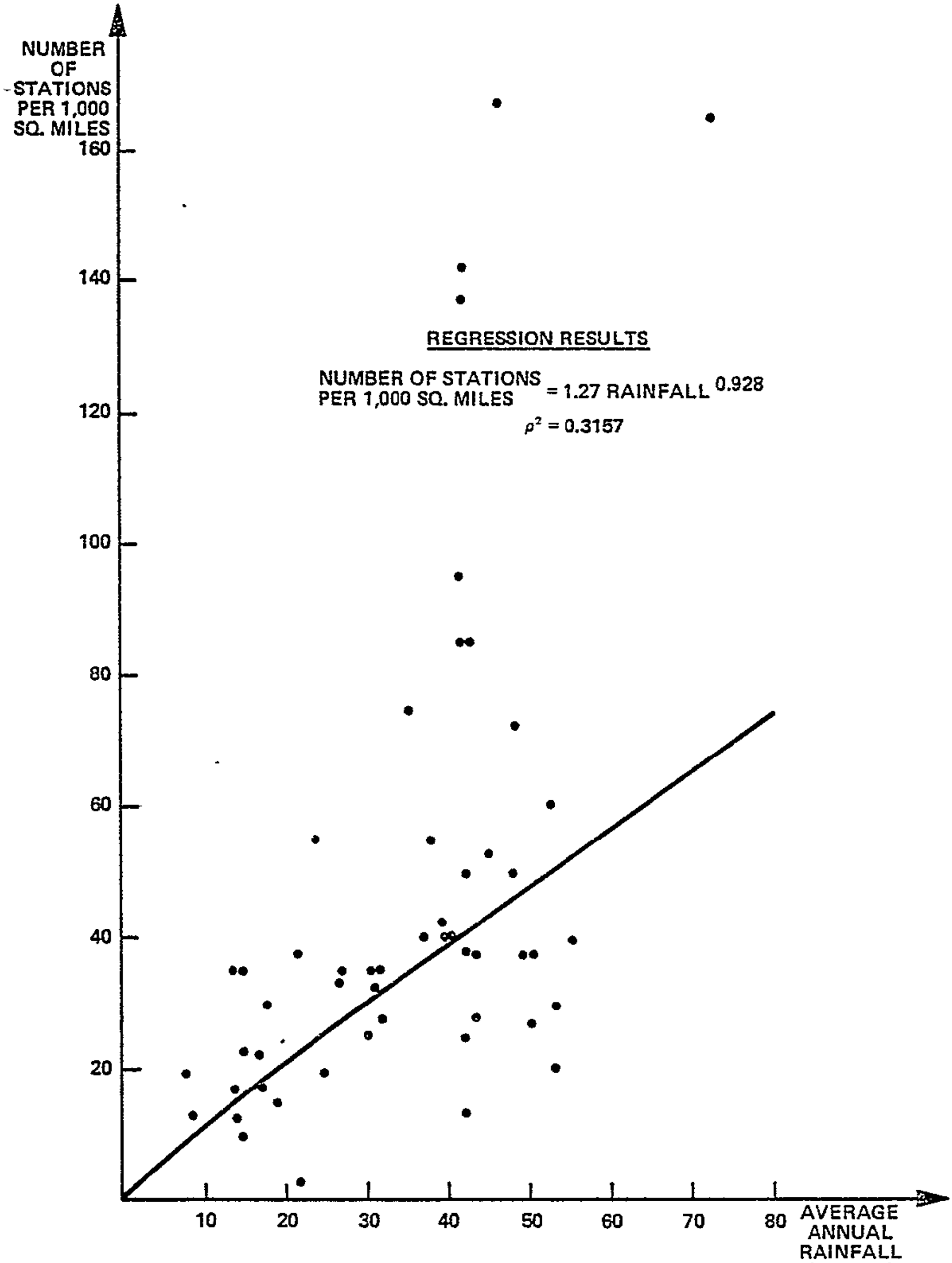


FIGURE 7.42. DENSITY OF STATIONS IN EACH STATE VERSUS AVERAGE ANNUAL RAINFALL OF THAT STATE

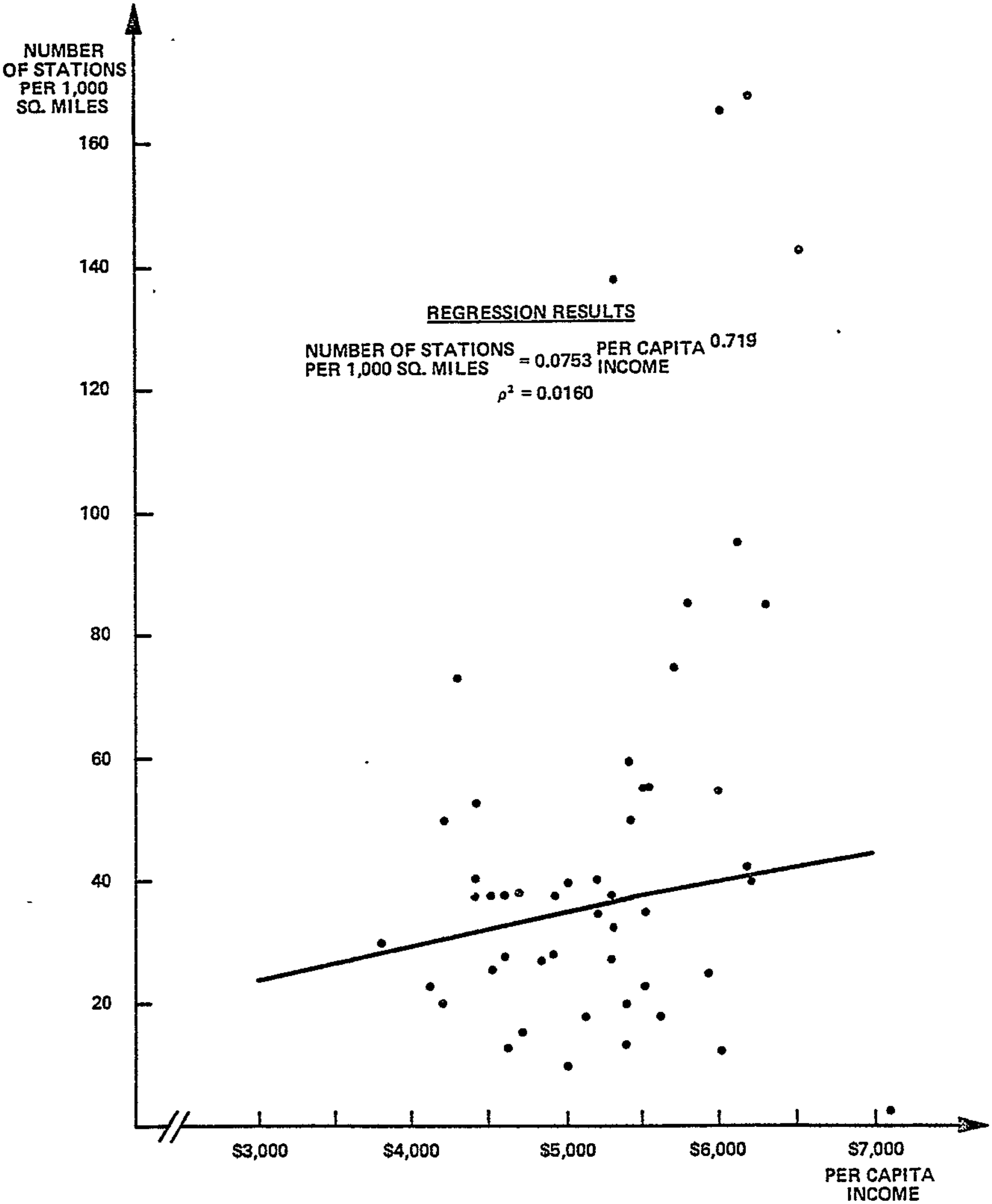


FIGURE 7.43. DENSITY OF STATIONS IN EACH STATE VERSUS THE PER CAPITA INCOME OF THAT STATE

Hence, very little correlation exists between the number of stations in a state and either the average annual rainfall or per capita income in the state, while a substantially higher correlation exists between the density of stations and either of these variables.

The second part of this analysis centered around obtaining results of a log linear regression analysis that was performed on the data. Four separate regressions were performed to determine, if any, the correlation between the number and density of stations, and each of the four regression variables. The results of the regression analyses consist of: 1) the coefficients of the power functions that are the least squares fit through the data points illustrated in the scatter plots, and 2) the values of the index of correlation of each case.

The power function that was fit to the data in the scatter plots by the regression analysis is given by the expression

$$y = ax^{b} \tag{7-3}$$

where x and y are the regression variables and a and b are the coefficients to be determined by the regression analysis. The values of these coefficients are given by these equations:

$$b = \frac{n \sum_{i=1}^{n} v_i w_i - \left(\sum_{i=1}^{n} v_i\right)\left(\sum_{i=1}^{n} w_i\right)}{n \sum_{i=1}^{n} v_i^{2} - \left(\sum_{i=1}^{n} v_i\right)^{2}} \tag{7-4a}$$

$$a = \log^{-1}\left(\frac{\sum_{i=1}^{n} w_i}{n} - b\,\frac{\sum_{i=1}^{n} v_i}{n}\right) \tag{7-4b}$$

where,

$$v_i = \log x_i \tag{7-5a}$$

$$w_i = \log y_i, \tag{7-5b}$$

and (x_i, y_i) are the pairs of sample values, and n is the number of sample pairs.

The index of correlation, ρ^2, is a number between zero and one that is a measure of the extent to which the values of one parameter (i.e. area of a state) are related to the values of another parameter (i.e. number of stations in the state). It is computed using the expression given below,

$$\rho^2 = \frac{\left[n \sum_{i=1}^{n} x_i y_i - \left(\sum_{i=1}^{n} x_i\right)\left(\sum_{i=1}^{n} y_i\right)\right]^2}{\left[n \sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2\right]\left[n \sum_{i=1}^{n} y_i^2 - \left(\sum_{i=1}^{n} y_i\right)^2\right]} \qquad (7\text{-}6)$$

where all parameters have been previously defined.

An index of correlation of one indicates that the parameters are completely correlated, and that each value of one parameter corresponds to only one value of the other parameter. An index of correlation of zero indicates that the parameters are not correlated, but not necessarily independent of each other, and that each value of one parameter does not correspond to any particular value of the other parameter. An index of correlation other than zero or one indicates that the value of one parameter corresponds to a range of values of the other parameter, where the larger the index of correlation, the smaller the range of values. Basically, the index of correlation represents a measure of the extent to which the variation of one parameter is related to (accounts for) the variation of the other parameter.

Figure 7.40 is the scatter plot of the number of stations in each state versus the area of the state. The results of the regression analysis of these two variables indicates that the variation in the sizes of the states accounts for 46% of the variation in the number of stations in the states.

Figure 7.41 illustrates the relationship between the number of stations in each state and the population of the state. The value of the index of correlation of the regression analysis of these two variables can be interpreted as meaning that the variation in the population of the states accounts for 25% of the variation in the number of stations in a state.

Figure 7.42 shows the dependence of the density of stations in each state upon the average annual rainfall in the state. The index of correlation that is part of the results of the regression analysis implies that the variation in the average annual rainfall of the states accounts for 32% of the variation in the density of stations in a state.

Figure 7.43 illustrates the influence of the per capita income of a state on the density of stations in the state. In this case, the index of correlation was very small, and it indicates that only 2% of the variation of the density of stations in a state can be accounted for by the variation in the per capita income of the states.

These results demonstrate that the number of data collection stations in a state is substantially dependent upon the area of the state and the average annual rainfall. They also suggest that the population of a state has some influence on the number of stations in the state, while the per capita income has little impact.

Individual Regression Parameters

Since the variation of the four regression parameters throughout the United States is not common knowledge, this information is being provided. The following figures illustrate the values of the four regression parameters for each of the fifty states. The area of each state is shown in Figure 7.44, the population density in Figure 7.45, the average annual rainfall in Figure 7.46, and the per capita income in Figure 7.47.

These figures have also been provided for the purpose of comparison with some of the previously discussed figures and with other figures that follow. It should be noted that my comparing the figures of the number and density of stations (Figures 7.37 and 7.38) with those of the four regression parameters (Figures 7.44 - 7.47), one can determine the degree to which the dark and light areas of each map match each other. This visual process is similar to the mathematical processes of correlation involved in the regression analysis described in the previous subsection.

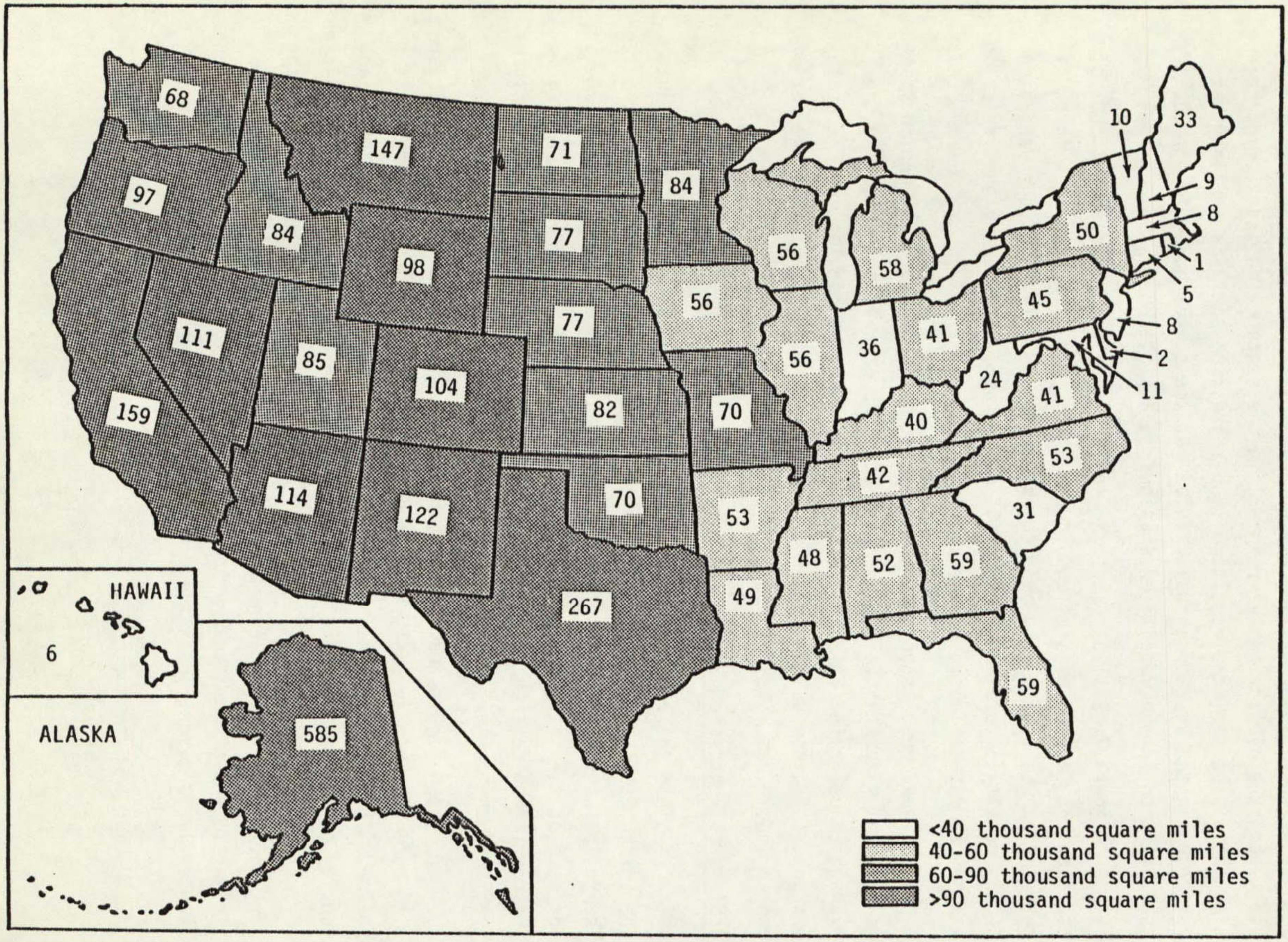


FIGURE 7.44. AREA OF EACH STATE

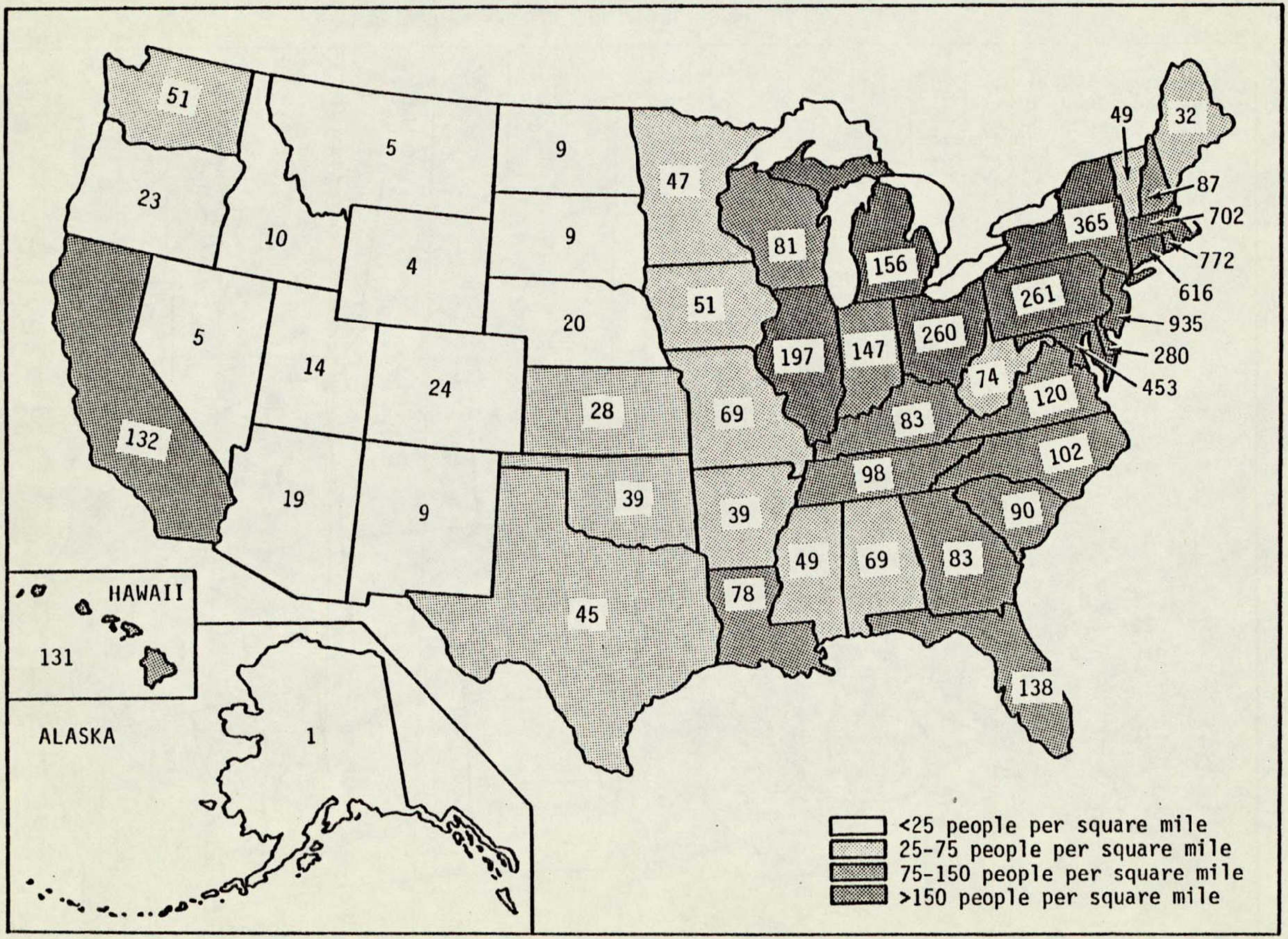


FIGURE 7.45. POPULATION DENSITY OF EACH STATE

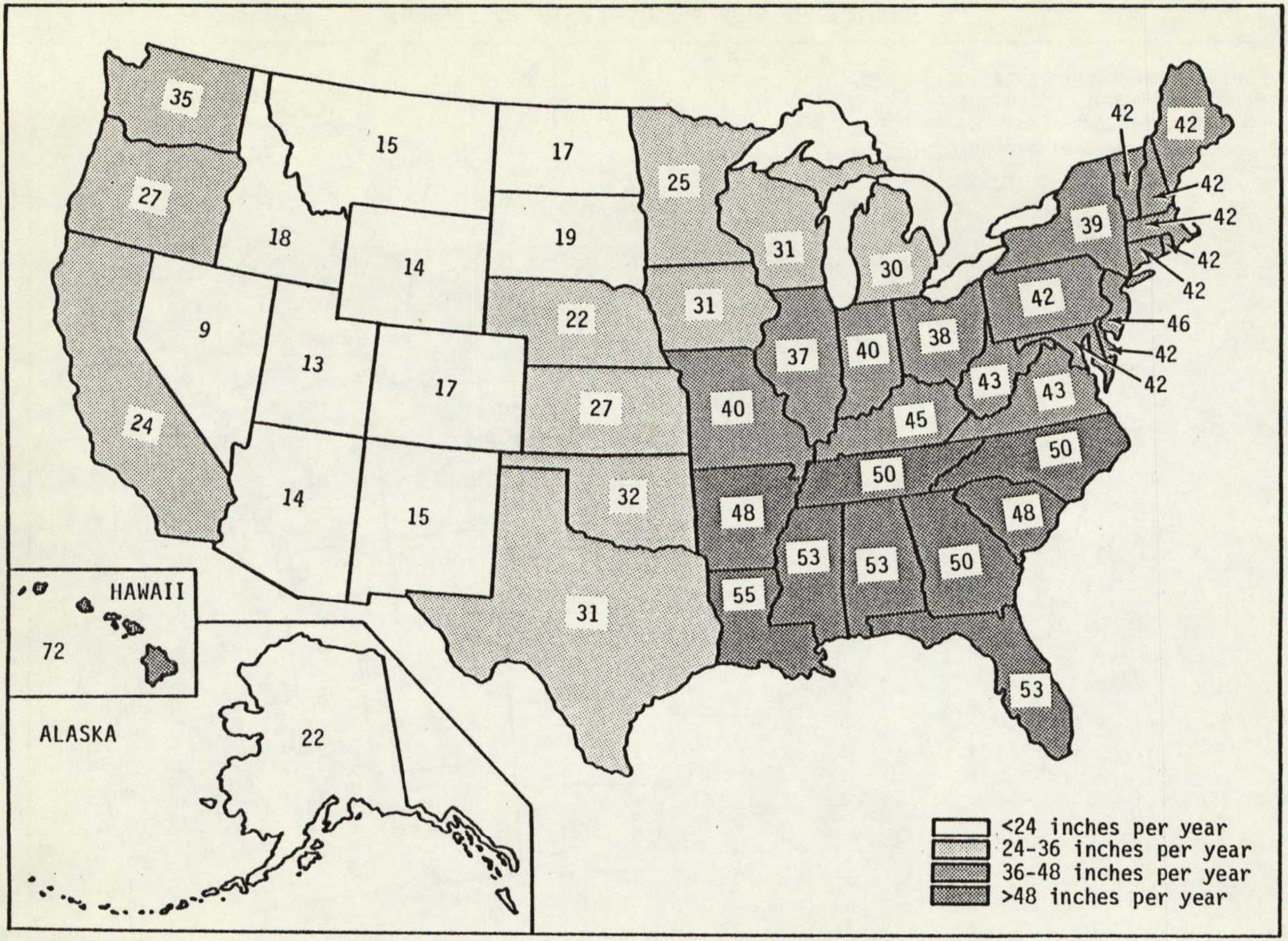


FIGURE 7.46. AVERAGE ANNUAL RAINFALL IN EACH STATE

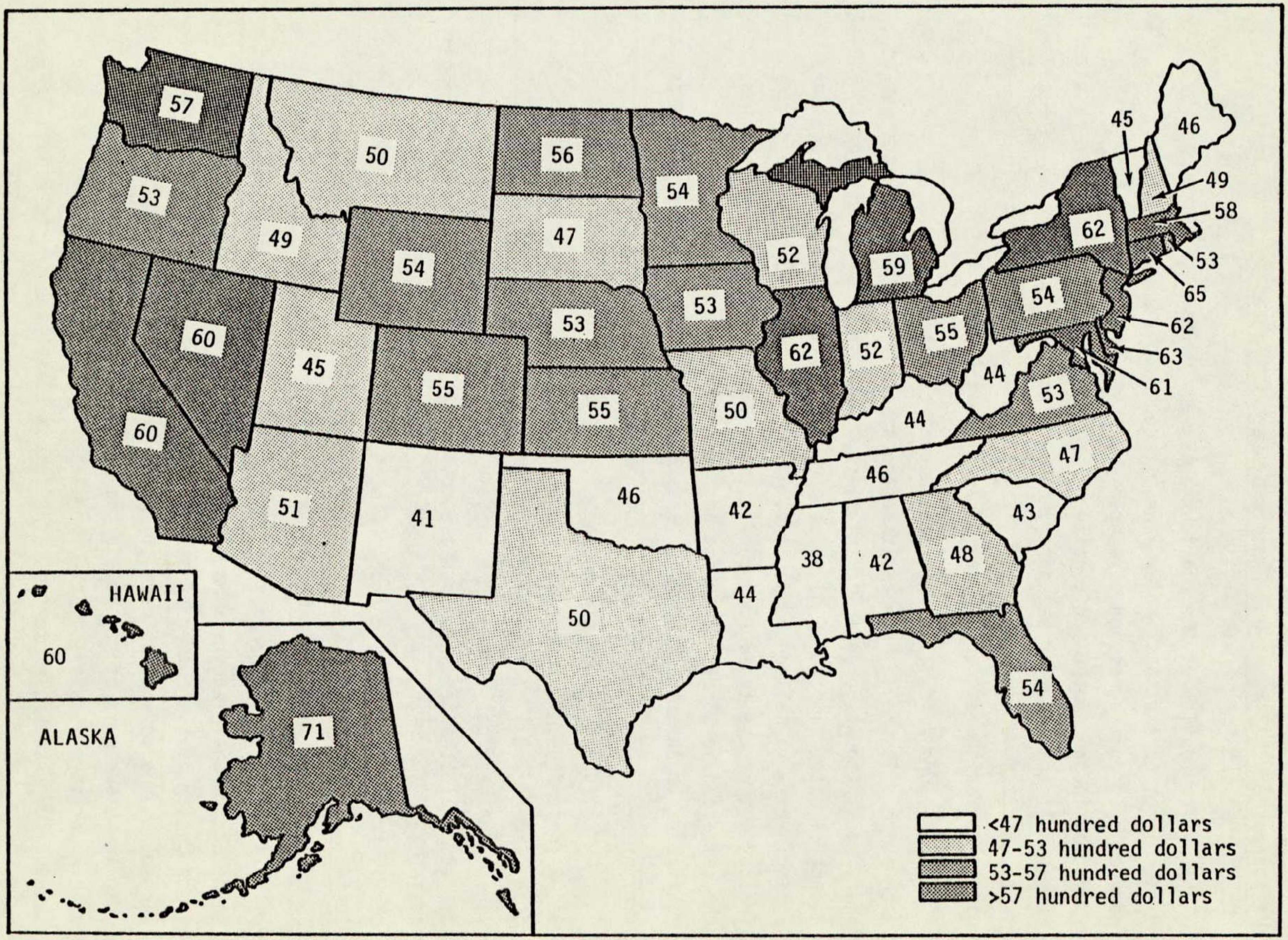


FIGURE 7.47. PER CAPITA INCOME OF EACH STATE

Histograms of the Amount and Density of Data Collected Versus Location

The results of the previous analyses indicate that the density of data collection stations varies widely throughout the United States, and that none of the four regression parameters accounts for more than half of the variation in the number and density of stations. Because of these results, it was felt that another parameter, the amount of data collected in each state, might be of more interest. This parameter was examined in the same manner as was the number of data collection stations.

Figure 7.48 illustrates the amount of data collected per year in each state. It should be noted that the state of Missouri collects one of the largest amounts of data of any state. A substantial portion of this amount of data, almost 4.8 gigabits per year, is collected by 25 stations in a single network called the Regional Air Monitoring System. This figure also indicates that the total amount of data collected by all of the stations in the data base is 135.7×10^9 bits per year. This total amount of data is equivalent to an average continuous data rate of approximately 4300 bits per second.

Figure 7.49 depicts the density of data collected versus location. It was determined in the same manner as the density of stations versus location (Figure 7.38). This figure shows that,like the density of the stations, density of data collected varies widely with location, and that the density of data collected tends to increase moving eastward across the United States. Again, it should be noted that the high density of data collected in the state of Missouri is the result of the 25 stations in the Regional Air Monitoring System. These stations alone produce a density of data collected of almost 68 megabits per year per 1,000 square miles.

An analysis identical to that of the density of stations was used to determine the histograms in Figures 7.50a and 7.50b. These figures show the distribution of the number of states, and the area of the United States with respect to the density of data collected. The values shown above each histogram are the number of states and the percent area of the United States that have a density of data collected in each of the 21 small intervals. The shading in these two histograms corresponds to the shading in Figure 7.49, C-3

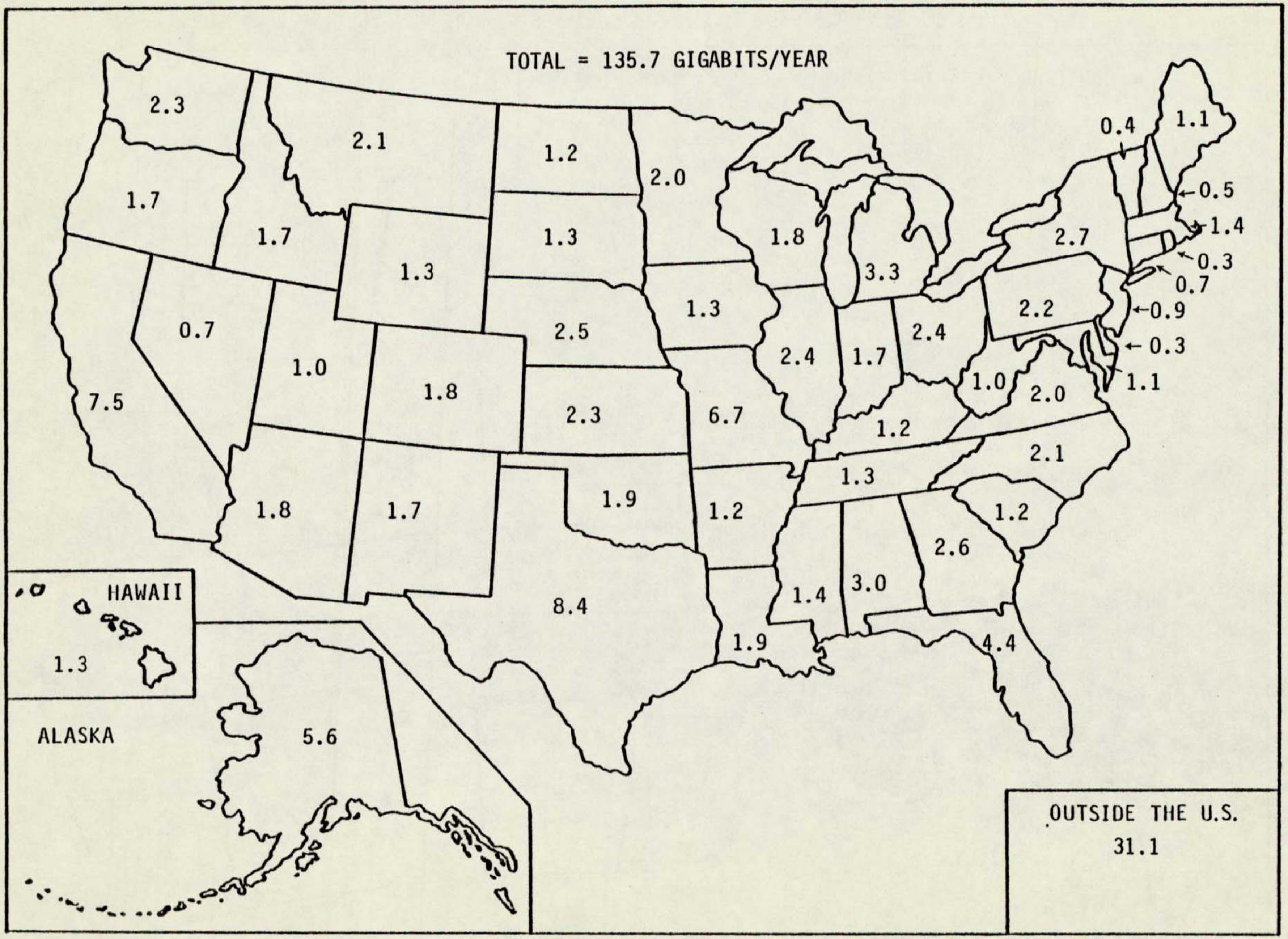


FIGURE 7.48. AMOUNT OF DATA COLLECTED PER YEAR VERSUS LOCATION (gigabits per year)

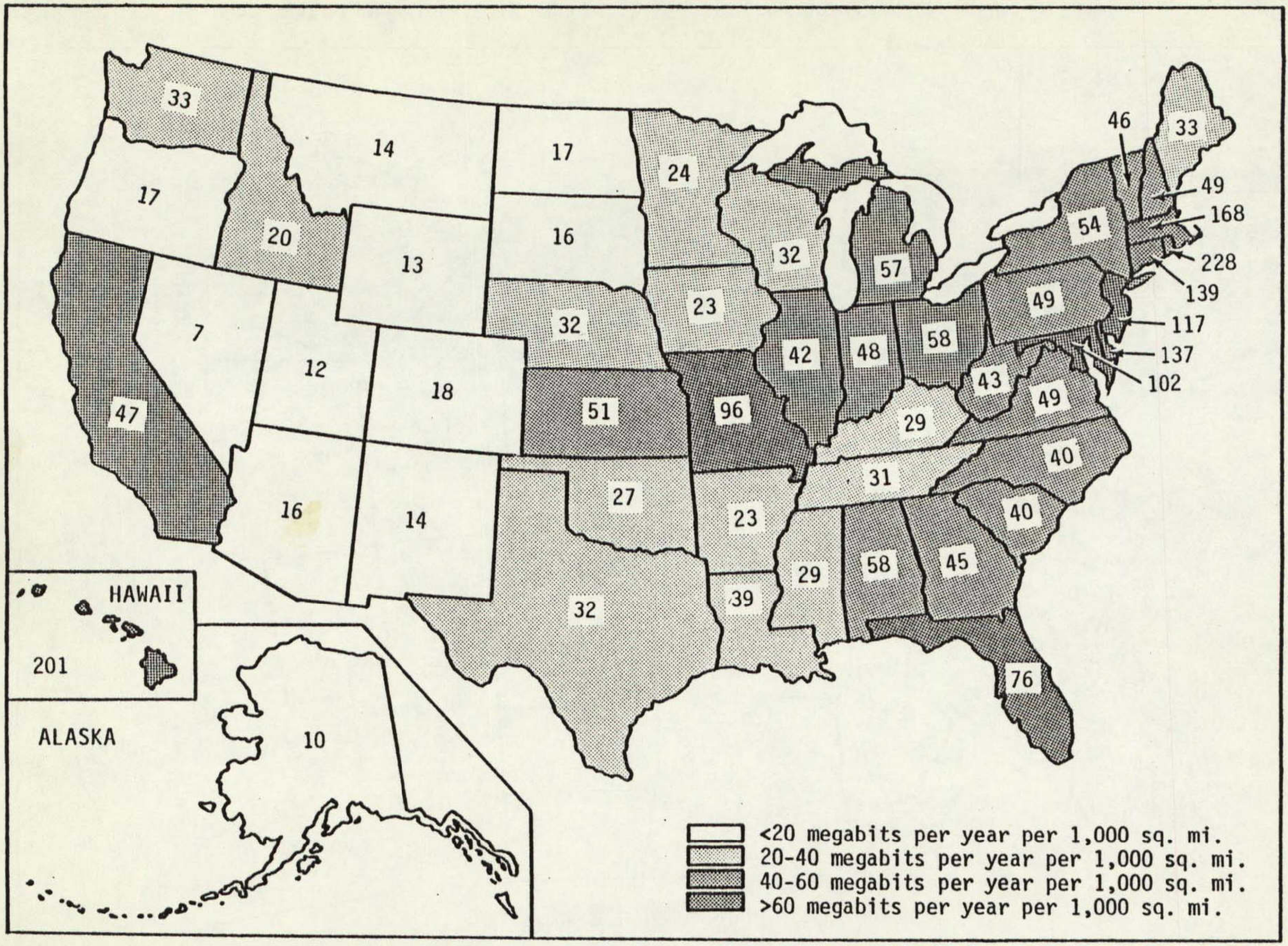


FIGURE 7.49. DENSITY OF DATA COLLECTED PER YEAR VERSUS LOCATION

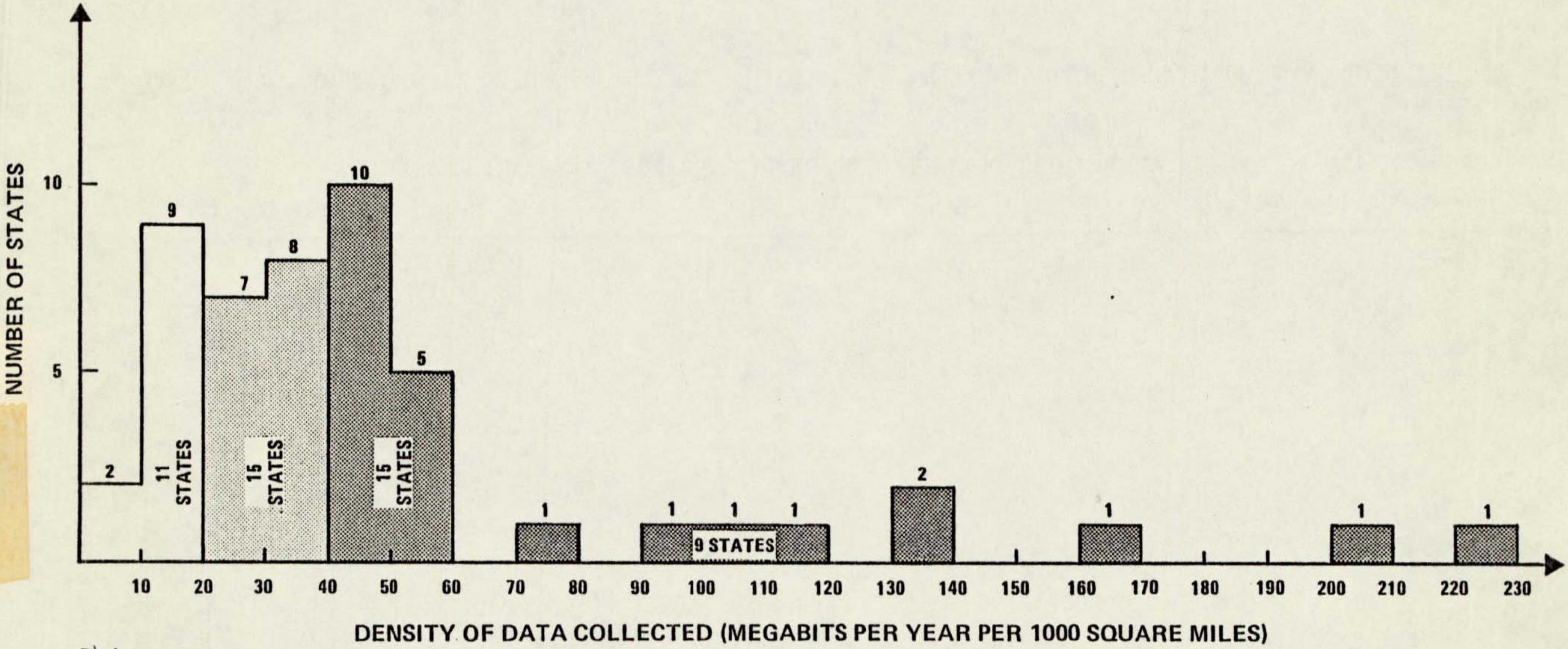


FIGURE 7.50a. DISTRIBUTION OF STATES ACCORDING TO THE DENSITY OF DATA COLLECTED

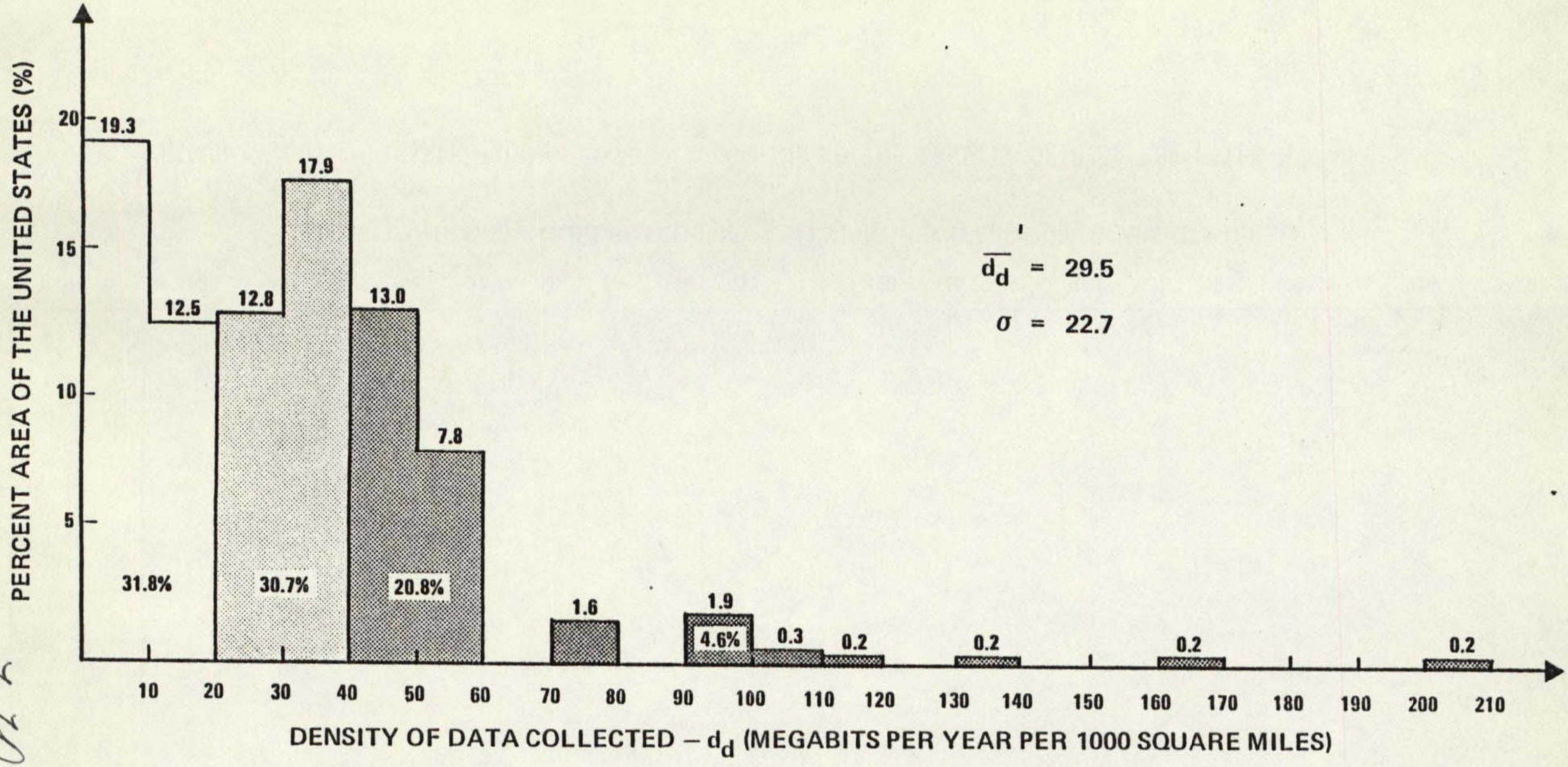


FIGURE 7.50b. DISTRIBUTION OF THE AREA OF THE UNITED STATES ACCORDING TO THE DENSITY OF DATA COLLECTED

and indicates identical ranges of the density of data collected. The number of states and the percent area of the United States that have a density of data collected in each of these shaded ranges is shown within the shaded portion of the histogram. Again, it should be noted that any discrepancies that exist between the data in Figures 7.49, 7.50a and 7.50b have occured because the values of density of data collected shown in Figure 7.49 have been rounded to the nearest whole number.

The mean and standard deviation of the density of data collected in the United States were determined using the previously mentioned equations. The mean of the density of data collected was found to be $\bar{d}_d = 29.5$ megabits per year per 1000 square miles, with a standard deviation of $\sigma = 22.7$ megabits per year per 1000 square miles. This value of the standard deviation, and the histogram showing the distribution of the area of the United States indicate that the density of data collected varies only slightly more widely than the density of stations.

Scatter Plots and Regression Results of the Amount of Data Collected

The analysis of the amount of data collected also includes an examination of the variation of the amount or density of data collected in each state with respect to the area, population, average annual rainfall, and the per capita income of each state. This analysis was performed in the same manner as that of the number and density of data collection stations discussed earlier. The first part of the results of this analysis consist of scatter plots of the number or density of data collected versus each of the four parameters mentioned above. The second part consists of the results of the log linear regressions that were performed on this data. These results are illustrated in Figures 7.51 through 7.54.

Figure 7.51 shows the scatter plot of the amount of data collected in each state versus the area of the state, and the results of the regression analysis of these two variables. The index of correlation that is part of the regression results implies that the variation in the sizes of the states accounts for 46% of the variation in the amount of data collected in each state.

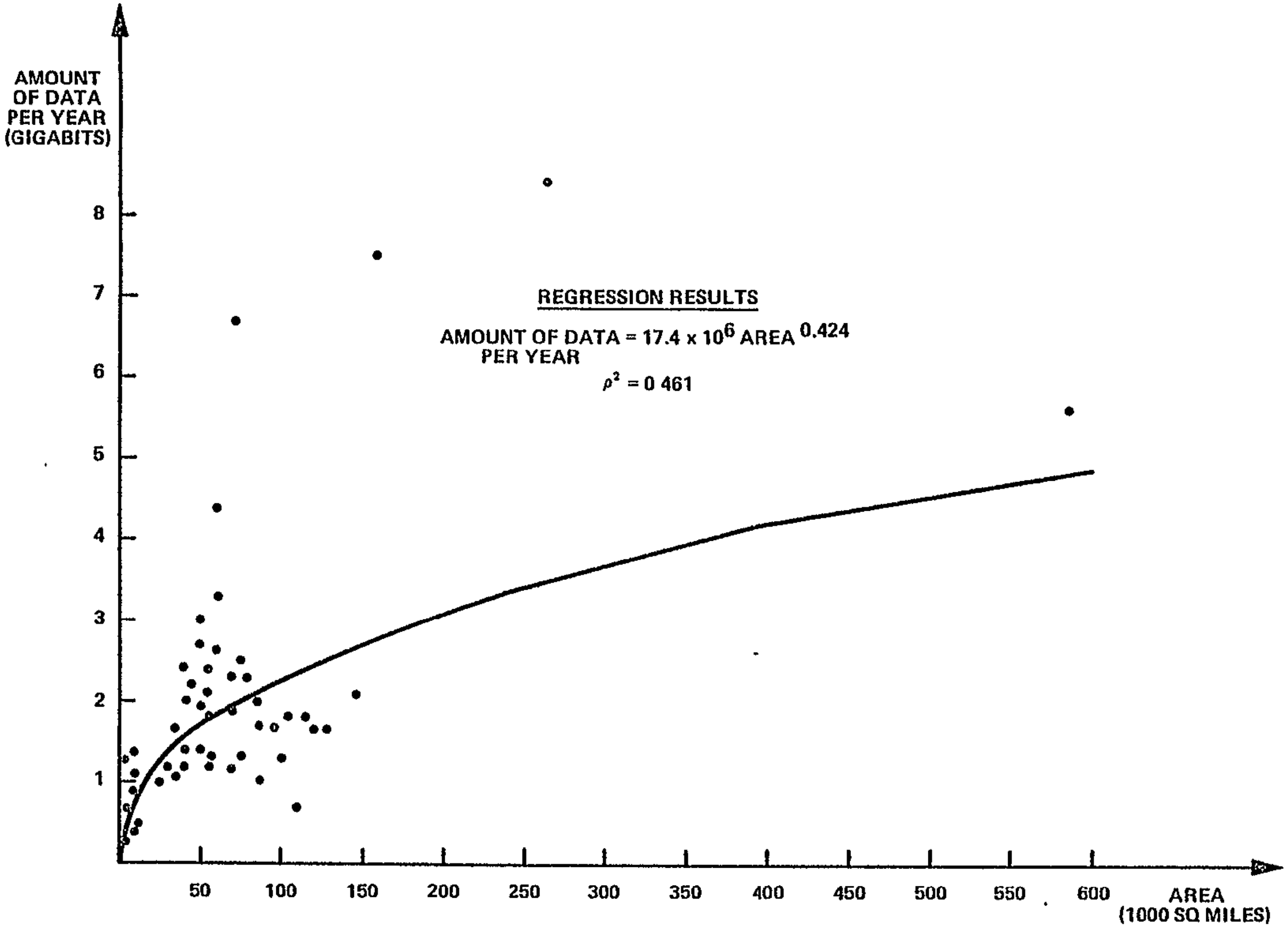


FIGURE 7.51. AMOUNT OF DATA COLLECTED PER YEAR IN EACH STATE VERSUS AREA OF THAT STATE

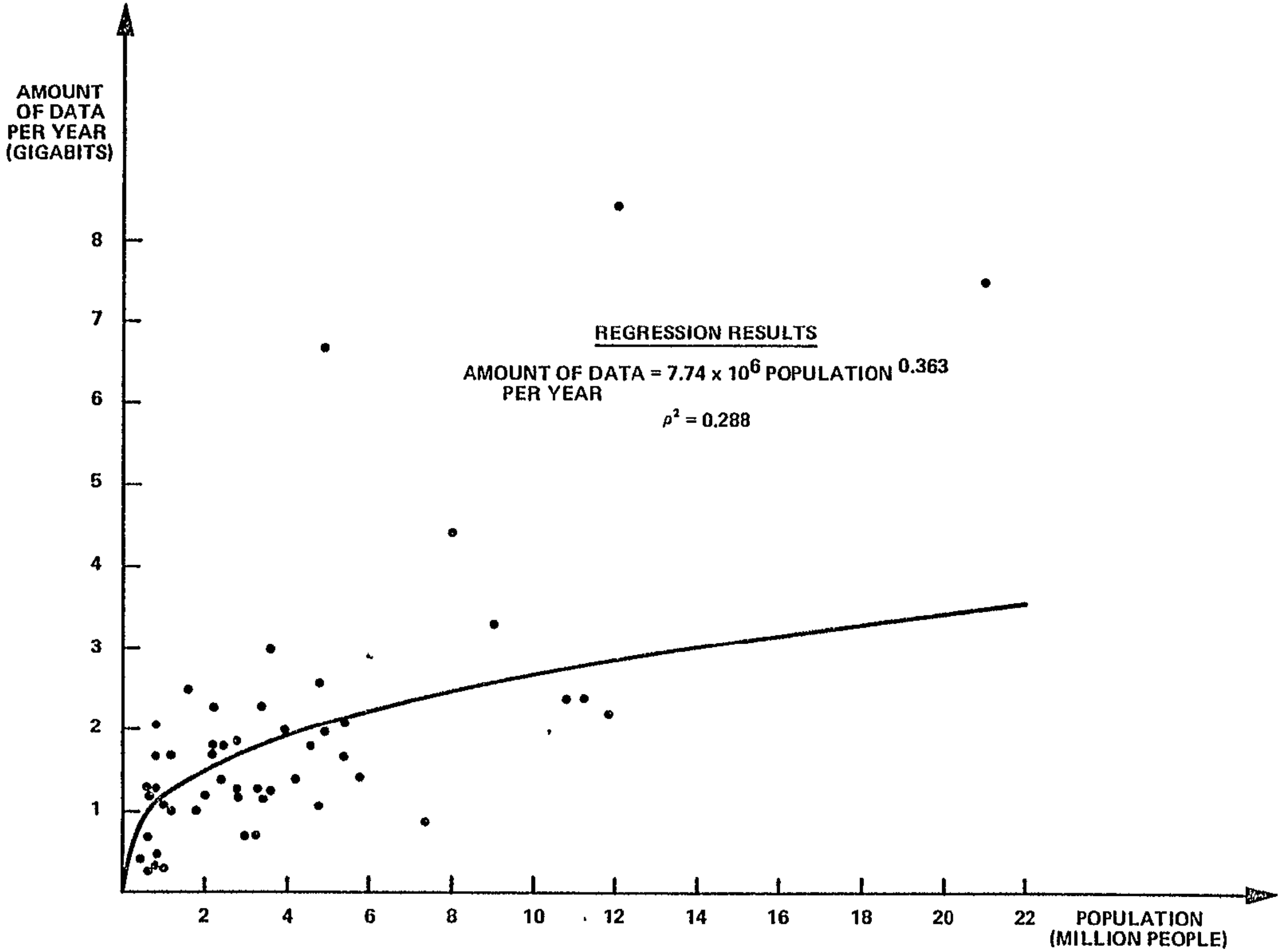


FIGURE 7.52. AMOUNT OF DATA COLLECTED PER YEAR IN EACH STATE VERSUS POPULATION OF THAT STATE

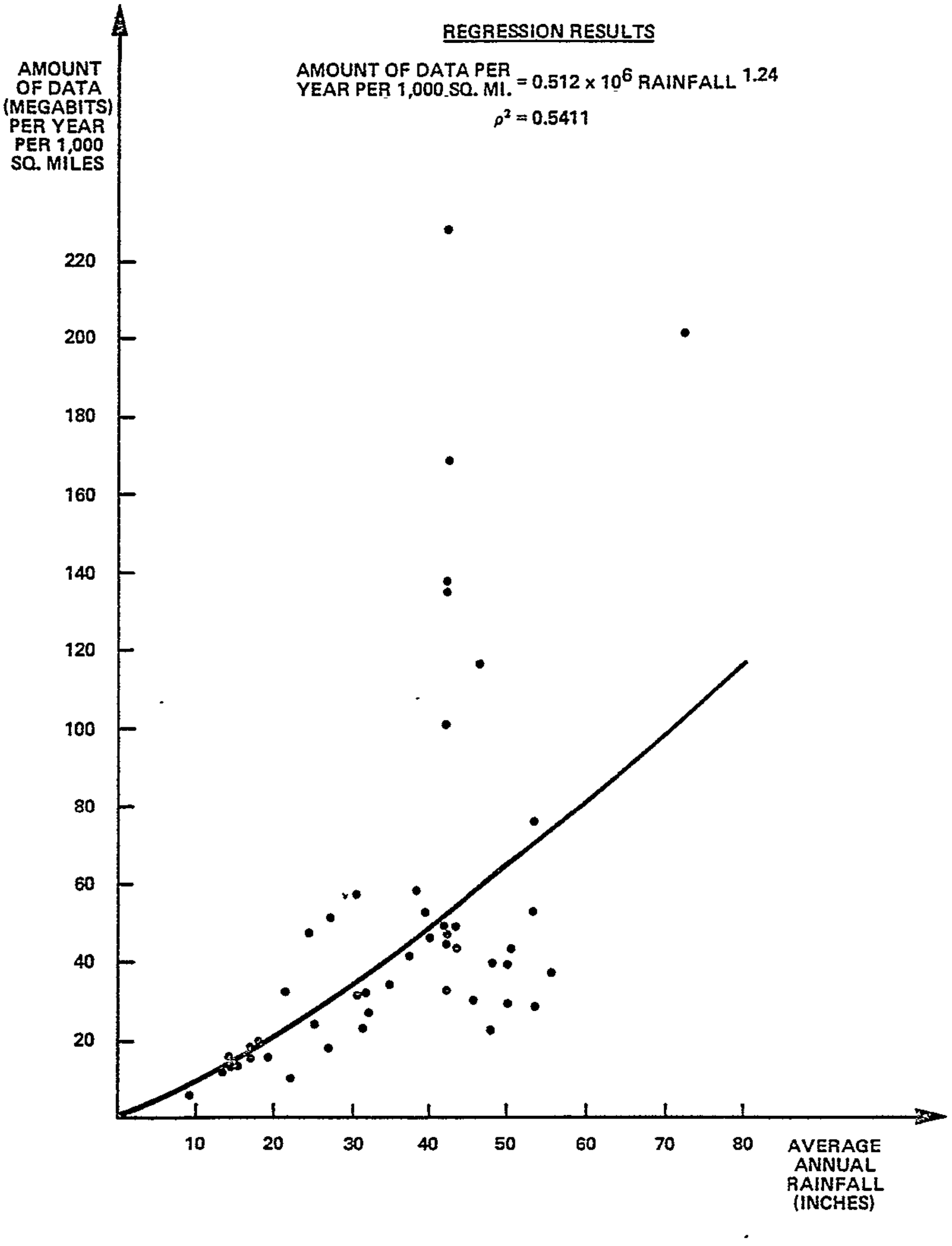


FIGURE 7.53. DENSITY OF DATA COLLECTED PER YEAR IN EACH STATE VERSUS AVERAGE ANNUAL RAINFALL IN THAT STATE

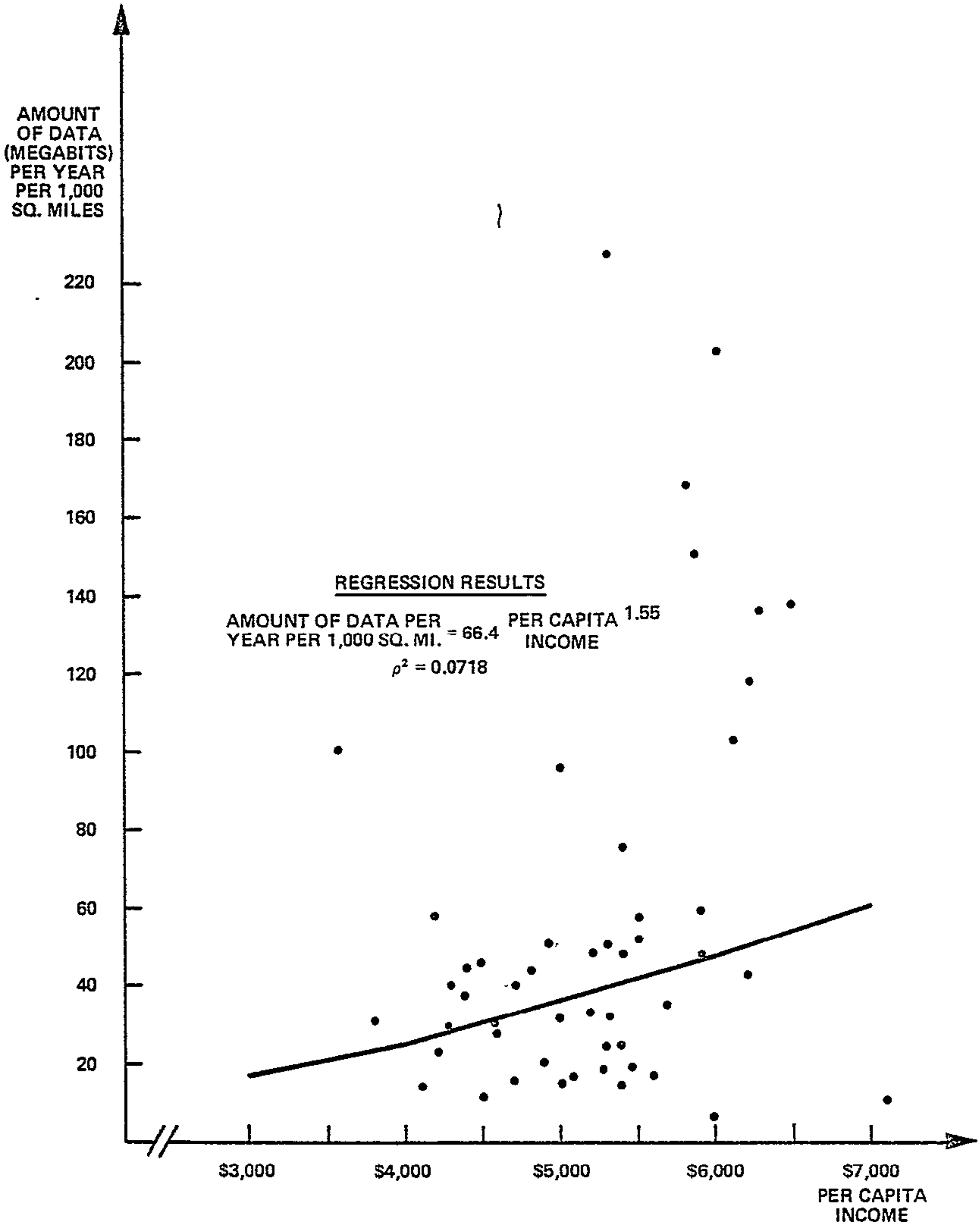


FIGURE 7.54. DENSITY OF DATA COLLECTED PER YEAR IN EACH STATE VERSUS PER CAPITA INCOME OF THAT STATE

Figure 7.52 illustrates the influence of the population of a state on the amount of data collected in the state. The value of the index of correlation of the regression analysis of these two variables can be interpreted as meaning that the variation in the population of the states accounts for almost 29% of the variation amount of data collected in each state.

Figure 7.53 shows the dependence of the density of data collected in each state upon the average annual rainfall in the state. The results of the regression analysis of these two variables indicates that the variation in the average annual rainfall in a state accounts for 54% of the variation in the density of data collected in the state.

Figure 7.54 illustrates the relationship between the density of data collected in each state and the per capita income of the state. In this case, the index of correlation indicates that the variation in the per capita income of the states can only account for 7% of the variation in the density of data collected in a state.

These results indicate that there is a higher correlation between the amount and density of data collected in a state and the four regression parameters mentioned above than between these four parameters and the number and density of data collection stations in a state (Figures 7.40 to 7.43). It should be noted that the correlation between the density of data collected and the average annual rainfall ($\rho^2 = .54$) is substantially higher than between the average annual rainfall and the density of data collection stations ($\rho^2 = .32$). It is also the highest correlation achieved in the entire analysis.

Multi-variable Regression Results

In addition to the regression analyses of the number of stations and amount of data collected that were done using each of the four variables individually, log linear regression analyses were done using all possible combinations of these four variables. In each case, the combination that contained all four of the variables produced the highest correlation index.

The regression analysis of the number of data collection stations in each state identified the following relationship between the number of stations in a state and the area (A), population (P), average annual rainfall (R), and per capita income (I) of the state.

$$\text{NUMBER OF STATIONS} = 8.62 \frac{A^{0.38} \; P^{0.45}}{R^{0.37} \; I^{0.50}} \tag{7-7}$$

The index of correlation associated with this analysis, $\rho^2 = 0.71$, indicates that the variation of the combination of these four variables accounts for 71% of the variation of the number of stations in a state.

The following relationship between the amount of data collected in a state and the four previously mentioned parameters was identified by the regression analysis of these variables.

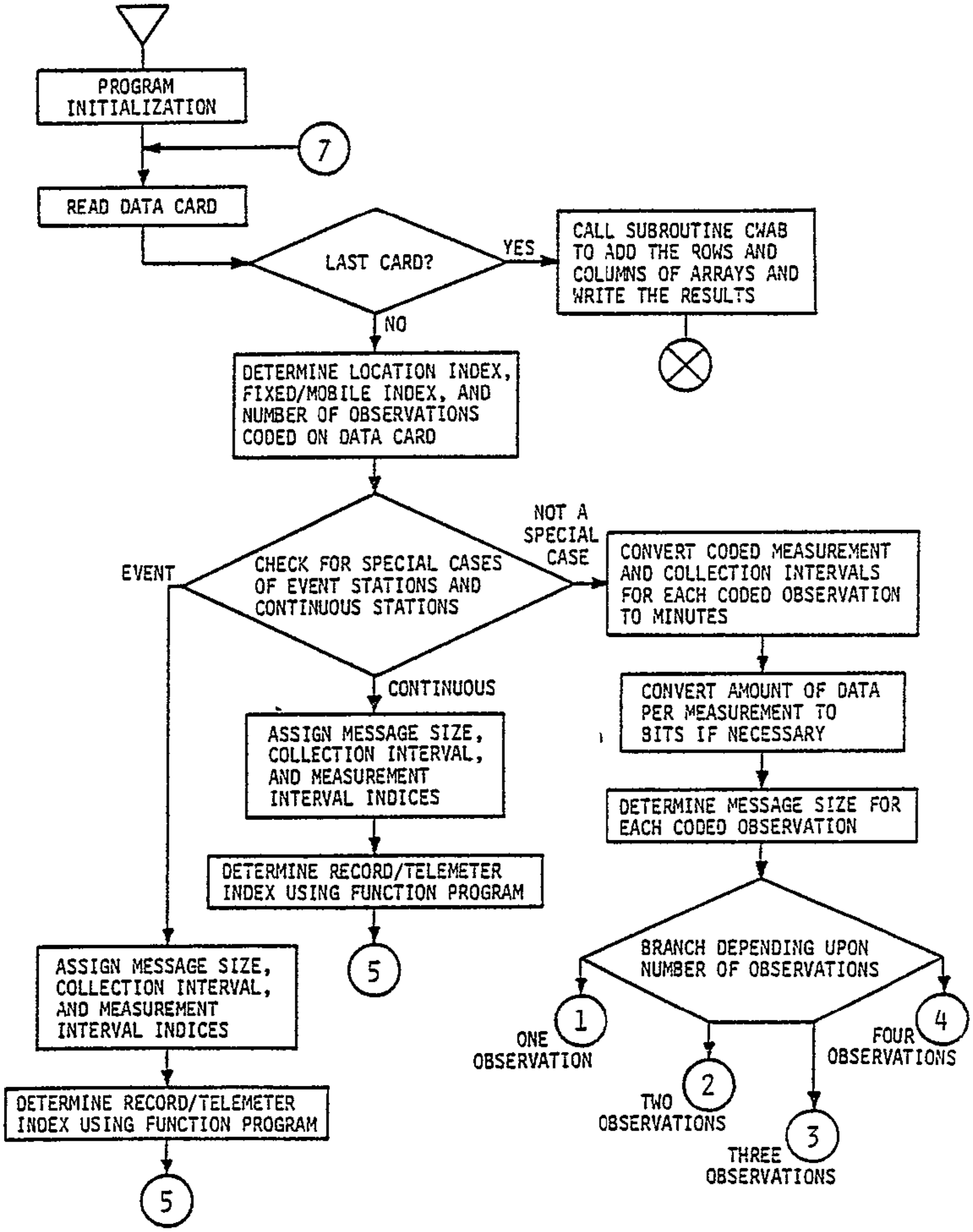
$$\text{AMOUNT OF DATA} = 0.0146 \; A^{0.51} \, P^{0.27} \, R^{0.35} \, I^{0.93} \tag{7-8}$$

The index of correlation resulting from the analysis of these variables, $\rho^2 = 0.76$, indicates that 76% of the variation in the amount of data collected in a state can be accounted for by the combined variation of the area, population, average annual rainfall, and per capita income of the state.

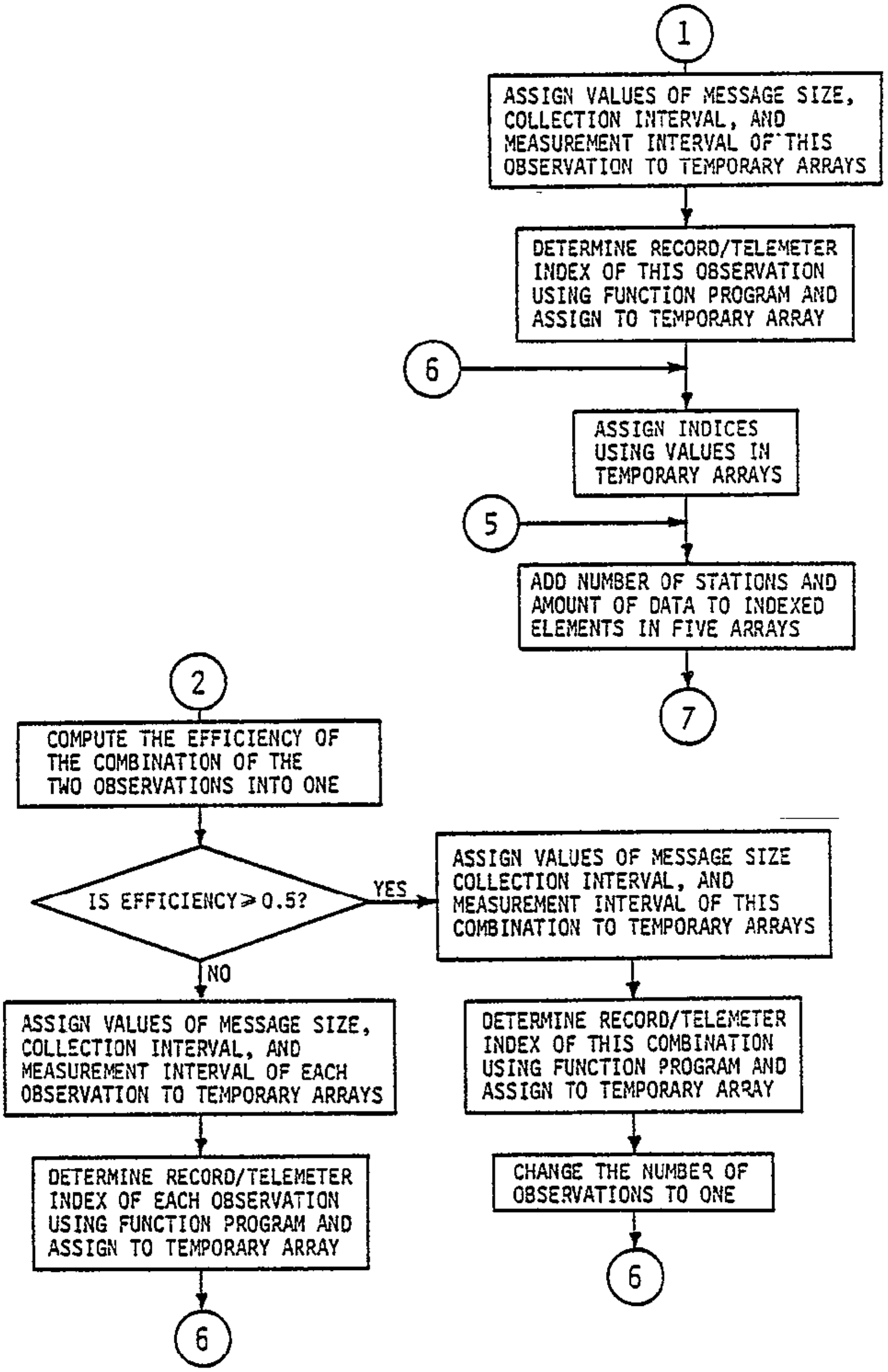
APPENDIX A
COMPUTER PROGRAM

This appendix contains an expanded version of the flowchart provided in Section 6. This flowchart indicates, in more detail, the tasks that are performed by the program. This appendix also contains a complete listing of the main program, the subroutine, CWAB, and the four function programs.

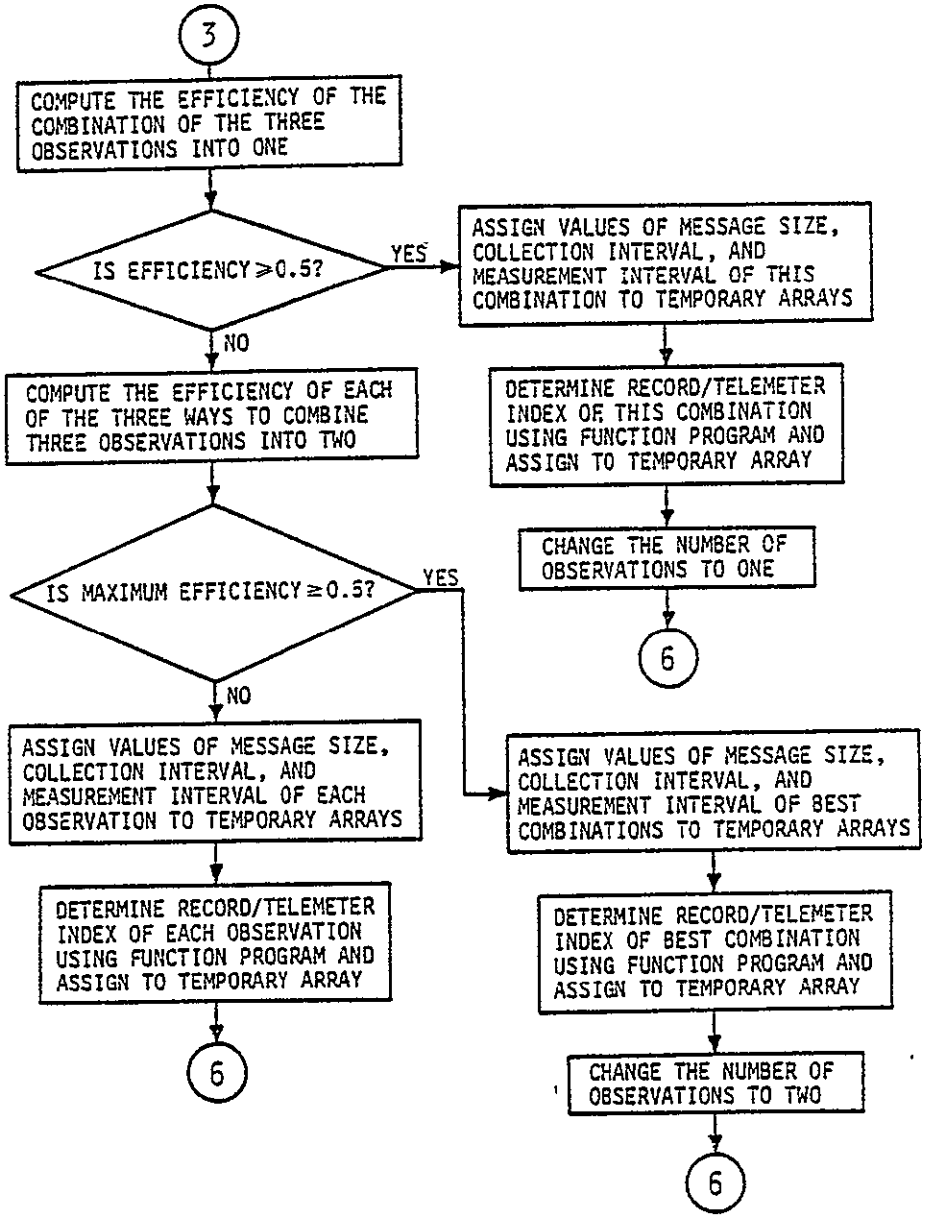
FLOWCHART OF MAIN PROGRAM



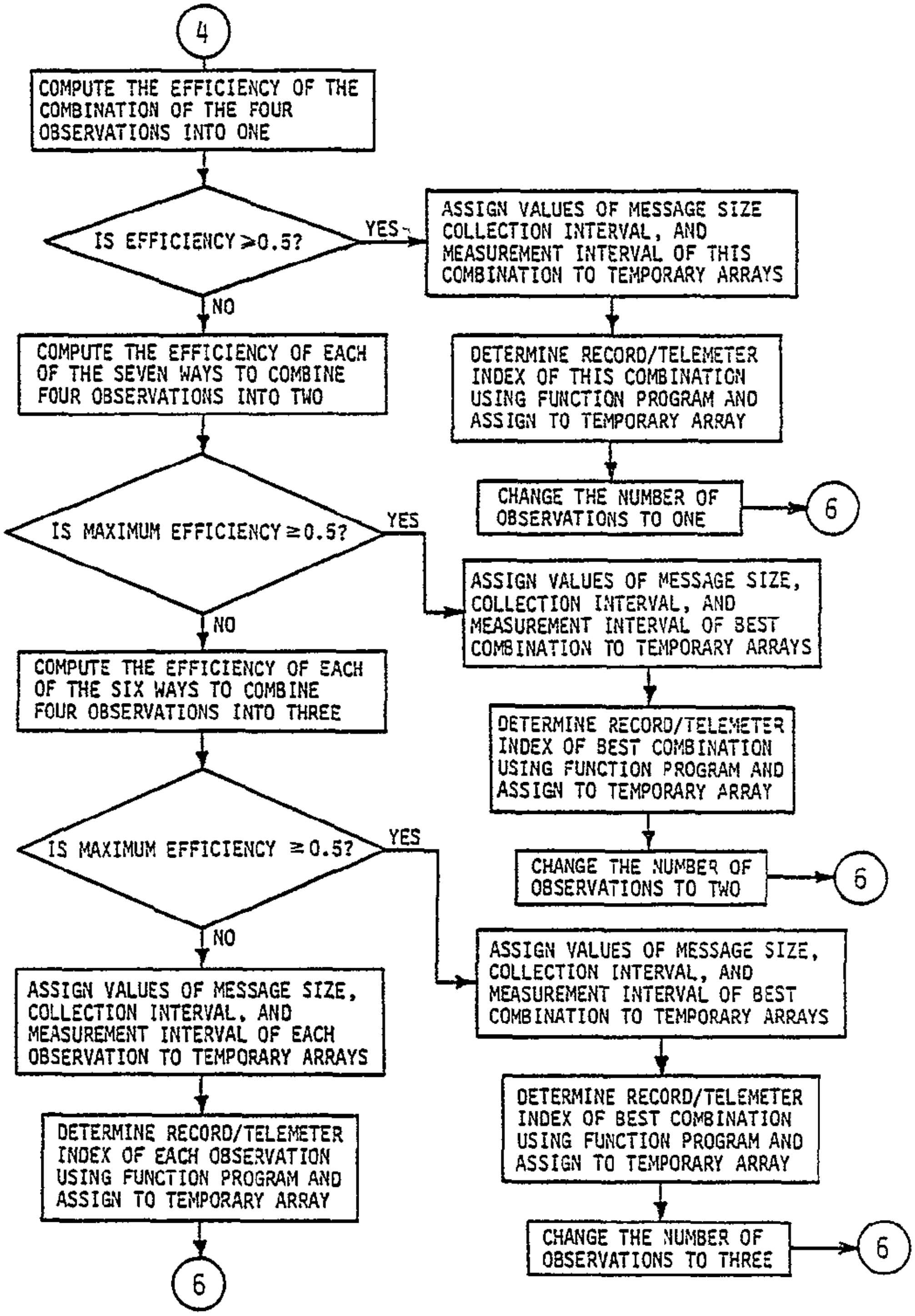
FLOWCHART OF
MAIN PROGRAM (continued)



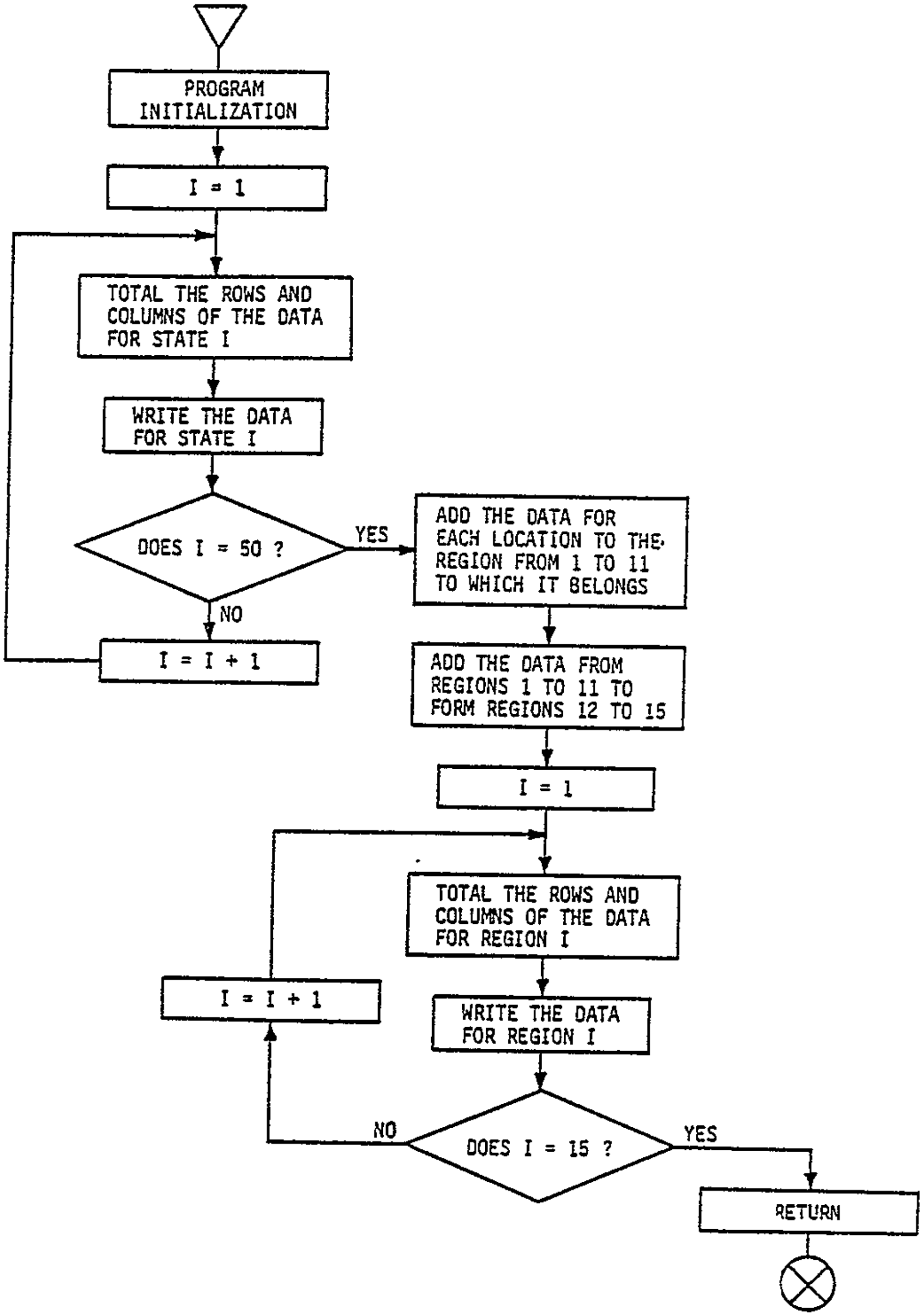
FLOWCHART OF
MAIN PROGRAM (continued)



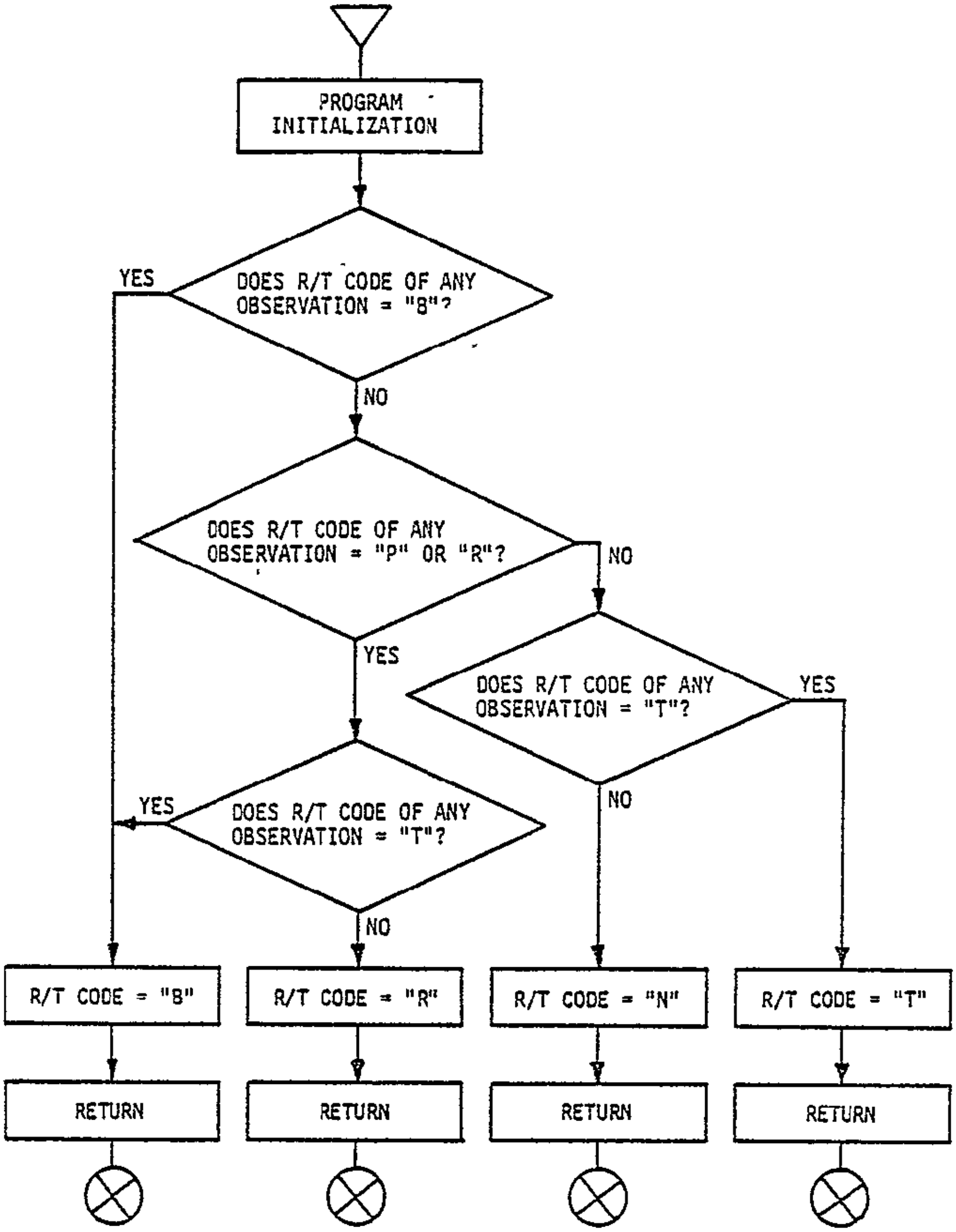
FLOWCHART OF
MAIN PROGRAM (continued)



FLOWCHART OF SUBROUTINE CWAB



FLOWCHART OF FUNCTION PROGRAMS



```
      INTEGER * 2  A(69,15,21)
      INTEGER AFM(69,4),ART(69,4),AMI(69,21)
      INTEGER * 2 I,N,I2,I3,I4
      INTEGER * 2 EPC,P3,Q3,CTM(4),CTC(4),NOBS
      INTEGER ATM(4),ATC(4),CONST(6),P(15),Q(21)
      INTEGER MEAS(5),M(4),~(4),MSG(4),C3
      INTEGER * 2 ST,FM,BC(4),RT(4),ZM(4),ZC(4),ZCC
      INTEGER * 2 STATES(71),TIME(6)
      INTEGER * 2 BC1,BC2,FM1,FM2,FM3,FM4
      INTEGER * 4 NAID,OBS(4)
      REAL C1,C2,E1,E2,E3,E4,E5,E6,E7,E8,EPP
      REAL ATLBTS(69)
C
      INTEGER * 2 ICT,IMS,ICI,IMI,IFM
      INTEGER  S(4),R(4),FRT1,FRT2,FRT3,FRT4,IRT
      INTEGER A12,A13,A14,A23,A24,A34,A1234
      INTEGER A123,A124,A134,A234
      INTEGER B12,B13,B14,B23,B24,B34
      INTEGER B123,B124,B134,B234,B1234


C
      DATA STATES/'AL','AK','AZ','AR','CA','CO','CT',
     +'DE','FL','GA','HI','ID','IL','IN','IA','KS','KY','LA',
     +'ME','MD','MA','MI','MN','MS','MO','MT',
     +'NB','NV','NH','NJ','NM','NY','NC','ND',
     +'OH','OK','OR','PA','RI','SC','SD','TN','TX','UT',
     +'VT','VA','WA','WV','WI','WY',
     +'CZ','CN','FI','AS','PR','JP','HK','AM',
     +'SA','AT','AC','PC','MX','GL','IC','GR','RU','RT','NR','OC','OC'/
C
      DATA TIME/'Y ','M ','W ','D ','H ','S '/
      DATA CONST/525600,43200,10080,1440,60,1/
C     DATA RT1/'N '/,RT2/'R '/,RT3/'T '/,RT4/'B '/,RT5/'P '/
      DATA FM1/'F '/,FM2/'S '/,FM3/'B '/,FM4/'E '/
      DATA BC1/'B '/,BC2/'C '/,MEAS(5)/0/,ZCC/'C '/
      DATA EPC/0/,EPP/0.500/,P3/15/,Q3/21/
      DATA P/0,0,20,50,100,200,500,1000,2000,5000,10000,20000,
     & 50000,100000,200000/
      DATA Q/0,0,3,11,23,47,95,143,287,575,1151,2303,8063,
     + 16127,34559,48383,69119,103679,207359,420479,600000/

C
      COMMON ATLBTS,AFM,ART,AMI,RT,A

C
C INITIALIZE ARRAYS TO ZERO
C
      DO 561 I2=1,69,1
      ATLBTS(I2)=0.0
       DO 562 I3=1,4,1
       AFM(I2,I3)=0
       ART(I2,I3)=0
  562 CONTINUE
       DO 563 I4=1,21,1
       AMI(I2,I4)=0
       DO 564 I3=1,15,1
       A(I2,I3,I4)=0
  564 CONTINUE
  563 CONTINUE
  561 CONTINUE
C     READ (1,1111) IVAL
 1111 FORMAT (I2)

C
C READ DATA CARD
C
  888 READ (5,150,END=444) N,ST,FM,NAID,
     & OBS(1),BC(1),RT(1),MEAS(1),CTM(1),ZM(1),CTC(1),ZC(1),
     & OBS(2),BC(2),RT(2),MEAS(2),CTM(2),ZM(2),CTC(2),ZC(2),
     & OBS(3),BC(3),RT(3),MEAS(3),CTM(3),ZM(3),CTC(3),ZC(3),
     & OBS(4),BC(4),RT(4),MEAS(4),CTM(4),ZM(4),CTC(4),ZC(4)
C
  150 FORMAT (I4,A2,A1,A3,
     & A3,A1,A1,I4,I2,A1,I2,A1,
     & A3,A1,A1,I4,I2,A1,I2,A1,
     & A3,A1,A1,I4,I2,A1,I2,A1,
     & A3,A1,A1,I4,I2,A1,I2,A1)


C
C CONVERT STATE CODES TO INDICES
C
      DO 128 I=1,71,1
          IF (STATES(I).EQ.ST) GO TO 129
  128 CONTINUE
      GO TO 666
  129 IF (I.EQ.70) GO TO 137
      IF (I.EQ.71) GO TO 136
      GO TO 135
  137 I=20
      GO TO 135
  136 I=52
      GO TO 135
  135 ICT=I
```

```
C
C INDEX FIXED AND MOBILE STATIONS
C
      IF (FM.EQ.FM1) GO TO 391
      IF (FM.EQ.FM2) GO TO 392
      IF (FM.EQ.FM3) GO TO 393
      IF (FM.EQ.FM4) GO TO 394
      GO TO 666
  391 IFM=1
      GO TO 395
  392 IFM=2
      GO TO 395
  393 IFM=3
      GO TO 395
  394 IFM=4
  395 CONTINUE
C     IF (IFM.NE.IVAL) GO TO 888

C
C DETERMINE NUMBER OF CODED OBSERVATIONS
C
      DO 138 NOBS=2,5,1
      IF (MEAS(NOBS).EQ.0). GO TO 139
  138 CONTINUE
      GO TO 666
  139 NOBS=NOBS-1

C
C INDEX AND COUNT EVENT AND CONTINUOUS STATIONS
C
      IF (FM.EQ.FM4) GO TO 81
      IF (ZM(1).EQ.ZCC) GO TO 82
      GO TO 84
   81 IMS=1
      ICI=1
      IMI=1
      IRT=FRT1(1)
      GO TO 83
   82 IMS=2
      ICI=2
      IMI=2
      IRT=FRT1(1)
   83 A(IST,IMS,ICI)=A(IST,IMS,ICI)+N
      AMI(IST,IMI)=AMI(IST,IMI)+N
      ART(IST,IRT)=ART(IST,IRT)+N
      AFM(IST,IFM)=AFM(IST,IFM)+N
      GO TO 888
   84 CONTINUE

C
C CONVERT MEASUREMENT INTERVAL TO MINUTES
C
      DO 90 I2=1,NOBS,1
          DO 91 I3=1,6,1
              IF (ZM(I2).EQ.TIME(I3)) GO TO 92
   91 CONTINUE
      GO TO 666
   92   ATM(I2)=CTM(I2)*CONST(I3)
   90 CONTINUE

C
C CONVERT COLLECTION INTERVAL TO MINUTES
C
      DO 100 I2=1,NOBS,1
          DO 101 I3=1,6,1
              IF (ZC(I2).EQ.TIME(I3)) GO TO 102
  101 CONTINUE
      GO TO 666
  102   ATC(I2)=CTC(I2)*CONST(I3)
  100 CONTINUE

C
C MULTIPLY BY BITS PER CHARACTER
C
          DO 611 I2=1,NOBS,1
          IF (BC(I2).EQ.BC1) GO TO 611
          IF (BC(I2).NE.BC2) GO TO 666
          MEAS(I2)=MEAS(I2)*BPC
 611      CONTINUE

C
C DETERMINATION OF MESSAGE SIZE
C
      DO 16  I2=1,NOBS,1
        ISG(I2)=(ATC(I2)/ATM(I2))*MEAS(I2)
   16 CONTINUE

C
C BRANCH DEPENDING UPON NUMBER OF CODED OBSERVATIONS
C
      GOTO (200,300,400,500),NOBS
      GO TO 666
```

COMPUTER PROGRAM (continued)

```
C
C IF ONE CODED OBSERVATION
C
   20 M(1)=MSG(1)
      T(1)=ATC(1)
      R(1)=FRT1(1)
      S(1)=ATM(1)
      GO TO 777

C
C IF TWO CODED OBSERVATIONS
C
   30 A12=MSG(1)+MSG(2)
      B12=MIN0(ATC(1),ATC(2))
      C3=MAX0(ATC(1),ATC(2))
      C1=C3
      C2=MSG(1)*C1/ATC(1)+MSG(2)*C1/ATC(2)
C
      E1=C2/(A12*C1/B12)
C
      IF (E1.GE.EFF) GO TO 304
      GO TO 305
C
  304 M(1)=A12
      T(1)=B12
      R(1)=FRT2(1,2)
      S(1)=MIN0(ATM(1),ATM(2))
      NOBS=1
      GO TO 777
C
  305 M(1)=MSG(1)
      M(2)=MSG(2)
      T(1)=ATC(1)
      T(2)=ATC(2)
      R(1)=FRT1(1)
      R(2)=FRT1(2)
      S(1)=ATM(1)
      S(2)=ATM(2)
      GO TO 777

C
C IF THREE CODED OBSERVATIONS
C
   40 A123= MSG(1)+MSG(2)+MSG(3)
      B123=MIN0(ATC(1),ATC(2),ATC(3))
      C3= MAX0(ATC(1),ATC(2),ATC(3))
      C1=C3
      C2 = MSG(1)*C1/ATC(1) + MSG(2)*C1/ATC(2) + MSC(3)*C1/ATC(3)
C
      E1= C2/(A123*C1/B123)
C
      IF ( E1. GE. EFF) GO TO 418
C
      A12= MSG(1)+MSG(2)
      A23=MSG(2)+MSG(3)
      A13=MSG(1)+MSG(3)
      B12=MIN0(ATC(1),ATC(2))
      B23=MIN0(ATC(2),ATC(3))
      B13=MIN0(ATC(1),ATC(3))
C
      E1 = C2/(A12*C1/B12 + MSG(3) * C1/ATC(3))
      E2=C2/(A23*C1/B23+MSG(1)*C1/ATC(1))
      E3=C2/(A13*C1/B13+MSG(2)*C1/ATC(2))
      E4 = AMAX1(E1,E2,E3)
C
      IF(E4. GE. EFF) GO TO 419
C
  417 M(1)=MSG(1)
      M(2)=MSG(2)
      M(3)=MSG(3)
      T(1)=ATC(1)
      T(2)=ATC(2)
      T(3)=ATC(3)
      R(1)=FRT1(1)
      R(2)=FRT1(2)
      R(3)=FRT1(3)
      S(1)=ATM(1)
      S(2)=ATM(2)
      S(3)=ATM(3)
      GO TO 777
C
  418 M(1)=A123
      T(1)=B123
      R(1)=FRT3(1,2,3)
      S(1)=MIN0(ATM(1),ATM(2),ATM(3))
      NOBS=1
      GO TO 777
C
  419 NOBS=2
      IF (E4.EQ.E1) GO TO 241
      IF (E4.EQ.E2) GO TO 242
      IF (E4.EQ.E3) GO TO 243
      GO TO 666
```

COMPUTER PROGRAM (continued)

```
C
  241 M(1)=A12
      M(2)=MSG(3)
      T(1)=B12
      T(2)=ATC(3)
      R(1)=FRT2(1,2)
      R(2)=FRT1(3)
      S(1)=MIN0(ATM(1),ATM(2))
      S(2)=ATM(3)
      GO TO 777
C
  242 M(1)=A23
      M(2)=MSG(1)
      T(1)=B23
      T(2)=ATC(1)
      R(1)=FRT2(2,3)
      R(2)=FRT1(1)
      S(1)=MIN0(ATM(2),ATM(3))
      S(2)=ATM(1)
      GO TO 777
C
  243 M(1)=A13
      M(2)=MSG(2)
      T(1)=B13
      T(2)=ATC(2)
      R(1)=FRT2(1,3)
      R(2)=FRT1(2)
      S(1)=MIN0(ATM(2),ATM(3))
      S(2)=ATM(2)
      GO TO 777

C
C IF FOUR CODED OBSERVATIONS
  500 A1234=MSG(1)+MSG(2)+MSG(3)+MSG(4)
      B1234=MIN0(ATC(1),ATC(2),ATC(3),ATC(4))
      C3= MAX0(ATC(1),ATC(2),ATC(3),ATC(4))
      C1=C3
      C2= MSG(1)*C1/ATC(1)+
     +        MSG(2)*C1/ATC(2)+
     +          MSG(3)*C1/ATC(3)+
     +            MSG(4)*C1/ATC(4)
C
      E1= C2/(A1234*C1/B1234)
C
      IF (E1. GE.EFF) GO TO 250
C
      A123= MSG(1)+MSG(2)+MSG(3)
      A124= MSG(1)+MSG(2)+MSG(4)
      A134= MSG(1)+MSG(3)+MSG(4)
      A234= MSG(2)+MSG(3)+MSG(4)
      A12= MSG(1)+MSG(2)
      A13= MSG(1)+MSG(3)
      A14= MSG(1)+MSG(4)
      A23= MSG(2)+MSG(3)
      A24= MSG(2)+MSG(4)
      A34= MSG(3)+MSG(4)
      B123= MIN0(ATC(1),ATC(2),ATC(3))
      B124= MIN0(ATC(1),ATC(2),ATC(4))
      B134= MIN0(ATC(1),ATC(3),ATC(4))
      B234= MIN0(ATC(2),ATC(3),ATC(4))
      B12= MIN0(ATC(1),ATC(2))
      B13= MIN0(ATC(1),ATC(3))
      B14= MIN0(ATC(1),ATC(4))
      B23= MIN0(ATC(2),ATC(3))
      B24= MIN0(ATC(2),ATC(4))
      B34= MIN0(ATC(3),ATC(4))
C
      E1=C2/(A123*C1/B123+MSG(4)*C1/ATC(4))
      E2=C2/(A124*C1/B124+MSG(3)*C1/ATC(3))
      E3=C2/(A134*C1/B134+MSG(2)*C1/ATC(2))
      E4=C2/(A234*C1/B234+MSG(1)*C1/ATC(1))
      E5=C2/(A12*C1/B12+ A34*C1/B34)
      E6=C2/(A13*C1/B13+ A24*C1/B24)
      E7=C2/(A14*C1/B14 + A23*C1/B23)
C
      E8=AMAX1(E1,E2,E3,E4,E5,E6,E7)
C
      IF (E8. GE. EFF) GO TO 260
C
      E1=C2/(MSG(1)*C1/ATC(1)+MSG(2)*C1/ATC(2)+A34*C1/B34)
      E2=C2/(MSG(1)*C1/ATC(1)+MSG(3)*C1/ATC(3)+A24*C1/B24)
      E3=C2/(MSG(2)*C1/ATC(2)+MSG(3)*C1/ATC(3)+A14*C1/B14)
      E4=C2/(MSG(3)*C1/ATC(3)+MSG(4)*C1/ATC(4)+A12*C1/B12)
      E5=C2/(MSG(2)*C1/ATC(2)+MSG(4)*C1/ATC(4)+A13*C1/B13)
      E6=C2/(MSG(1)*C1/ATC(1)+MSG(4)*C1/ATC(4)+A23*C1/B23)
C
      E7=AMAX1(E1,E2,E3,E4,E5,E6)
C
      IF (E7. GE. EFF) GO TO 270
      GO TO 280
C
  250 M(1)=A1234
      T(1)=B1234
      R(1)=FRT4(1,2,3,4)
      S(1)=MIN0(ATM(1),ATM(2),ATM(3),ATM(4))
      NOBS=1
      GO TO 777
```

COMPUTER PROGRAM (continued)

```
C                                                                       00003610
  260 NOBS=2                                                            00003620
      IF (E8.EQ.E1) GO TO 261                                           00003630
      IF (E8.EQ.E2) GO TO 262                                           00003640
      IF (E8.EQ.E3) GO TO 263                                           00003650
      IF (E8.EQ.E4) GO TO 264                                           00003660
      IF (E8.EQ.E5) GO TO 265                                           00003670
      IF (E8.EQ.E6) GO TO 266                                           00003680
      IF (E8.EQ.E7) GO TO 267                                           00003690
      GO TO 666                                                         00003700
C                                                                       00003710
  261 M(1)=A123                                                         00003720
      M(2)=MSG(4)                                                       00003730
      T(1)=B123                                                         00003740
      T(2)=ATC(4)                                                       00003750
      R(1)=FRT3(1,2,3)                                                  00003760
      R(2)=FRT1(4)                                                      00003770
      S(1)=MINO(ATM(1),ATM(2),ATM(3))                                   00003780
      S(2)=ATM(4)                                                       00003790
      GO TO 777                                                         00003800
C                                                                       00003810
  262 M(1)=A124                                                         00003820
      M(2)=MSG(3)                                                       00003830
      T(1)=B124                                                         00003840
      T(2)=ATC(3)                                                       00003850
      R(1)=FRT3(1,2,4)                                                  00003860
      R(2)=FRT1(3)                                                      00003870
      S(1)=MINO(ATM(1),ATM(2),ATM(4))                                   00003880
      S(2)=ATM(3)                                                       00003890
      GO TO 777                                                         00003900
C                                                                       00003910
  263 M(1)=A134                                                         00003920
      M(2)=MSG(2)                                                       00003930
      T(1)=B134                                                         00003940
      T(2)=ATC(2)                                                       00003950
      R(1)=FRT3(1,3,4)                                                  00003960
      R(2)=FRT1(2)                                                      00003970
      S(1)=MINO(ATM(1),ATM(3),ATM(4))                                   00003980
      S(2)=ATM(2)                                                       00003990
      GO TO 777                                                         00004000
C                                                                       00004010
  264 M(1)=A234                                                         00004020
      M(2)=MSG(1)                                                       00004030
      T(1)=B234                                                         00004040
      T(2)=ATC(1)                                                       00004050
      R(1)=FRT3(2,3,4)                                                  00004060
      R(2)=FRT1(1)                                                      00004070
      S(1)=MINO(ATM(2),ATM(3),ATM(4))                                   00004080
      S(2)=ATM(1)                                                       00004090
      GO TO 777                                                         00004100
C                                                                       00004110
  265 M(1)=A12                                                          00004120
      M(2)=A34                                                          00004130
      T(1)=B12                                                          00004140
      T(2)=B34                                                          00004150
      R(1)=FRT2(1,2)                                                    00004160
      R(2)=FRT2(3,4)                                                    00004170
      S(1)=MINO(ATM(1),ATM(2))                                          00004180
      S(2)=MINO(ATM(3),ATM(4))                                          00004190
      GO TO 777                                                         00004200
C                                                                       00004210
  266 M(1)=A13                                                          00004220
      M(2)=A24                                                          00004230
      T(1)=B13                                                          00004240
      T(2)=B24                                                          00004250
      R(1)=FRT2(1,3)                                                    00004260
      R(2)=FRT2(2,4)                                                    00004270
      S(1)=MINO(ATM(1),ATM(3))                                          00004280
      S(2)=MINO(ATM(2),ATM(4))                                          00004290
      GO TO 777                                                         00004300
C                                                                       00004310
  267 M(1)=A14                                                          00004320
      M(2)=A23                                                          00004330
      T(1)=B14                                                          00004340
      T(2)=B23                                                          00004350
      R(1)=FRT2(1,4)                                                    00004360
      R(2)=FRT2(2,3)                                                    00004370
      S(1)=MINO(ATM(1),ATM(4))                                          00004380
      S(2)=MINO(ATM(2),ATM(3))                                          00004390
      GO TO 777                                                         00004400
C                                                                       00004410
  270 NOBS=3                                                            00004420
      IF (E7.EQ.E1) GO TO 351                                           00004430
      IF (E7.EQ.E2) GO TO 352                                           00004440
      IF (E7.EQ.E3) GO TO 353                                           00004450
      IF (E7.EQ.E4) GO TO 354                                           00004460
      IF (E7.EQ.E5) GO TO 355                                           00004470
      IF (E7.EQ.E6) GO TO 356                                           00004480
      GO TO 666                                                         00004490
```

COMPUTER PROGRAM (continued)

```
C
  351 M(1)=MSG(1)
      M(2)=MSG(2)
      M(3)=A34
      T(1)=ATC(1)
      T(2)=ATC(2)
      T(3)=B34
      R(1)=FRT1(1)
      R(2)=FRT1(2)
      R(3)=FRT2(3,4)
      S(1)=ATM(1)
      S(2)=ATM(2)
      S(3)=MIN0(ATM(3),ATM(4))
      GO TO 777
C
  352 M(1)=MSG(1)
      M(2)=MSG(3)
      M(3)=A24
      T(1)=ATC(1)
      T(2)=ATC(3)
      T(3)=B24
      R(1)=FRT1(1)
      R(2)=FRT1(3)
      R(3)=FRT2(2,4)
      S(1)=ATM(1)
      S(2)=ATM(3)
      S(3)=MIN0(ATM(2),ATM(4))
      GO TO 777
C
  353 M(1)=MSG(2)
      M(2)=MSG(3)
      M(3)=A14
      T(1)=ATC(2)
      T(2)=ATC(3)
      T(3)=B14
      R(1)=FRT1(2)
      R(2)=FRT1(3)
      R(3)=FRT2(1,4)
      S(1)=ATM(2)
      S(2)=ATM(3)
      S(3)=MIN0(ATM(1),ATM(4))
      GO TO 777
C
  354 M(1)=MSG(3)
      M(2)=MSG(4)
      M(3)=A12
      T(1)=ATC(3)
      T(2)=ATC(4)
      T(3)=B12
      R(1)=FRT1(3)
      R(2)=FRT1(4)
      R(3)=FRT2(1,2)
      S(1)=ATM(3)
      S(2)=ATM(4)
      S(3)=MIN0(ATM(1),ATM(2))
      GO TO 777
C
  355 M(1)=MSG(2)
      M(2)=MSG(4)
      M(3)=A13
      T(1)=ATC(2)
      T(2)=ATC(4)
      T(3)=B13
      R(1)=FRT1(2)
      R(2)=FRT1(4)
      R(3)=FRT2(1,3)
      S(1)=ATM(2)
      S(2)=ATM(4)
      S(3)=MIN0(ATM(1),ATM(3))
      GO TO 777
C
  356 M(1)=MSG(1)
      M(2)=MSG(4)
      M(3)=A23
      T(1)=ATC(1)
      T(2)=ATC(4)
      T(3)=B23
      R(1)=FRT1(1)
      R(2)=FRT1(4)
      R(3)=FRT2(2,3)
      S(1)=ATM(1)
      S(2)=ATM(4)
      S(3)=MIN0(ATM(2),ATM(3))
      GO TO 777
C
   28 M(1)=MSG(1)
      M(2)=MSG(2)
      M(3)=MSG(3)
      M(4)=MSG(4)
      T(1)=ATC(1)
      T(2)=ATC(2)
      T(3)=ATC(3)
      T(4)=ATC(4)
      R(1)=FRT1(1)
      R(2)=FRT1(2)
      R(3)=FRT1(3)
      R(4)=FRT1(4)
      S(1)=ATM(1)
      S(2)=ATM(2)
      S(3)=ATM(3)
      S(4)=ATM(4)
      GO TO 777
```

COMPUTER PROGRAM (continued)

```
C
C THIS SECTION INDEXES MESSAGE SIZE AND COLLECTION INTERVAL.
C AND ADDS THE NUMBER OF STATIONS TO A
C
  777 DO 177 I2=1,NOBS,1
C     IF (R(I2).NE.IVAL) GO TO 177
          DO 171 I3=1,P3,1
              IF (M(I2).LE.P(I3)) GO TO 172
  171     CONTINUE
      GO TO 666
  172 IMS=I3
C
          DO 174 I3=1,Q3,1
              IF (T(I2).LE.Q(I3)) GO TO 175
  174     CONTINUE
      GO TO 666
  175 ICI=I3
C
      DO 177 I3=1,O3,1
      IF (S(I2).LE.C(I3)) GO TO 178
  177 CONTINUE
      GO TO 666
  178 IMI=I3
C
      IRT=R(I2)
C
      A(IST,IMS,ICI)=A(IST,IMS,ICI)+N
      ATLBTS(IST)=ATLBTS(IST)+525600./T(I2)*N*M(I2)
      AEM(IST,IEM)=AEM(IST,IEM)+N
      ART(IST,IRT)=ART(IST,IRT)+N
      AMI(IST,IMI)=AMI(IST,IMI)+N
  177 CONTINUE
      GO TO 888

C
C PRINT DATA CARD WHEN AN ERROR
C
  666 WRITE (6,667) N,ST,EM,NAID
  667 FORMAT(1X,I4,1X,A2,1X,A2,1X,A4)
      WRITE (6,668) OBS(1),BC(1),RT(1),MEAS(1),CTM(1),ZM(1),CTC(1),ZC(1)
      WRITE (6,668) OBS(2),BC(2),RT(2),MEAS(2),CTM(2),ZM(2),CTC(2),ZC(2)
      WRITE (6,668) OBS(3),BC(3),RT(3),MEAS(3),CTM(3),ZM(3),CTC(3),ZC(3)
      WRITE (6,668) OBS(4),BC(4),RT(4),MEAS(4),CTM(4),ZM(4),CTC(4),ZC(4)
C
  668 FORMAT (1X,A4,1X,A2,1X,A2,1X,I6,1X,I2,1X,A2,1X,I2,1X,A2)
C
      GO TO 888

C
  444 CALL EXAE
      STOP
      END
```

COMPUTER PROGRAM (continued)

```
      SUBROUTINE CWAB
C
      INTEGER B(15,15,21),BFM(15,4),BRT(15,4),BMI(15,21),P(15)
      INTEGER HTL(4),HMS(4,15),HRT1,HRT2,HRT3,HFM,HCI(21)
      INTEGER * 4 LOCAT(15),SCALE(21)
      INTEGER * 2 CTRL(4,3),RGN(69),STATES(50),A(69,15,21)
      INTEGER * 2 I2,I3,I4,I5,I6,I7,I8,I9,F3,G3,J2,RT(4)
      REAL DTL(4),ATLBTS(69),STSQM(51),RGNSQM(15),BTLBTS(15)
      INTEGER AFM(69,4),ART(69,4),AMI(69,21)

      DATA P/0,10,20,50,100,200,500,1000,2000,5000,10000,20000,
     + 50000,100000,200000/
      DATA LOCAT/'NENG','MEST','GTLK','PLNS','SEST','SWST','RKMT',
     + 'PWST','ALSK','HAWI','RMDR','FAS ','48ST','50ST','TCTL'/
      DATA SCALE/'EVNT','CONT',' 1MN',' 5MN','15MN','30MN',
     + ' 1HR',' 2HR',' 3HR',' 6HR','12HR',' 1DA',' 2DA',
     + ' 1WK',' 2WK',' 1MO',' 6WK',' 2MO',' 3MO',' 6MO',' 1YR'/
      DATA CTRL/3,1,1,1,10,8,10,11,12,13,14,15/
      DATA RGN/5,9,6,5,8,7,1,2,5,5,10,7,3,3,4,4,5,5,
     + 1,2,1,3,4,5,4,7,4,9,1,2,6,2,5,4,3,6,8,2,1,5,4,
     + 7,5,6,1,5,3,5,3,7,19*11/
      DATA STATES/'AL','AK','AZ','AR','CA','CO','CT',
     + 'DE','FL','GA','HI','ID','IL','IN','IA','KS','KY','LA',
     + 'ME','MD','MA','MI','MN','MS','MO','MT',
     + 'NB','NV','NH','NJ','NM','NY','NC','ND',
     + 'OH','OK','OR','PA','RI','SC','SD','TN','TX','UT',
     + 'VT','VA','WA','WV','WI','WY'/
      DATA F3/15/,G3/21/
      DATA STSQM/51.609,586.412,113.909,53.104,158.693,104.247,5.009,
     + 2.057,58.56,58.876,6.45,83.557,56.4,36.291,56.29,82.264,
     + 40.395,48.523,33.215,10.644,8.257,58.216,84.068,47.716,69.686,
     + 147.138,77.227,110.540,9.304,7.836,121.666,49.576,52.586,
     + 70.665,41.222,69.919,96.981,45.333,1.214,31.055,77.047,
     + 42.244,267.338,84.916,9.609,40.817,68.192,24.181,
     + 56.154,97.914/
      DATA RGNSQM/66.608,116.436,248.283,517.247,549.666,
     + 572.732,517.772,434.406,586.412,6.450,1.0,1026.263,
     + 3022.15,3614.012,1.0/
C
      COMMON ATLBTS,AFM,ART,AMI,RT,A

C
C INITIALIZE ARRAYS TO ZERO
C
      DO 565 I2=1,15,1
      BTLBTS(I2)=0.000
      DO 566 I3=1,4,1
      BFM(I2,I3)=0
      BRT(I2,I3)=0
  566 CONTINUE
      DO 567 I4=1,21,1
      BMI(I2,I4)=0
      DO 568 I3=1,15,1
      B(I2,I3,I4)=0
  568 CONTINUE
  567 CONTINUE
  565 CONTINUE

C
C COUNT AND WRITE A
C
      DO 60 I2=1,50,1
C
      DO 69 I5=1,4,1
      HTL(I5)=0
      DO 61 I3=1,F3,1
      HMS(I5,I3)=0
   61 CONTINUE
   69 CONTINUE
      DO 62 I4=1,G3,1
      HCI(I4)=0
   62 CONTINUE
C
      HFM=AFM(I2,1)+AFM(I2,2)+AFM(I2,3)+AFM(I2,4)
      HRT1=ART(I2,2)+ART(I2,4)
      HRT2=ART(I2,3)+ART(I2,4)
      HRT3=ART(I2,1)+ART(I2,2)+HRT2
      DO 63 I3=1,F3,1
      DO 64 I4=1,G3,1
      HCI(I4)=HCI(I4)+A(I2,I3,I4)
      HTL(1)=HTL(1)+A(I2,I3,I4)
      HMS(1,I3)=HMS(1,I3)+A(I2,I3,I4)
   64 CONTINUE
      DTL(1)=HTL(1)/STSQM(I2)
      DO 65 I4=3,9,1
      HTL(2)=HTL(2)+A(I2,I3,I4)
      HMS(2,I3)=HMS(2,I3)+A(I2,I3,I4)
   65 CONTINUE
      DTL(2)=HTL(2)/STSQM(I2)
      DO 66 I4=10,18,1
      HTL(3)=HTL(3)+A(I2,I3,I4)
      HMS(3,I3)=HMS(3,I3)+A(I2,I3,I4)
   66 CONTINUE
      DTL(3)=HTL(3)/STSQM(I2)
      DO 67 I4=19,21,1
      HTL(4)=HTL(4)+A(I2,I3,I4)
      HMS(4,I3)=HMS(4,I3)+A(I2,I3,I4)
   67 CONTINUE
      DTL(4)=HTL(4)/STSQM(I2)
   63 CONTINUE
```

COMPUTER PROGRAM (continued)

```
      IF (HTL(1) .EQ. 0) GO TO 60
      WRITE (6,202) I2,STATES(I2),HTL(1),DTL(1),ATLBTS(I2)
      WRITE (6,203)
      WRITE (6,204) (AFM(I2,J2),J2=1,4),HFM
      WRITE (6,205)
      WRITE (6,206) (ART(I2,J2),J2=1,4),HRT1,HRT2,HRT3
      WRITE (6,207)
      WRITE (6,208) (AMI(I2,J2),J2=1,Q3)
      WRITE (6,209) (HCI(J2),J2=1,Q3)
      WRITE (6,210) (P(J2),J2=3,15)
      DO 68 I5=1,4,1
      WRITE (6,212) HTL(I5),DTL(I5)
      WRITE (6,211) (HMS(I5,J2),J2=1,P3)
   68 CONTINUE
   60 CONTINUE
C
  202 FORMAT (1H0,I4,5X,A2,5X,I8,5X,F10.4,5X,E15.7)
  222 FORMAT (1H0,I4,5X,A4,5X,I8,5X,F10.4,5X,E15.7)
  203 FORMAT (1H0,5X,5HFIXED,6X,4HSHIP,6X,4HBUOY,5X,5HEVENT,3X,5HTOTAL)
  204 FORMAT (1H ,5I10)
  205 FORMAT (1H0,3X,7HNEITHER,4X,6HRECORD,1X,9HTELEMETER,6X,
     + 4HBOTH,2X,8HREC+BOTH,2X,8HTEL+BOTH,5X,5HTOTAL)
  206 FORMAT (1H ,7I10)
  207 FORMAT (1H0,39H          EVNT   CONT   1MIN   5MIN  15MIN  30MIN,
     + 48H       1HR    2HR    3HR    6HR   12HR    1DA    2DA    1WK,
     + 42H       2WK    1MO    6WK    2MO    3MO    6MO    1YR)
  208 FORMAT (1H ,3HMI=,21I6)
  209 FORMAT (1H ,3HCI=,21I6)
  210 FORMAT (1H0,21HBITS=     EVNT     CONT,13I8)
  211 FORMAT (1H ,5X,15I8)
  212 FORMAT (1H0,I8,5X,F10.5)
  213 FORMAT (1H ,1X,A4,15I8)

C
C COMPUTE FIRST PART OF B
C
      DO 85 I2=1,69,1
      I5=RGN(I2)
      BTLBTS(I5)=BTLBTS(I5)+ATLBTS(I2)
      DO 86 I3=1,4,1
      BRT(I5,I3)=BRT(I5,I3)+ART(I2,I3)
      BFM(I5,I3)=BFM(I5,I3)+AFM(I2,I3)
   86 CONTINUE
      DO 87 I4=1,Q3,1
      BMI(I5,I4)=BMI(I5,I4)+AMI(I2,I4)
      DO 88 I3=1,P3,1
      B(I5,I3,I4)=B(I5,I3,I4)+A(I2,I3,I4)
   88 CONTINUE
   87 CONTINUE
   85 CONTINUE

C
C COMPUTE SECOND PART OF B
C
      DO 231 I8=1,4,1
      I9=CTRL(I8,3)
      I6=CTRL(I8,1)
      I7=CTRL(I8,2)
      DO 232 I2=I6,I7,1
      BTLBTS(I9)=BTLBTS(I9)+BTLBTS(I2)
      DO 233 I3=1,4,1
      BRT(I9,I3)=BRT(I9,I3)+BRT(I2,I3)
      BFM(I9,I3)=BFM(I9,I3)+BFM(I2,I3)
  233 CONTINUE
      DO 234 I4=1,Q3,1
      BMI(I9,I4)=BMI(I9,I4)+BMI(I2,I4)
      DO 235 I3=1,P3,1
      B(I9,I3,I4) = B(I9,I3,I4) + B(I2,I3,I4)
  235 CONTINUE
  234 CONTINUE
  232 CONTINUE
  231 CONTINUE

C
C COUNT AND WRITE B
C
      DO 251 I2=1,15,1
C
      DO 259 I5=1,4,1
      HTL(I5)=0
      DO 252 I3=1,P3,1
      HMS(I5,I3)=0
  252 CONTINUE
  259 CONTINUE
      DO 253 I4=1,Q3,1
      HCI(I4)=0
  253 CONTINUE
```

```
C                                                                       00007830
      HRT1=BRT(I2,2)+BRT(I2,4)                                          00007840
      HRT2=BRT(I2,3)+BRT(I2,4)                                          00007850
      HRT3=BRT(I2,1)+BRT(I2,2)+HRT2                                     00007860
      HFM=BFM(I2,1)+BFM(I2,2)+BFM(I2,3)+BFM(I2,4)                       00007870
      DO 254 I3=1,P3,1                                                  00007880
      DO 255 I4=1,Q3,1                                                  00007890
      HCI(I4)=HCI(I4)+B(I2,I3,I4)                                       00007900
      HTL(1)=HTL(1)+B(I2,I3,I4)                                         00007910
      HMS(1,I3)=HMS(1,I3)+B(I2,I3,I4)                                   00007920
  255 CONTINUE                                                          00007930
      DTL(1)=HTL(1)/RGNSQM(I2)                                          00007940
      DO 256 I4=3,9,1                                                   00007950
      HTL(2)=HTL(2)+B(I2,I3,I4)                                         00007960
      HMS(2,I3)=HMS(2,I3)+B(I2,I3,I4)                                   00007970
  256 CONTINUE                                                          00007980
      DTL(2)=HTL(2)/RGNSQM(I2)                                          00007990
      DO 257 I4=10,18,1                                                 00008000
      HTL(3)=HTL(3)+B(I2,I3,I4)                                         00008010
      HMS(3,I3)=HMS(3,I3)+B(I2,I3,I4)                                   00008020
  257 CONTINUE                                                          00008030
      DTL(3)=HTL(3)/RGNSQM(I2)                                          00008040
      DO 258 I4=19,21,1                                                 00008050
      HTL(4)=HTL(4)+B(I2,I3,I4)                                         00008060
      HMS(4,I3)=HMS(4,I3)+B(I2,I3,I4)                                   00008070
  258 CONTINUE                                                          00008080
      DTL(4)=HTL(4)/RGNSQM(I2)                                          00008090
  254 CONTINUE                                                          00008100
      IF (HTL(1) .EQ. 0) GO TO 251                                      00008110
      WRITE (6,222) I2,LOCAT(I2),HTL(1),DTL(1),BTLBTS(I2)               00008120
      WRITE (6,203)                                                     00008130
      WRITE (6,204) (BFM(I2,J2),J2=1,4),HFM                             00008140
      WRITE (6,205)                                                     00008150
      WRITE (6,206) (BRT(I2,J2),J2=1,4),HRT1,HRT2,HRT3                  00008160
      WRITE (6,207)                                                     00008170
      WRITE (6,208) (SMI(I2,J2),J2=1,Q3)                                00008180
      WRITE (6,209) (HCI(J2),J2=1,Q3)                                   00008190
      WRITE (6,210) (P(J2),J2=3,15)                                     00008200
      DO 271 I5=1,4,1                                                   00008210
      WRITE (6,212) HTL(I5),DTL(I5)                                     00008220
      WRITE (6,211) (HMS(I5,J2),J2=1,P3)                                00008230
  271 CONTINUE                                                          00008240
      WRITE (6,210) (P(J2),J2=3,15)                                     00008250
      DO 457 I4=1,Q3,1                                                  00008260
      WRITE (6,213) SCALE(I4),(B(I2,J2,I4),J2=1,P3)                     00008270
  457 CONTINUE                                                          00008280
  251 CONTINUE                                                          00008290
C                                                                       00008300
          WRITE (6,299)                                                 00008310
  299     FORMAT ('    I AM FINISHED')                                  00008320
      RETURN                                                            00008330
      END                                                               00008340
```

COMPUTER PROGRAM (continued)

```
C
C DETERMINE RECORDED OR TELEMETERED FOR ONE OBSERVATION
C
      INTEGER FUNCTION FRT1(L1)
      INTEGER AFM(69,4),ART(69,4),L1,AMI(69,21)
      INTEGER * 2 RT(4),A(69,15,21),RT2,RT3,RT4,RT5
      REAL ATLBTS(69)
      COMMON ATLBTS,AFM,ART,AMI,RT,A
      DATA RT2/'R '/,RT3/'T '/,RT4/'B '/,RT5/'P '/
      IF (RT(L1).EQ.RT4) GO TO 152
      IF (RT(L1).EQ.RT3) GO TO 153
      IF (RT(L1).EQ.RT2) GO TO 154
      IF (RT(L1).EQ.RT5) GO TO 154
      FRT1=1
      RETURN
  154 FRT1=2
      RETURN
  153 FRT1=3
      RETURN
  152 FRT1=4
      RETURN
      END
```

```
C
C DETERMINE RECORDED OR TELEMETERED FOR TWO OBSERVATIONS
C
      INTEGER FUNCTION FRT2(L2,L3)
      REAL ATLBTS(69)
      INTEGER * 2 RT(4),A(69,15,21),RT2,RT3,RT4,RT5
      INTEGER AFM(69,4),ART(69,4),AMI(69,21),L2,L3
      COMMON ATLBTS,AFM,ART,AMI,RT,A
      DATA RT2/'R '/,RT3/'T '/,RT4/'B '/,RT5/'P '/
      IF (RT(L2).EQ.RT4) GO TO 601
      IF (RT(L3).EQ.RT4) GO TO 601
      IF (RT(L2).EQ.RT5) GO TO 606
      IF (RT(L3).EQ.RT5) GO TO 606
      IF (RT(L2).EQ.RT2) GO TO 606
      IF (RT(L3).EQ.RT2) GO TO 606
      IF (RT(L2).EQ.RT3) GO TO 602
      IF (RT(L3).EQ.RT3) GO TO 602
      FRT2=1
      RETURN
  606 IF (RT(L2).EQ.RT3) GO TO 601
      IF (RT(L3).EQ.RT3) GO TO 601
      FRT2=2
      RETURN
  601 FRT2=4
      RETURN
  602 FRT2=3
      RETURN
      END
```

```
C
C DETERMINE RECORDED OR TELEMETERED FOR THREE OBSERVATIONS
C
      INTEGER FUNCTION FRT3(L4,L5,L6)
      INTEGER AFM(69,4),ART(69,4),AMI(69,21),L4,L5,L6
      INTEGER * 2 RT(4),A(69,15,21),RT2,RT3,RT4,RT5
      REAL ATLBTS(69)
      COMMON ATLBTS,AFM,ART,AMI,RT,A
      DATA RT2/'R '/,RT3/'T '/,RT4/'B '/,RT5/'P '/
      IF (RT(L4).EQ.RT4) GO TO 621
      IF (RT(L5).EQ.RT4) GO TO 621
      IF (RT(L6).EQ.RT4) GO TO 621
      IF (RT(L4).EQ.RT5) GO TO 626
      IF (RT(L5).EQ.RT5) GO TO 626
      IF (RT(L6).EQ.RT5) GO TO 626
      IF (RT(L4).EQ.RT2) GO TO 626
      IF (RT(L5).EQ.RT2) GO TO 626
      IF (RT(L6).EQ.RT2) GO TO 626
      IF (RT(L4).EQ.RT3) GO TO 622
      IF (RT(L5).EQ.RT3) GO TO 622
      IF (RT(L6).EQ.RT3) GO TO 622
      FRT3=1
      RETURN
  626 IF (RT(L4).EQ.RT3) GO TO 621
      IF (RT(L5).EQ.RT3) GO TO 621
      IF (RT(L6).EQ.RT3) GO TO 621
      FRT3=2
      RETURN
  621 FRT3=4
      RETURN
  622 FRT3=3
      RETURN
      END
```

COMPUTER PROGRAM (continued)

```
C
C DETERMINE RECORDED OR TELEMETERED FOR FOUR OBSERVATIONS
C
      INTEGER FUNCTION FRT4(L7,L8,L9,L10)
      INTEGER AFM(69,4),ART(69,4),AMI(69,21),L7,L8,L9,L10
      INTEGER * 2 RT(4),A(69,15,21),RT2,RT3,RT4,RT5
      REAL ATLETS(69)
      COMMON ATLETS,AFM,ART,AMI,RT,A
      DATA RT2/'R '/,RT3/'T '/,RT4/'B '/,RT5/'P '/
      IF (RT(L7).EQ.RT4) GO TO 631
      IF (RT(L8).EQ.RT4) GO TO 631
      IF (RT(L9).EQ.RT4) GO TO 631
      IF (RT(L10).EQ.RT4) GO TO 631
      IF (RT(L7).EQ.RT2) GO TO 636
      IF (RT(L8).EQ.RT2) GO TO 636
      IF (RT(L9).EQ.RT2) GO TO 636
      IF (RT(L10).EQ.RT2) GO TO 636
      IF (RT(L7).EQ.RT5) GO TO 636
      IF (RT(L8).EQ.RT5) GO TO 636
      IF (RT(L9).EQ.RT5) GO TO 636
      IF (RT(L10).EQ.RT5) GO TO 636
      IF (RT(L7).EQ.RT3) GO TO 632
      IF (RT(L8).EQ.RT3) GO TO 632
      IF (RT(L9).EQ.RT3) GO TO 632
      IF (RT(L10).EQ.RT3) GO TO 632
      FRT4=1
      RETURN
  636 IF (RT(L7).EQ.RT3) GO TO 631
      IF (RT(L8).EQ.RT3) GO TO 631
      IF (RT(L9).EQ.RT3) GO TO 631
      IF (RT(L10).EQ.RT3) GO TO 631
      FRT4=2
      RETURN
  631 FRT4=4
      RETURN
  632 FRT4=3
      RETURN
      END
```

APPENDIX B

CODING INFORMATION FOR DATA COLLECTION STATION DATA BASE

This appendix contains an explanation of the format of the data cards in the data collection station data base, some sample data, codes that were used to encode the data on the data cards, the method that was used to encode the amount of data per measurement, and the measurement and collection intervals.

DATA CARD FORMAT

The general format of the information on the data card is given in Table B.1. The general format identifies two specific components, station information, and observation information. The format of the station information is given in Table B.2, and the format of the observation information is given in Table B.3. Some sample data is shown in Figure B.1. It should be noted that many additional spaces have been inserted between the columns of data in order to facilitate reading it.

TABLE B.1
GENERAL FORMAT

COLUMNS	CONTENTS
1-4	Number of data collection stations
5-10	Station information
11-25	Observation 1 information
26-40	Observation 2 information
41-55	Observation 3 information
56-70	Observation 4 information

TABLE B.2
STATION INFORMATION FORMAT

COLUMNS	CONTENTS
5-6	State Code
7	Fixed/mobile code
8-10	Network/agency identification code

TABLE B.3
OBSERVATION INFORMATION FORMAT

COLUMNS				CONTENTS
OBS 1	OBS 2	OBS 3	OBS 4	
11-13	26-28	41-43	56-58	Observation identification
14	29	44	59	Bits/characters code
15	30	45	60	Record/Telemeter code
16-19	31-34	46-69	61-64	Amount of data per measurement
20-22	35-37	50-52	65-67	Measurement interval
23-25	38-40	53-55	68-70	Collection interval

```
Number of        Observation 1         Observation 2          Observation 3          Observation 4
Stations         Information           Information            Information            Information
and Station
Information

  1 SC F ERD     GQ6 B N 16 3M 3M
  1 SC F ERD     GQ7 B N 80 1Y 1Y
 29 SC F ERD     GQ7 B N 96 1Y 1Y
  2 SD F L03     GQ5 B N 64 2W 2W
  8 SD F L03     GQ5 B N 64 1M 1M
 14 UT F V53     GQ7 B N 80 1Y 1Y
  3 UT F V51     GQ7 B N 48 1Y 1Y      GQ5 B N 32 2W 2W
 11 UT F V54     GQ7 B N 48 1Y 1Y      GQ5 B N 32 1M 1M
  1 WA F X09     GQ2 B N 64 1D 1D
  6 WA F BRX     GQ8 B N 64 1Y 1Y
  1 WA F BRX     GQ8 B N 48 1Y 1Y
  3 WA F ERD     GQ6 B N 16 3M 3M
  1 WA F ERD     GQ5 B N 32 1M 1M      GQ6 B N 16 3M 3M
  1 WV F X51     GQ6 B N 80 3M 3M      GQ5 B N 16 1M 1M
  1 WV F X51     GQ6 B N 80 3M 3M      GQ3 B N 16 1D 1D
  1 WI F Y02     CQ5 B N 48 1M 1M      GQ8 B N 16 1Y 1Y
  1 ND F Q51     GQ5 B N 48 1M 1M      GQ6 B N 32 3M 3M       GQ8 B N 16 1Y 1Y
  1 ND F Q51     GQ6 B N 48 3M 3M      GQ8 B N 16 1Y 1Y
  1 ND F Q51     GQ6 B N 64 3M 3M      GQ4 B N 16 1W 1W       GQ1 B R 16 1H 1M
  1 ND F Q51     GQ5 B N 32 1M 1M      GQ8 B N 16 1Y 1Y       GQ7 B N 16 1Y 1Y       HQ4 B N 16 1W 1W
  1 ND F Q51     GQ5 B N 48 1M 1M      GQ8 B N 32 1Y 1Y
```

FIGURE B.1. SAMPLE DATA

CODES

The following tables contain the codes that were used to encode the data on the data card. The information that was coded includes location, fixed/mobile type, network/agency identification, observation identification, and the use of automatic recording and telemetering devices. The codes for the locations of the stations are given in Table B.4. The codes for the fixed/mobile types and a definition of each type are given in Table B.5.

The codes for the Federal network/agency identification codes are given in Table B.6, and the codes for the non-Federal network/agency identification codes are given in Table B.7. The codes identifying the observations contained in the data base are given in Table B.8. The codes that indicate whether or not an observation is automatically recorded or telemetered are given in Table B.9. Except for the codes used to indicate whether the amount of data produced by a single measurement is a quantity of bits or characters, and the time codes that are used when encoding measurement and collection intervals, these are all of the codes that are used to encode the data in the data collection station data base.

TABLE B.4

LOCATION CODES

AL - Alabama
AK - Alaska
AZ - Arizona
AR - Arkansas
CA - California
CO - Colorado
CT - Connecticut
DE - Delaware
FL - Florida
GA - Georgia
HI - Hawaii
ID - Idaho
IL - Illinois
IN - Indiana
IA - Iowa
KS - Kansas
KY - Kentucky
LA - Louisiana
ME - Maine
MD - Maryland
MA - Massachusetts
MI - Michigan
MN - Minnesota
MS - Mississippi
MO - Missouri
MT - Montana
NB - Nebraska
NV - Nevada
NH - New Hampshire
NJ - New Jersey
NM - New Mexico
NY - New York
NC - North Carolina
ND - North Dakota
OH - Ohio
OK - Oklahoma
OR - Oregon
PA - Pennsylvania
RI - Rhode Island
SC - South Carolina
SD - South Dakota
TN - Tennessee
TX - Texas
UT - Utah
VT - Vermont
VA - Virginia
WA - Washington
WV - West Virginia
WI - Wisconsin
WY - Wyoming
DC - District of Columbia
CB - Caribbean
CN - Canada
PI - Pacific Islands
AO - Atlantic Ocean
PO - Pacific Ocean
JP - Japan
HK - Hong Kong
AM - Central America
SA - South America
AT - Antarctica
AC - Atlantic Coast
PC - Pacific Coast
MX - Mexico
GL - Great Lakes
BC - British Columbia
IC - Iceland
GR - Greenland
RU - Russia
RT - Arctic Ocean
NR - Antarctic Ocean

TABLE B.5

FIXED/MOBILE CODES

F - Refers to stations, both stationary and portable that have a fixed location.

S - Refers to stations that are mobile and are capable of providing position information.

B - Refers to stations that are mobile, but are not capable of providing position information.

E - Refers to stations that make observations and/or relay data only after a specific event occurs.

TABLE B.6

FEDERAL NETWORK/AGENCY IDENTIFICATION CODES

AGW	Agriculture Weather Reporting Station
AFX	Air Force
ASR	Alaskan Seismic Recording Network
ATW	Alaskan Tsunami Warning System
ADJ	Arctic Ice Dynamics Joint Experiment
ARM	Army
AEC	Atomic Energy Commission
BHW	Bahamas Cooperative Hurricane Warning Network
BPA	Bonneville Power Administration
BIA	Bureau of Indian Affairs
BLM	Bureau of Land Management
BRX	Bureau of Reclamation
CGX	Coast Guard
CSS	Coastal Ship Observing Station
COS	Cooperative Observing Station
CUA	Cooperative Upper Air Station
CEX	Corps of Engineers
DOD	Department of Defense
EML	Earthquake Mechanism Laboratory
ERL	Earthquake Research Laboratory
ERD	Energy Research and Development Administration
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FWS	Fish and Wildlife Service
FSX	Forest Service
GRP	GARP Experiment FGGE
GSX	Geological Survey
GSC	GS/California Institute of Technology Cooperative Station
GLS	Great Lakes Ship Station
HSS	High Seas Ship Station
HYD	Hydrology Weather Reporting Station
IBW	International Boundary and Water Commission

TABLE B.6 (continued)

IRD	Irrigation District Stations
LAR	Limited Aviation Weather Reporting Stations
MCX	Marine Corps
NAS	National Aeronautics and Space Administration
NDB	National Data Buoy Office
MFS	National Marine Fisheries Service
NOS	National Ocean Survey
NSM	NOAA/Colorado School of Mines Cooperative Network
NWS	National Weather Service
NFC	NWS/FAA Combined Station
NFE	Naval Facilities Engineering Command
NAV	Navy
NPX	Northern Pacific Experiment
OSS	Other Substations
OMP	Ozone Monitoring Program
POL	Polar Experiment
RAM	Regional Air Monitoring System
SGN	Seismograph Network
SCS	Soil Conservation Service
SSS	SCS/Others Cooperative Snow Surveys
SMN	Strong Motion Network
SAR	Supplemental Aviation Weather Reporting Station
TVA	Tennessee Valley Authority
TWS	Tsunami Warning System
VSN	Volcano Surveillance Network
WQB	Water Quality Branch, Environment Canada
WSC	Water Resources Branch, Environment Canada

TABLE B.7

NON-FEDERAL NETWORK/AGENCY IDENTIFICATION CODES

AWE	Agriculature Weather and State Agriculture Experiment Station
CIT	California Institute of Technology
OTH	Other Organizations with Seismograph Stations
AGE	State Agriculture Experiment Station
SAQ	State Air Quality Station
SFX	State Forestry Agency or Local Fire Department
UNV	University of Nevada
USC	University of Southern California
	ALASKA
A50	Chugach Electric Association
A51	Alaska Department of Highways
	ARIZONA
B00	Salt River Project
B01	Water Resources Research Center, University of Arizona
B02	Roosevelt Irrigation District
B03	Arizona Game and Fish Department
B04	Maricopa County Municipal Water Conservation
B05	Gila Water Commissioner
	ARKANSAS
B50	Bureau of Environmental Engineering, Arkansas State Department of Health
B51	Arkansas Game and Fish Commission
B52	Arkansas Pollution Control and Ecology
	CALIFORNIA
C00	California Department of Water Resources
C01	Los Angeles County Water District
C03	Alameda County Water District
C04	County of Sacramento, Water Resources Division
C05	Whitewater Mutual Water Company
C06	California Water Quality Control Board
C09	Ventura County Flood Control District
C10	San Diego Department of Sanitation and Flood Control

TABLE B.7 (continued)

C11	Orange County Flood Control District
C12	Merced Irrigation District
C13	Turlock Irrigation District
C14	Tridam Irrigation District
C15	Pacific Gas and Electric
C16	Oroville-Wyandotte Irrigation District
C17	Mosquito Irrigation District
C18	Contracting Entities
C19	East Bay Municipal Utility District
C20	Modesto Irrigation District
C21	El Nido Irrigation District
C22	Madera Irrigation District
C23	Hetch Hetchy Water Supply, City and County of San Francisco
C24	Southern California Edison Company
C25	Pacific Power and Light
C26	Kings River Water Association
C27	Fresno Irrigation District
C28	Kaweah and St. Johns Water Association
C29	Tulare Irrigation District
C31	Kern County Land Company
C32	Buena Vista Water Storage District
C33	Terra Bella Irrigation District
C34	Sausalito Irrigation District
C35	Monterey County Flood Control and Water Conservation District
C36	San Luis Obispo County Flood Control and Water Conservation District
C37	Montecito County Water District
C38	Santa Barbara County Flood Control and Water Conservation District
C39	Metropolitan Water District of Southern California
C40	Marin Municipal Water District
C41	Marin, North, County Water District
C42	Sonoma County Flood Control and Water Conservation District
C43	Alameda County Flood Control and Water Conservation District
C44	Santa Clara Valley Water District

TABLE B.7 (continued)

C45	Tule Irrigation District
C46	Montague Water Conservation District
C47	City of Los Angeles, Department of Water and Power
C48	Palm Springs Water Company
C49	Escondido Mutual Water Company
Z00	San Bernardino County Flood Control District
Z01	San Antonio Water Company
Z02	Temescal Water Company
Z03	Riverside County Flood Control and Water Conservation District
Z04	Ventura River Municipal Water District
Z05	Ventura County Water Resources Division
Z06	United Water Conservation District
Z07	Kings River Water Conservation Board
Z09	San Gabriel Electric Company
	COLORADO
C50	Board of Water Commissioners, City and County of Denver
C51	Division of Water Resources, Office of Colorado State Engineer
C52	City of Colorado Springs, Water Division
C53	Boulder City County Health Department
C54	Pueblo Board of Water Works
	CONNECTICUT
D00	Environmental Health Service Division, State Department of Health
D01	The Water Bureau of the Metropolitan District, Hartford
D02	Bridgeport Hydraulic Company
	DELAWARE
D50	Delaware Geological Survey
	DISTRICT OF COLUMBIA
D53	Department of Sanitary Engineering
D54	Department of Environmental Health Administration
	FLORIDA
E00	Hollywood Reclamation District

TABLE B.7 (continued)

E02	Manatee County Health Department
E03	Central and Southern Florida Flood Control District
E21	Hillsborough County Environmental Protection Commission
	GEORGIA
E50	Savannah Department of Water and Sewage
E52	Valdosta Water and Sewer Department
E53	Water Works, City of Gainesville
E54	Rome City Manager
E55	Water Works, City of Griffin
E56	Board of Water Commissioners, City of Macon
E57	Atlanta Water Works
E58	Columbus Water Works
	HAWAII
F00	Board of Water Supply, City and County of Honolulu
F01	Department of Water, County of Kauai
F02	Board of Water Supply, County of Maui
F03	Board of Water Supply, County of Hawaii
F04	Department of Hawaiian Home Lands, State of Hawaii
F06	Department of Land and Natural Resources, State of Hawaii, Division of Water and Land Development
	IDAHO
F51	Water Resources Research Institute, University of Idaho
F52	Idaho Department of Environmental and Community Services
	ILLINOIS
G00	Illinois Department of Public Health
G01	Metropolitan Sanitary District of Greater Chicago
G02	Illinois Department of Registration and Education
G03	Illinois Department of Public Works and Buildings
	INDIANA
G50	Indiana State Broad of Health

TABLE B.7 (continued)

	IOWA
H00	Iowa State Hygenic Laboratory
H01	Director of Lakeside Laboratory, University of Iowa
H02	Des Moines Water Works
H03	Ottumwa Water Works
H05	Iowa Department of Preventive Medicine and Environmental Health
H06	Agricultural Engineering Department, Iowa State University
H07	Fort Dodge Department of Municipal Utilities
H09	Des Moines County Drainage District No. 7
	KANSAS
H50	Kansas State Department of Health
H51	Board of Public Utilities, Kansas City
H52	Kansas State Board of Agriculture
H53	Topeka Water Department
H54	Kansas Forestry, Fish, and Game Commission
	KENTUCKY
I00	Kentucy Department for Human Resources
I01	Kentucky Department of Natural Resources and Environmental Protection
I02	Louisville Water Company
	LOUISIANA
I50	Rapides Parish Water Works District No. 3
I51	Louisiana State Department of Health
I52	Houma Light and Water Plant
I53	Jefferson Water Works District No. 2
I54	Lafourche Water Works District No. 1
I55	East Jefferson Water Works District No. 1
I56	New Orleans Sewerage and Water Board
I57	Bossier City Water Plant
I58	Utilities Commission Water Treatment Plant, City of Monroe
I59	Louisiana Wildlife and Fisheries Commission
I60	City of Shreveport Department of Water Utilities

TABLE B.7 (continued)

	MARYLAND
D51	Baltimore County Health Department
D52	City of Baltimore, Water Supply Treatment and Pumping Division
	MICHIGAN
K50	Michigan Department of Natural Resources
	MINNESOTA
L00	Hennepin County Highway Department
L01	Eveleth Taccnite Company
L02	Minnesota Department of Natural Resources
L03	Otter Tail Power Company
L04	Ramsey County Engineer's Department
L05	Northern State Power Company
L06	Water, Gas and Sewage Treatment Department, City of Duluth
L07	Minnesota Ore Operations, USS Corporation
L08	Blandin Paper Company
L09	Minnesota Power and Light Company
L10	Metropolitan Sewer Board
L11	Minnesota Pollution Control Agency
L12	Washington County Highway Department
L13	Unknown
	MISSISSIPPI
L50	City of Vicksburg Water Treatment Plant
L51	City of Jackson Water Works
L52	Pearl River Valley Water Supply District
L53	City of Meridian Water and Sewer Department
L54	City of Columbus Light and Water Department
L55	Mississippi State Board of Health
	MISSOURI
M00	Division of Health of Missouri
M02	University of Missouri at Rolla
M03	Metropolitan St. Louis Sewer District
M04	Little River Drainage District
M05	Missouri Geological Survey and Water Resources

TABLE B.7 (continued)

M06	Missouri Clean Water Commission
M07	Union Electric Company, Bagnell Dam
	MONTANA
M50	Montana Fish and Game Department
M51	Montana University Joint Water Resources Research Center
M53	Montana Department of Natural Resources and Conservation
	NEBRASKA
N01	State of Nebraska Department of Environmental Control
N02	Metropolitan Utilities District, City of Omaha
N03	Soil and Water Testing Laboratory, University of Nebraska
	NEVADA
N50	Nevada State Health Division
N51	Walker River Irrigation District
N54	Nevada Irrigation District
	NEW MEXICO
P00	New Mexico State Engineer's Office
	NEW JERSEY
O50	Passaic Valley Water Commission
O51	New Jersey State Department of Environmental Protection
O52	North Jersey District Water Supply Commission
O54	Delaware River Joint Toll Bridge Commission
O56	Unknown
	NEW YORK
P50	New York State Department of Environmental Conservation
P51	Nassau County Department of Public Works
	NORTH CAROLINA
Q00	North Carolina Department of Human Resources
Q01	North Carolina Department of Natural and Economic Resources

TABLE B.7 (continued)

	NORTH DAKOTA
Q50	North Dakota Game and Fish Department
Q51	North Dakota State Department of Health
Q52	Minot City Water Treatment Plant
Q53	City of Bismarck Water Department
Q54	City of Dickinson Water Treatment
Q55	Grand Forks Water Treatment Plant
	OHIO
R00	Ohio Department of Natural Resources
R01	The Miami Conservancy District
R02	Ohio River Valley Water Sanitation Commission
R03	Ohio Environmental Protection Agency
	OKLAHOMA
R50	Oklahoma State Department of Health
	OREGON
S01	Oregon Wildlife Commission
S03	Oregon State Engineer
S04	Fish Commission of Oregon
S13	Portland General Electric
	PACIFIC ISLANDS
F07	Public Utility Agency Water Division, Government of Guam
F08	Ryukyu Industrial Research Institute, Government of Ryukyu Islands
	PENNSYLVANIA
S50	Pennsylvania Department of Environmental Resources
	PUERTO RICO
T01	Puerto Rico Water Resources Authority
	SOUTH CAROLINA
T50	Agricultural Engineering Department, Clemson University
T51	Greenville Water System
T52	Spartanburg Water Works
T53	South Carolina Department of Health and Environmental Control

TABLE B.7 (continued)

	SOUTH DAKOTA
U01	East Dakota Conservancy Sub-District
	TENNESSEE
U51	Tennessee Department of Public Health
U52	Cleveland Water System
U54	Bristol Water Plant
U55	University of Tennessee Experiment Station
U56	Memphis Light, Gas and Water Division
	TEXAS
V00	Texas Water Development Board
	UTAH
V50	Utah State Health Department
V51	Metropolitan Water District of Salt Lake City
V53	Salt Lake County Water Conservancy Dsitrict
V54	Salt Lake City Water Supply and Waterworks
V56	Clear Lake Waterfowl Management Area
V57	Utah Department of Natural Resources
V58	Utah Geological and Mineralogical Survey
V59	Ogden River Water Users
V60	Weber Distribution System
	VIRGINIA
W00	State Water Control Board
	WASHINGTON
X00	State of Washington, Department of Ecology, Water Resources Division
X01	Public Utility District No. 1, Skagit County
X02	Chelan County PUD No. 1
X03	College of Fisheries, University of Washington
X05	Department of Zoology, University of Washington
X06	City of Bremerton Water Department
X07	City of Everett Department of Water
X08	Seattle Water Department

TABLE B.7 (continued)

X09	City of Tacoma, Department of Public Utilities
X12	Municipality of Metropolitan Seattle
X16	King County, Washington, Department of Public Works
X19	The Washington Water Power Company
X20	Douglas County Public Utility District
X24	Puget Sound Power and Light Company
X25	City of Seattle
	WEST VIRGINIA
X50	West Virginia Department of Natural Resources
X51	West Virginia Department of Health
	Wisconsin
Y00	Wisconsin Department of Natural Resources
Y02	Dairyland Power Cooperative
Y04	Northern States Power Company
Y05	Wisconsin Michigan Power Company
	WYOMING
Y50	City of Casper Board of Public Utilities
Y51	Sheridan Water Department
Y52	Wyoming State Engineer

TABLE B.8
OBSERVATION CODES

AGR	Agricultural weather data
AQU	Air quality and meteorological data
CMO	Air quality, carbon monoxide
NO2	Air quality, nitrogen dioxide
PCO	Air quality, photochemical oxidants
SO2	Air quality, sulfur dioxide
TSP	Air quality, total suspended particulates
ATC	Air Traffic Control Radar
AIB	Arctic ice buoy
AMS	Arctic manned station
TRB	Atmospheric turbidity
AOS	Automatic observing station
AVA	Aviation weather observation
BUO	Buoy
CSS	Coastal ship
CRP	Creepmeter
DTB	Drifting tall buoy
EVA	Evaporation
EHS	Evaporation and snow depth
EGS	Evaporation and soil temperature
EGH	Evaporation, soil temperature, and snow depth
FRW	Fire-weather data
GRD	Gamma radiation
GLS	Great Lakes ship observations
GW1	Ground water level, continuous recorder
GW3	Ground water level, daily
GW4	Ground water level, weekly
GW5	Ground water level, monthly
GW6	Ground water level, quarterly
GW7	Ground water level, semi-annually
GW8	Ground water level, annually
GW9	Ground water level, other periodic

TABLE B.8 (continued)

GQ1	Ground water quality*, continuous
GQ2	Ground water quality*, seasonal
GQ3	Ground water quality*, daily
GQ4	Ground water quality*, weekly
GQ5	Ground water quality*, monthly
GQ6	Ground water quality*, quarterly
GQ7	Ground water quality*, annually
GQ8	Ground water quality*, other periodic
GQ9	Ground water quality*, irregular
GQT	Ground water quality*, telemetered
HSS	High seas ship observation
LAR	Limited aviation weather observations
LRD	Local radar observations
LLS	Low level soundings
MAG	Magnetic field
MOS	Manned automatic observing station
MRS	Marine reporting station
MRC	Meteorological rocket soundings
MEN	Moderate environment drifting buoy
OCW	Ocean weather observations
OMP	Ozone monitoring program
PLF	Peak stage and/or low flow
PIB	Pilot balloon observations
PRE	Precipitation
RAD	Radar observations
RDR	Radar remoting
RRS	Radiosonde/Rawinsonde observations
HPR	Recording precipitation gage
SEC	Seismic event counter
SMG	Seismograph

---

*Water quality observations consist of measurements of one or more of the water quality parameters temperature, specific conductance, pH, turbidity, dissolved oxygen, and chloride.

TABLE B.8 (continued)

SEN	Severe environment drifting buoy
SEX	Small expendable drifting buoy
HSN	Snow data
SSV	Snow survey
SMS	Soil moisture
GST	Soil temperature
GHS	Soil temperature and snow data
GAJ	Soil temperature and supplemental data
SRD	Solar radiation
SPR	Storage precipitation gage
SW1	Stream gage, continuous
SW2	Stream gage, seasonal
SW3	Stream gage, daily
SW4	Stream gage, weekly
SW5	Stream gage, monthly
SW6	Stream gage, quarterly
SW7	Stream gage, annual
SW8	Stream gage, other periodic
SW9	Stream gage, irregular
SW0	Stream gage, not indicated
ST1	Stream gage and tide information, continuous
ST2	Stream gage and tide information, seasonal
ST3	Stream gage and tide information, daily
ST9	Stream gage and tide information, irregular
SMI	Strong motion instrument
SAR	Supplemental aviation weather data
JSD	Supplemental data
WQ1	Surface water quality*, continuous
WQ2	Surface water quality*, seasonal
WQ3	Surface water quality*, daily

---

* Water quality observations consist of measurements of one or more of the water quality parameters temperature, specific conductance, pH, turbidity, dissolved oxygen, and chloride.

TABLE B.8 (continued)

WQ4	Surface water quality*, weekly
WQ5	Surface water quality*, monthly
WQ6	Surface water quality*, quarterly
WQ7	Surface water quality*, annually
WQ8	Surface water quality*, other periodic
WQ9	Surface water quality*, irregular
WQT	Surface water quality*, telemetered
SYN	Synoptic weather observation
TEM	Temperature
TAE	Temperature and evaporation
TAP	Temperature and precipitation
TAH	Temperature and snow data
TID	Tide gage
TLT	Tiltmeter

---

* Water quality observations consist of measurements of one or more of the water quality parameters temperature specific conductance, pH, turbidity, dissolved oxygen, and chloride.

TABLE B.9

RECORD/TELEMETER CODES

N - Refers to observations which are neither automatically recorded on-site, nor automatically telemetered to a distant site.

P - Refers to observations of several parameters, some which are automatically recorded on-site, and others which are not.

R - Refers to observations which are automatically recorded on-site.

T - Refers to observations which are automatically telemetered to a distant site.

B - Refers to observations which are both automatically recorded on-site, and automatically telemetered to a distant site.

CODING OF AMOUNT OF DATA PER MEASUREMENT, AND MEASUREMENT AND COLLECTION INTERVALS

The amount of data per measurement for an observation may be the amount of data produced by one measurement of a single parameter, or by one measurement of a group of parameters. This amount of data may be either a quantity of bits, as in the case of a punched paper tape from a stream gage, or it may be a quantity of characters, as in the case of a weather message. Four columns of the data card have been provided to indicate the amount of data per measurement, and one column has been provided to indicate whether the amount of data is a quantity of bits or characters. The bits/characters codes are given in Table B.10.

Measurement intervals and the collection intervals are each encoded in three columns on the data card. Typical intervals to be encoded are 2 hours, 3 months, and 1 day. Each of these consists of a number, 2, 3, or 1, and the units of the number, hours, months, or days. Measurement intervals and collection intervals are encoded in the data base in the same way. Two columns are provided to indicate the number and one column is provided to indicate the units of the interval. The units that are used in the data base and their codes are shown in Table B.11.

The following example illustrates how the amount of data per measurement, and the measurement and collection intervals of a sample observation are encoded. The sample observation produces 16 bits of data per measurement, makes measurement every 15 minutes, and collects the data every 2 weeks.

?	?	?	B	?			1	6	1	5	S		2	W

columns 11-25 for observation 1 information

TABLE B.10
BITS/CHARACTERS CODE

B - Indicates that the amount of data resulting from a single measurement is a number of bits.

C - Indicates that the amount of data resulting from a single measurement is a number of characters, and that the number of bits must be computed.

TABLE B.11
TIME CODES

C - Continuous
S - Minutes
H - Hours
D - Days
W - Weeks
M - Months
Y - Years

APPENDIX C
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