OPERATION OF HYDROLOGIC DATA COLLECTION STATIONS BY THE U.S. GEOLOGICAL SURVEY IN 1985

By Alberto Condes de la Torre

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CONTENTS

FIGURES

TABLE

OPERATION OF HYDROLOGIC DATA-COLLECTION STATIONS BY THE U.S. GEOLOGICAL SURVEY IN 1985

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ABSTRACT

The U.S. Geological Survey operated hydrologic data-collection stations during fiscal year 1985 in response to the needs of all levels of Government for hydrologic information. Surface-water discharge was determined at 11,076 stations; stage data on streams, reservoirs, and lakes were recorded at 2,141 stations; and surface-water quality was determined at 4,166 stations. Ground-water levels were measured at 39,301 stations, and the quality of ground water was determined at 9,263 stations nationwide. Data on sediment were collected daily at 212 stations and on a periodic basis at 1,027 stations. Information on precipitation quantity was collected at 921 stations, and the quality of precipitation was analyzed at 108 stations. Data-collection platforms for satellite telemetry of hydrologic information were used at 1,520 U.S. Geological Survey stations. Funding support for the hydrologic stations was derived either solely or from a combination of three major sources--the Geological Survey's Federal Program appropriation, the Federal-State Cooperative Program, and reimbursements from other Federal agencies.

INTRODUCTION

The U.S. Geological Survey operates hydrologic data-collection stations throughout the United States, Puerto Rico, and several Trust Territories. These hydrologic stations are used to monitor: the quantity and quality of the water in the Nation's streams, lakes, and reservoirs; changes in ground-water levels; and quality of the ground water.

The purpose of this report is to describe the number, distribution, and source of funding of hydrologic stations operated during fiscal year (FY) 1985. A similar report on hydrologic stations was prepared previously for FY 1983 (Condes de la Torre, 1983). A comparison of the number of hydrologic stations operated in the 2 years is made. The sources of funding support for the stations are the Geological Survey's Federal Program appropriation, the Federal-State Cooperative Program, and reimbursements from other Federal agencies -- or a combination of these.

For the purposes of this report, "project" refers to a hydrologic investigation being conducted by the U.S. Geological Survey, and a "scheduled, long-term operation" station is one at which measurements are made or samples are taken on a fixed time interval over an indefinite period.

SURFACE WATER

Surface-water discharge (flow) was determined by the U.S. Geological Survey at 11,076 stations in FY 1985 (see table 1). At 7,019 of these stations, continuous discharge records were computed. That is, records were kept such that the flow can be determined for any moment during any day. At 4,057 other streamflow stations, partial records were collected. For example, at a station where there is an interest only in peak flows, data are collected and recorded only at stages greater than some predetermined level. The number of stations in each State where continuous surface-water discharge data were collected ranged from 641 in California to 12 in Delaware (figure 1). The Federal-State Cooperative Program funded operation of the largest number of continuous streamflow-discharge stations--it provides sole support for 3,223 stations (figure 2), and in combination with other sources, provided support for 1,498 more (table 1). The Federal-State Cooperative Program also funded the largest number of partial record-discharge stations--sole support of 3,013 stations (figure 3), and in combination with other sources, 633 more (table 1).

The change in the total number of continuous record-discharge stations from 1983 to 1985 varied from State to State, but overall the number decreased from 7,152 to 7,019 for a net loss of 133 stations. The largest gain was in Idaho with an increase of 52 stations and the greatest loss was in Ohio with a decrease of 91 stations (figure 4). The total number of partial record-discharge stations increased 133 stations during the period. Several factors influence the size of the number of stations operated in each State. The most influential of these factors is economics -- the

Table 1.--*Types and number of hydrologic data collection stations operated by the U.S. Geological Survey during the 1985 fiscal year and the sources of funding support*

Type of Station	Number of Stations by Source of Funding							Total Stations
	Single Program Support			Combined Support				
	Federal Program (Federal)	Federal-State Cooperative Program (COOP)	Reimbursement from other Federal agencies (OFA)	Federal, COOP	Federal, OFA	COOP, OFA	Federal, COOP, OFA	
SURFACE WATER								
Discharge								
Continuous record	554	3,223	1,607	1,024	137	410	64	7,019
Partial record	84	3,013	293	627	34	5	1	4,057
Stage Only - Streams								
Continuous record	13	198	212	16	2	6	--	447
Partial record	14	418	45	30	--	--	--	507
Stage Only - Lakes and Reservoirs								
Continuous record	21	338	254	134	--	25	10	782
Partial record	11	278	67	49	--	--	--	405
Quality								
Continuous record	111	284	252	75	17	1	3	743
Scheduled, long-term operations	519	1,346	352	197	21	7	4	2,446
Short-term or project stations	74	718	124	59	2	--	--	977
GROUND WATER								
Water Levels								
Continuous record	94	1,783	215	192	--	--	--	2,284
Scheduled, long-term operations	814	19,487	1,501	3,221	--	--	--	25,023
Short-term or project stations	2,973	7,411	974	636	--	--	--	11,994
Quality								
Scheduled, long-term operations	52	3,796	193	293	--	--	--	4,334
Short-term or project stations	546	3,709	468	206	--	--	--	4,929
PRECIPITATION								
Quantity	59	574	269	19	--	--	--	921
Quality	56	46	4	2	--	--	--	108

availability of funding to support the hydrologic data collection. The increased number of stations in Idaho was generated by the State of Idaho's need for hydrologic information to be used in the adjudication of waters of the Snake River. The decrease in Ohio resulted from a cutting back by the Corps of Engineers of natural streamflow stations which are not specifically used in their operation, and from program reductions by two State agencies faced with reduced budgets.

At all stations where discharge was computed, a record of the stage--water-surface elevation--was maintained either continuously or during certain events at partial record stations. In addition, stage only was collected by the Geological Survey at 954 stream stations. The continuous collection of stage only at streams ranged from 115 stations in Florida to none in several States (figure 5). The reimbursement from other Federal agencies (OFA) supported the largest number of continuous stage-only stations--212 (figure 6)--while the Federal-State Cooperative Program supported the most partial record stage-only stations--418 (figure 7).

Stage data were also collected at 1,187 stations on lakes and reservoirs by the Geological Survey. Continuous record of stage was collected at 782 lake and reservoir stations, ranging from 93 in Florida to none in several States (figure 8). The Federal-State Cooperative Program supported the largest number of both continuous (figure 9) and partial record (figure 10) stage stations on lakes and reservoirs--338 and 278 stations, respectively.

Stream samples were collected and analyzed for water-quality characteristics at 4,166 stations nationwide (figure 11). The types of water-quality parameters measured vary from site to site and could include: field determinations for temperature, specific conductance, pH, dissolved oxygen, fecal coliform, and fecal streptococci; common constituents such as calcium, magnesium, fluoride, sodium, potassium, dissolved solids, silica, chloride, sulfate, hardness, bicarbonate, carbonate, and turbidity; major nutrients such as phosphorus, ammonia, nitrite, and nitrate; trace metals such as arsenic, cadmium, chromium, cobalt, copper, iron, lead, manganese, mercury, selenium, and zinc; and selected radiochemical parameters and suspended sediment. A continuous record was maintained at 743 of these sites (figure 12), mainly for water temperature and conductance, but other parameters such as dissolved oxygen and pH are also recorded continuously at times. There are 2,446 stream sites at which water-quality data were collected as part of a scheduled, long-term operation (figure 13). These include 501 stations, supported in the Survey's Federal Program, which make up the National Stream Quality Accounting Network (NASQAN). NASQAN was established by the U.S. Geological Survey to provide a uniform basis for continually assessing the quality of United States streams. An identical suite of water-quality characteristics is measured at each NASQAN station using the same set of procedures concerning sample-collection techniques, frequency of sampling, and analytical methods (Briggs and Ficke, 1977). There were 977 stations which were sampled as short term or project stations (figure 14). The collection of surface-water quality data received its largest funding support from the Federal-State Cooperative Program.

The number of surface-water quality data-collection stations changed for various reasons in different States (figure 15). In Florida, for example, surface-water quality work in the Miami area was reduced when the National Park Service cut back on their support for water quality in the Everglades National Park and when a study on the Caloosahatchie River was reduced. In Alabama, the State reduced its support of the water-quality program and the Bureau of Land Management reduced its support of the coal hydrology program. Increases occurred in some States such as in New Jersey where intensive basin studies were started in 1984 in cooperation with the State. These intensive investigations will go on for 2 years and then a new basin will be studied.

GROUND WATER

Ground water is one of the most widely available of the Nation's natural resources. It is estimated that 88 billion gallons per day of ground water are withdrawn in the United States for public supply, rural use, irrigation, and industrial uses (Solley and others, 1983). To provide the information required to develop knowledge about ground water, a good data base must be established and maintained. Water-level fluctuations are indicators of the stresses placed on aquifers, their ability to yield water, and the quantity of water in storage beneath the earth's surface. The U.S. Geological Survey collected information on ground-water levels at 39,301 sites in 1985 (figure 16). Data on water levels were collected continuously at 2,284 sites, of which 1,783 were funded by the Federal-State Cooperative Program (figure 17).

Ground-water levels were collected at 25,023 stations as part of a scheduled, long-term operation to assess long-term trends (figure 18). When special areal studies were conducted, water levels were at times collected at short-term or project stations to supplement the information available in the area from the long-term stations. In 1985, water-level data were collected at 11,994 stations for these investigations (figure 19). The Federal-State Cooperative Program provided funding support for 62 percent of these stations.

The measurement of ground-water levels increased overall nationwide (figure 20). The changes varied by State with the number increasing in most and decreasing in some. In Arizona, for example, there was a reduction in the number of stations at which water levels were measured by the Geological Survey because the State of Arizona took over the areal ground-water studies formerly performed by the U.S. Geological Survey. The State also took over the measuring of water levels in some wells in active management areas where pumping was critical and had to be controlled by the State. In Idaho, a Governor's Select Committee decided the ground-water data-collection activities of the U.S. Geological Survey should be increased to provide information for irrigation development. In New Jersey, coastal plain studies done in cooperation with the State of New Jersey were underway in 1985 and the number of short-term stations increased significantly. Also, in New Jersey a group of ground-water level measurements, which are taken every 5 years, took place in 1985 but not in 1983.

The quality of ground water is also of importance to users. In 1985, ground water was sampled and analyzed at 9,263 stations (figure 21). To maintain information on the changes in quality of critical ground-water bodies, samples were collected at 4,334 stations as part of a scheduled, long-term operation (figure 22). Of these, sampling at 3,796 stations was funded by the Federal-State Cooperative Program. Ground-water quality data were also collected at 4,929 stations to provide information needed for short-term, generally site-specific studies (figure 23).

The number of stations at which ground-water quality was sampled increased by 1,615 stations from 1983 to 1985 (figure 24). Across the country, the number of ground-water quality stations increased in some States and decreased in others. In Iowa, for example, a major ground-water investigation was underway in 1985 in cooperation with two Iowa State agencies which accounts for the increased number of ground-water quality stations in that State. In New Jersey, the increase resulted from studies concerned with the quality of New Jersey's ground water which were being conducted in 1985 in cooperation with the State of New Jersey. In Idaho, the number of ground-water quality stations was reduced when a study in an area along the upper Snake River was completed.

SEDIMENT

Some of the concerns that relate to sediment in rivers of the United States are: the effect of sediment deposition on reservoir storage; the importance of large infrequent storms on erosion and transport of sediment; and the effects of urban and rural non-point contributions of sediment and the associated transport and fate of nutrients, toxic metals, and organic substances. Burkham (1985) states: "The U.S. Geological Survey (USGS) and other Federal, State, and local agencies obtain records of suspended-sediment discharge at many sites throughout the United States. The use of these records has greatly increased in recent years. Uses involve the evaluation of sediment transport to the oceans, geomorphological studies of denudation and rates of erosion, assessment of soil erosion and soil loss, reservoir sedimentation, general environmental impact assessment, water treatment problems of sediment-associated nutrients and pollutants, and evaluation of the precise impacts of humans."

New analytical techniques are being developed (1985) to analyze the sediment chemistry to provide information on the transport and fate of toxic substances in river systems. The movement of sediment into reservoirs and estuaries and the associated chemical processes must be understood because sediment can provide a potential source of toxic substances that could have a serious impact on the local biota and the food chain, as well as directly on water supplies.

To address the problems and issues of sediment in rivers, the U.S. Geological Survey collected daily sediment data at 212 stations and periodic data at 1,027 other stations (figure 25).

PRECIPITATION

Collection of precipitation data by the U.S. Geological Survey is undertaken only as part of an investigation of a specific hydrologic system. Most of the time, precipitation data from the National Weather Service are used. Precipitation data were collected at 921 sites nationwide (figure 26). At 108 of these sites, quality of precipitation was determined. The largest support for the collection of precipitation quantity (figure 27) and quality (figure 28) data came from the Federal-State Cooperative Program and the Federal Program, respectively.

SATELLITE TELEMETRY OF HYDROLOGIC DATA

The use of satellite telemetry is playing a major role in the collection of hydrologic data in real time. A satellite data-collection system consists of a data-collection platform (which is a small battery operated radio), an Earth-orbiting satellite, and an Earth receive and data-processing station. The demand for a cost effective means of collecting hydrologic data in real time for hazard warning systems and water management has increased rapidly (Paulson and Shope, 1984). Data-collection platforms were located in 1,520 U.S. Geological Survey hydrologic data-collection stations and were transmitting data on one, or a combination, of the following parameters: stream stage or discharge, reservoir stage, water quality, and precipitation. There were 1,001 stations at which the data-collection platforms were operated by the U.S. Geological Survey and 519 U.S. Geological Survey stations at which the data-collection platforms were operated by others. About two-thirds of the funding for the operation of the data-collection platforms is provided by other Federal agencies.

SUMMARY

The U.S. Geological Survey operates an extensive network nationwide for the collection of hydrologic data, which is summarized in table 1. The surface-water data include information on discharge and stage of streams, stage of lakes and reservoirs, and surface-water quality. Data are also collected on ground-water levels and the quality of ground water. Data on sediment are collected on a daily and periodic basis. Data on the quantity and quality of precipitation are usually collected only in selected study areas. Satellite telemetry is being used to collect hydrologic data in real time.

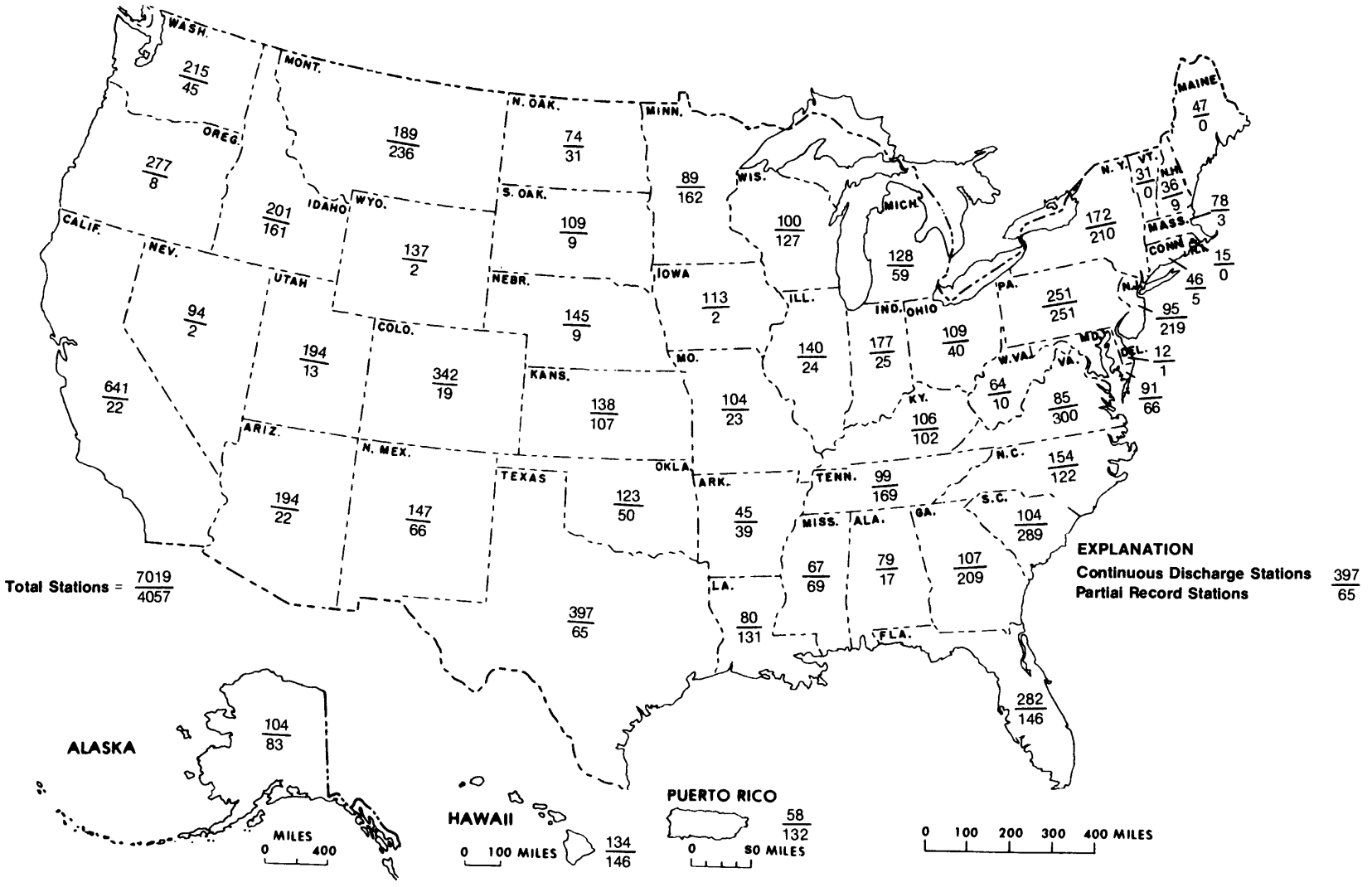
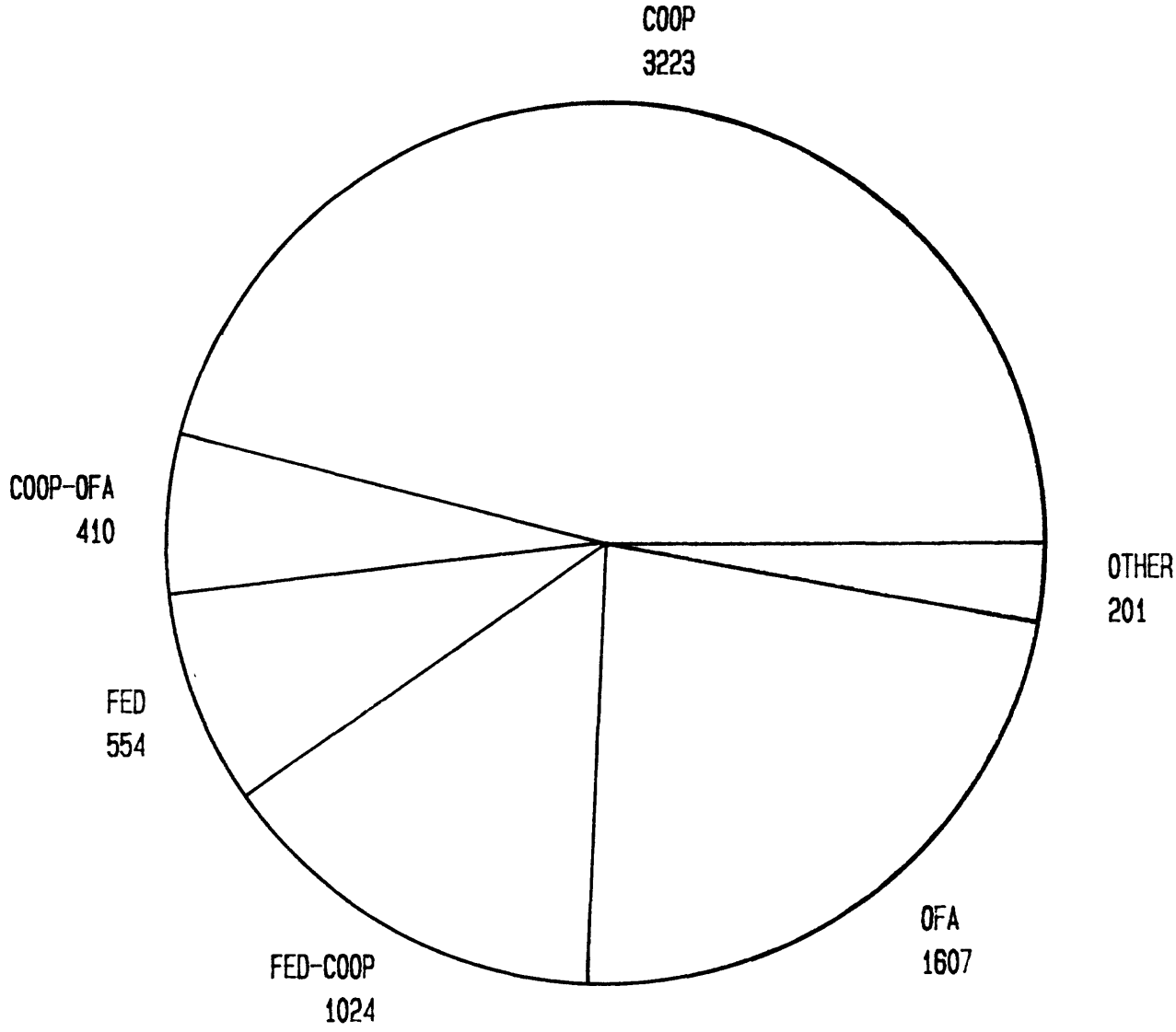


Figure 1.--Number of stations, by State, at which surface-water discharge data were collected in fiscal year 1985.



TOTAL STATIONS = 7,019

EXPLANATION:

SINGLE PROGRAM SUPPORT

FED = Federal

OFA = Other Federal Agencies

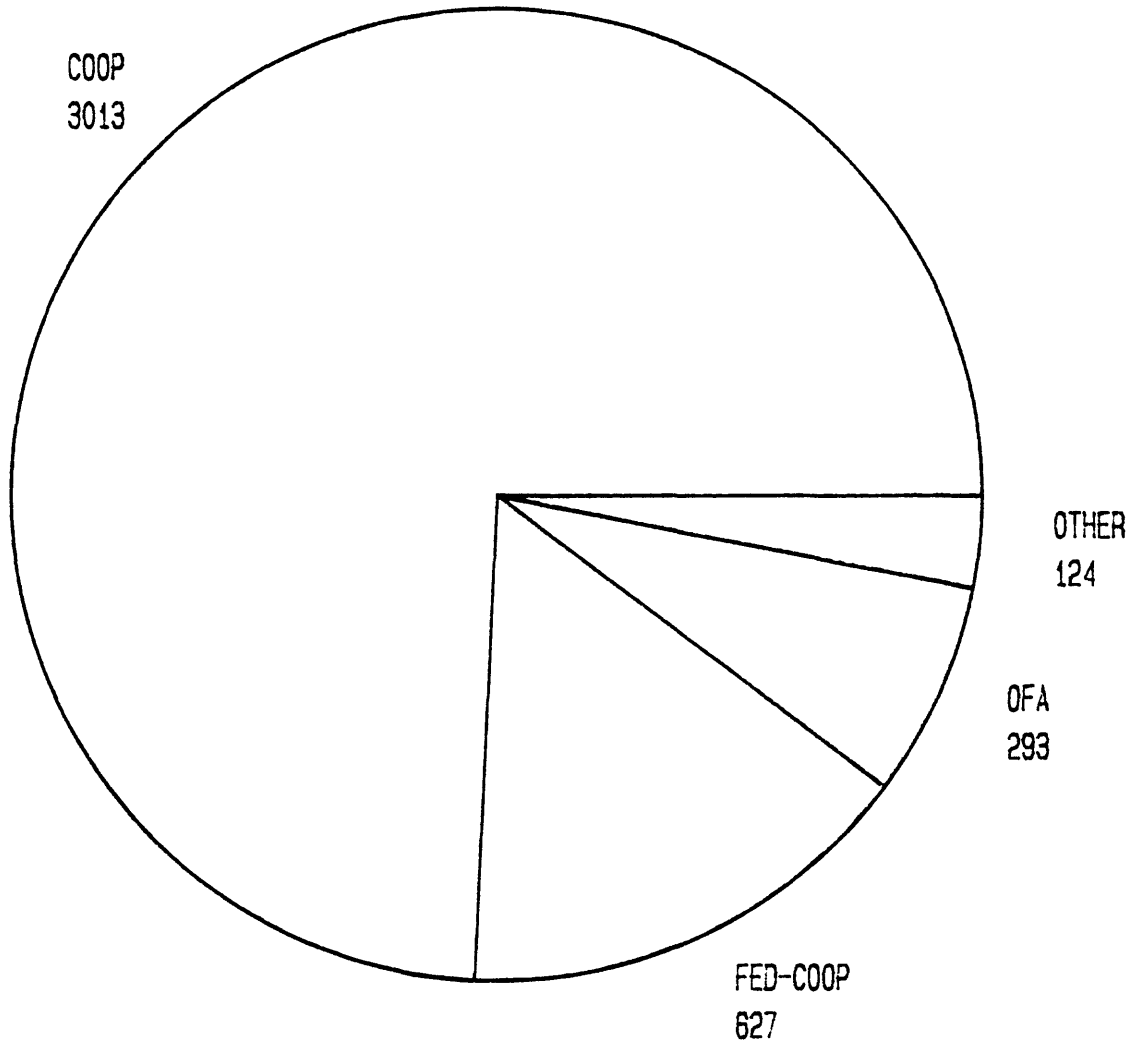
COOP = Federal-State Cooperative Program

COMBINED PROGRAM SUPPORT

FED-COOP = Federal and Federal-State Cooperative Program

COOP-OFA=Federal-State Cooperative and Other Federal Agencies

Figure 2.--Number of continuous surface-water discharge stations and sources of funding support, fiscal year 1985.



TOTAL STATIONS = 4,057

EXPLANATION:

SINGLE PROGRAM SUPPORT

OFA = Other Federal Agencies

COOP = Federal-State Cooperative Program

COMBINED PROGRAM SUPPORT

FED-COOP = Federal and Federal-State Cooperative Program

Figure 3.--Number of partial record surface-water discharge stations and sources of funding support, fiscal year 1985.

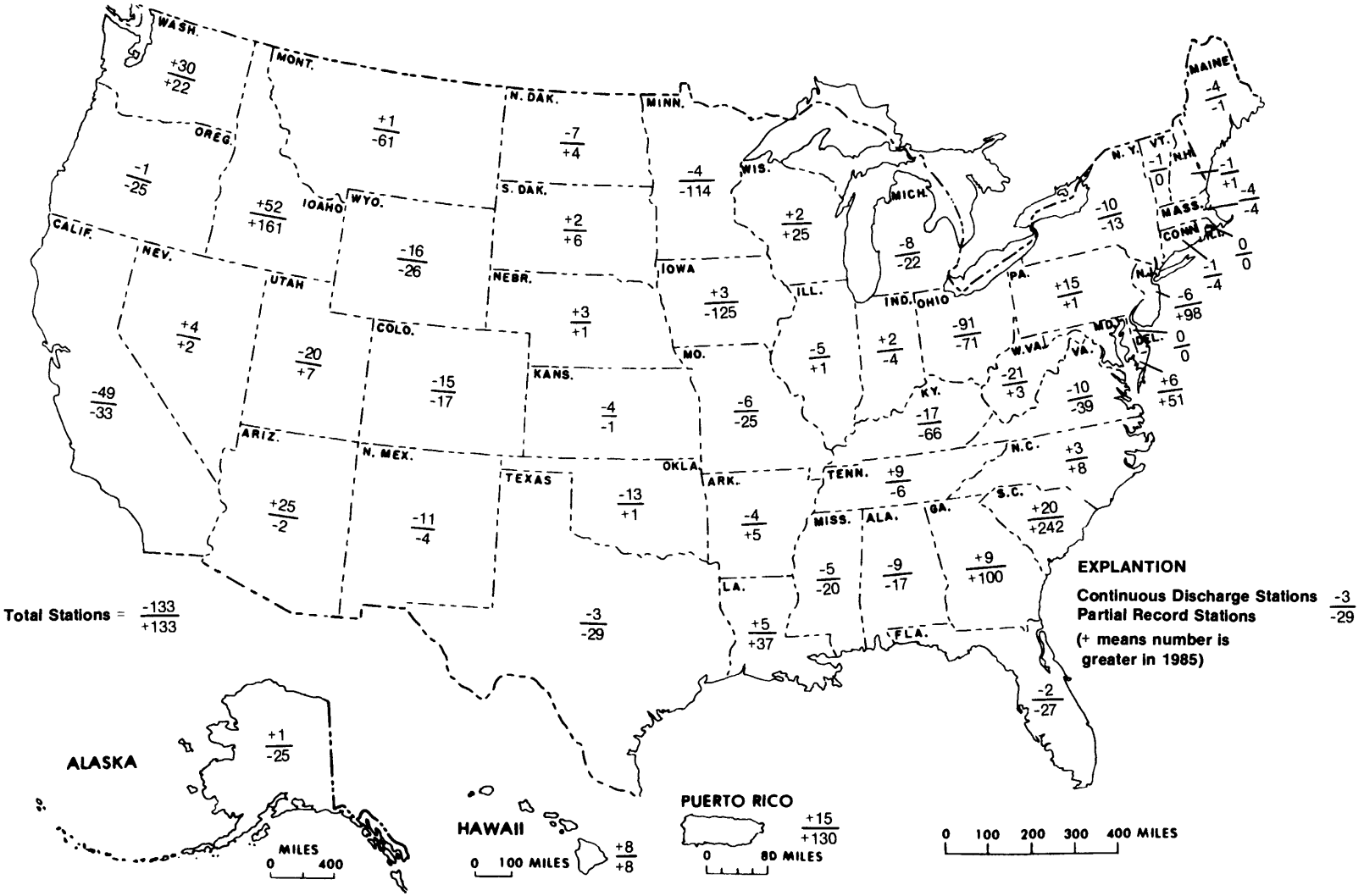


Figure 4.--Change in number of stations, by State, at which surface-water discharge data were collected from fiscal year 1983 to fiscal year 1985.

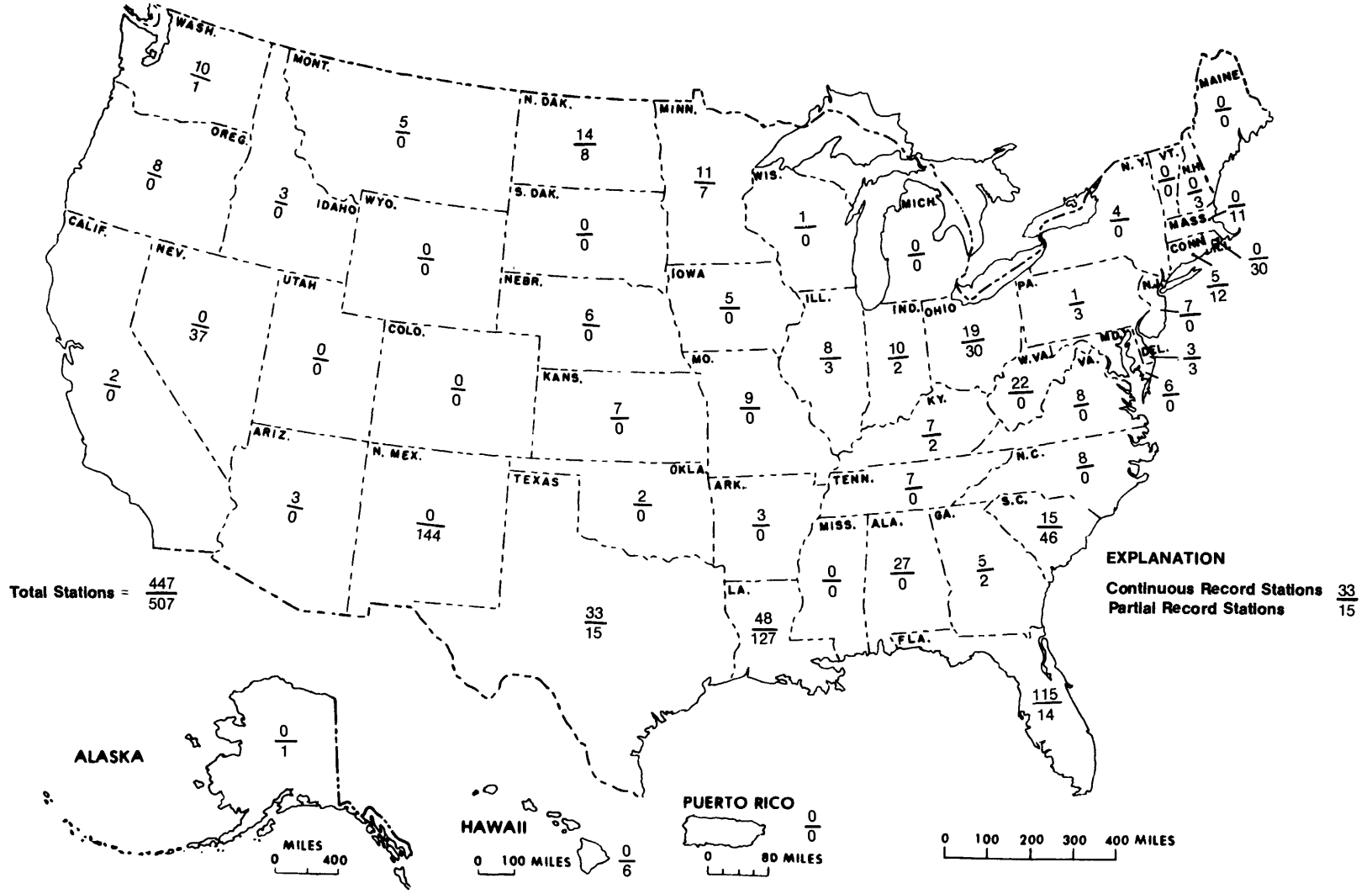
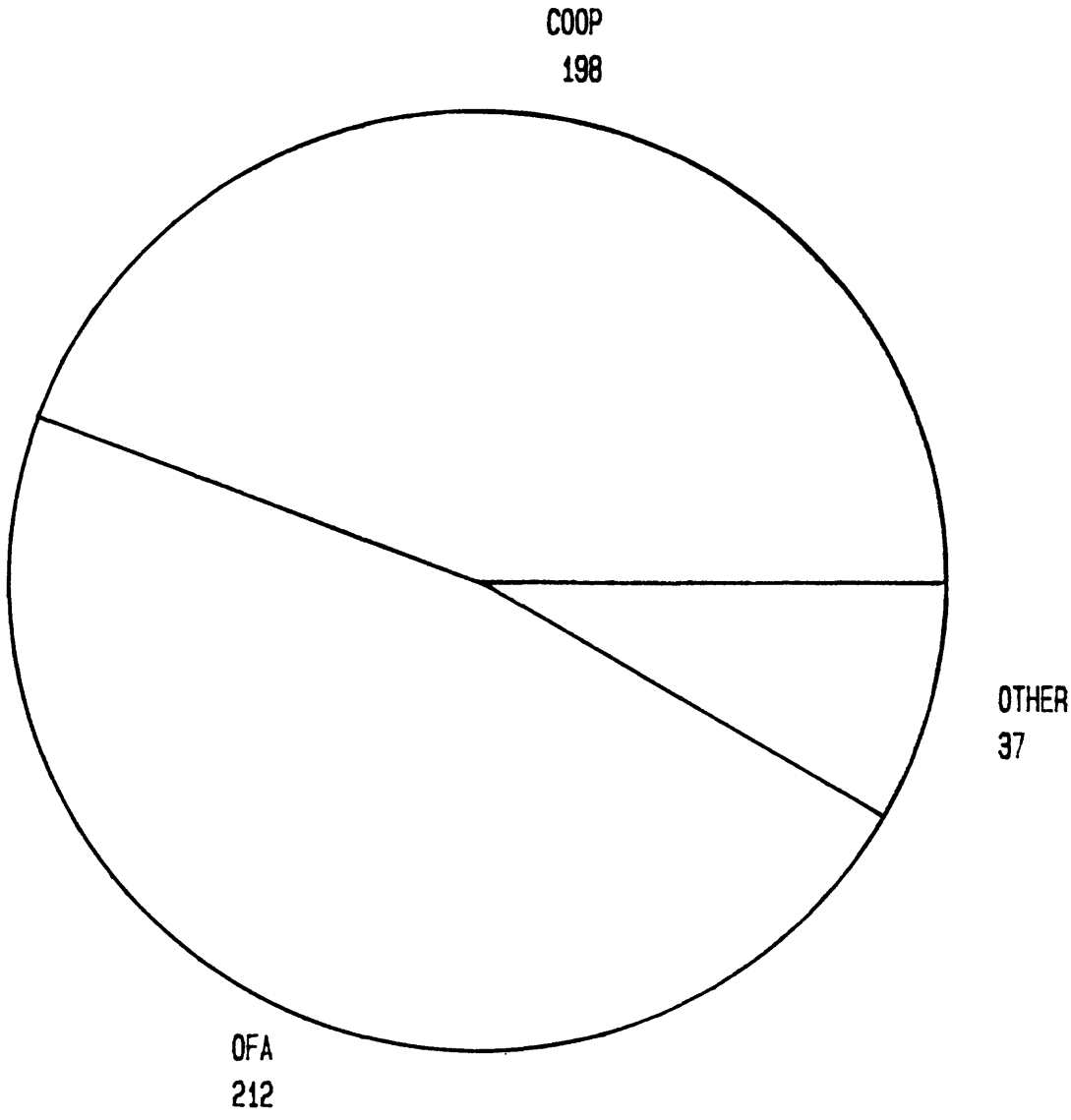


Figure 5.--Number of stations, by State, at which stage-only data were collected on streams in fiscal year 1985.



TOTAL STATIONS = 447

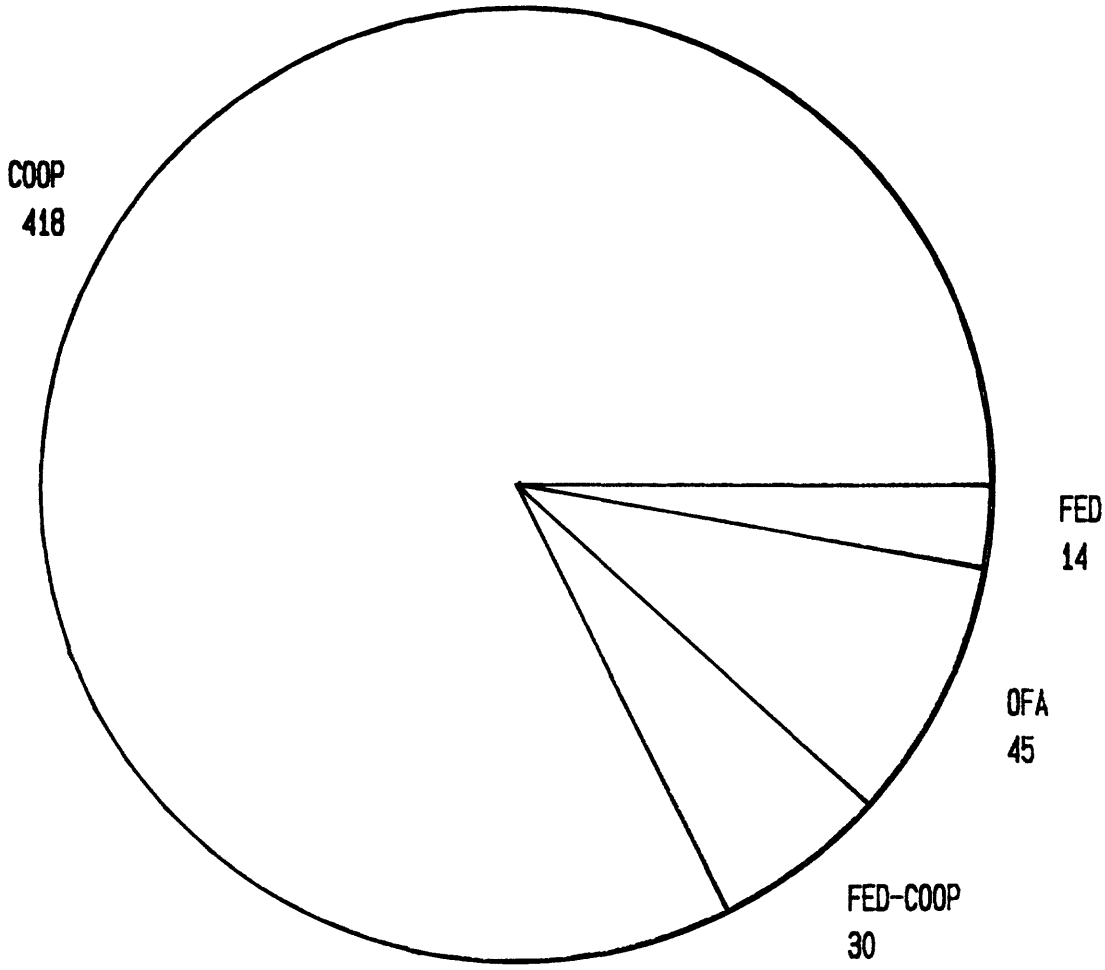
EXPLANATION:

SINGLE PROGRAM SUPPORT

OFA = Other Federal Agencies

COOP = Federal-State Cooperative Program

Figure 6.--Number of continuous surface-water stage-only stations on streams and sources of funding support, fiscal year 1985.



TOTAL STATIONS = 507

EXPLANATION:

SINGLE PROGRAM SUPPORT

FED = Federal

OFA = Other Federal Agencies

COOP = Federal-State Cooperative Program

COMBINED PROGRAM SUPPORT

FED-COOP = Federal and Federal-State Cooperative Program

Figure 7.--Number of partial record surface-water stage-only stations on streams and the source of funding support, fiscal year 1985.

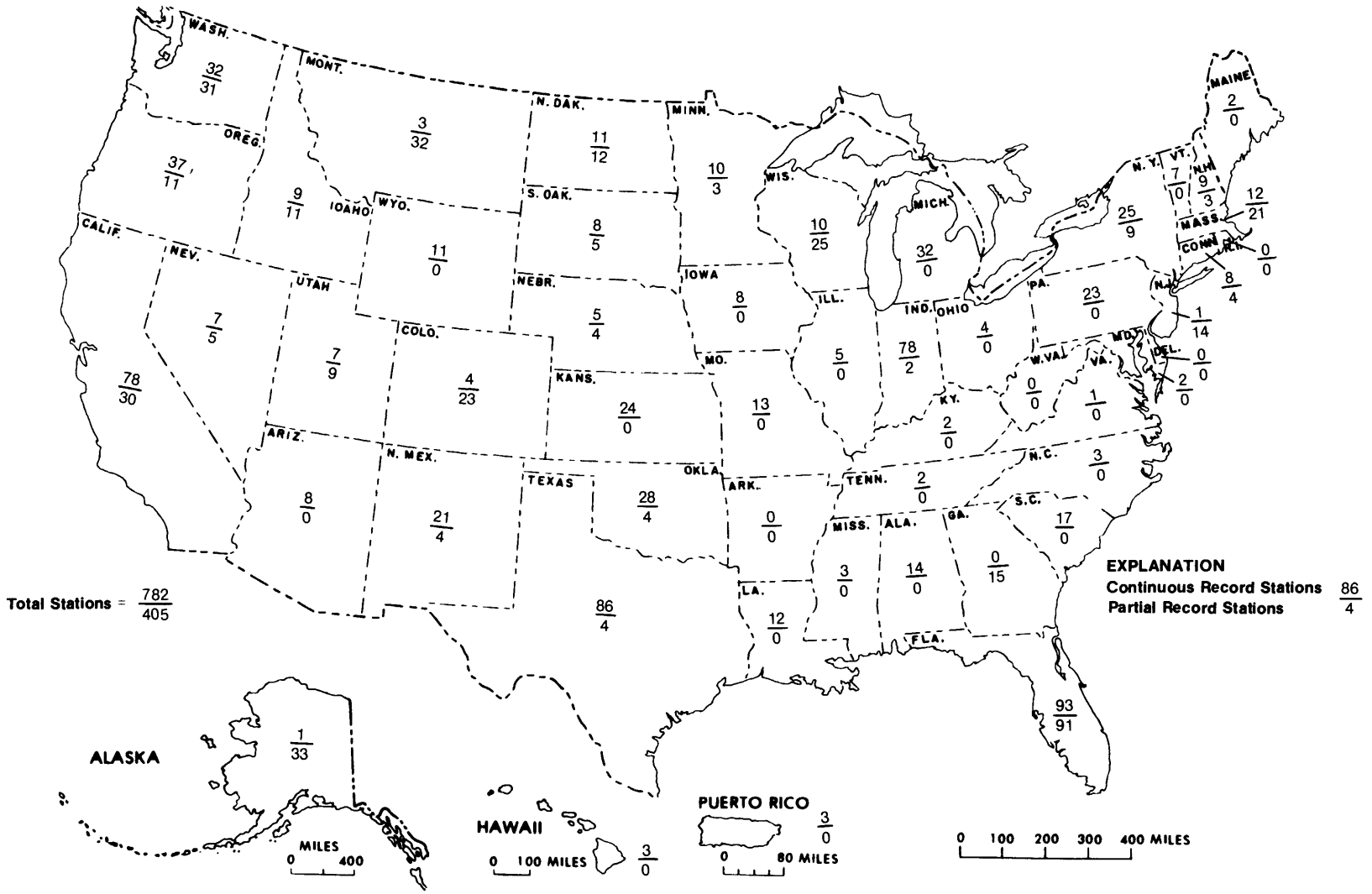
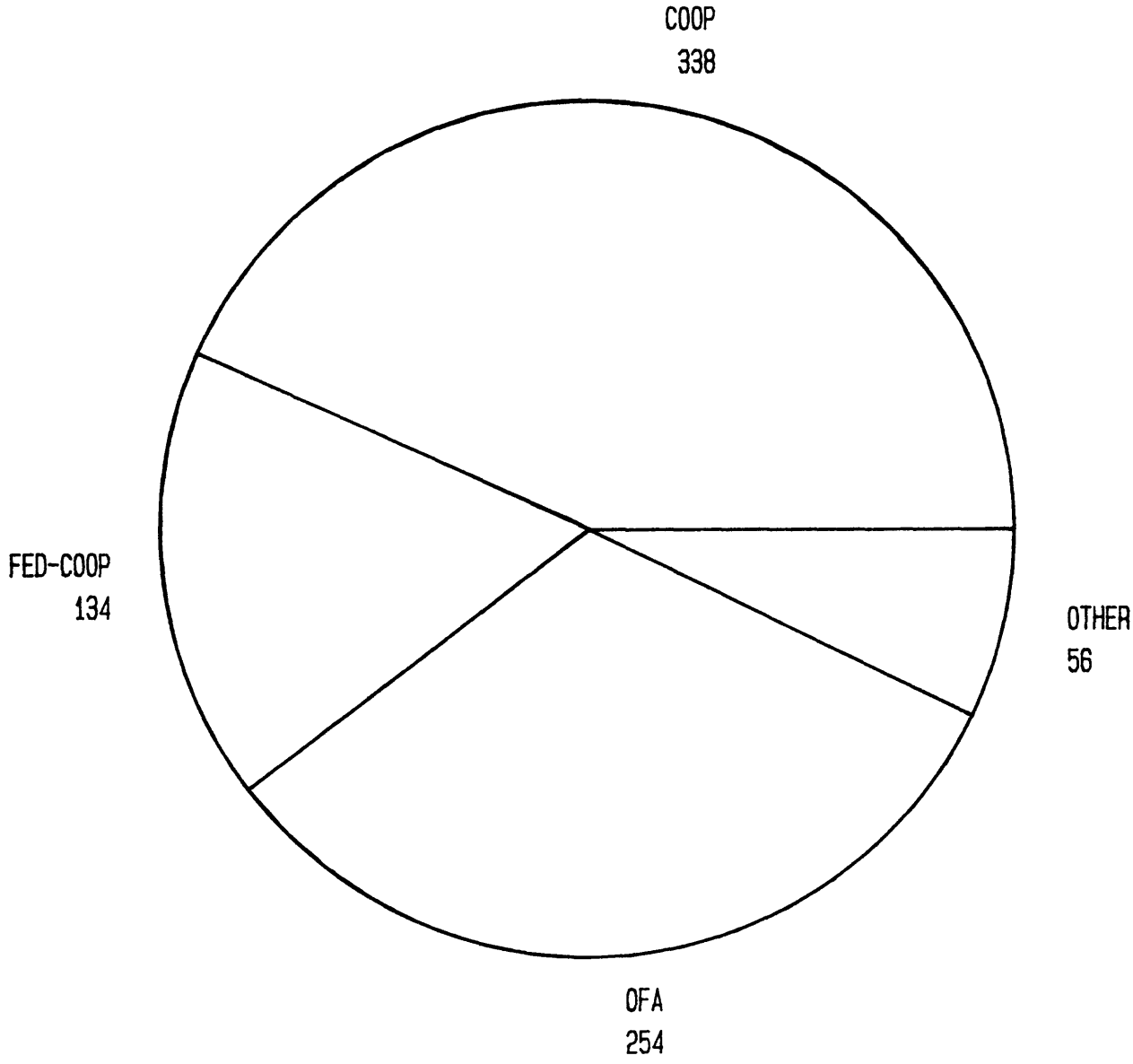


Figure 8.--Number of stations, by State, at which stage data were collected on lakes and reservoirs in fiscal year 1985.



EXPLANATION:

SINGLE PROGRAM SUPPORT

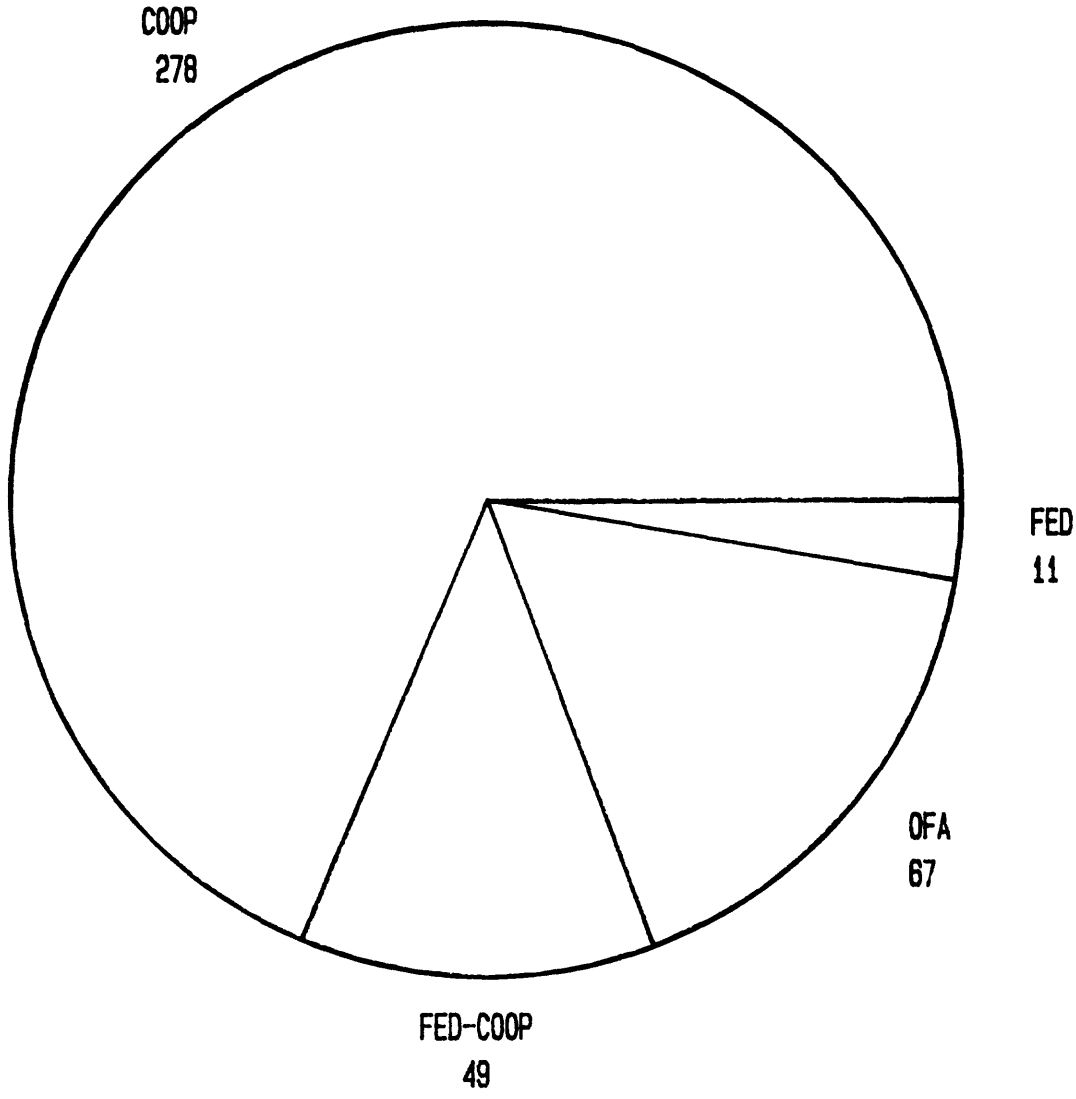
OFA = Other Federal Agencies

COOP = Federal-State Cooperative Program

COMBINED PROGRAM SUPPORT

FED-COOP = Federal and Federal-State Cooperative Programs

Figure 9.--Number of continuous surface-water stage stations on lakes and reservoirs and the sources of funding support, fiscal year 1985.



TOTAL STATIONS = 405

EXPLANATION:

SINGLE PROGRAM SUPPORT

FED = Federal

OFA = Other Federal Agencies

COOP = Federal-State Cooperative Program

COMBINED PROGRAM SUPPORT

FED-COOP = Federal and Federal-State Cooperative Program

Figure 10.--Number of partial record surface-water stage stations on lakes and reservoirs and the sources of funding support, fiscal year 1985.

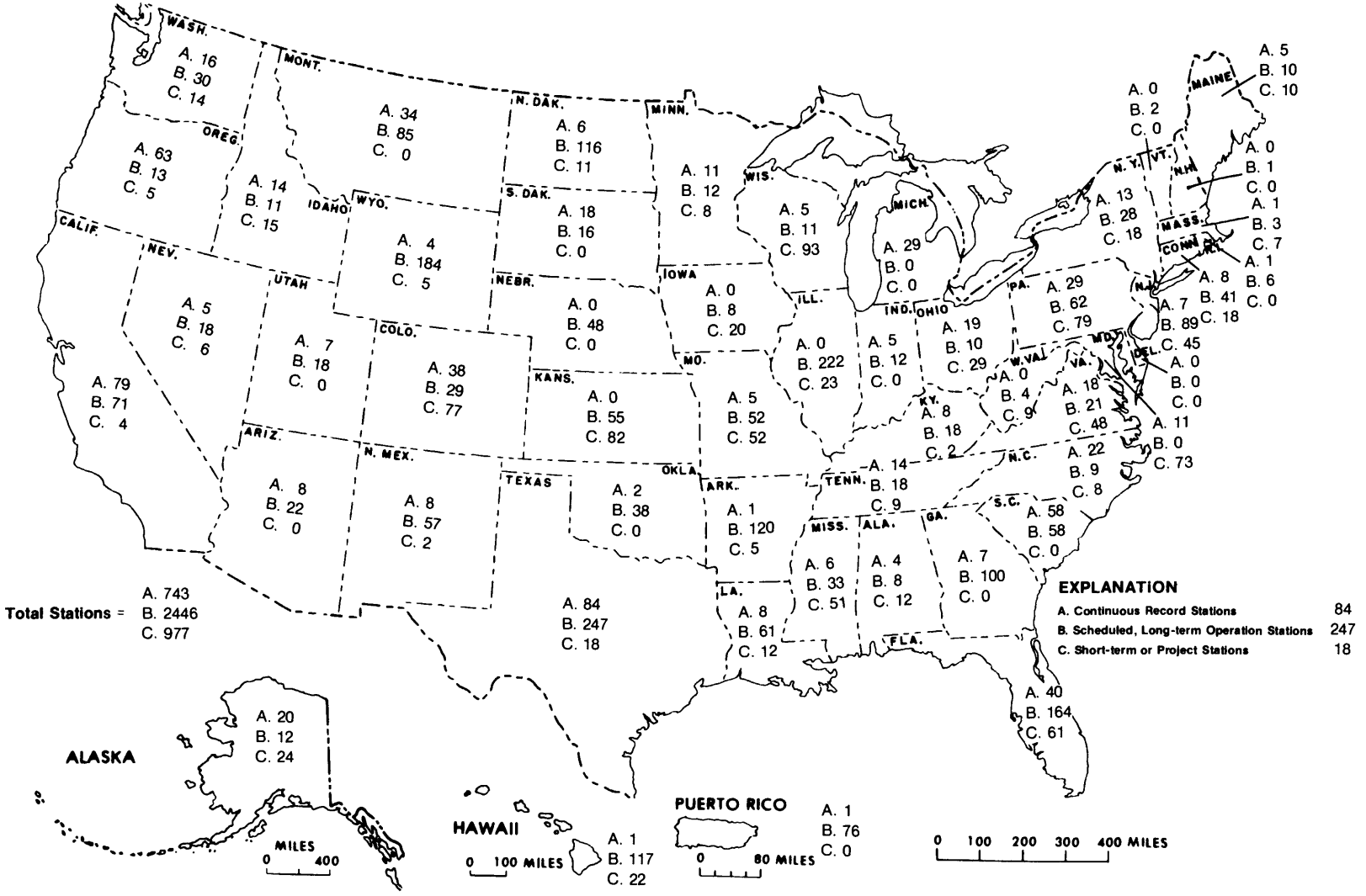
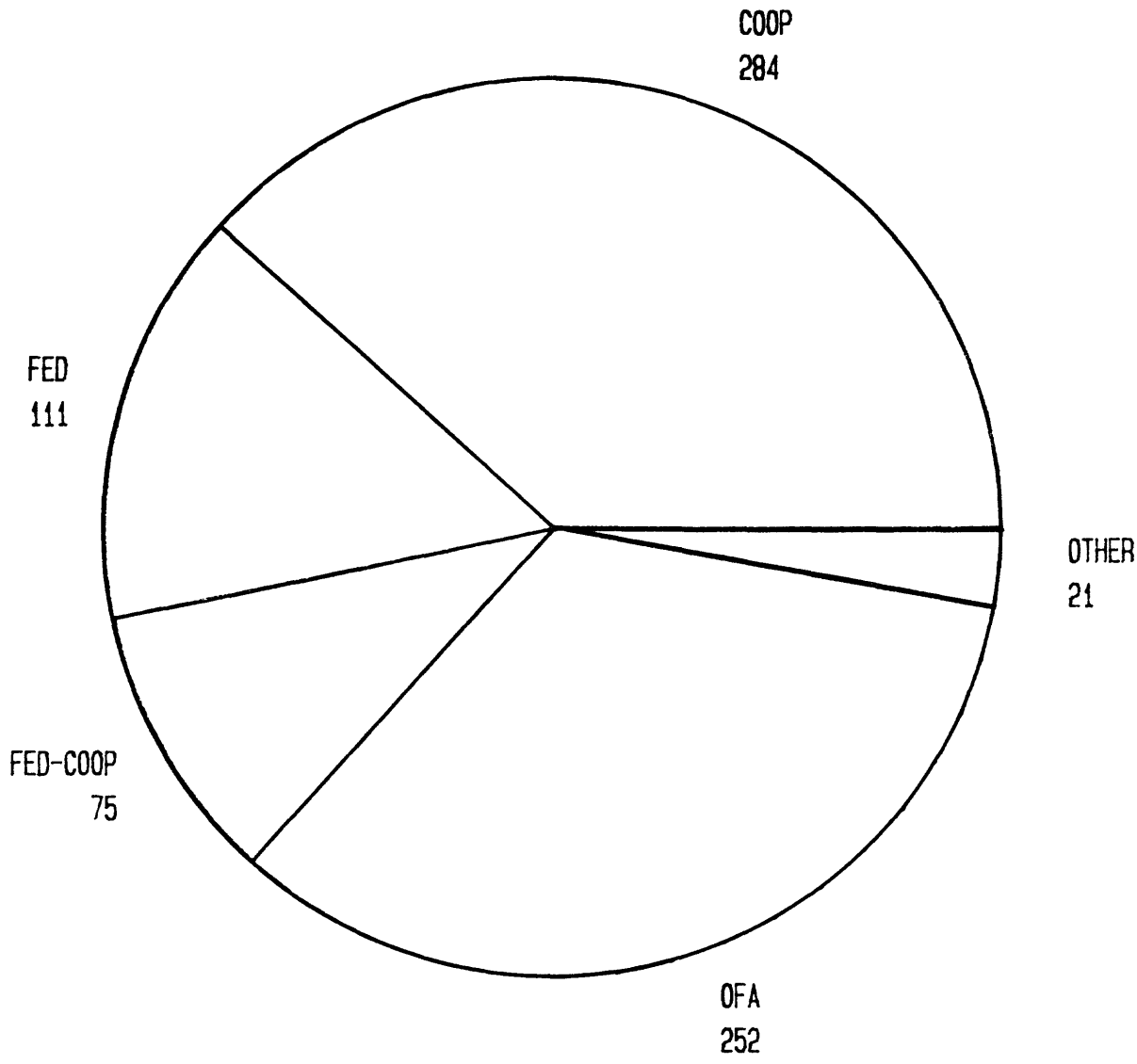


Figure 11.--Number of stations, by State, at which surface-water quality data were collected in fiscal year 1985.



TOTAL STATIONS = 743

EXPLANATION:

SINGLE PROGRAM SUPPORT

FED = Federal

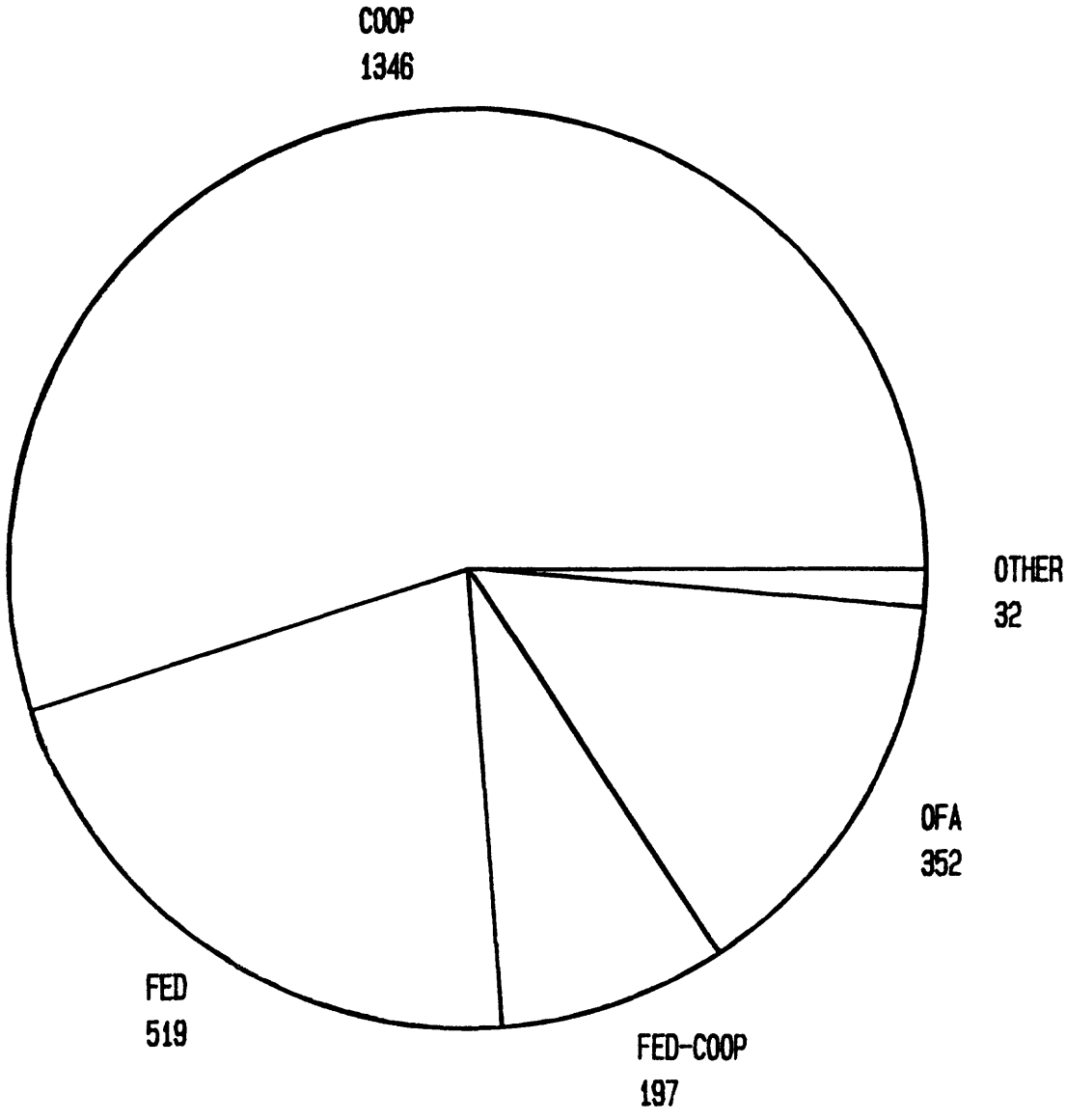
OFA = Other Federal Agencies

COOP = Federal-State Cooperative Program

COMBINED PROGRAM SUPPORT

FED-COOP = Federal and Federal-State Cooperative Program

Figure 12.--Number of continuous surface-water quality stations and sources of funding support, fiscal year 1985.



TOTAL STATIONS = 2,446

EXPLANATION:

SINGLE PROGRAM SUPPORT

FED = Federal

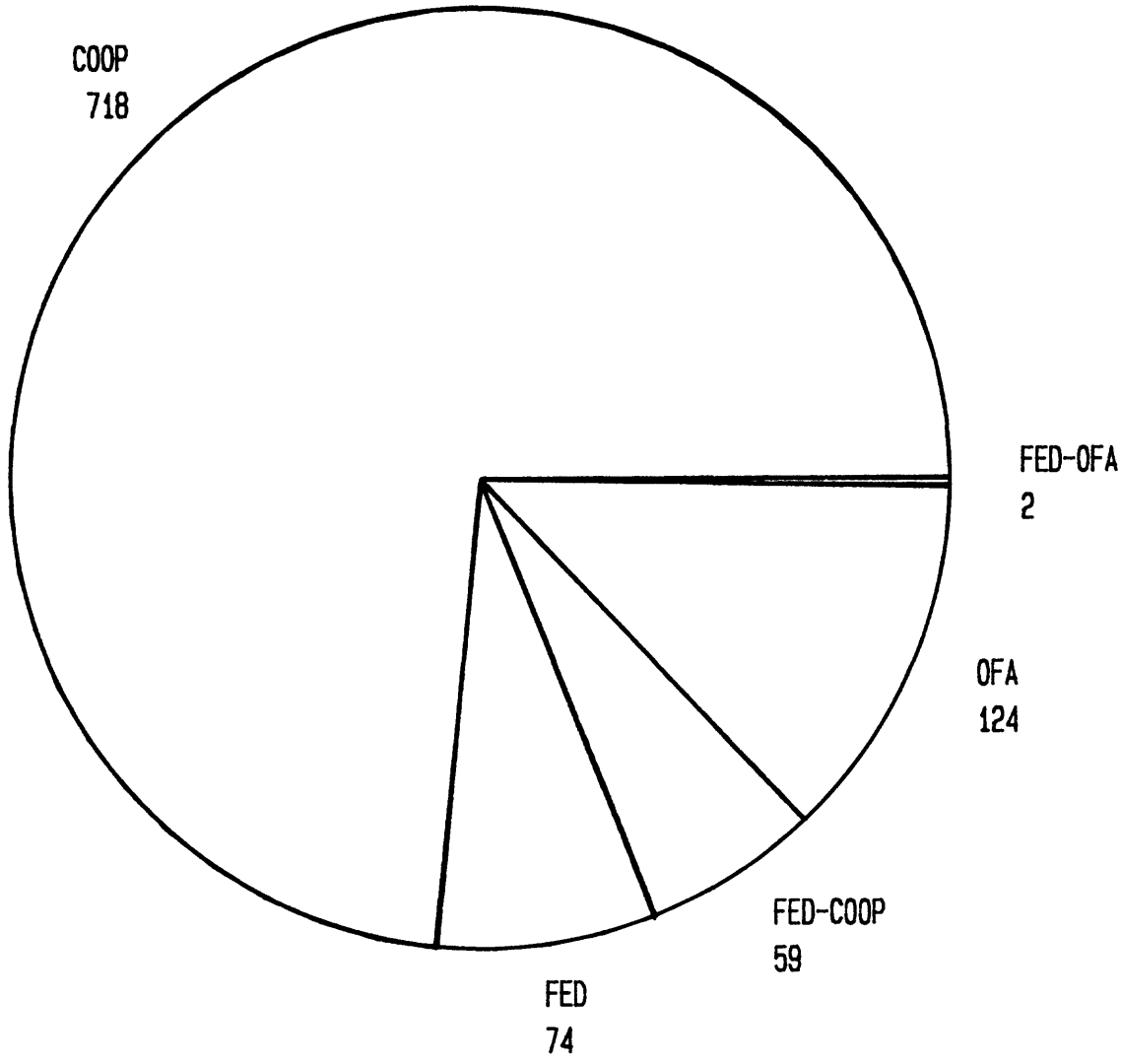
OFA = Other Federal Agencies

COOP = Federal-State Cooperative Program

COMBINED PROGRAM SUPPORT

FED-COOP = Federal and Federal-State Cooperative Program

Figure 13.--Number of scheduled, long-term operation surface-water quality stations and sources of funding support, fiscal year 1985.



EXPLANATION:

SINGLE PROGRAM SUPPORT

TOTAL STATIONS=977

FED = Federal

OFA = Other Federal Agencies

COOP = Federal-State Cooperative Program

COMBINED PROGRAM SUPPORT

FED-COOP = Federal and Federal-State Cooperative Programs

FED-OFA = Federal and Other Federal Agencies

Figure 14.--Number of short-term or project surface-water quality stations and sources of funding support, fiscal year 1985.

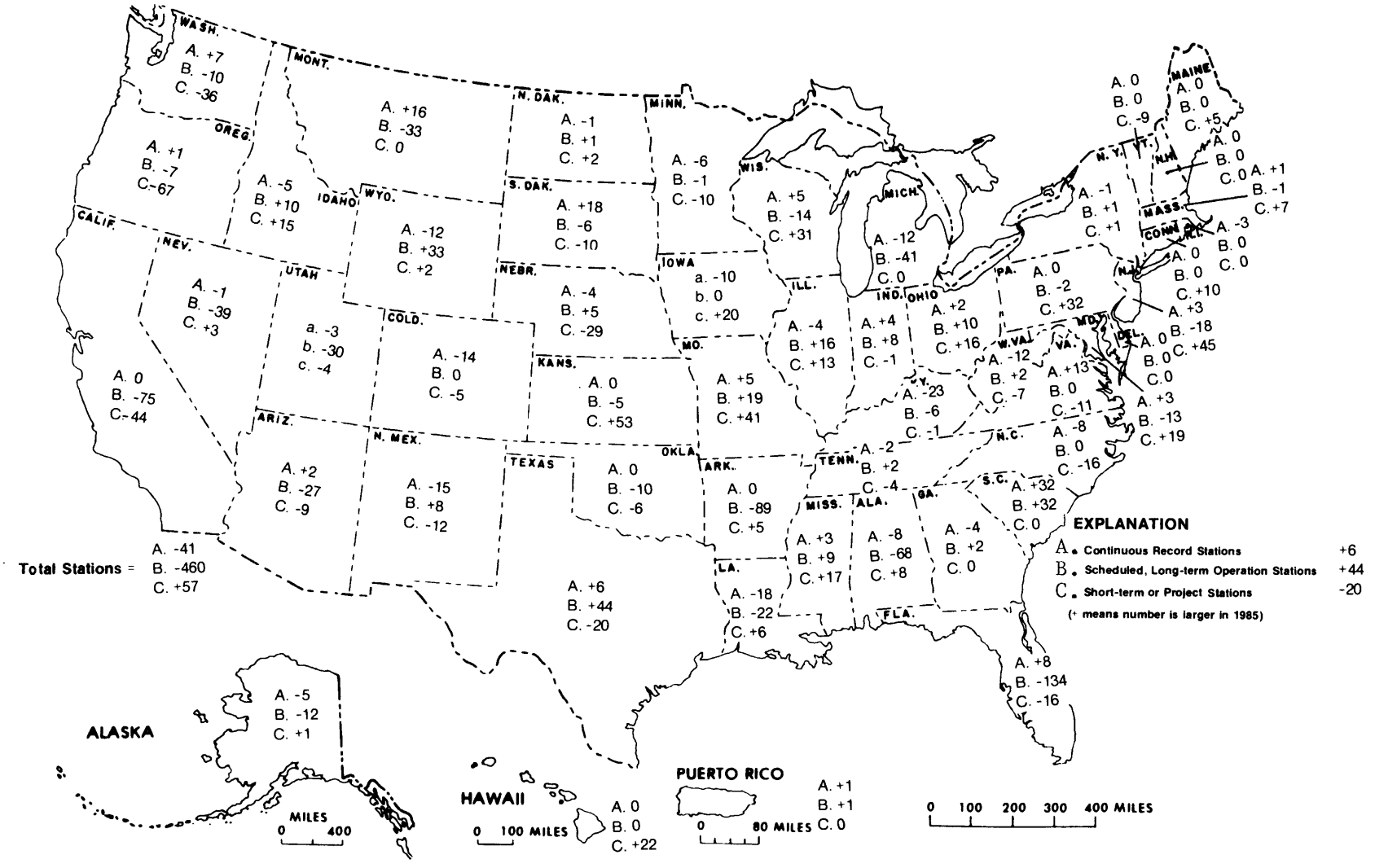


Figure 15.--Change in number of stations, by State, at which surface-water quality data were collected from fiscal year 1983 to fiscal year 1985.

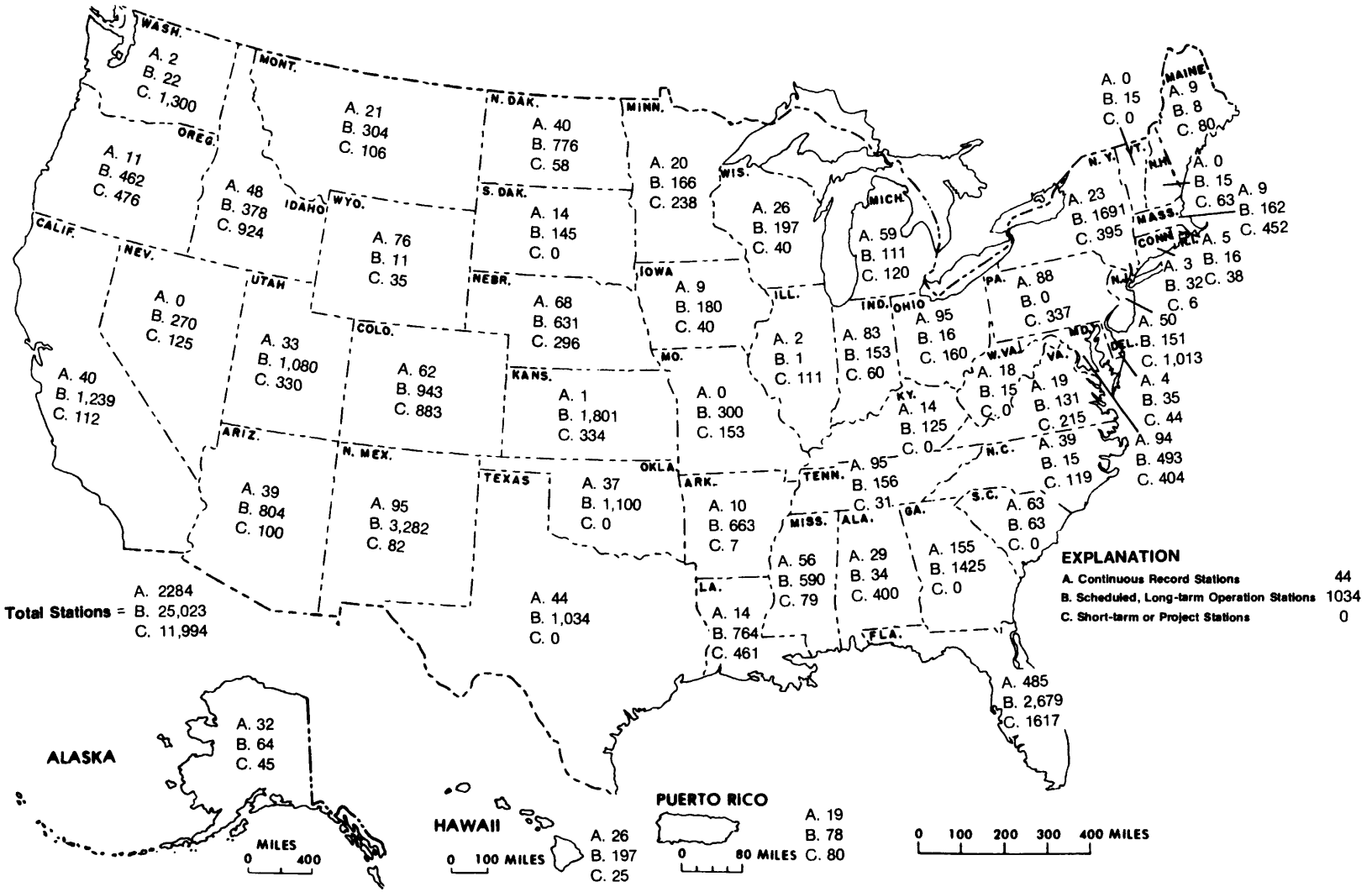
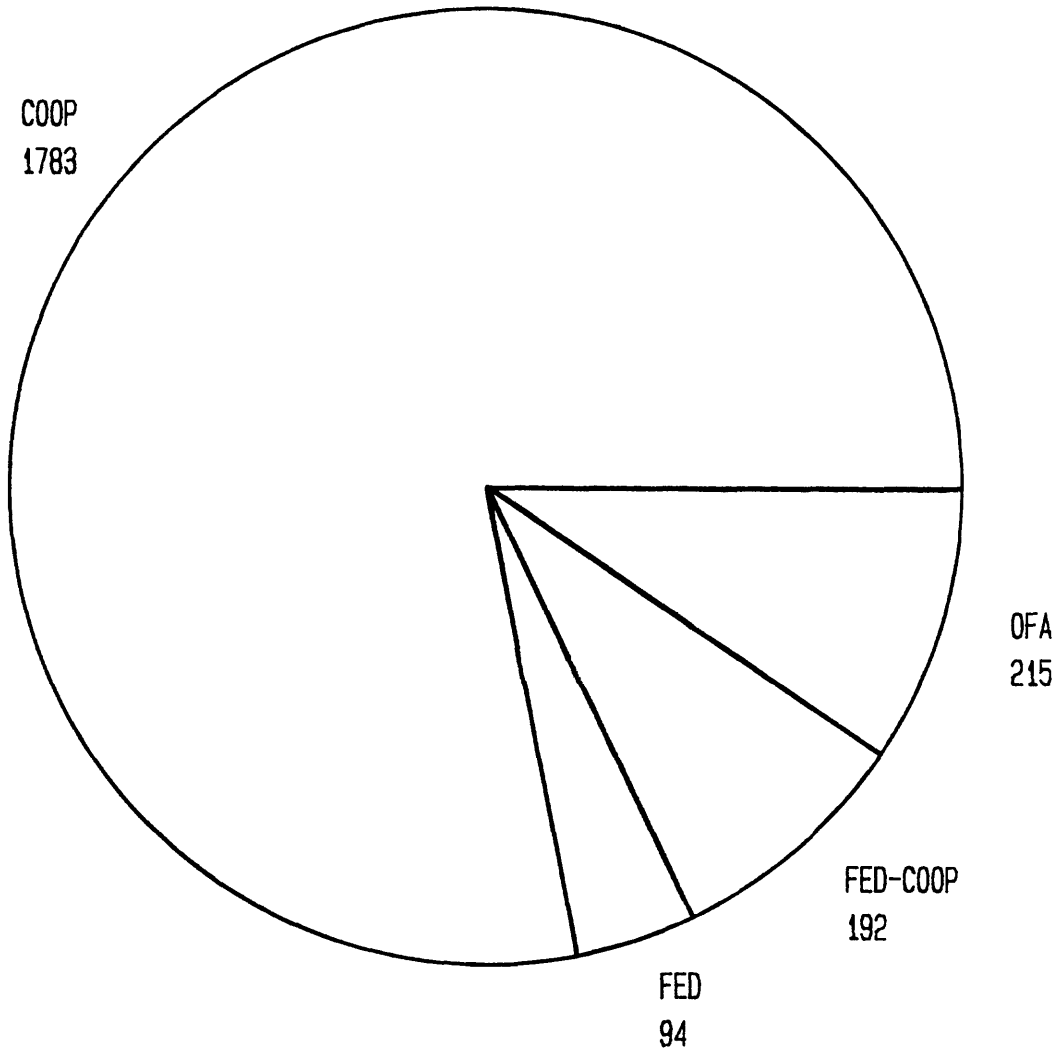


Figure 16.--Number of stations, by State, at which ground-water levels were collected in fiscal year 1985.



EXPLANATION:

SINGLE PROGRAM SUPPORT

FED = Federal

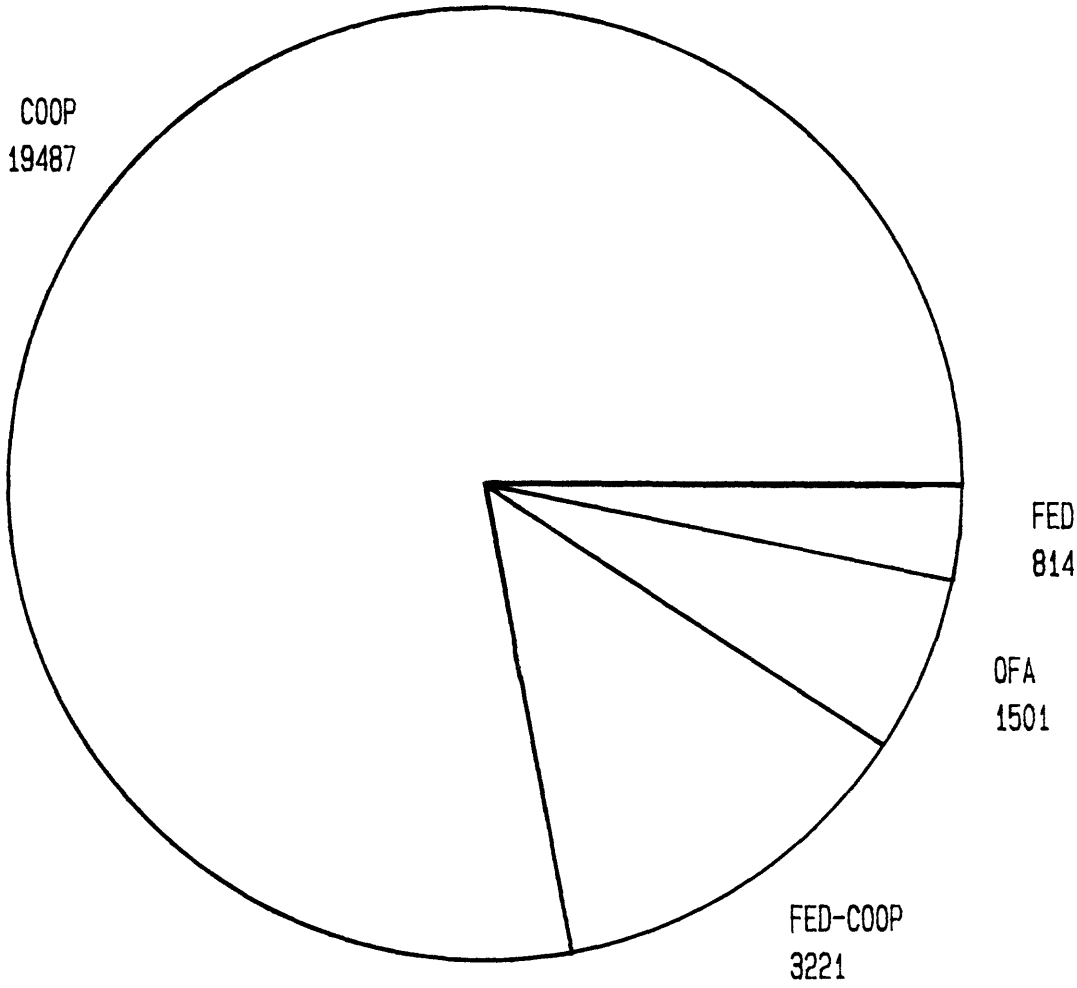
OFA = Other Federal Agencies

COOP = Federal-State Cooperative Program

COMBINED PROGRAM SUPPORT

FED-COOP = Federal and Federal-State Cooperative Programs

Figure 17.--Number of continuous ground-water level stations and the sources of funding support, fiscal year 1985.



TOTAL STATIONS = 25,023

EXPLANATION:

SINGLE PROGRAM SUPPORT

FED = Federal

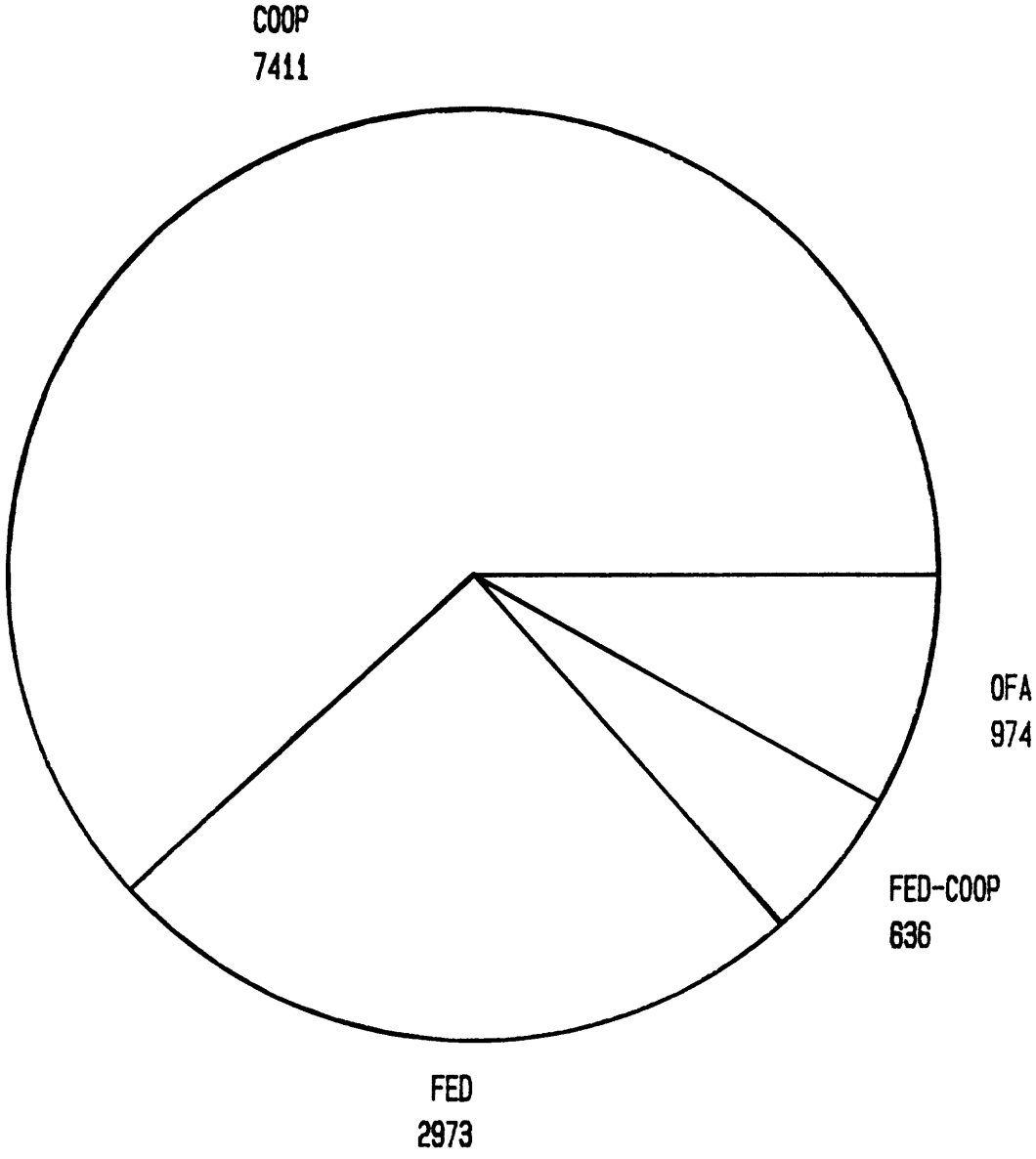
OFA = Other Federal Agencies

COOP = Federal-State Cooperative Program

COMBINED PROGRAM SUPPORT

FED-COOP = Federal and Federal-State Cooperative Program

Figure 18.--Number of scheduled, long-term operation ground-water level stations and sources of funding support, fiscal year 1985.



TOTAL STATIONS = 11,994

EXPLANATION:

SINGLE PROGRAM SUPPORT

FED = Federal

OFA = Other Federal Agencies

COOP = Federal-State Cooperative Program

COMBINED PROGRAM SUPPORT

FED-COOP = Federal and Federal-State Cooperative Program

Figure 19.--Number of short-term or project ground-water level stations and the source of funding support, fiscal year 1985.

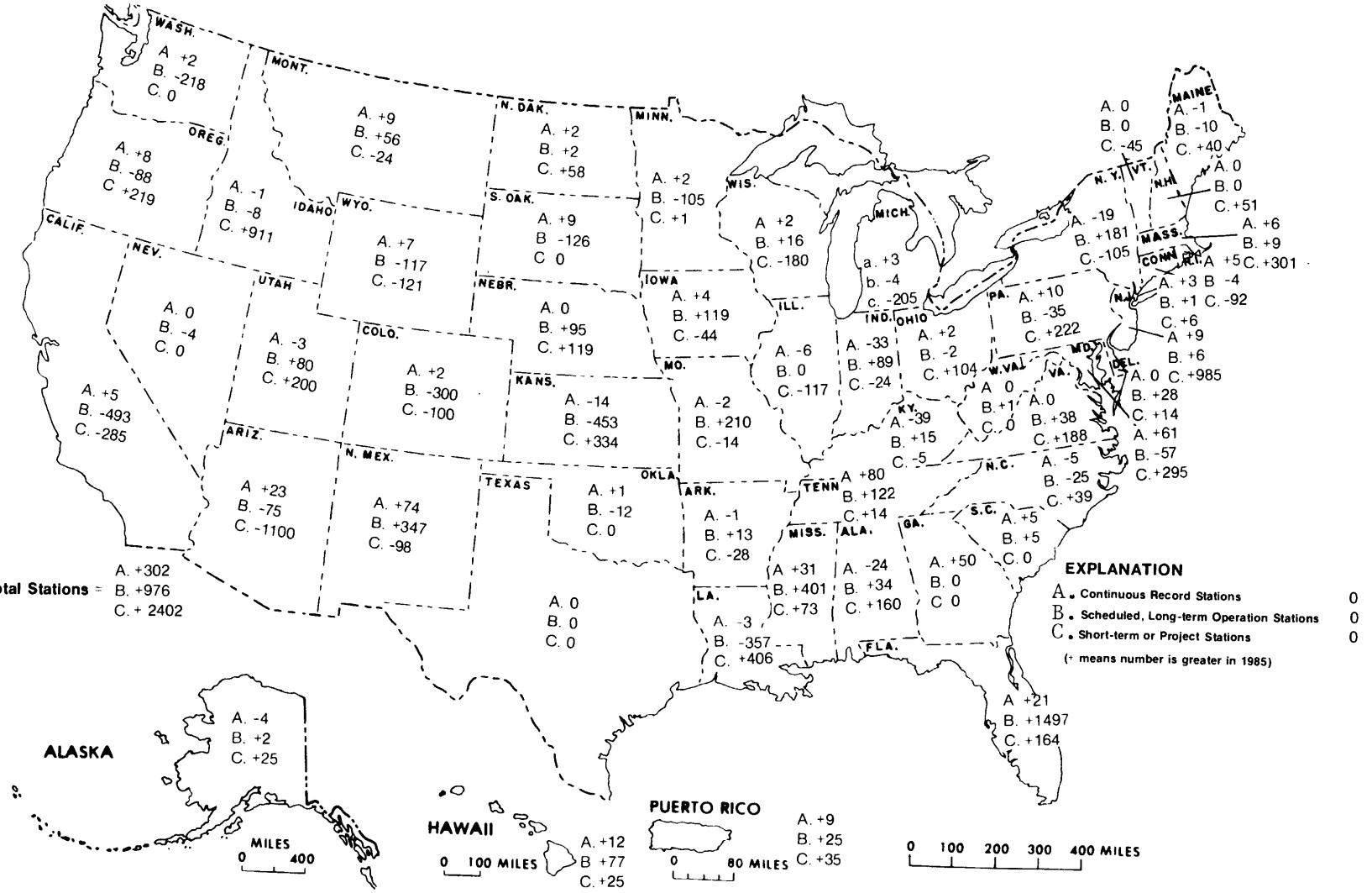


Figure 20.--Change in number of stations, by State, at which ground-water levels were collected from fiscal year 1983 to fiscal year 1985.

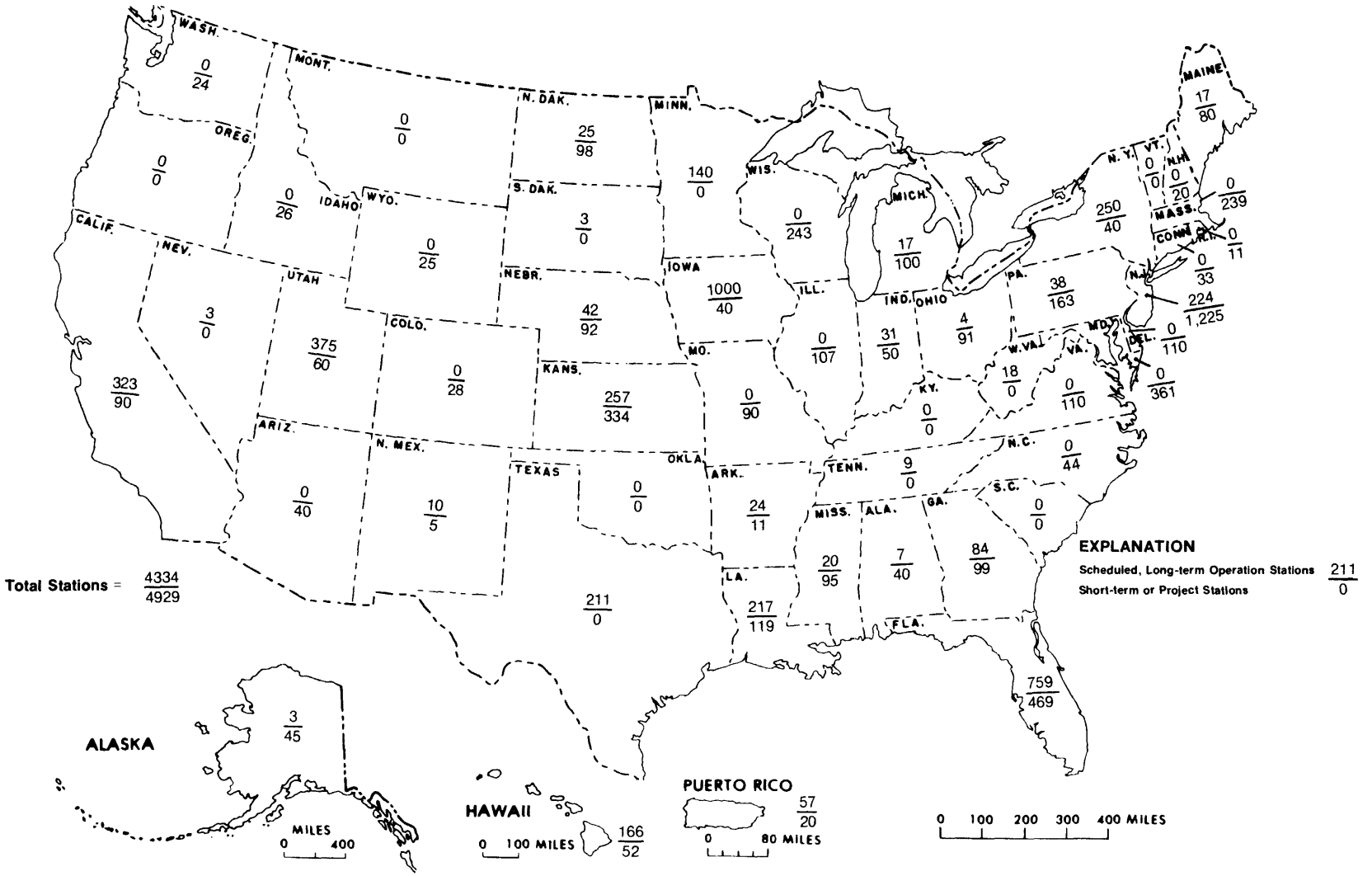
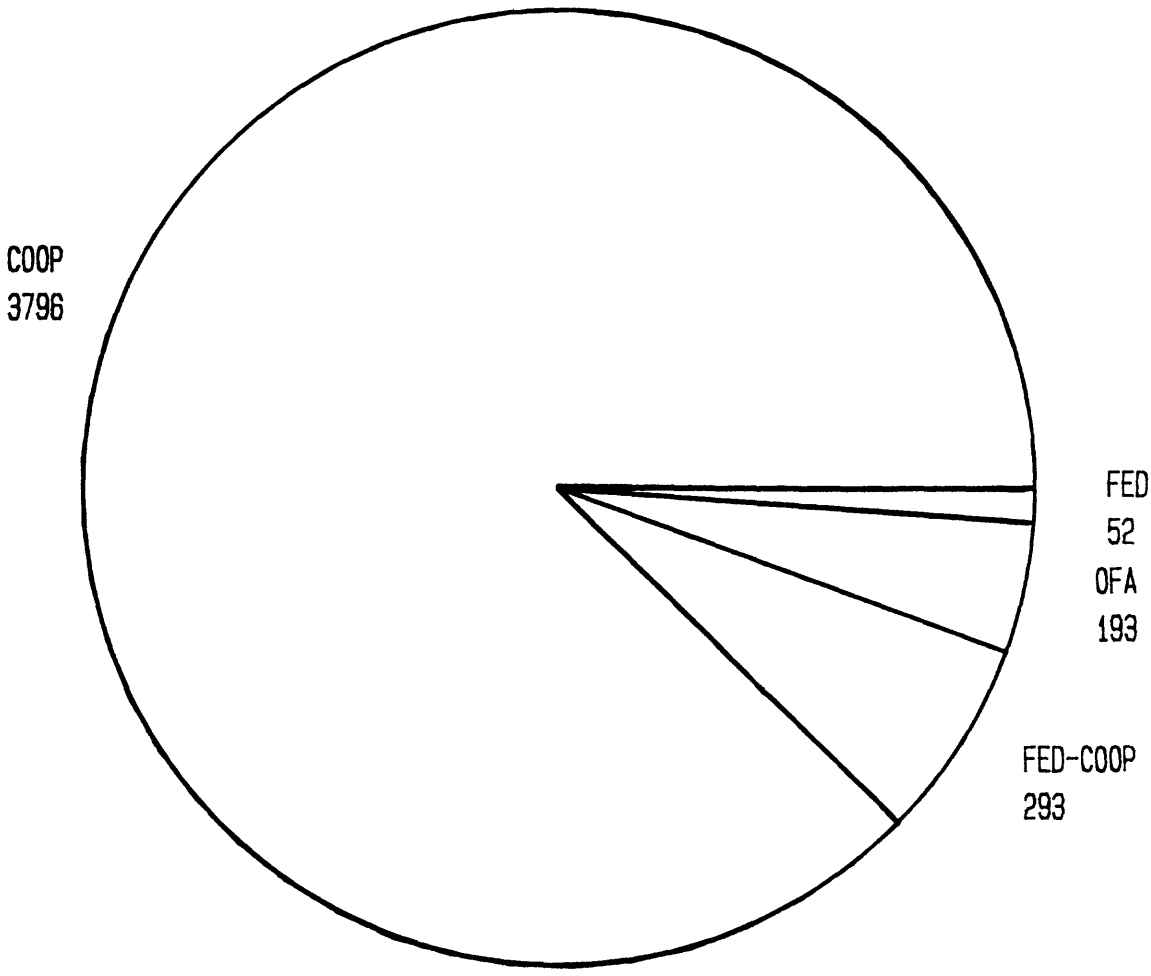


Figure 21.--Number of stations, by State, at which ground-water quality data were collected in fiscal year 1985.

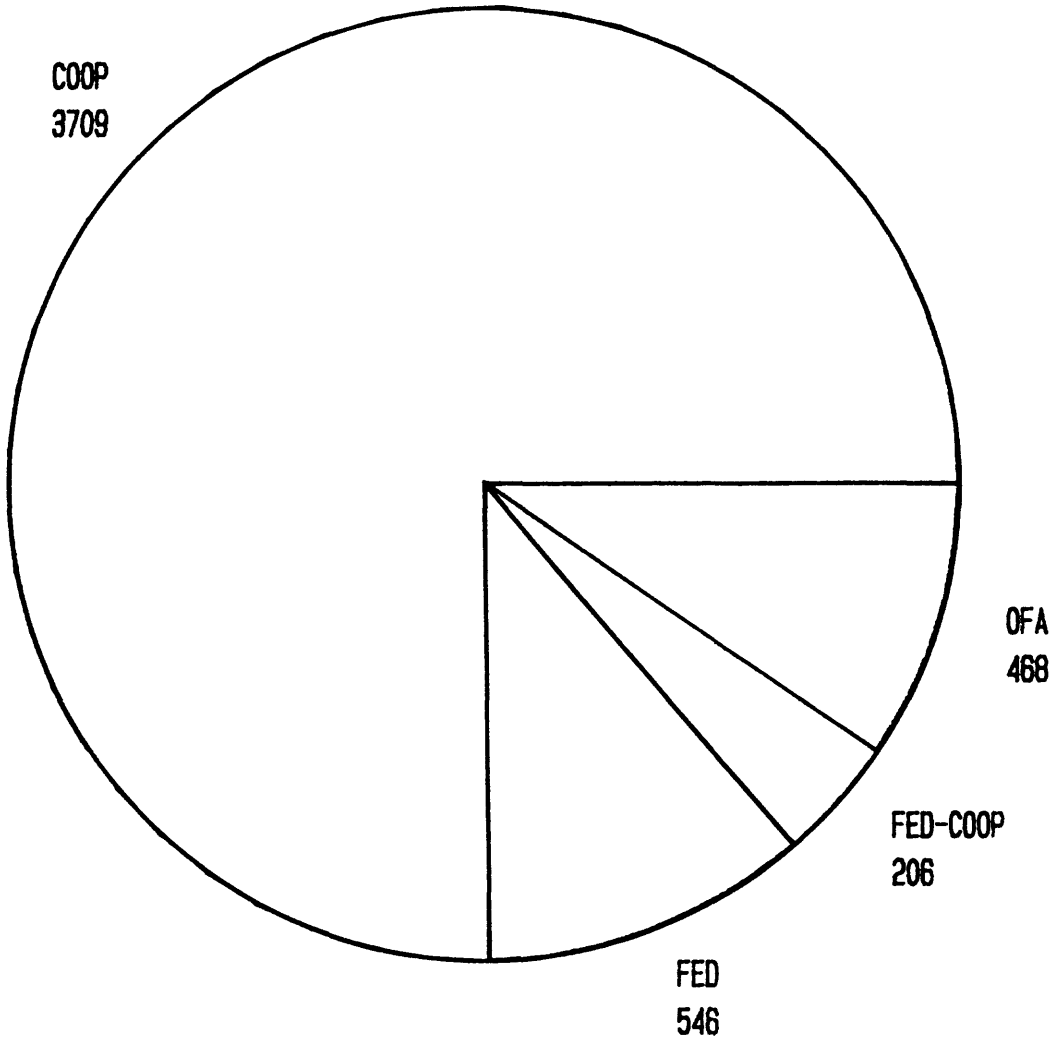


TOTAL STATIONS = 4,334

SINGLE PROGRAM SUPPORT
- FED = Federal
- OFA = Other Federal Agencies
- COOP = Federal-State Cooperative Program

COMBINED PROGRAM SUPPORT
- FED-COOP = Federal and Federal-State Cooperative Program

Figure 22.--Number of scheduled, long-term operation ground-water quality stations and the sources of funding support, fiscal year 1985.



TOTAL STATIONS = 4,929

EXPLANATION:

SINGLE PROGRAM SUPPORT

FED = Federal

OFA = Other Federal Agencies

COOP = Federal-State Cooperative Program

COMBINED PROGRAM SUPPORT

FED-COOP = Federal and Federal-State Cooperative Program

Figure 23.--Number of short-term or project ground-water quality stations and the sources of funding support, fiscal year 1985.

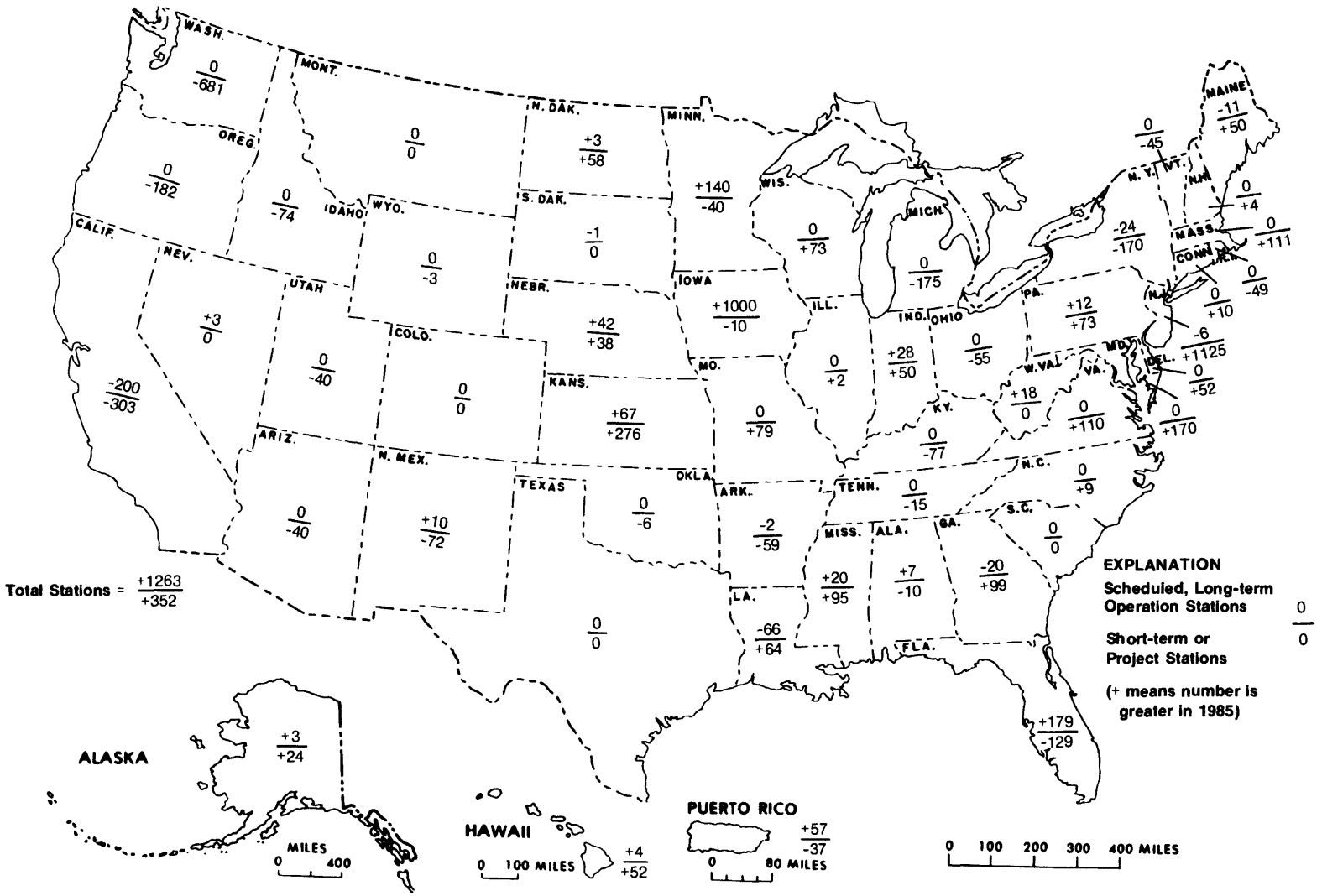


Figure 24.--Change in number of stations, by State, at which ground-water quality data were collected from fiscal year 1983 to fiscal year 1985.

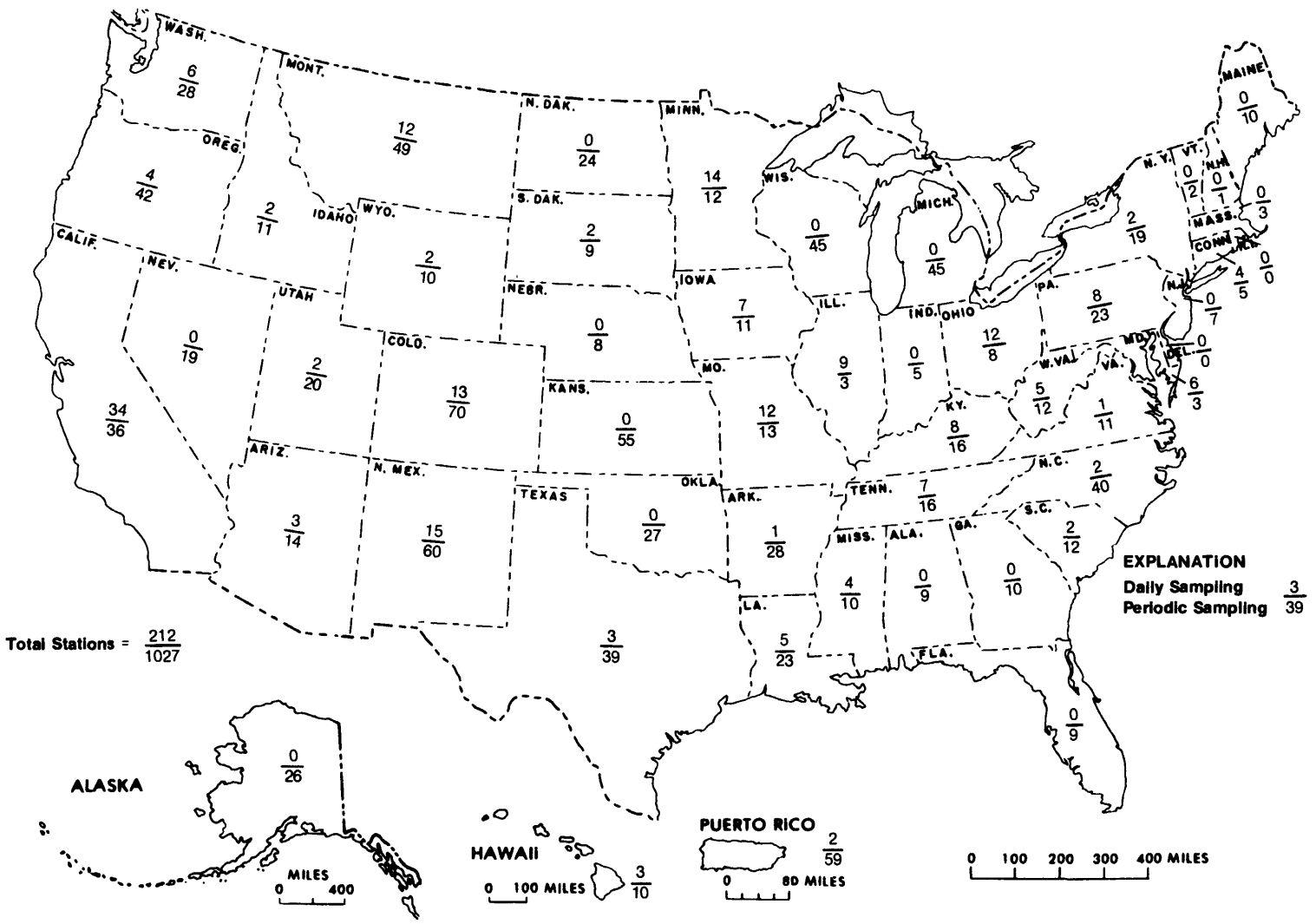


Figure 25.--Number of stations, by State, at which sediment data were collected in fiscal year 1985.

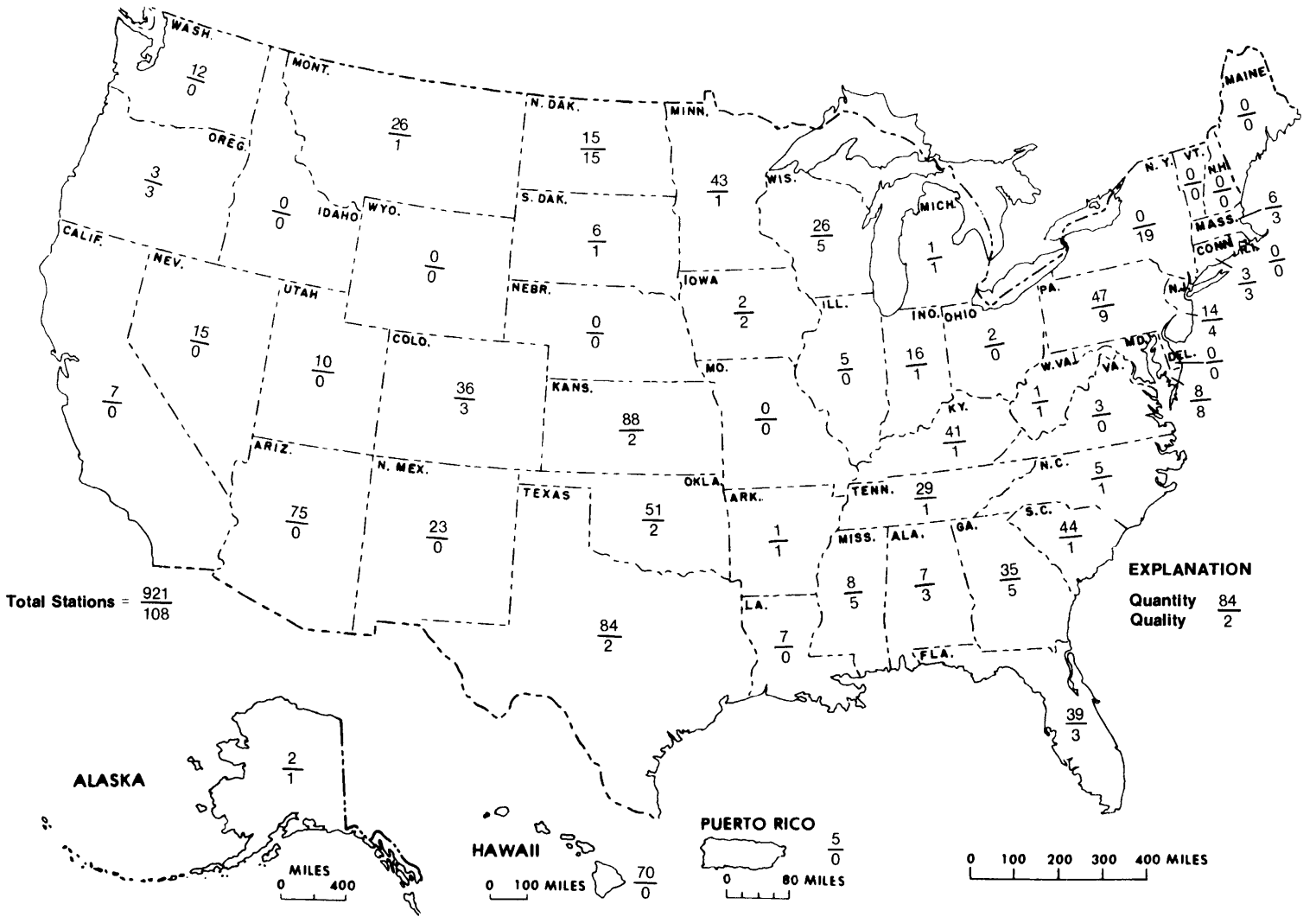
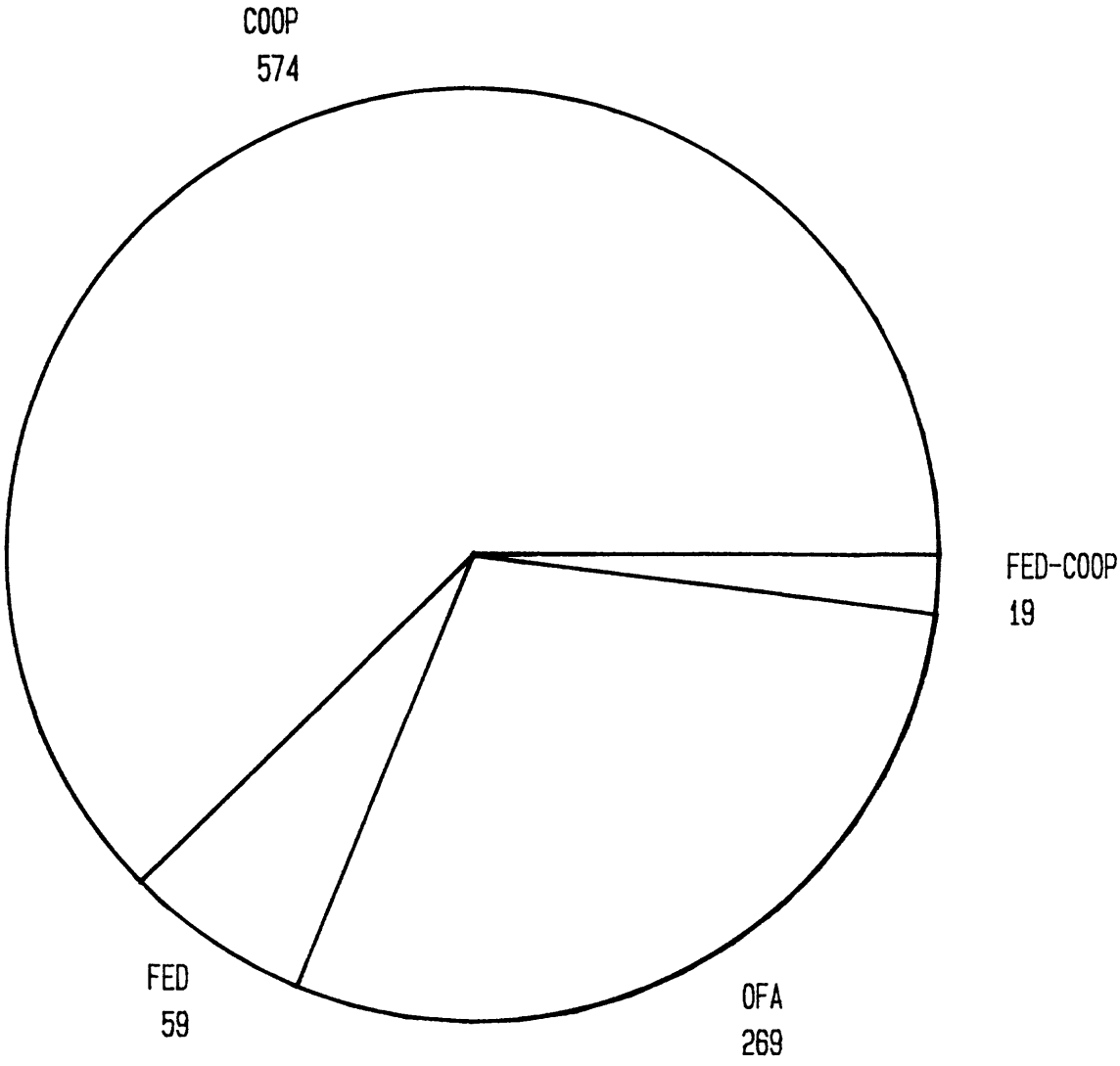


Figure 26.--Number of stations, by State, at which precipitation data were collected in fiscal year 1985.



TOTAL STATIONS = 921

EXPLANATION:

SINGLE PROGRAM SUPPORT

FED = Federal

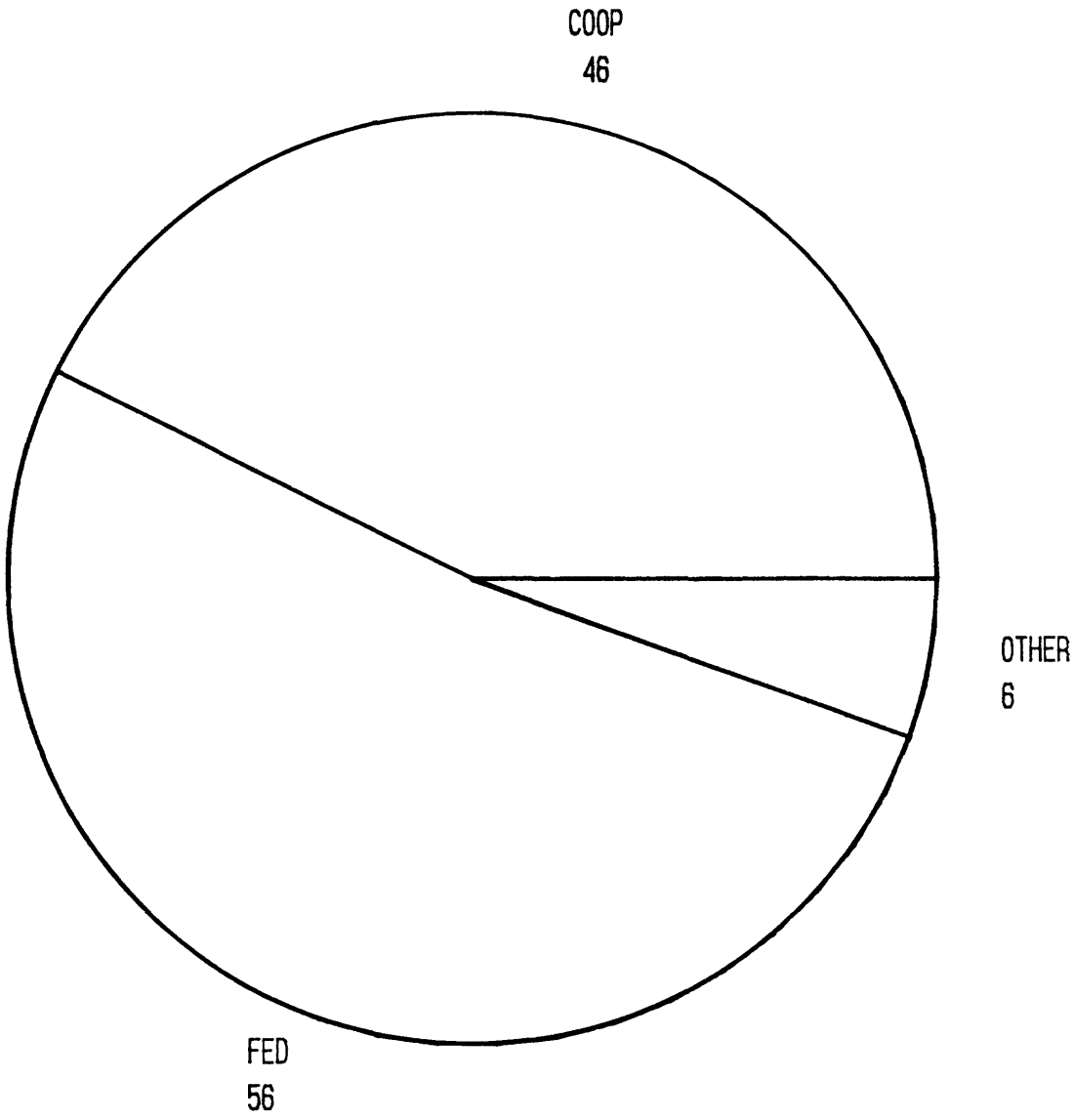
OFA = Other Federal Agencies

COOP = Federal-State Cooperative Program

COMBINED PROGRAM SUPPORT

FED-COOP = Federal and Federal-State Cooperative Program

Figure 27.--Number of precipitation-quantity stations and the source of funding support, fiscal year 1985.



TOTAL STATIONS = 108

EXPLANATION:

SINGLE PROGRAM SUPPORT

FED = Federal

COOP = Federal-State Cooperative Program

Figure 28.--Number of precipitation-quality stations and the source of funding support, fiscal year 1985.

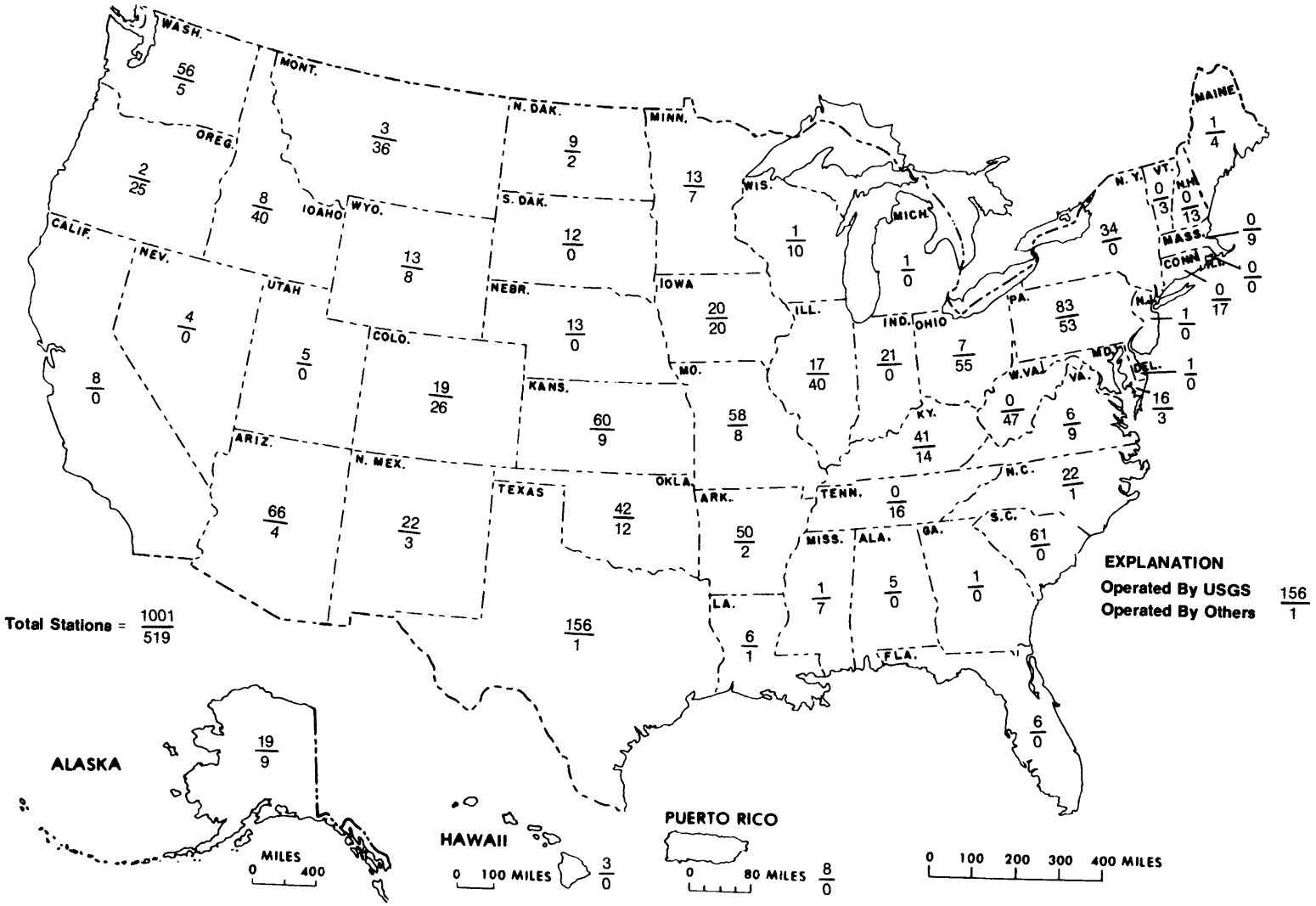


Figure 29.---Number of U.S. Geological Survey stations, by State, at which data-collection platforms for satellite telemetry were operated in fiscal year 1985.

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