OPERATION OF HYDROLOGIC DATA COLLECTION STATIONS BY THE U.S. GEOLOGICAL SURVEY IN 1987

By Alberto Condes de la Torre

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ABSTRACT

The U.S. Geological Survey operates hydrologic data-collection stations nationwide which serve the needs of all levels of government, the private sector, and the general public, for water-resources information. During fiscal year 1987, surface-water discharge was determined at 10,624 stations; stage data on streams, reservoirs, and lakes were recorded at 1,806 stations; and various surface-water quality characteristics were determined at 2,901 stations. In addition, ground-water levels were measured at 32,588 stations, and the quality of ground water was determined at 9,120 stations. Data on sediment were collected daily at 174 stations and on a periodic basis at 878 stations. Information on precipitation quantity was collected at 909 stations, and the quality of precipitation was analyzed at 78 stations. Data-collection platforms for satellite telemetry of hydrologic information were used at 2,292 Geological Survey stations. Funding for the hydrologic stations was derived, either solely or from a combination, from three major sources--the Geological Survey's Federal Program appropriation, the Federal-State Cooperative Program, and reimbursements from other Federal agencies.

The number of hydrologic stations operated by the Geological Survey declined from fiscal year 1983 to 1987. The number of surface-water discharge stations was reduced by 452 stations; surface-water quality stations declined by 925 stations; ground-water level stations declined by 1,051 stations; while ground-water quality stations increased by 1,472 stations.

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 the quality of 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) 1987. Similar reports on hydrologic stations were prepared previously for FY 1983 (Condes de la Torre, 1983), and FY 1985 (Condes de la Torre, 1985). An analysis is provided of the number of hydrologic stations operated from FY 1983 to FY 1987. 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 (table 1).

For the purpose of this report, "project" refers to a hydrologic investigation conducted by the 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.

HYDROLOGIC DATA COLLECTION STATIONS

Surface Water Data

Surface-water discharge (flow) was determined by the U.S. Geological Survey at 10,624 stations in FY 1987. At 7,000 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 3,624 other streamflow stations, partial records were collected. For example, at a station where the sole interest is 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 605 in California to 13 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 3,158 stations (figure 2), and in combination with other sources, provided support for 1,640 more (table 1). The Federal-State Cooperative Program also funded the largest number of partial record-discharge stations; it provides sole support of 2,880 stations (figure 3), and in combination with other sources, 281 more.

The number of continuous record surface-water discharge stations decreased from 7,152 stations in FY 1983 to 7,000 stations in FY 1987 (figure 4). During the same period, the total number of surface-water discharge stations decreased by 452, to 10,624 stations in FY 1987. The change reflects decreases in some States and increases in others. In Virginia, for example, 215 partial record stations were discontinued between

Table 1.--*Types and number of hydrologic data collection stations operated by the U.S. Geological Survey during the 1987 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	481	3,158	1,575	1,130	146	472	38	7,000
Partial record	99	2,880	273	268	91	12	1	3,624
Stage Only - Streams								
Continuous record	13	86	245	93	3	8	0	448
Partial record	1	166	28	33	0	1	0	229
Stage Only - Lakes and Reservoirs								
Continuous record	12	274	277	210	1	4	1	779
Partial record	11	177	75	87	0	0	0	350
Quality								
Continuous record	66	243	217	62	9	2	0	599
Scheduled, long-term operation	389	1,109	330	312	24	19	2	2,185
Short-term or project stations	26	512	116	47	15	0	0	716
GROUND WATER								
Water Levels								
Continuous record	90	1,413	200	656	14	0	0	2,373
Scheduled, long-term operation	656	17,089	1,098	3,791	0	0	0	22,634
Short-term or project stations	1,157	4,202	1,061	3,219	315	0	0	9,954
Quality								
Scheduled, long-term operation	49	3,053	158	640	0	0	0	3,900
Short-term or project stations	560	3,475	730	429	26	0	0	5,220
SEDIMENT								
Daily Sampling	29	65	72	5	1	2	0	174
Periodic Sampling	460	225	161	17	10	5	0	878
PRECIPITATION								
Quantity	45	460	319	79	6	0	0	909
Quality	32	32	8	3	3	0	0	78

FY 1985 and FY 1987 when a multiyear program to develop state-wide low flow regression equations reached the end of the data collection stage. In Louisiana, 102 partial record stations were discontinued after an analysis showed that, with the data presently available, regression equations could define flood flows well enough to meet existing needs.

Stage-only data were collected by the Geological Survey at 677 stream stations. The number of stage-only data stations on streams ranged from 88 in Florida to none in several States (figure 5). The reimbursement from other Federal agencies supported the largest number of continuous stage-only stations--245 (figure 6)--while the Federal-State Cooperative Program supported the most partial record stage-only stations--166 (figure 7). The number of continuous record stations collecting stage-only data on streams increased slightly from 1983 to 1987 (figure 8), whereas the number of partial record stations decreased as studies using the data were completed in New Mexico and Louisiana.

Stage data were also collected at 1,129 stations on lakes and reservoirs by the Geological Survey. Continuous records of stage were collected at 779 lake and reservoir stations, ranging from 92 in Florida to none in several States (figure 9). Reimbursements from other Federal agencies and the Federal-State Cooperative Program supported the largest number of both continuous (figure 10) and partial record (figure 11) stage stations on lakes and reservoirs. The number of stage stations on lakes and reservoirs decreased from 1,246 in FY 1983 to 1,129 in FY 1987 (figure 12).

Stream samples were collected and analyzed for water-quality characteristics at stations across the Nation (figure 13). 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, flouride, 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 599 of these sites (figure 14), mainly for water temperature and conductance, but other parameters such as dissolved oxygen and pH were also recorded continuously at times.

There are 2,185 stream sites at which water-quality data were collected as part of a scheduled, long-term operation (figure 15). These include 411 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 716 stations which were sampled as short term or project stations (figure 16). The collection of surface-water quality data received its largest funding support from the Federal-State Cooperative Program for all types of stations.

The number of stations at which surface-water quality data were collected on a scheduled, long-term basis increased in some States, but the overall total declined from 2,906 in 1983 to 2,185 in 1987 (figure 17). The number of short-term or project stations also declined. In Wyoming, for example, the number of sampling stations was reduced when the emphasis changed from analyses for major dissolved constituents to more expensive analyses for pesticides and herbicides. Thus, in order to accomodate to a static level of available funds, the number of sampling stations had to be decreased. In Florida and Alabama, surface-water quality work was reduced as a result of decreased funding from other Federal and local agencies.

Ground Water Data

Ground water is one of the most widely available of the Nation's natural resources. It is estimated that 73 billion gallons per day of ground water are withdrawn in the United States for public supply, domestic, commercial, irrigation, livestock, industrial, mining, and thermo-electric uses (Wayne B. Solley, U.S. Geological Survey, written commun., 1987). 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 32,588 sites in 1987 (figure 18). Data on water levels were collected continuously at 2,373 sites, of which 1,413 were funded by the Federal-State Cooperative Program (figure 19).

Ground-water levels were collected at 22,634 stations as part of a scheduled, long-term operation to assess long-term trends (figure 20). 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 1987, water-level data were collected at 9,954 stations for these investigations (figure 21). The Federal-State Cooperative Program provided total funding support for 42 percent of these stations.

From fiscal year 1983 to 1987, the number of scheduled, long-term operation ground-water level stations decreased from 24,047 in 1983 to 22,634 in 1987 (figure 22). Meanwhile, the short-term or project stations increased from 9,592 in 1983 to 9,954 in 1987.

In 1987, samples of ground water at 9,120 stations were analyzed (figure 23). To maintain information on the changes in quality of critical ground-water bodies, samples were collected at 3,900 stations as part of a scheduled, long-term operation (figure 24). Of these, sampling at 3,053 stations was funded by the Federal-State Cooperative Program. Ground-water quality data were also collected at 5,220 stations to provide information needed for short-term, generally site-specific studies (figure 25).

Across the country, the number of stations at which ground-water quality samples were collected increased from 7,648 in 1983 to 9,120 in 1987 (figure 26). There were increases in some States and decreases in others. In

Iowa, for example, a major ground-water investigation underway in cooperation with two Iowa State agencies, called for an increased number of ground-water quality stations. In New Jersey, studies of ground-water quality, in cooperation with the State of New Jersey, required additional stations. 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 Data

Data are needed to evaluate the effect of sediment deposition on reservoir storage; the influence of infrequent large 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 field techniques to collect suspended sediment are being tested to determine whether or not they produce a representative sample of sediment for chemical analysis. These techniques will be of use in determining the 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 help address the problems and issues of sediment in rivers, the Geological Survey collected daily sediment data at 174 stations and periodic data at 878 other stations (figure 27). This represents a reduction of 38 and 149 stations, respectively, from 1985 to 1987. Reimbursements from other Federal agencies provided support for 41 percent of the daily sampling stations (figure 28), and the Federal program provided support for 52 percent of the periodic sampling stations (figure 29).

Precipitation Data

Collection of precipitation data by the 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 in Geological Survey investigations. Precipitation data were collected at 909 sites nationwide (figure 30). At 78 of these sites, quality of precipitation was determined. The largest support for the collection of precipitation quantity (figure 31) and quality (figure 32) data came from the Federal-State Cooperative Program and the Federal Program, respectively.

Satellite Telemetry of Hydrologic Data

Satellite telemetry is playing an increasing 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 2,292 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 (figure 33). There were 1,720 stations at which data-collection platforms were operated by the U.S. Geological Survey and 572 U.S. Geological Stations at which the data-collection platforms were operated by others. About two-thirds of the funding for the operaton of the data-collection platforms is provided by other Federal agencies (figure 34).

SUMMARY

The U.S. Geological Survey operates an extensive network nationwide for the collection of hydrologic data. The surface-water data include information on discharge and stage of streams, stages 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. The number of hydrologic stations operated by the Geological Survey declined from fiscal year 1983 to 1987. The number of surface-water discharge stations was reduced; surface-water quality stations declined; ground-water level stations declined, while ground-water quality stations increased.

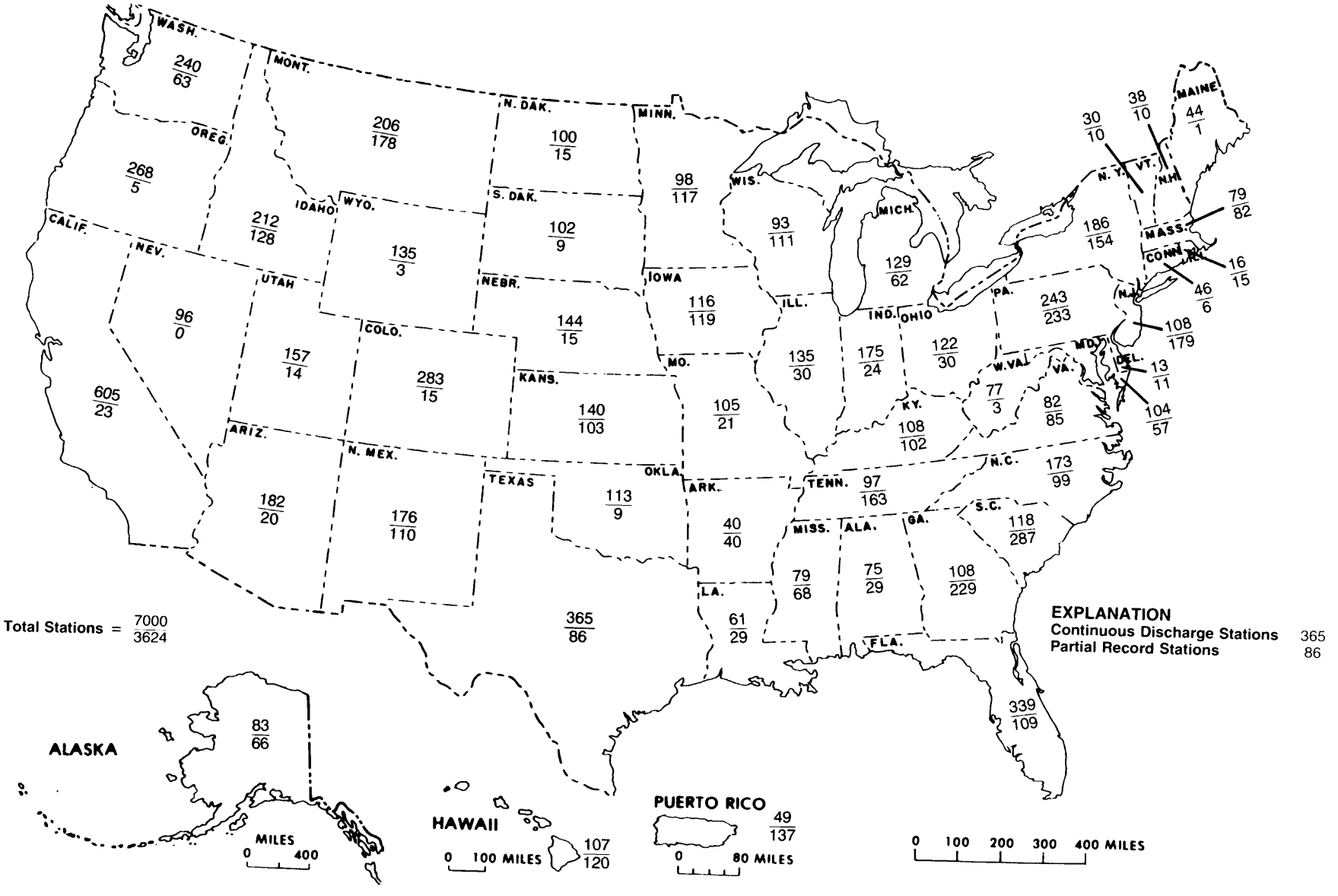
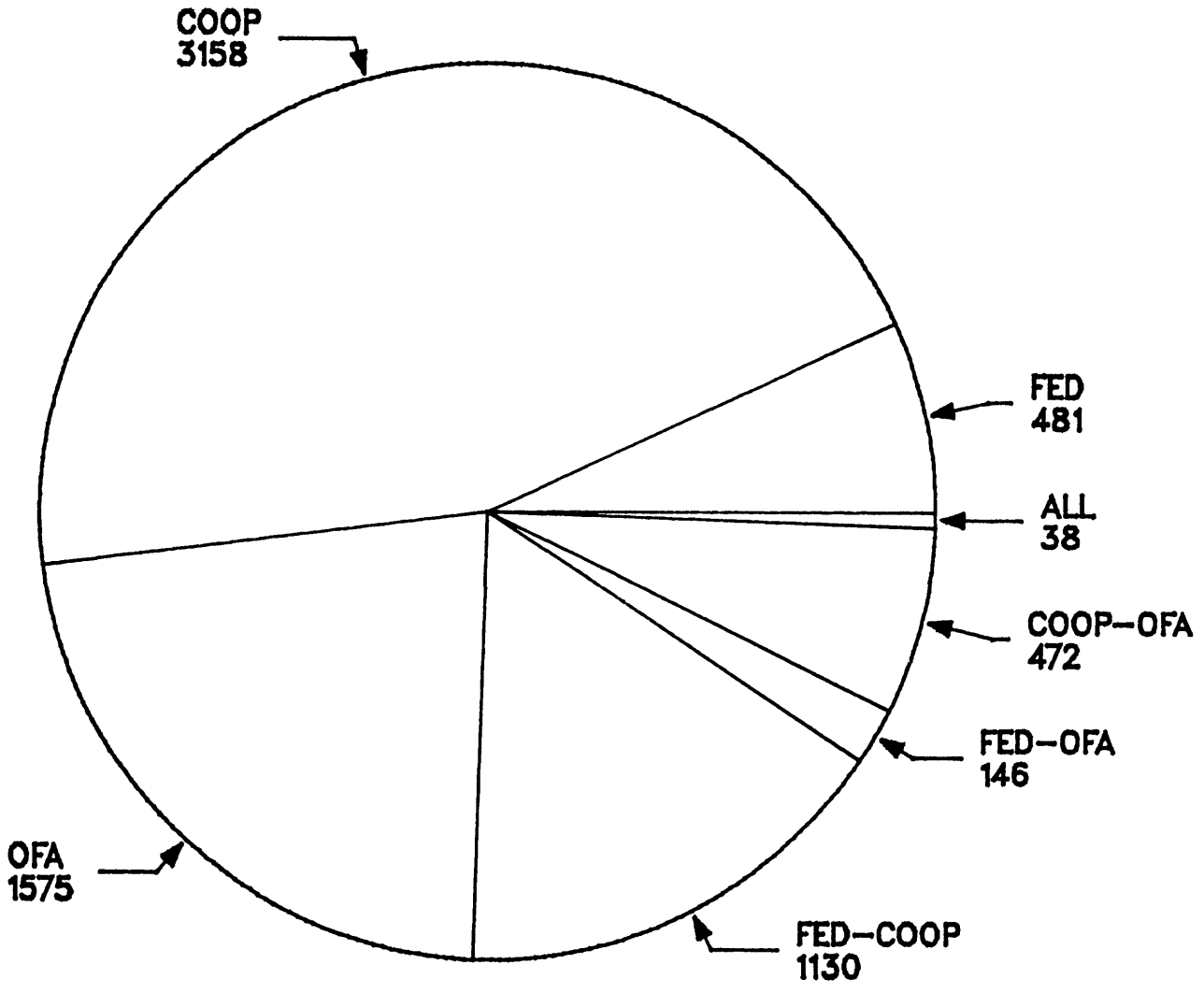


Figure 1.--Number of stations, by State, at which surface-water discharge data were collected in fiscal year 1987.



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
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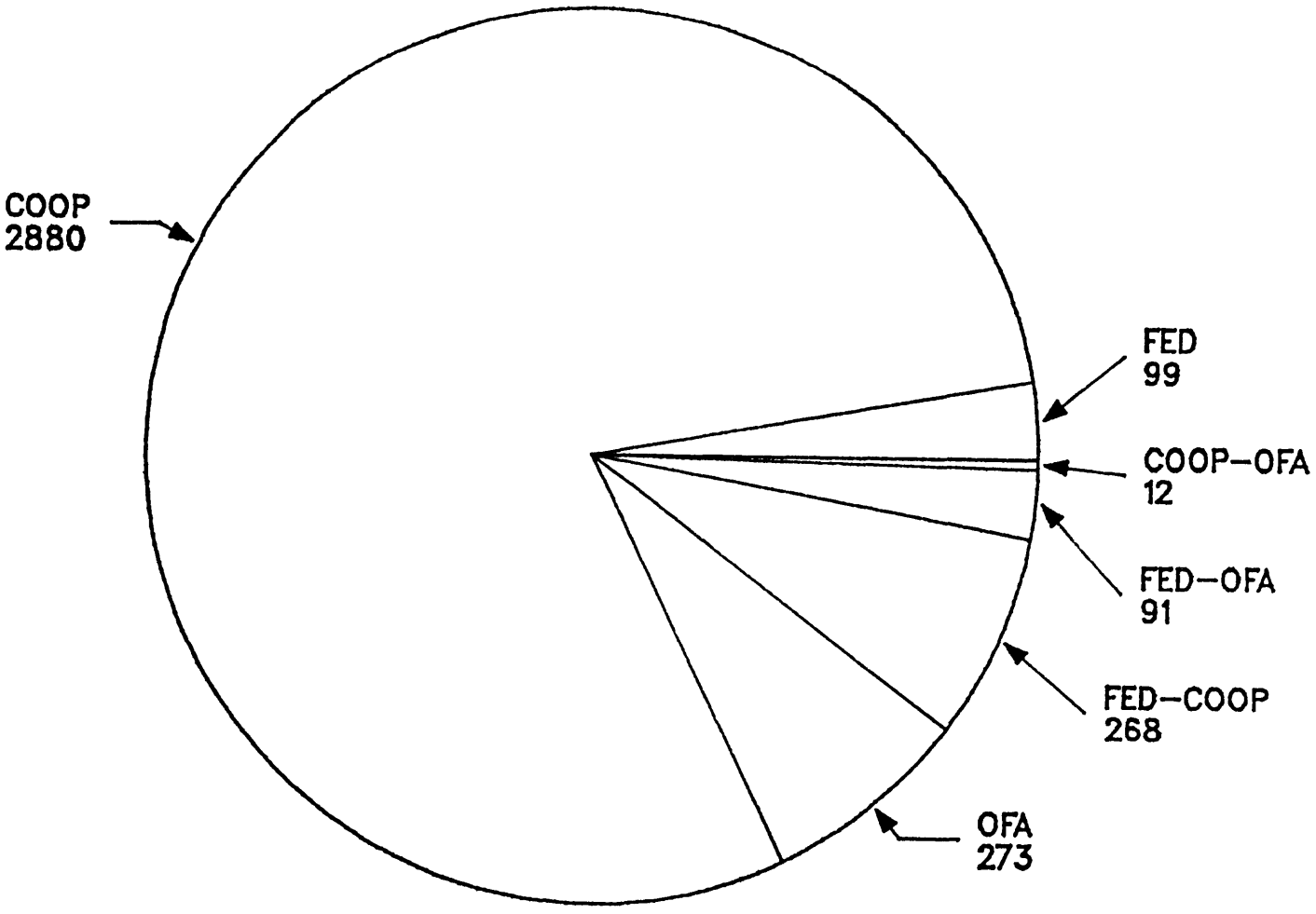
TOTAL STATIONS = 7,000

Figure 2.--Number of continuous surface-water discharge stations, and sources of funding support, fiscal year 1987.



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TOTAL STATIONS = 3,624

Figure 3.--Number of partial record surface-water discharge stations, and sources of funding support, fiscal year 1987.

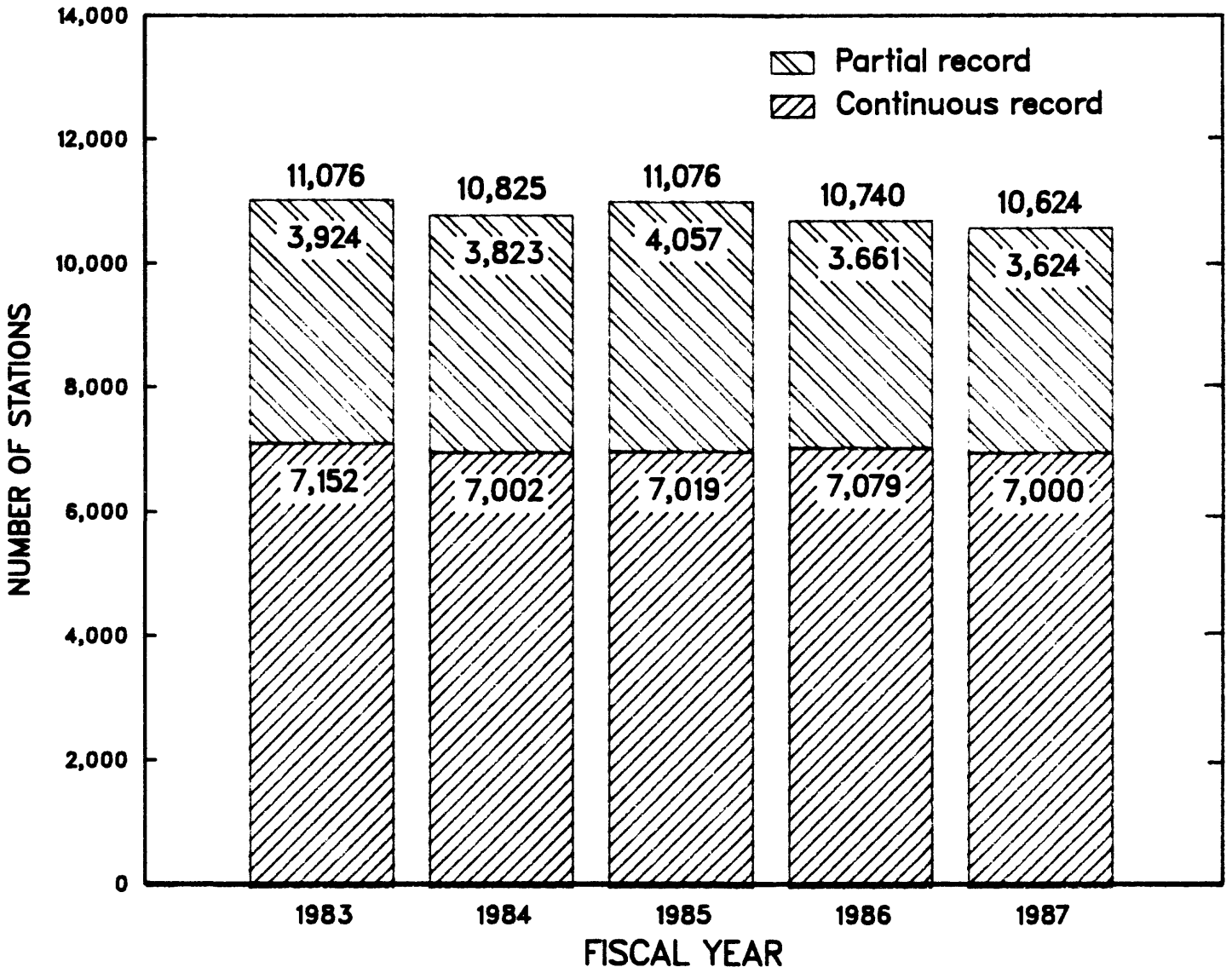


Figure 4.--Number of stations, by year, at which surface-water discharge data were collected from fiscal year 1983 to 1987.

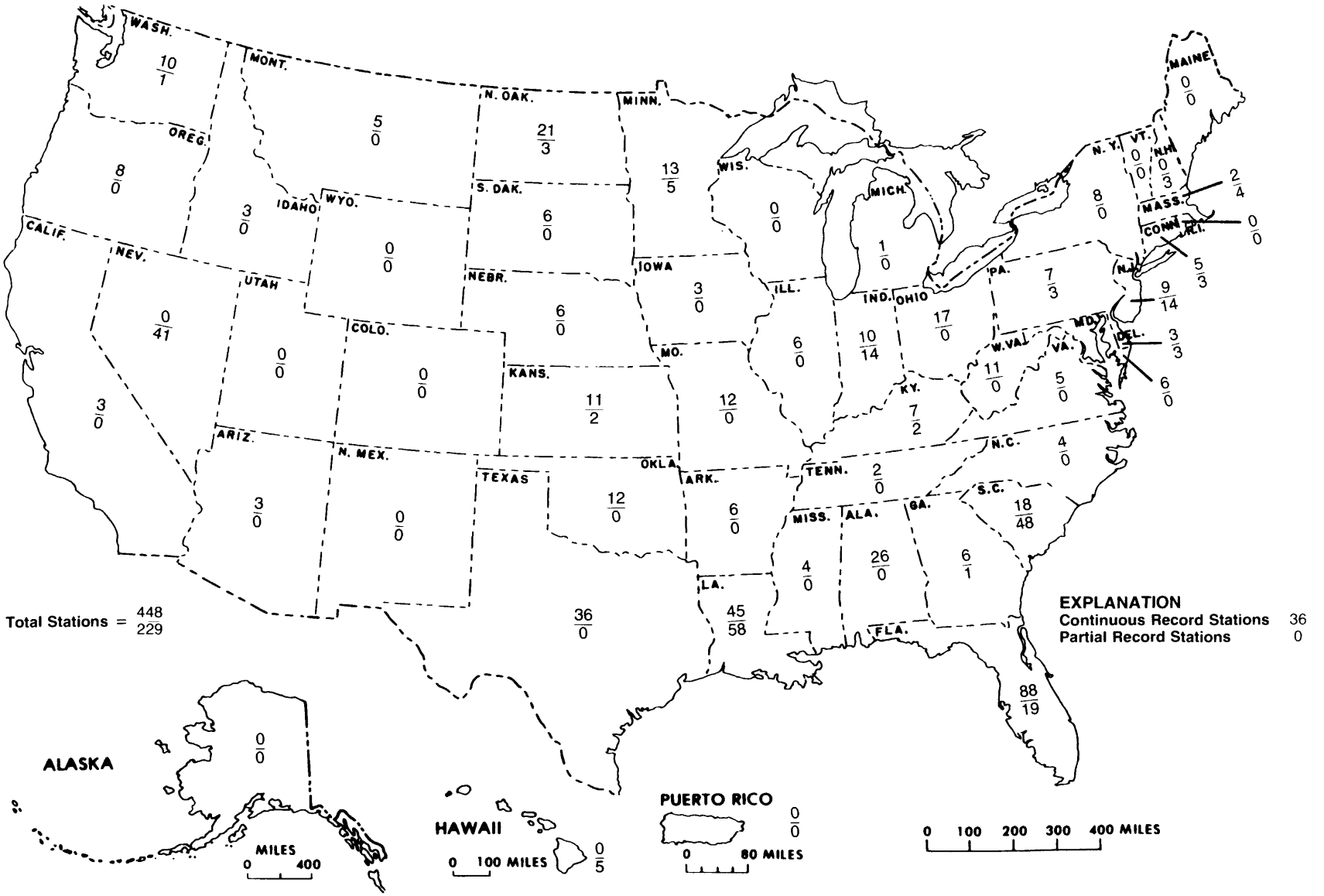
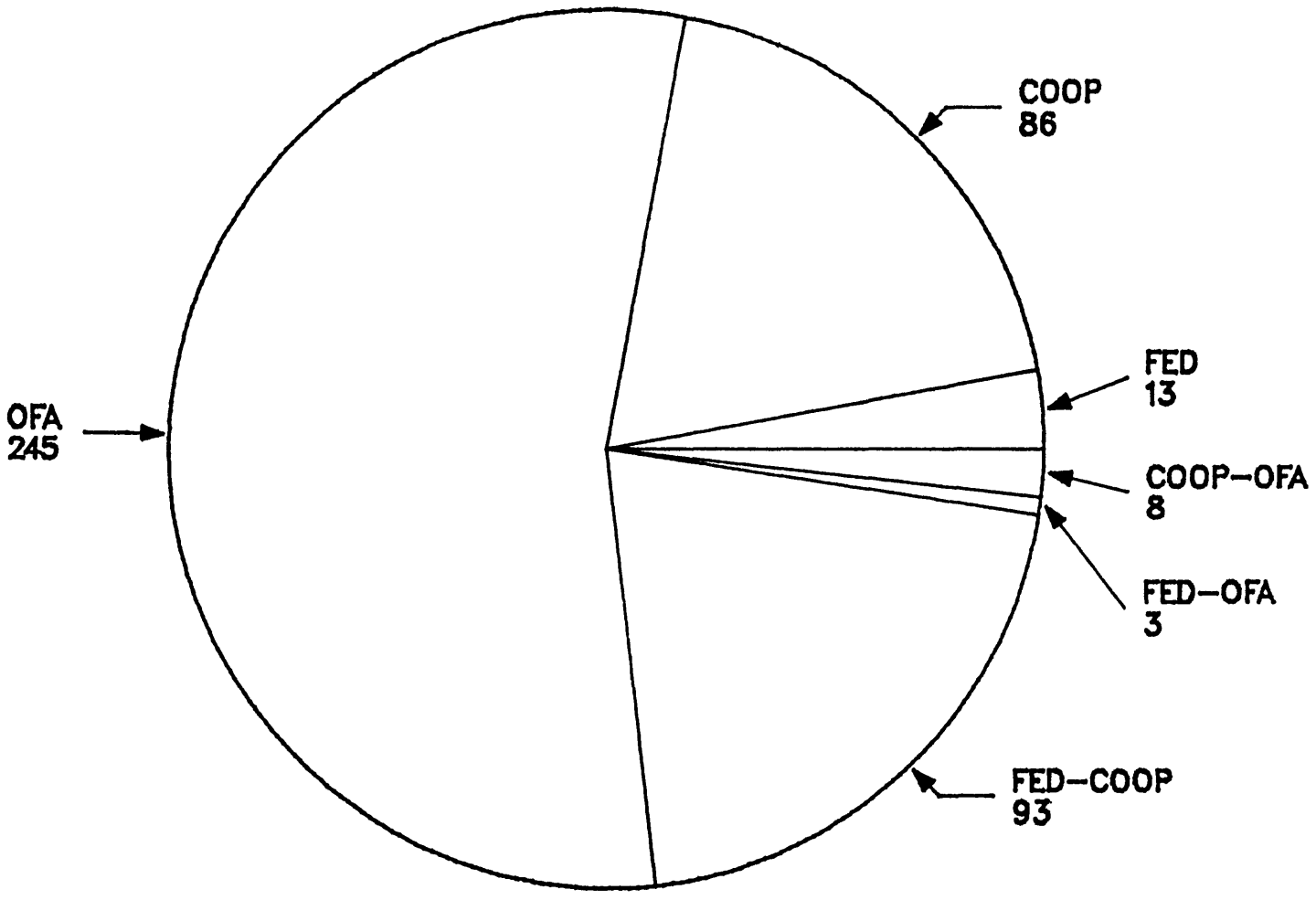


Figure 5.--Number of stations, by State, at which stage-only data were collected on streams in fiscal year 1987.



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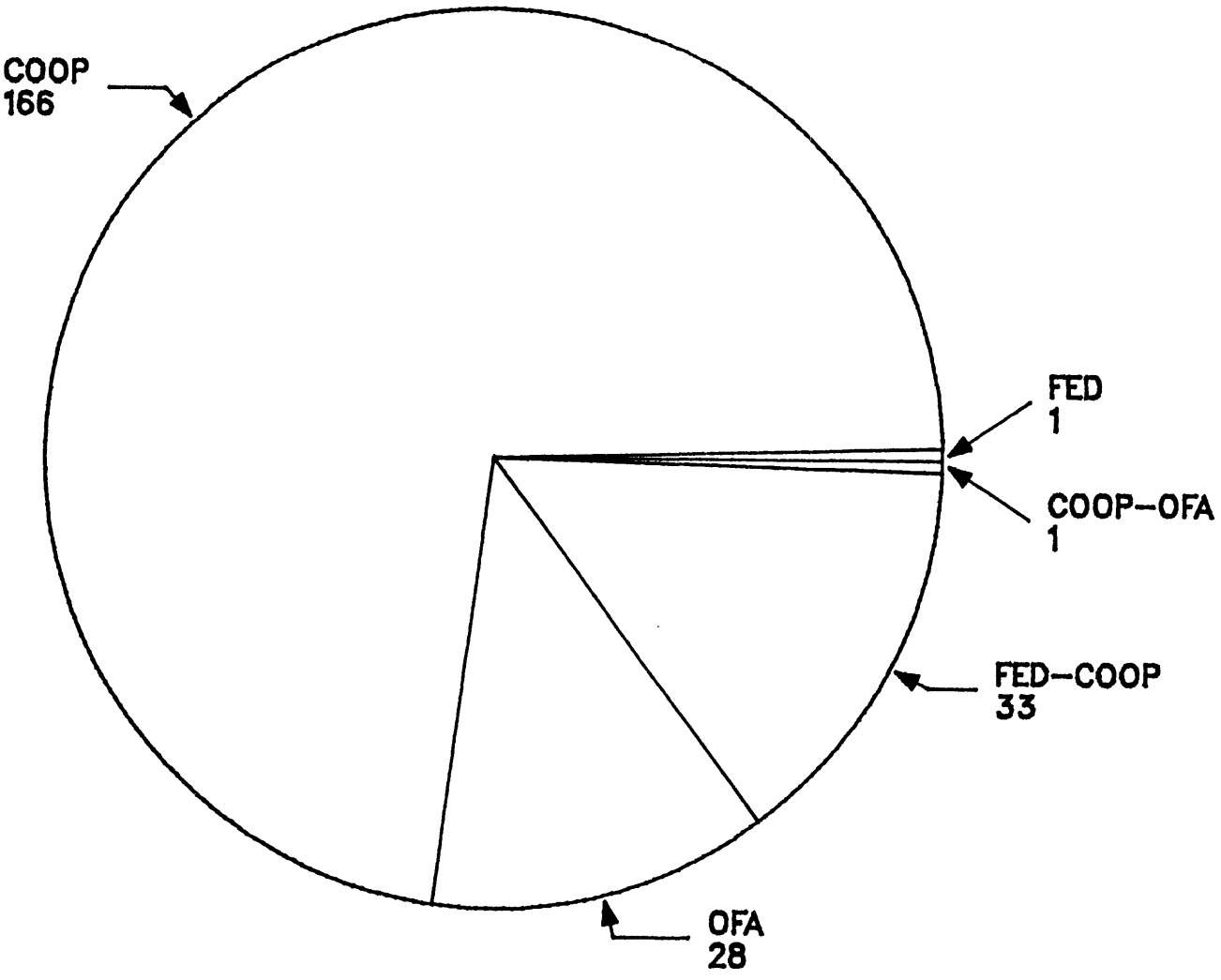
TOTAL STATIONS = 448

Figure 6.--Number of continuous surface-water stage-only stations on streams, and sources of funding support, fiscal year 1987.



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    Federal Agencies

TOTAL STATIONS = 229

Figure 7.--Number of partial record surface-water stage-only stations on streams, and sources of funding support, fiscal year 1987.

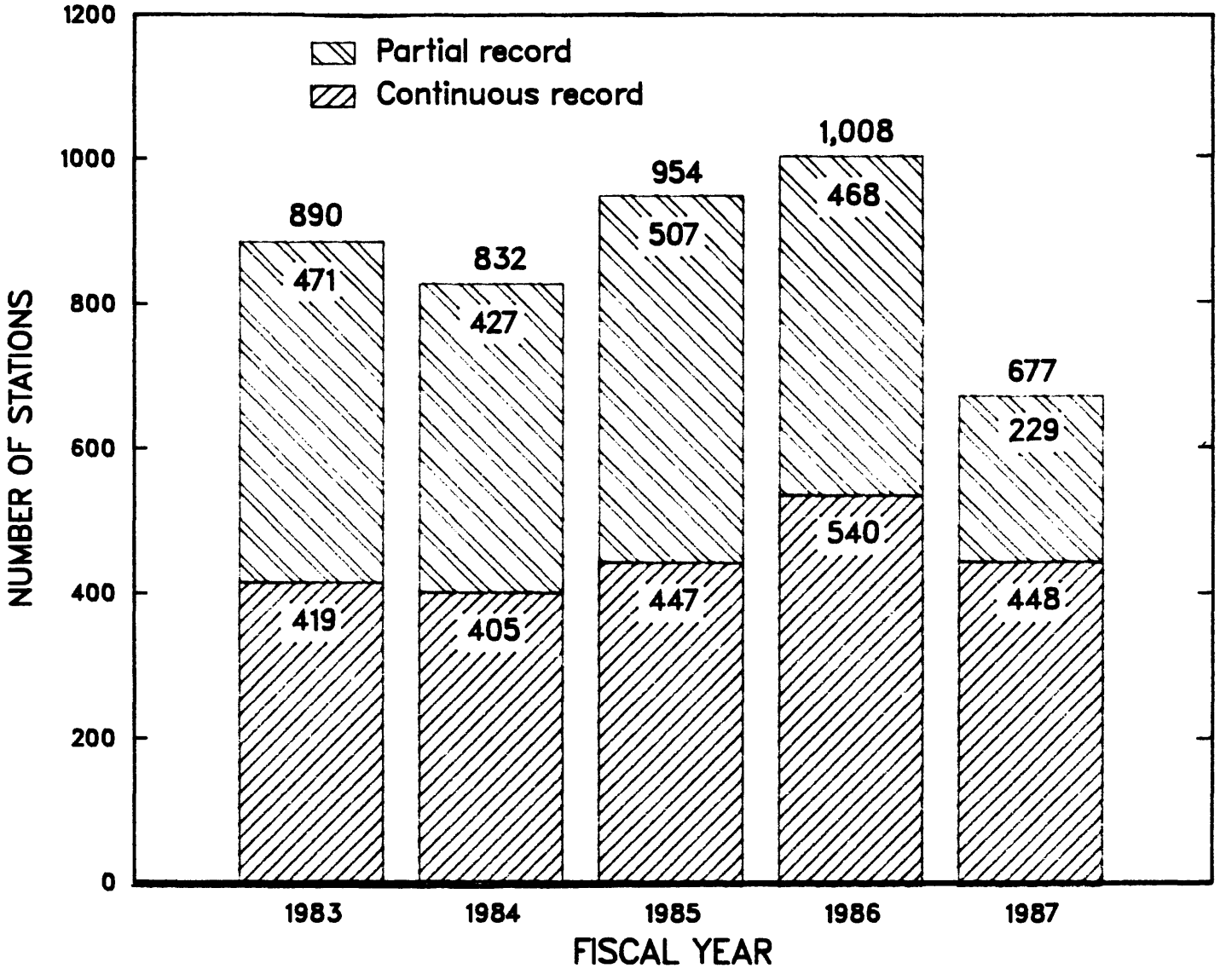


Figure 8.--Number of stations, by year, at which stage-only data were collected on streams from fiscal year 1983 to 1987.

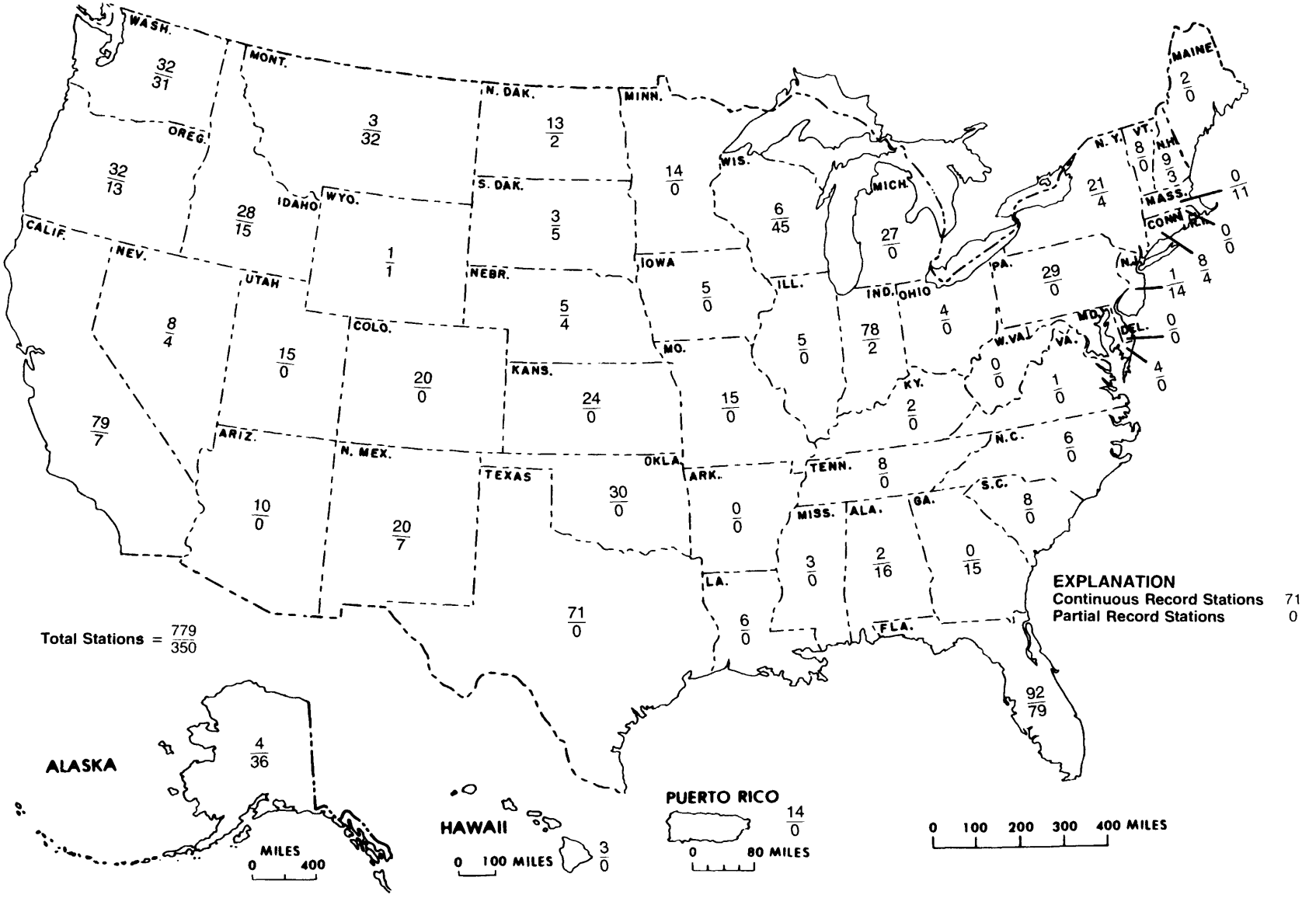
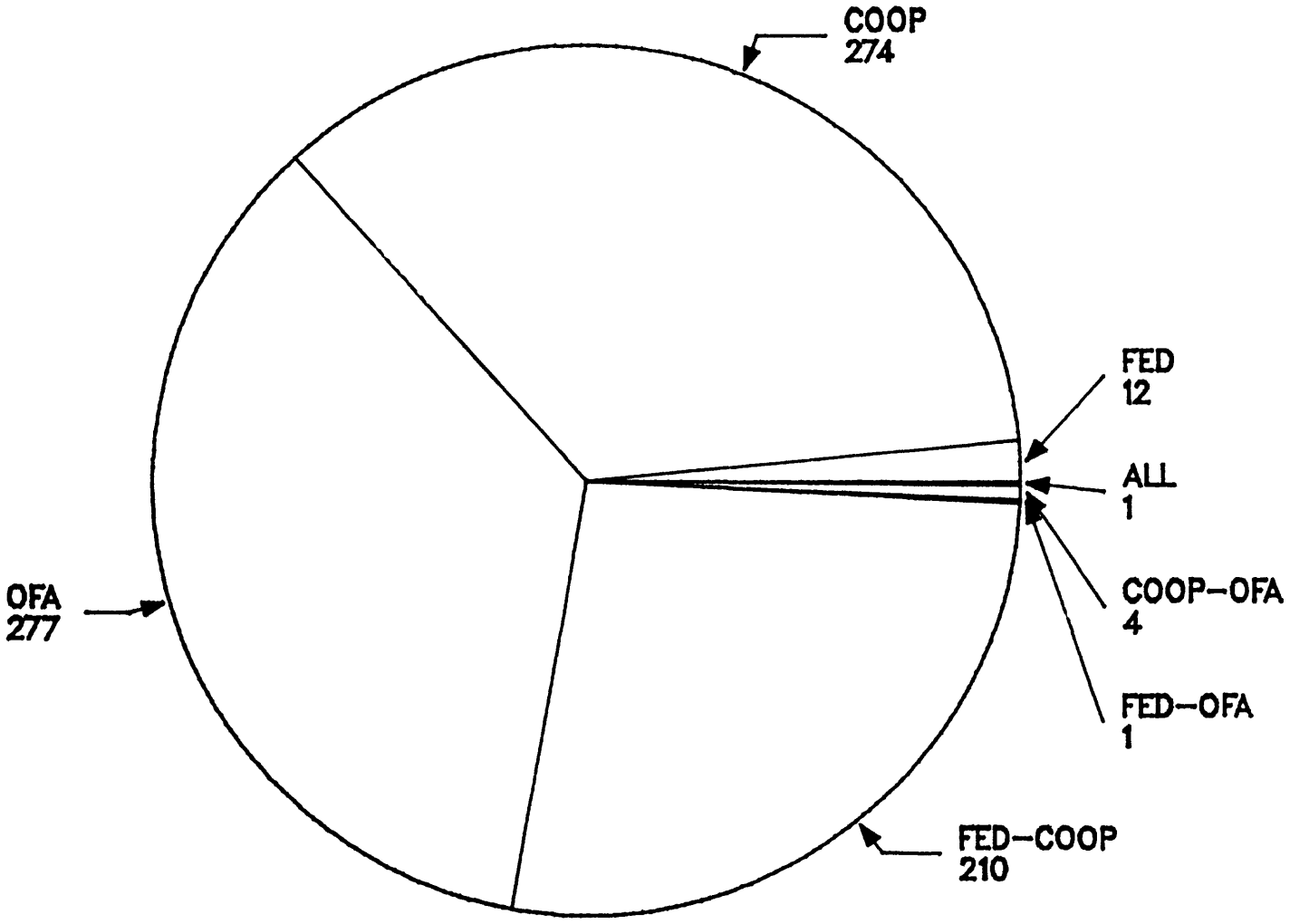


Figure 9.--Number of stations, by State, at which stage data were collected on lakes and reservoirs in fiscal year 1987.



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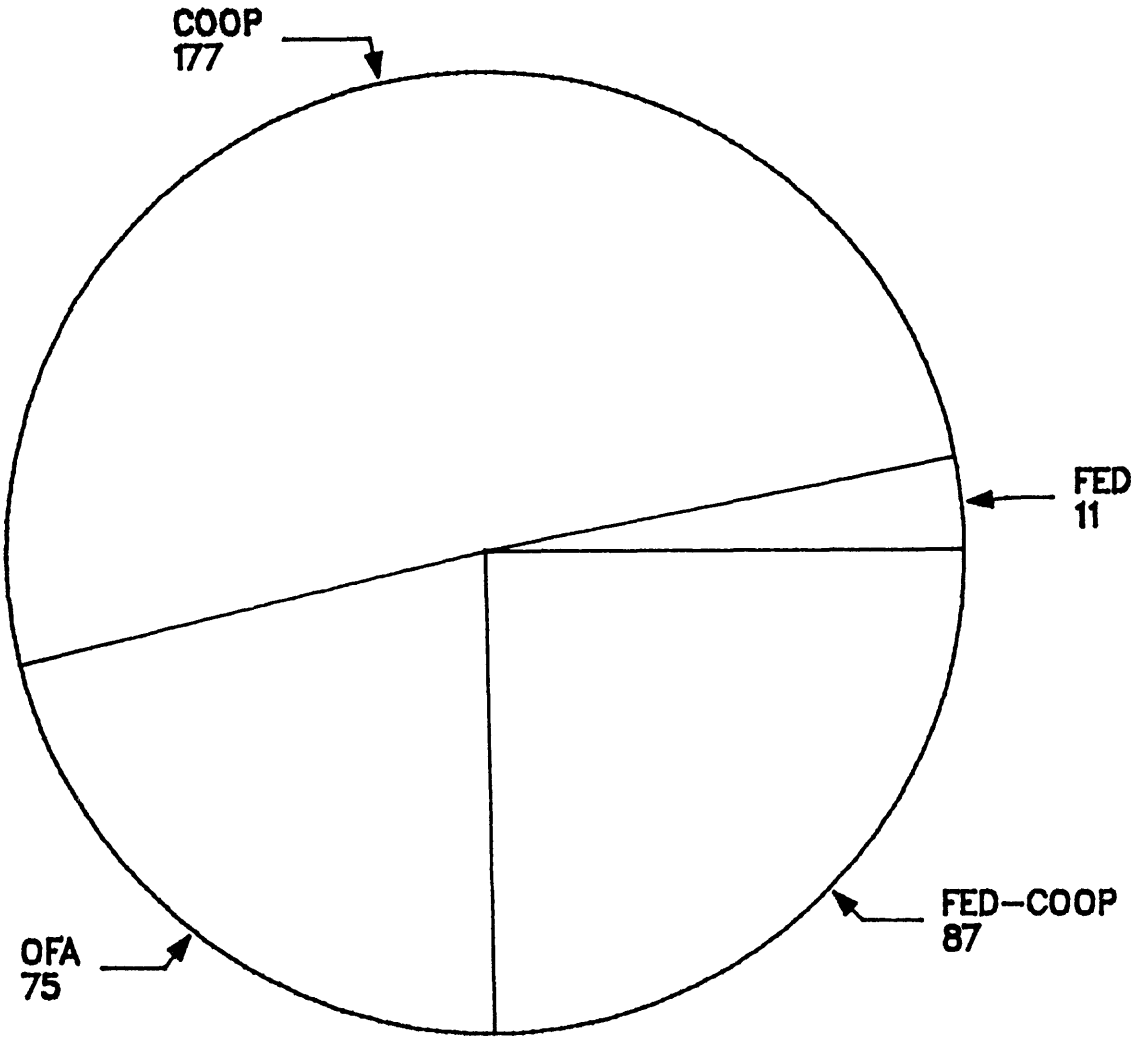
TOTAL STATIONS = 779

Figure 10.--Number of continuous surface-water stations on lakes and reservoirs, and sources of funding support, fiscal year 1987.



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TOTAL STATIONS = 350

Figure 11.--Number of partial record surface-water stage stations on lakes and reservoirs, and sources of funding support, fiscal year 1987.

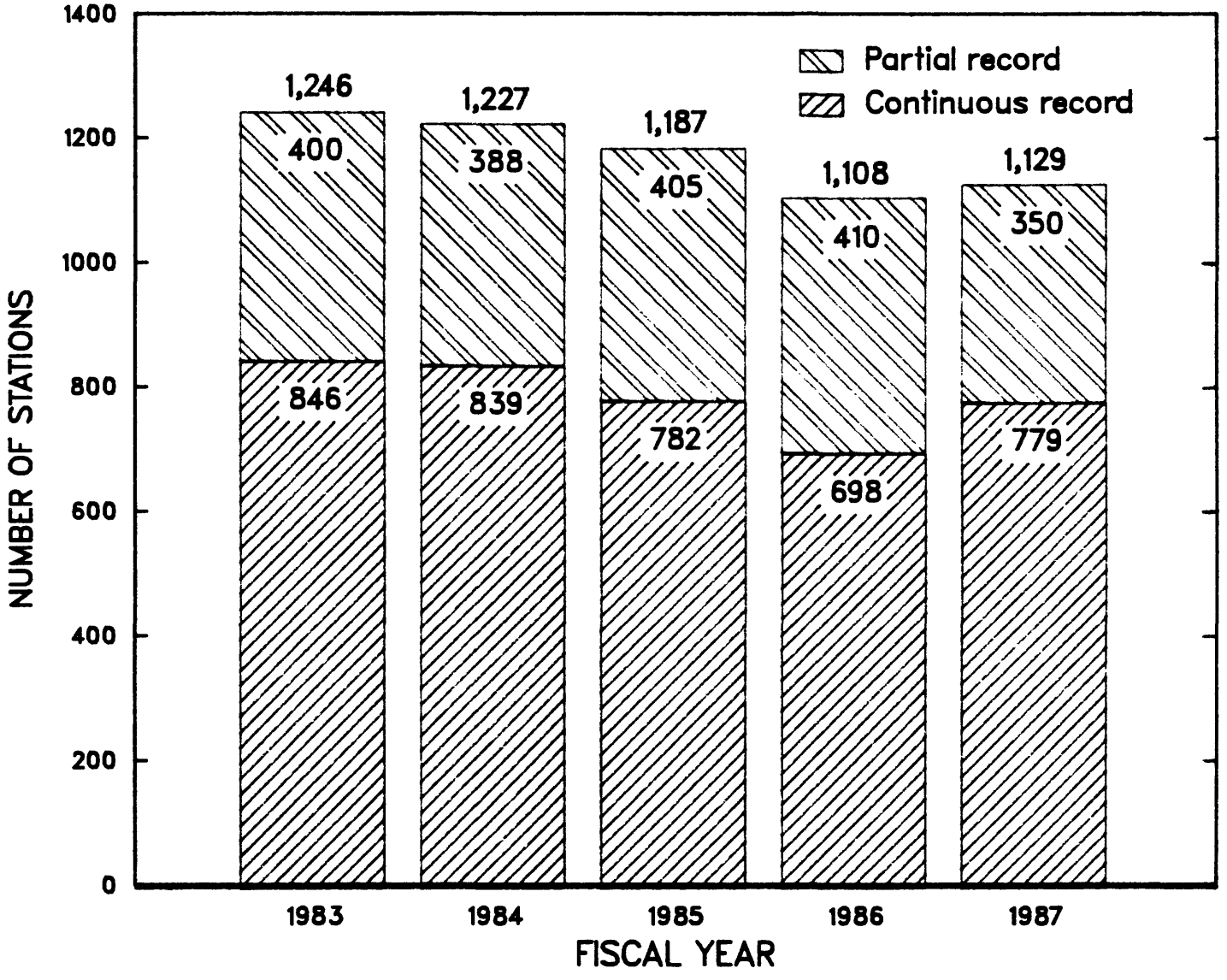


Figure 12.--Number of stations, by year, at which surface-water stage data were collected on lakes and reservoirs from fiscal year 1983 to 1987.

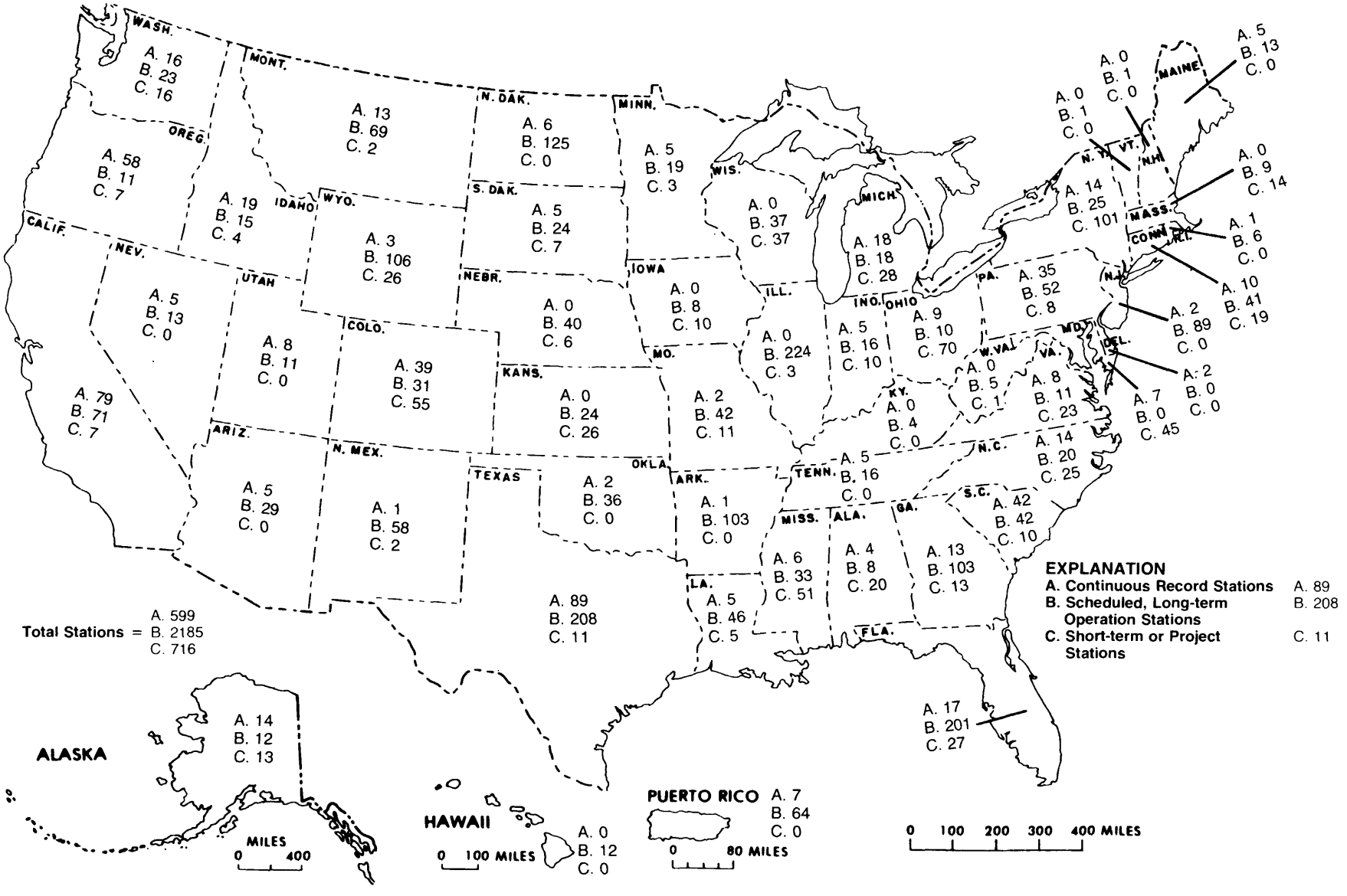
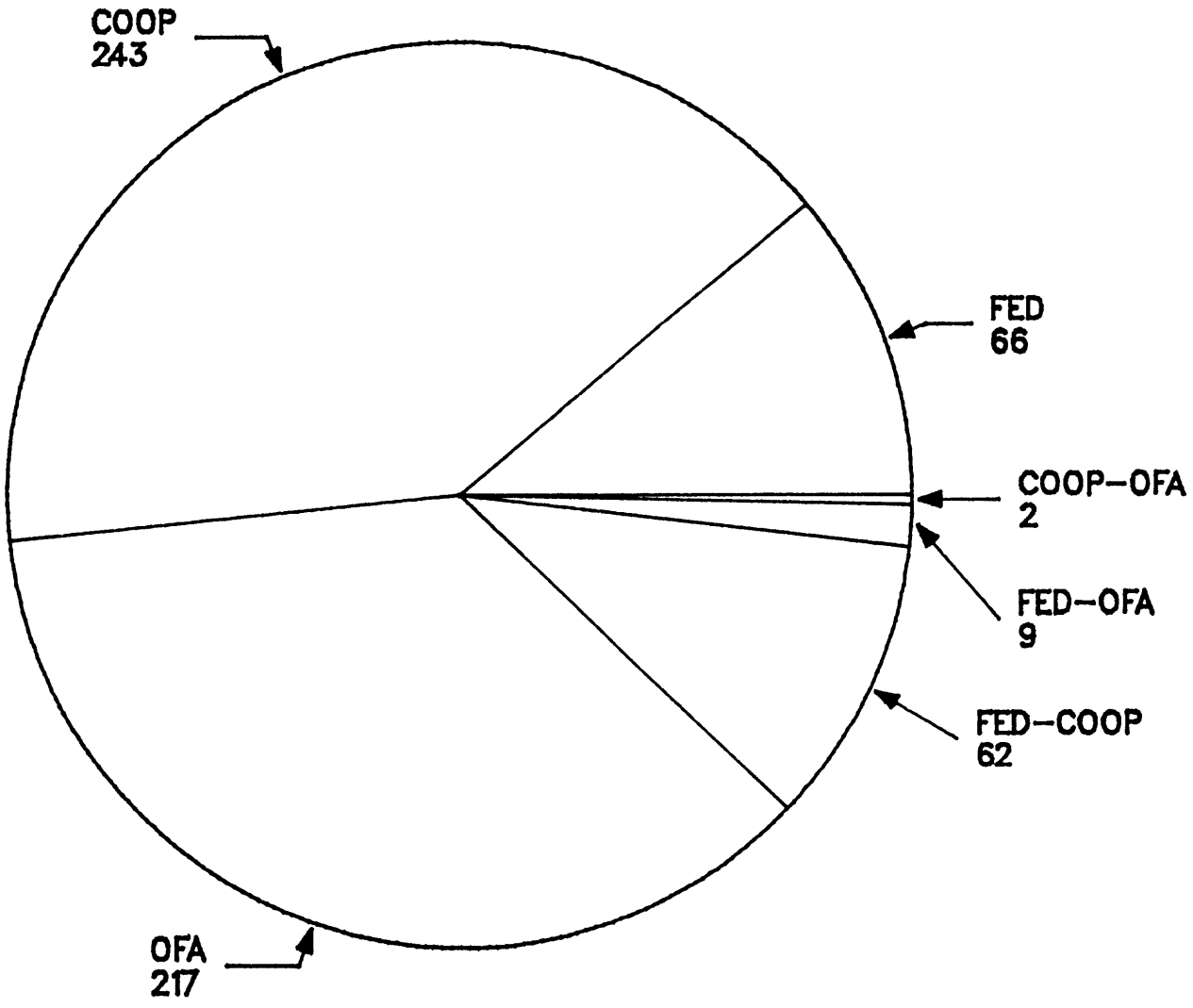


Figure 13.--Number of stations, by State, at which surface-water quality data were collected in fiscal year 1987.



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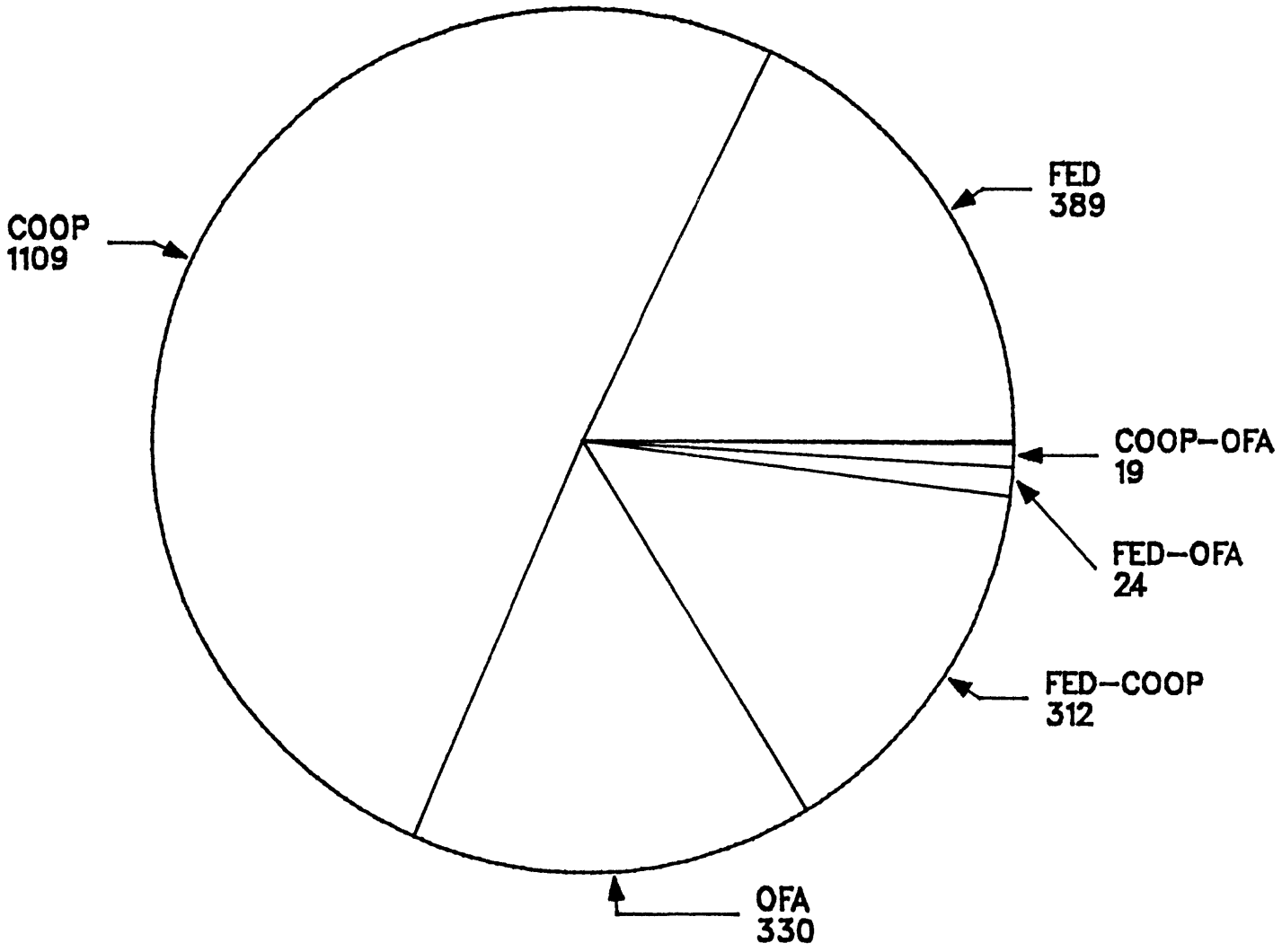
TOTAL STATIONS = 599

Figure 14.--Number of continuous surface-water quality stations, and sources of funding support, fiscal year 1987.



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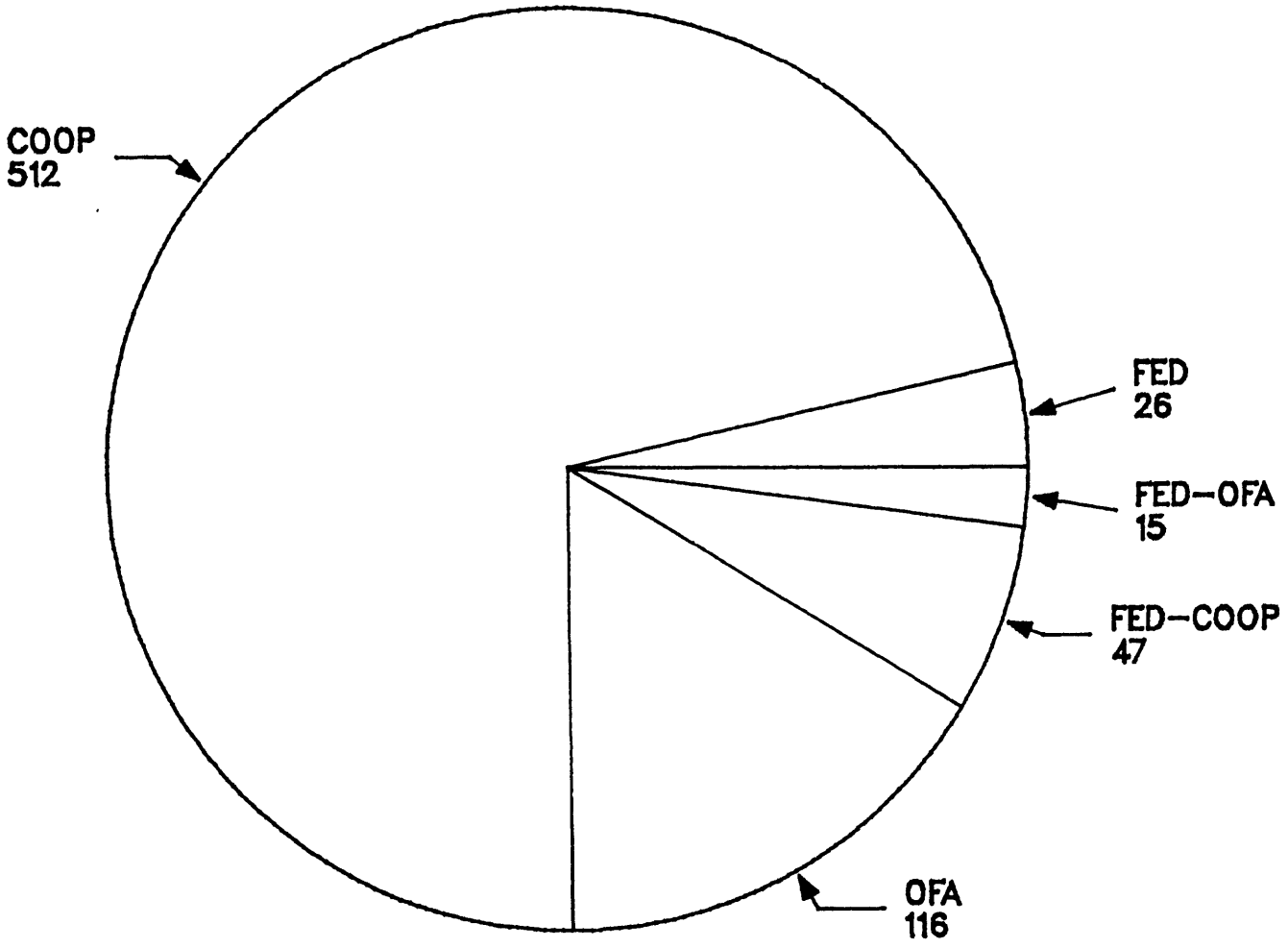
TOTAL STATIONS = 2,185

Figure 15.--Number of scheduled, long-term operation surface-water quality stations, and sources of funding support, fiscal year 1987.



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TOTAL STATIONS = 716

Figure 16.--Number of short-term or project surface-water quality stations, and sources of funding support, fiscal year 1987.

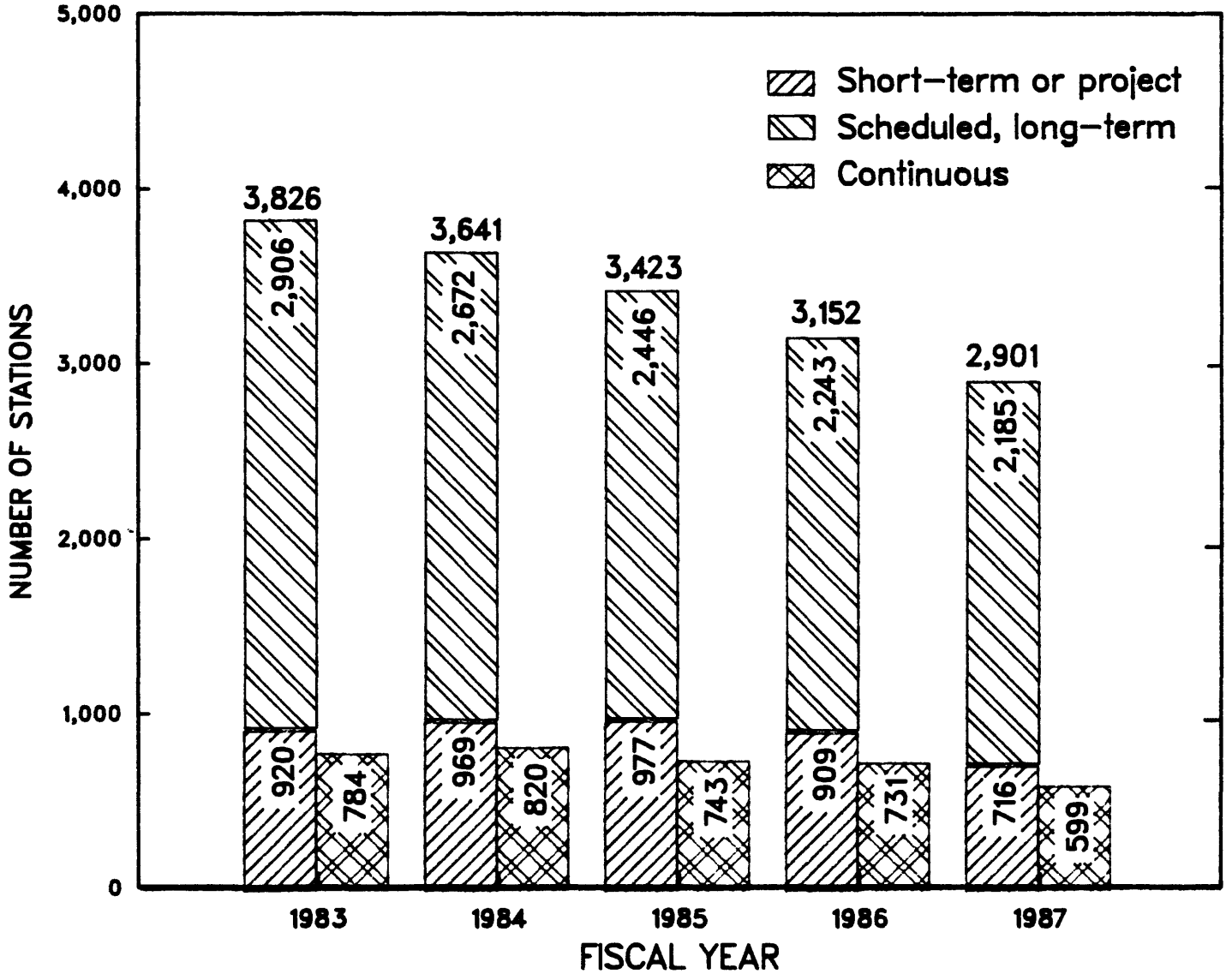


Figure 17.--Number of stations, by year, at which surface-water quality data were collected from fiscal year 1983 to 1987.

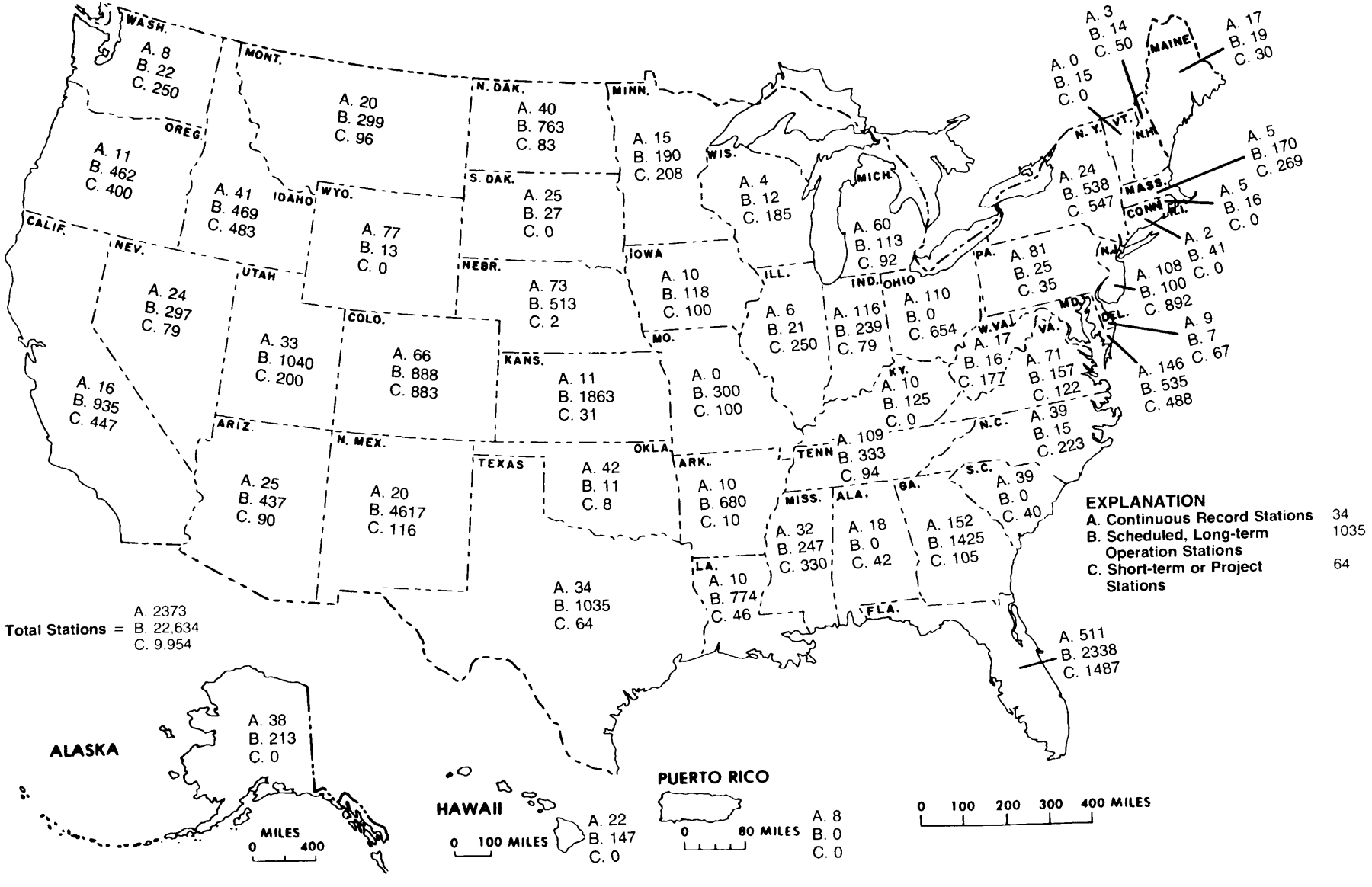
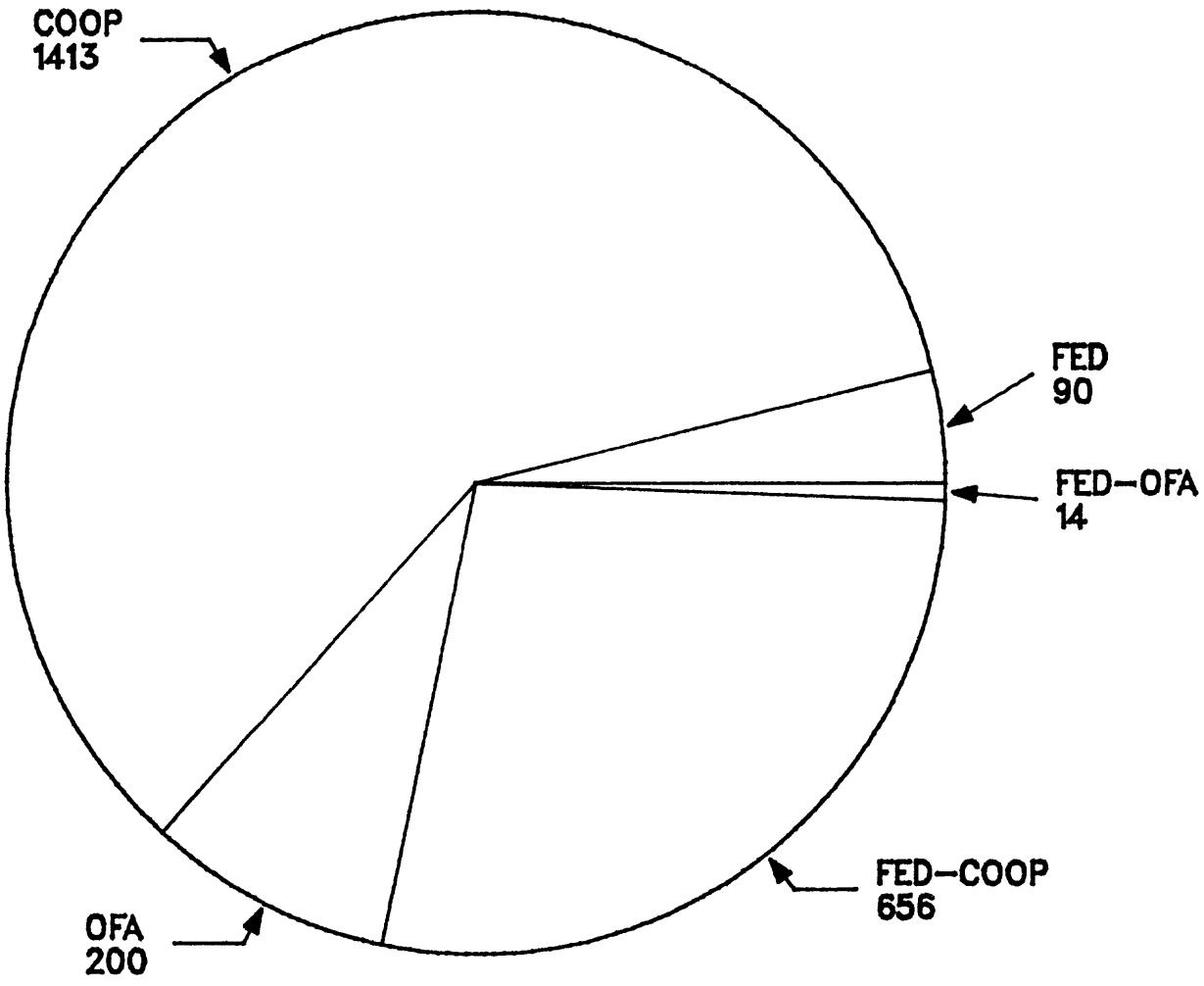


Figure 18.--Number of stations, by State, at which ground-water levels were collected in fiscal year 1987.



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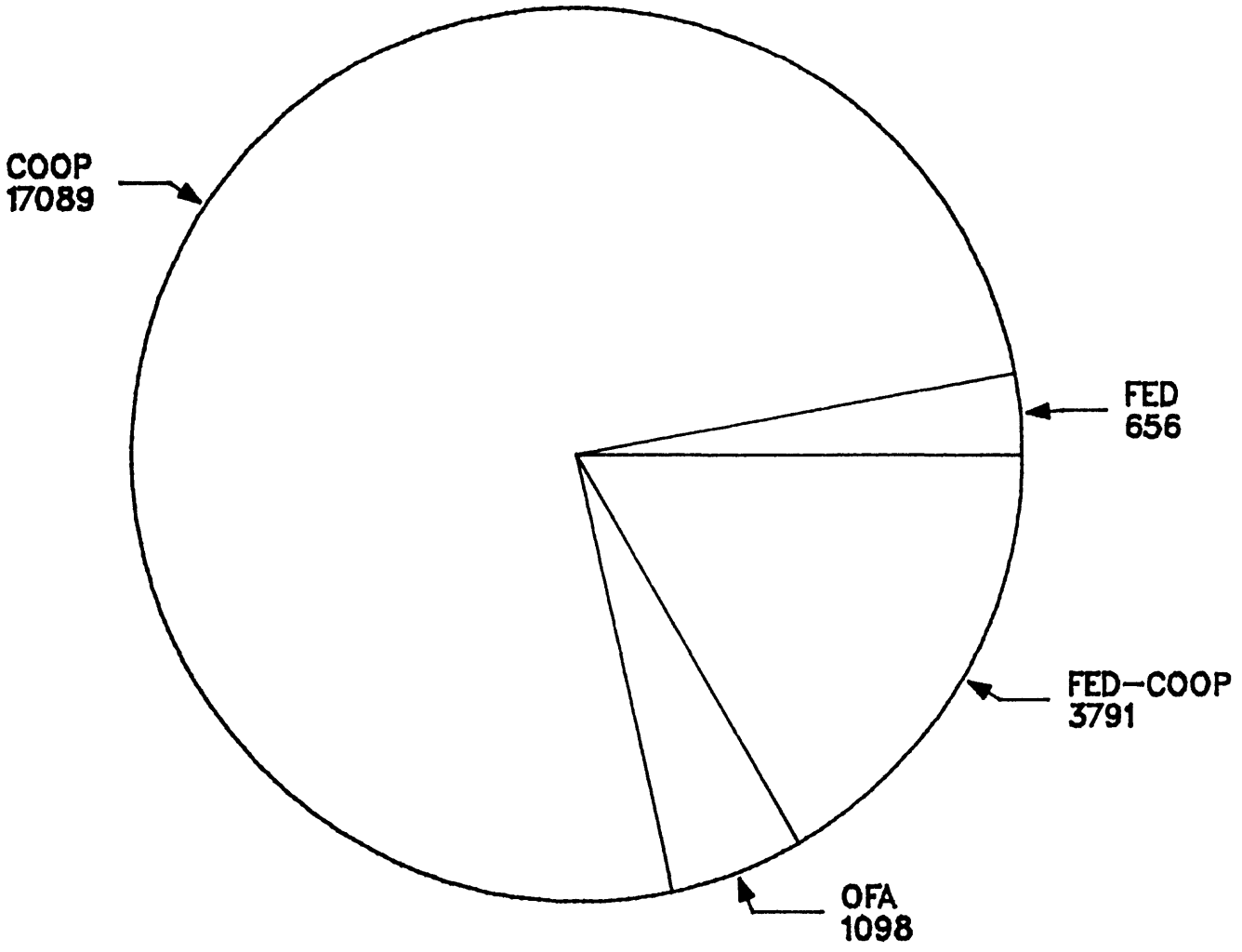
COMBINED PROGRAM SUPPORT
  FED-COOP = Federal and Federal-State Cooperative Program
  FED-OFA = Federal and Other Federal Agencies

TOTAL STATIONS = 2,373

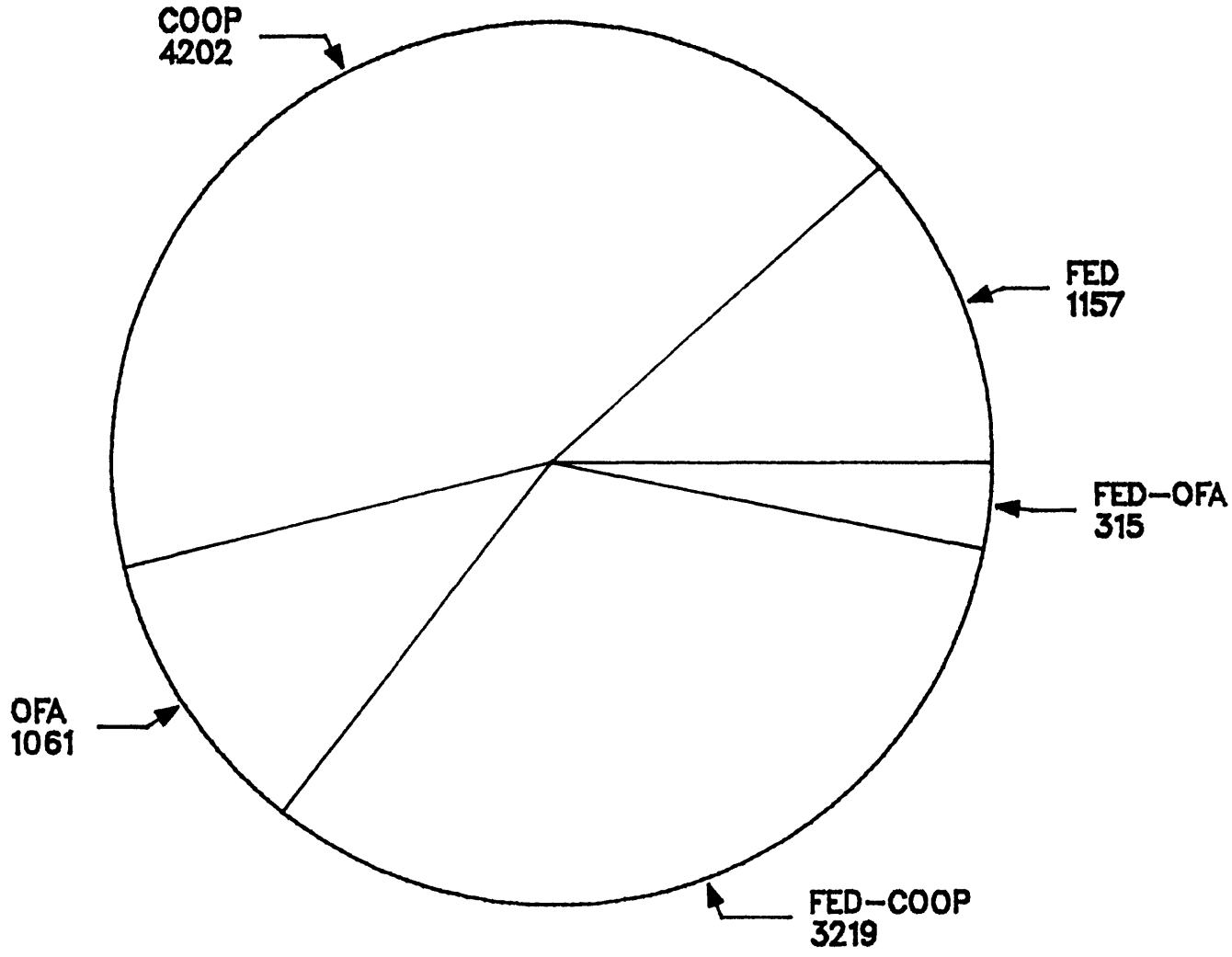
Figure 19.--Number of continuous ground-water level stations, and sources of funding support, fiscal year 1987.



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

TOTAL STATIONS = 22,634

Figure 20.--Number of scheduled, long-term operation ground-water level stations, and sources of funding support, fiscal year 1987.



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
  FED-OFA = Federal and Other Federal Agencies

TOTAL STATIONS = 9,954

Figure 21.--Number of short-term or project ground-water level stations, and sources of funding support, fiscal year 1987.

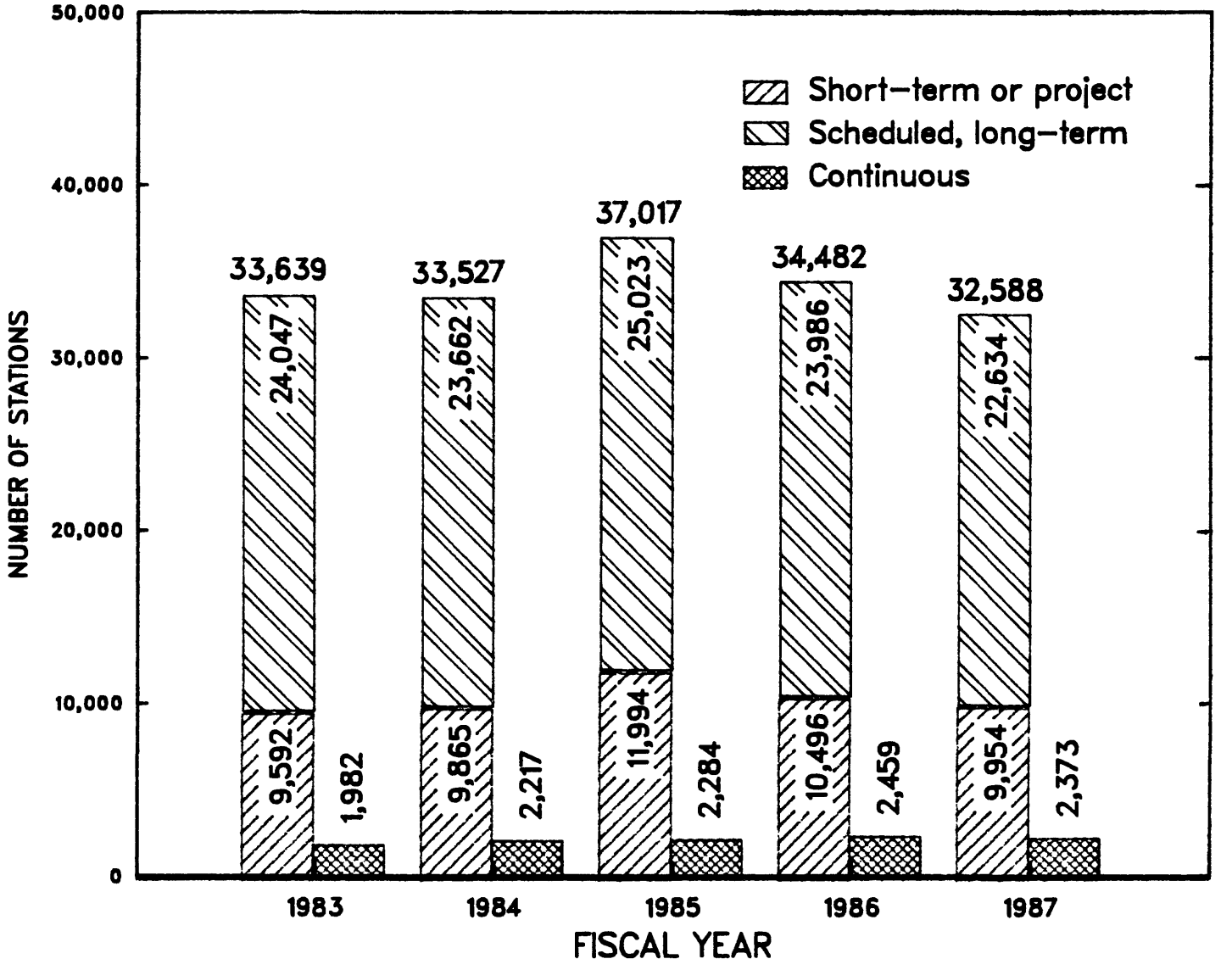


Figure 22.--Number of stations, by year, at which ground-water levels were collected from fiscal year 1983 to 1987.

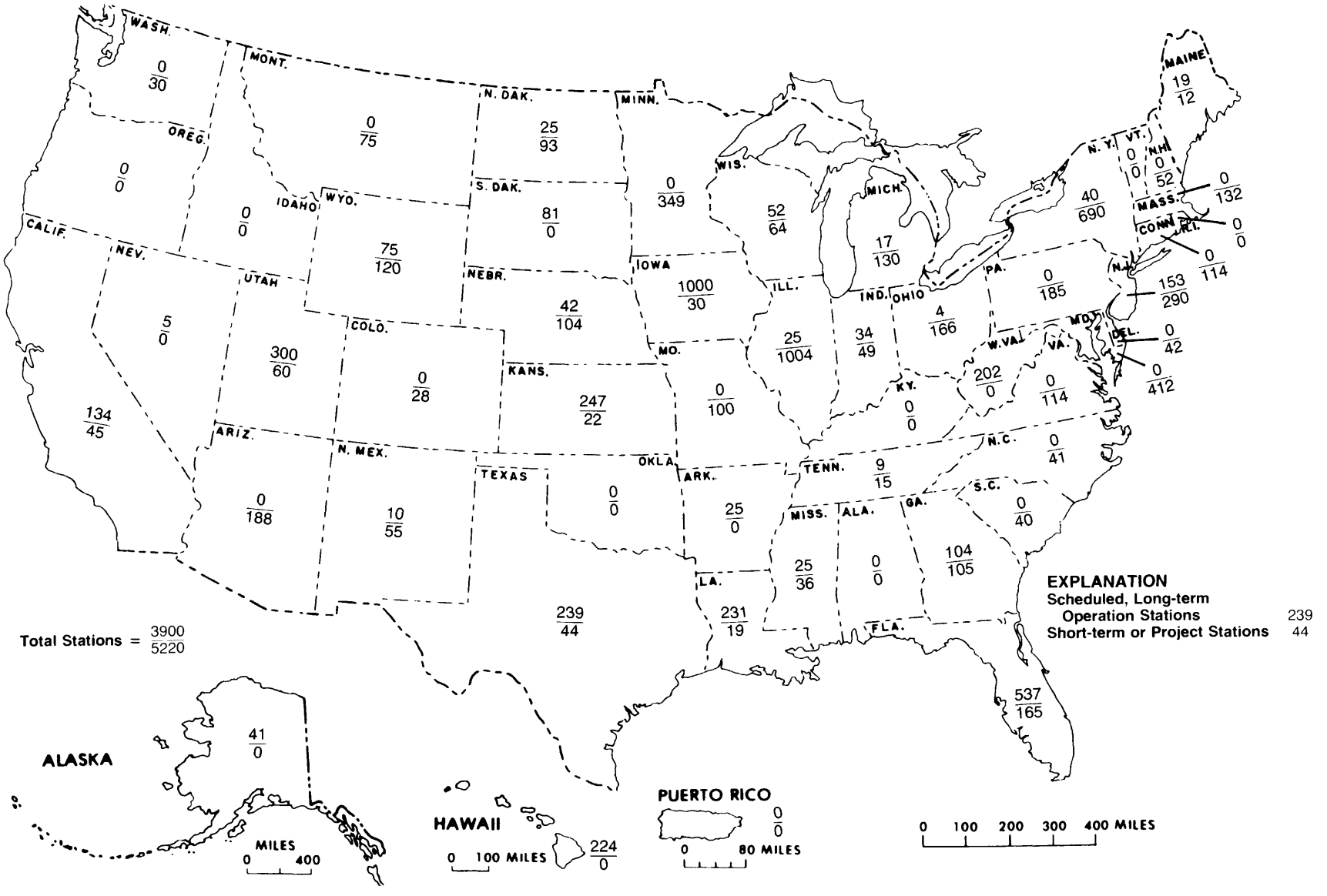
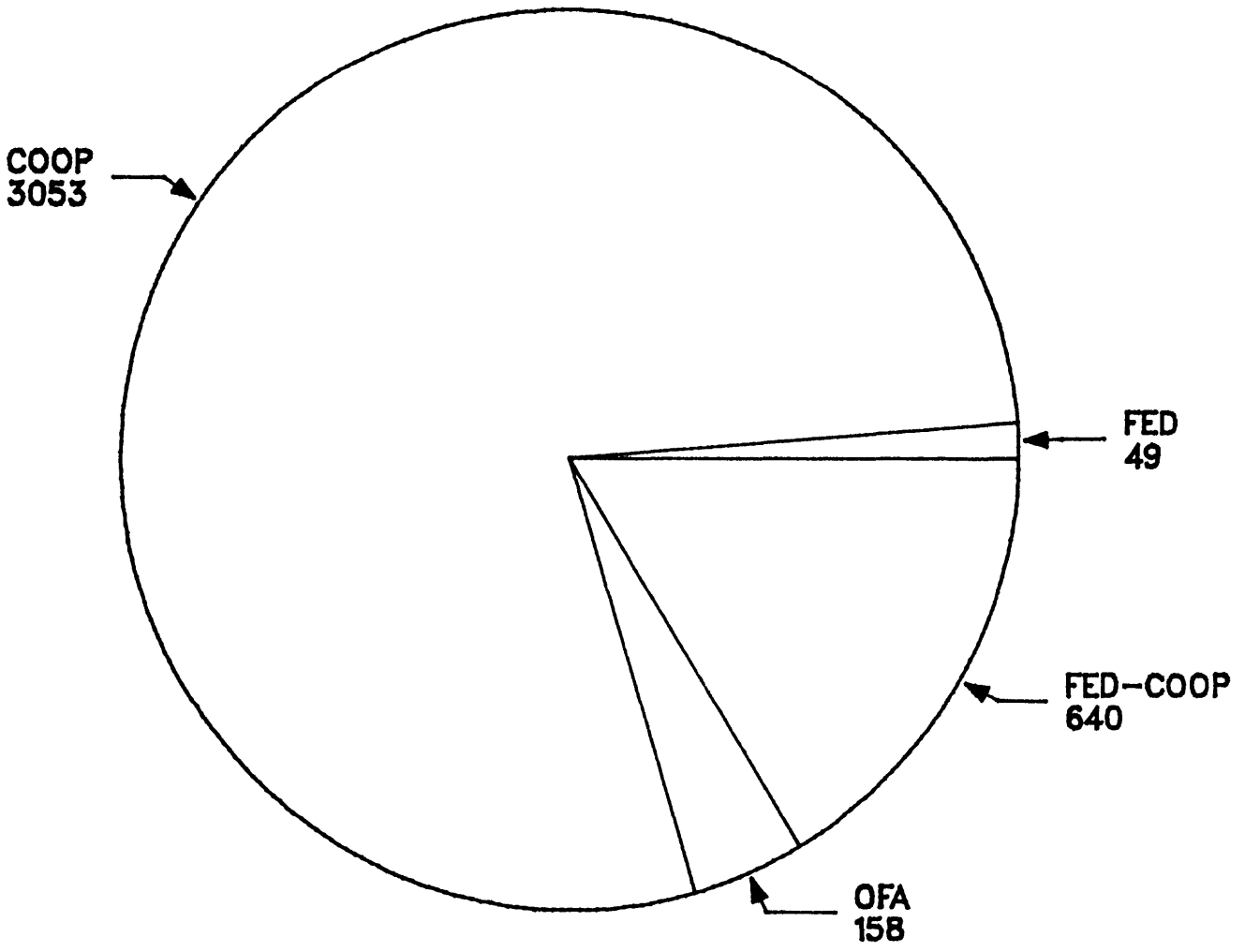


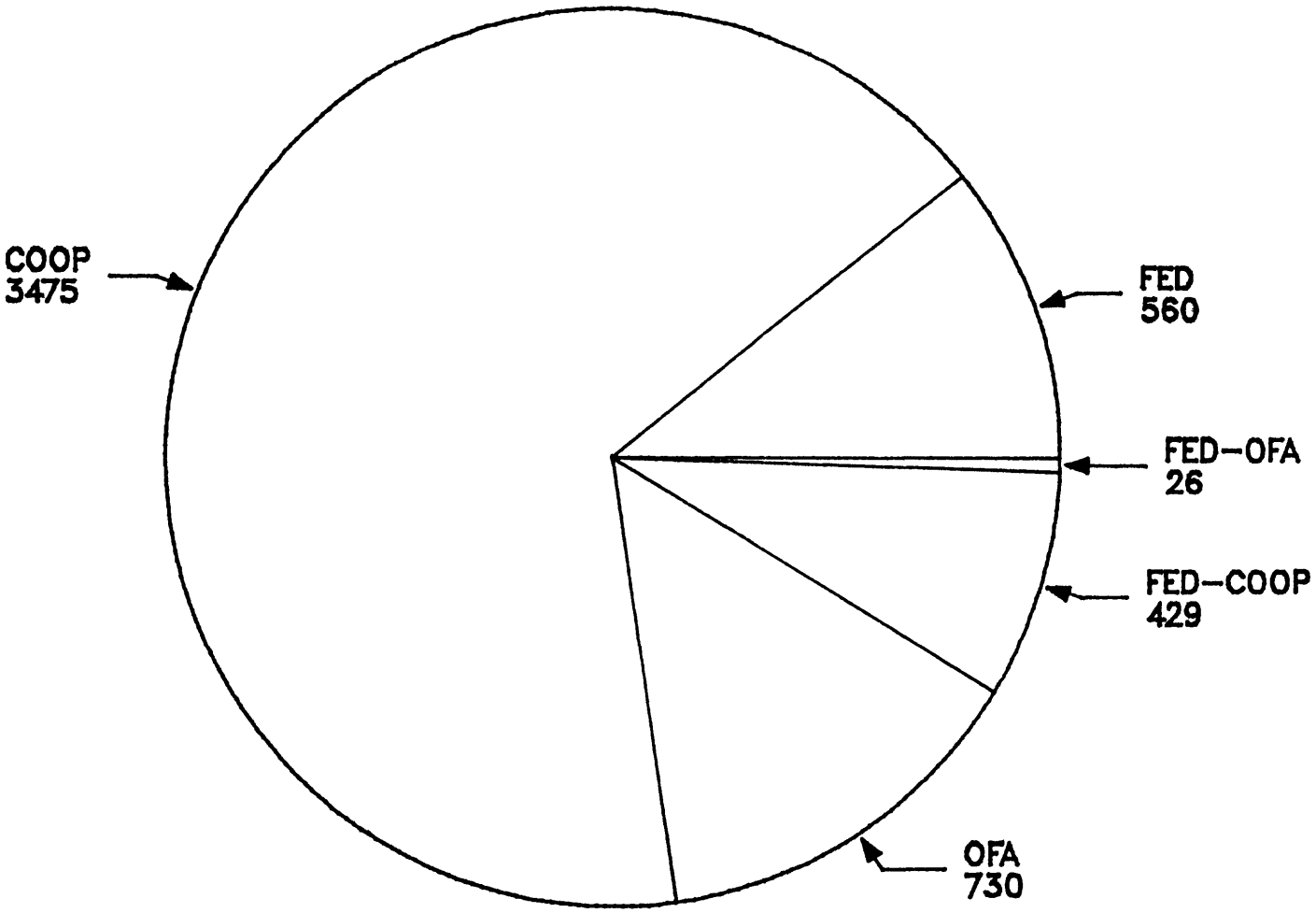
Figure 23.--Number of stations, by State, at which ground-water quality data were collected in fiscal year 1987.



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

TOTAL STATIONS = 3,900

Figure 24.--Number of scheduled, long-term operation ground-water quality stations, and sources of funding support, fiscal year 1987.



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

FED-OFA = Federal and Other Federal Agencies

TOTAL STATIONS = 5,220

Figure 25.--Number of short-term or project ground-water quality stations, and sources of funding support, fiscal year 1987.

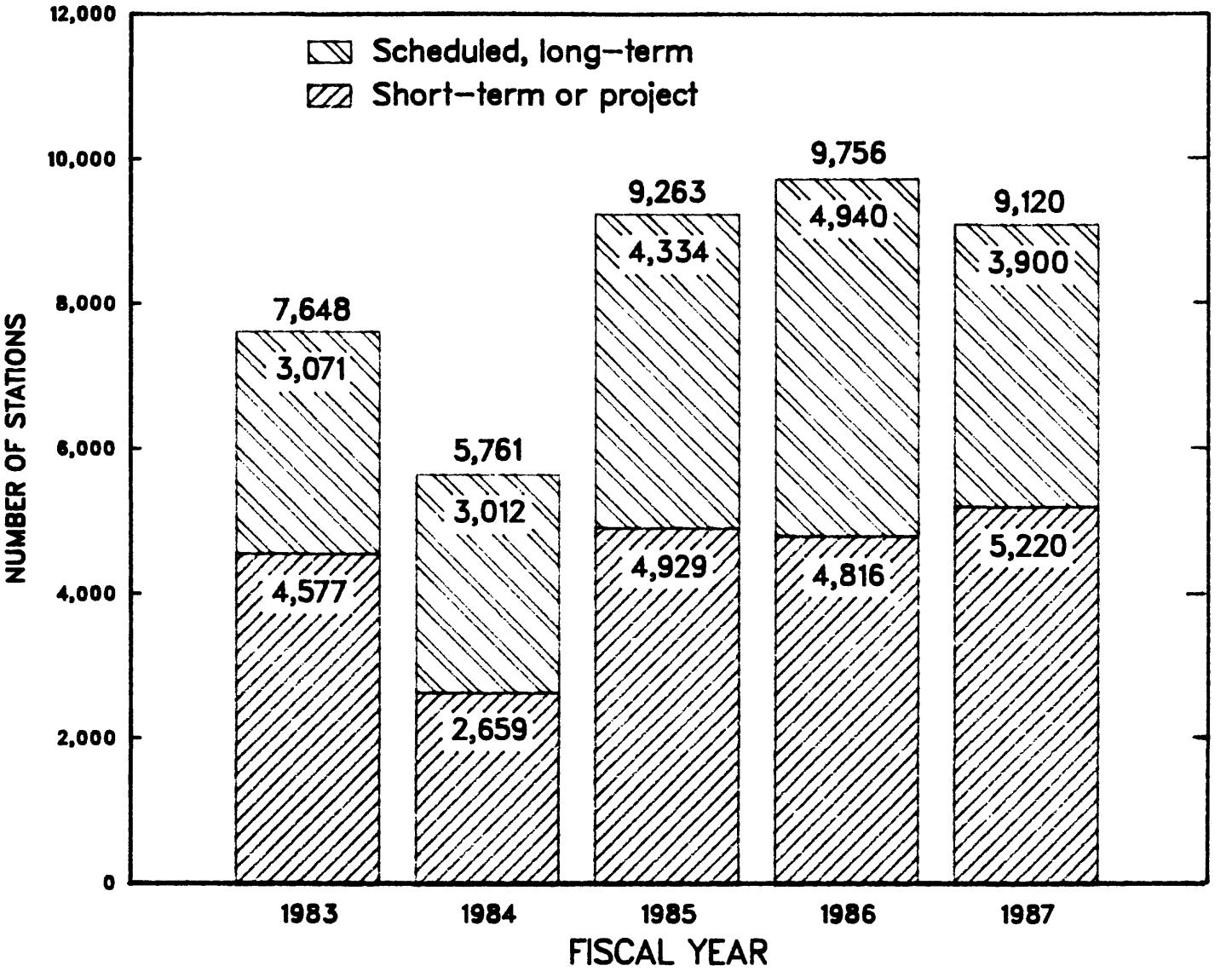


Figure 26.--Number of stations, by year, at which ground-water quality data were collected from fiscal year 1983 to 1987.

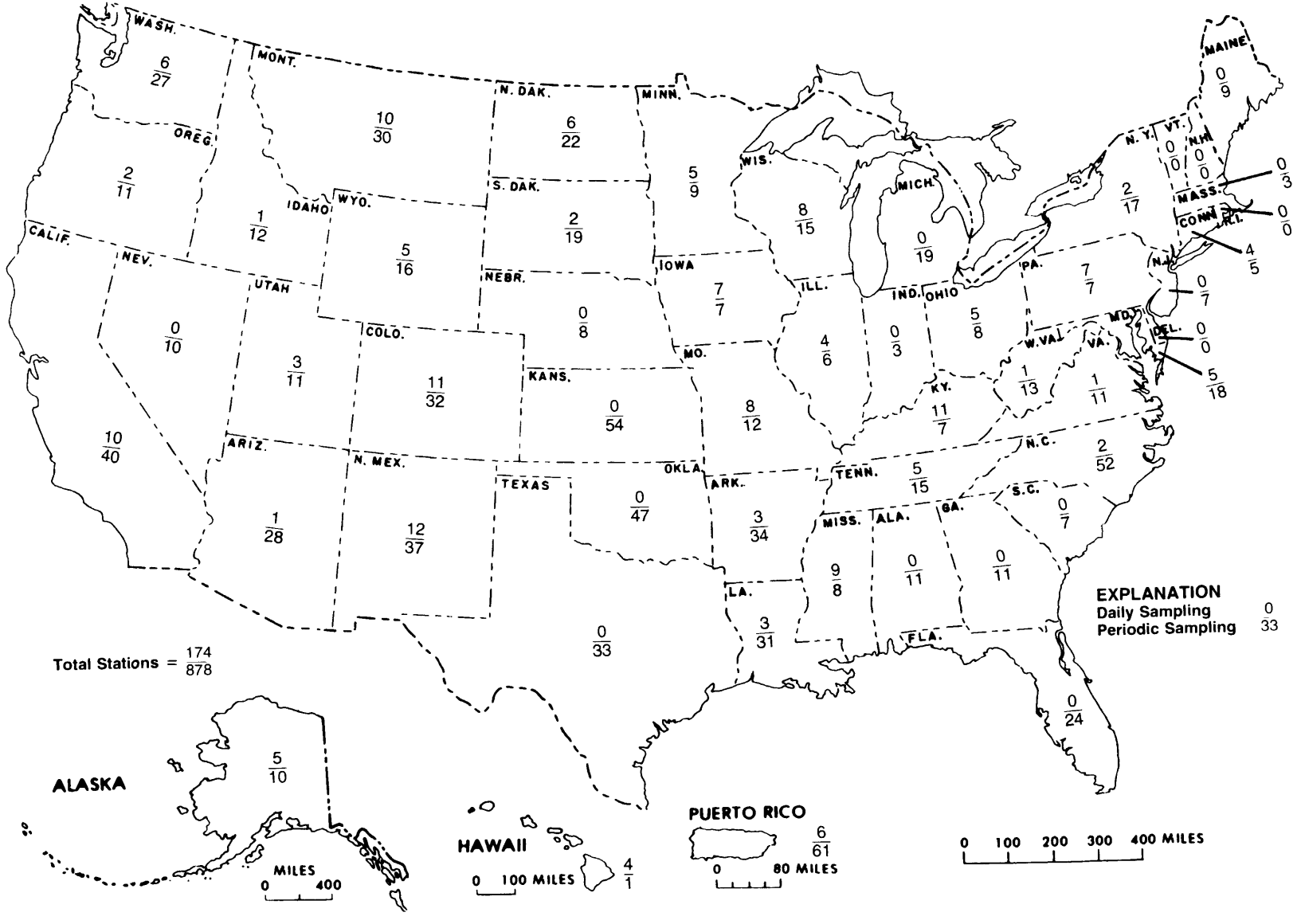
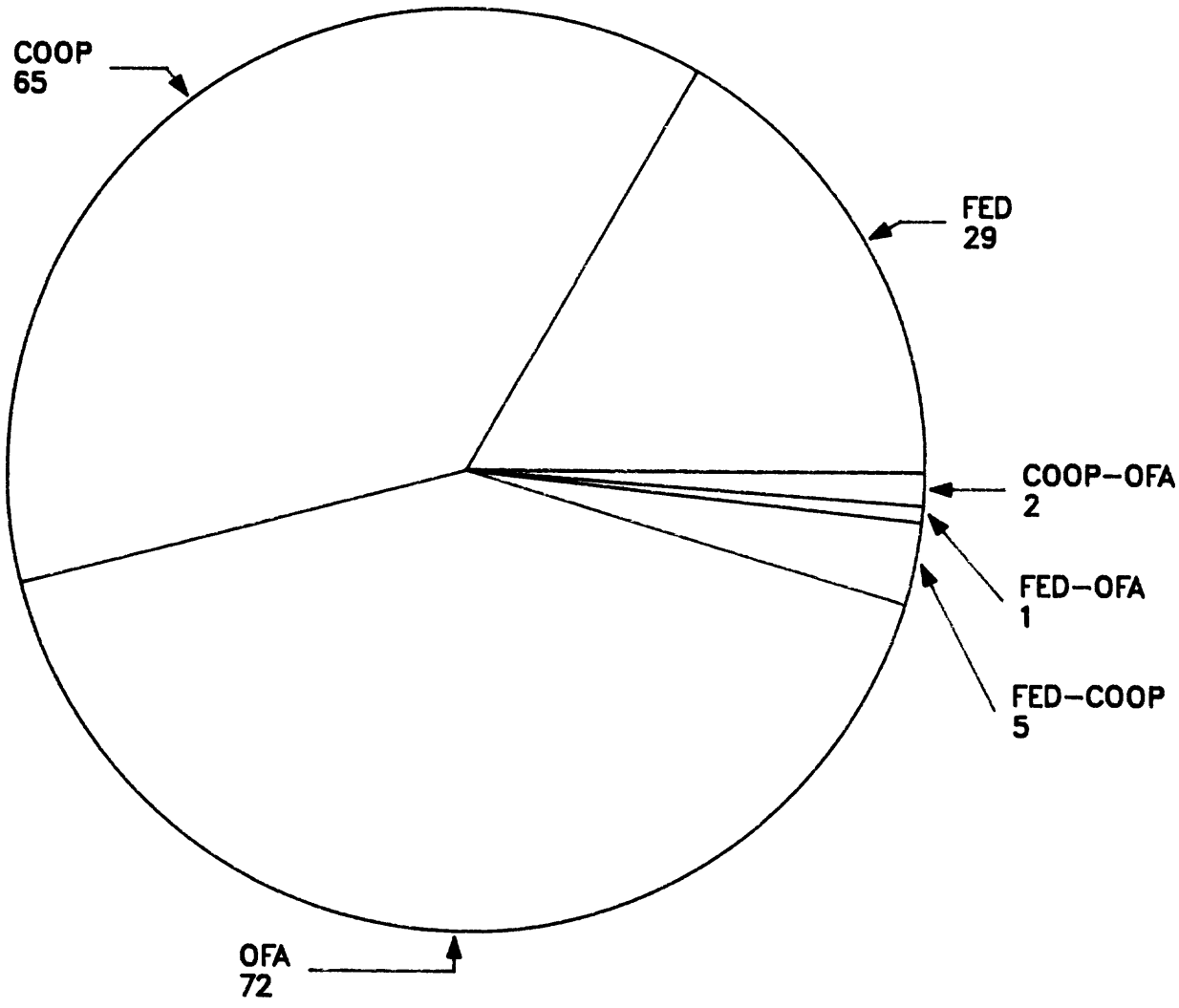


Figure 27.--Number of stations, by State, at which sediment data were collected in fiscal year 1987.



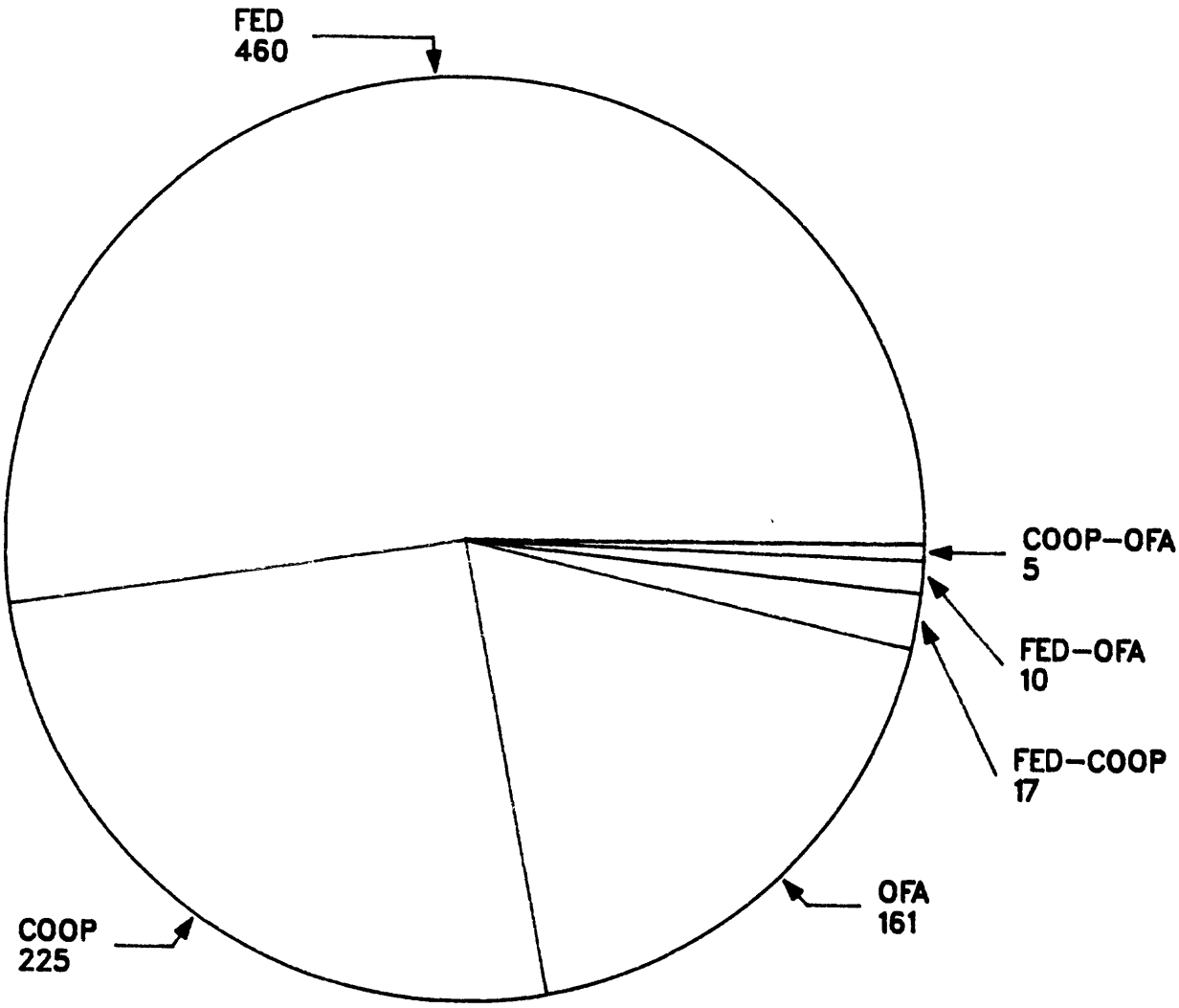
TOTAL STATIONS = 174

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 Program and Other Federal Agencies
- FED-OFA = Federal and Other Federal Agencies

Figure 28.--Number of daily sampling sediment stations, and sources of funding support, fiscal year 1987.



EXPLANATION:
SINGLE PROGRAM SUPPORT
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  COOP = Federal-State Cooperative Program
COMBINED PROGRAM SUPPORT
  FED-COOP = Federal and Federal-State Cooperative Program
  COOP-OFA = Federal-State Cooperative Program and Other
    Federal Agencies
  FED-OFA = Federal and Other Federal Agencies

TOTAL STATIONS = 878

Figure 29.--Number of periodic sampling sediment stations, and sources of funding support, fiscal year 1987.

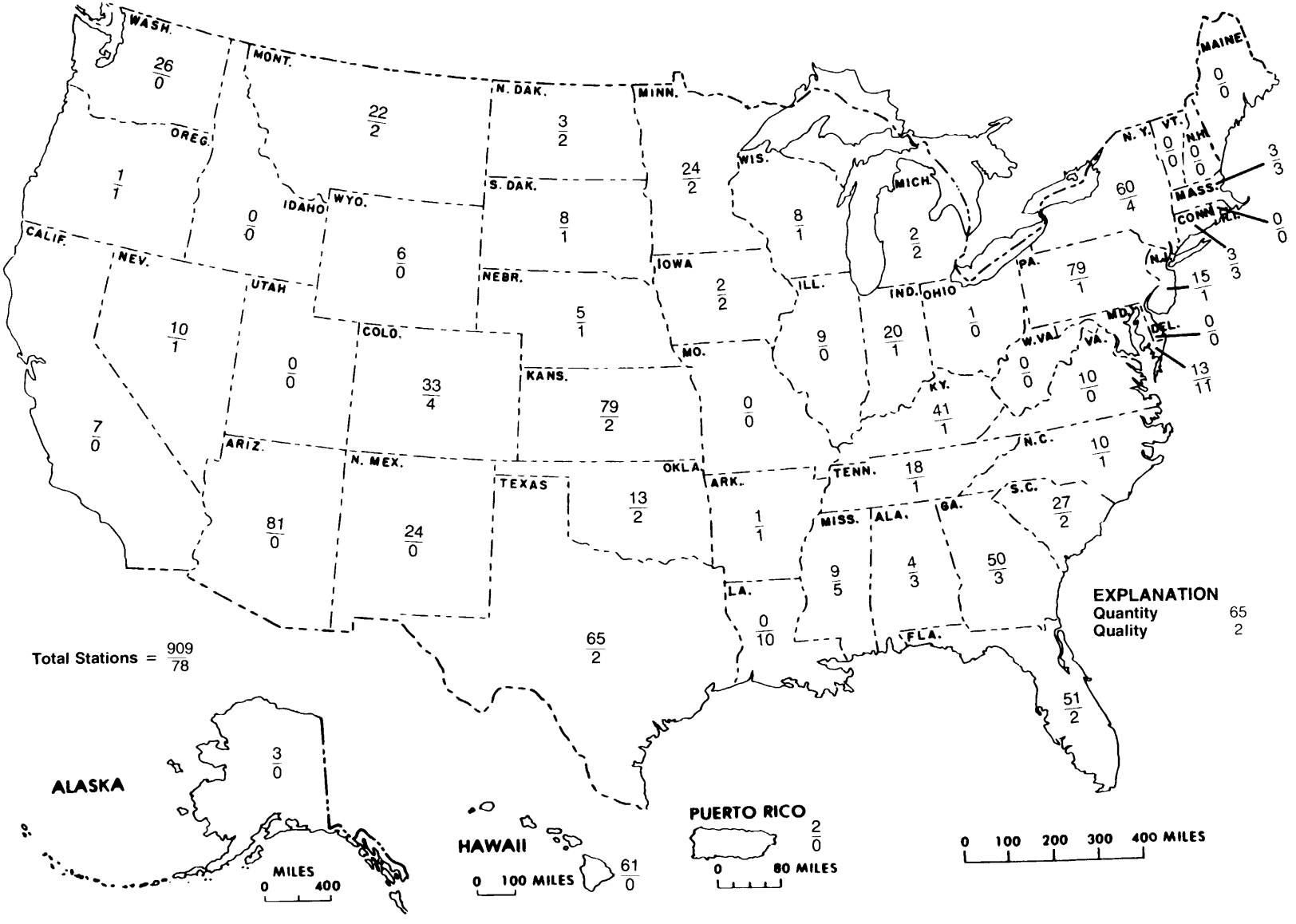
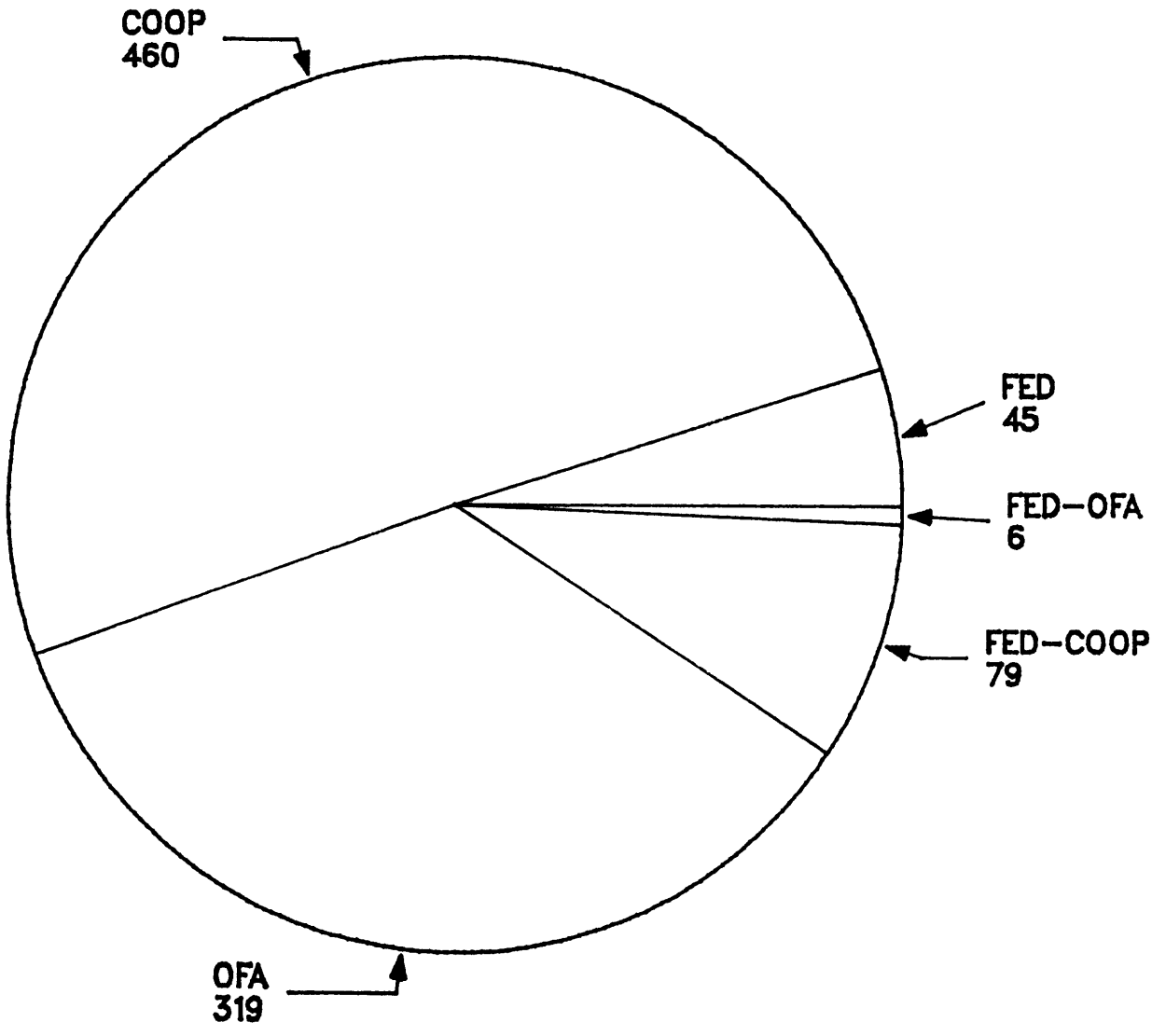


Figure 30.--Number of stations, by State, at which precipitation data were collected in fiscal year 1987.



EXPLANATION:
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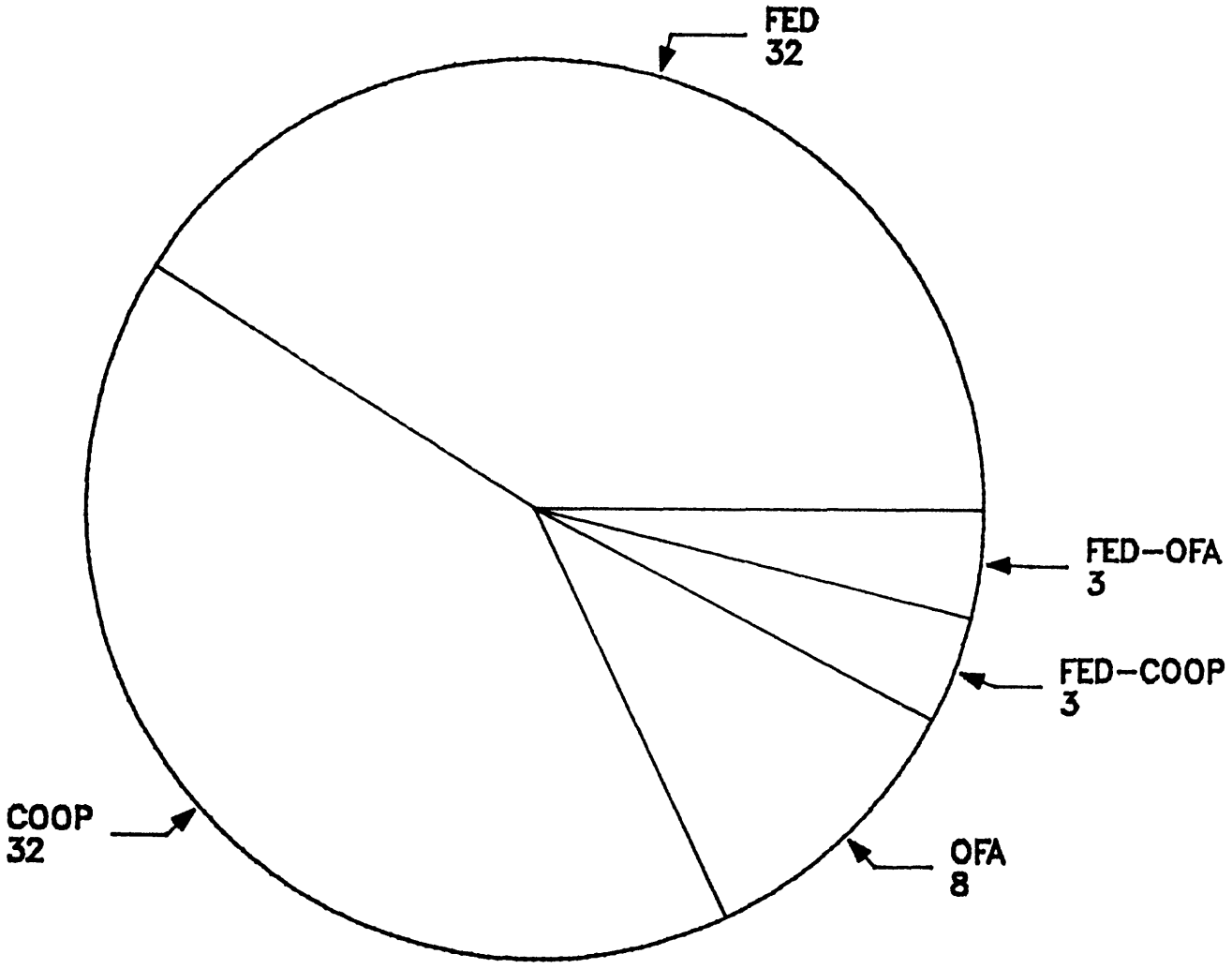
  COOP = Federal-State Cooperative Program
COMBINED PROGRAM SUPPORT
  FED-COOP = Federal and Federal-State Cooperative Program
  FED-OFA = Federal and Other Federal Agencies

TOTAL STATIONS = 909

Figure 31.--Number of precipitation-quantity stations, and sources of funding support, fiscal year 1987.



EXPLANATION:
SINGLE PROGRAM SUPPORT
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  COOP = Federal-State Cooperative Program
COMBINED PROGRAM SUPPORT
  FED-COOP = Federal and Federal-State Cooperative Program
  FED-OFA = Federal and Other Federal Agencies

TOTAL STATIONS = 78

Figure 32.--Number of precipitation-quality stations, and sources of funding support, fiscal year 1987.

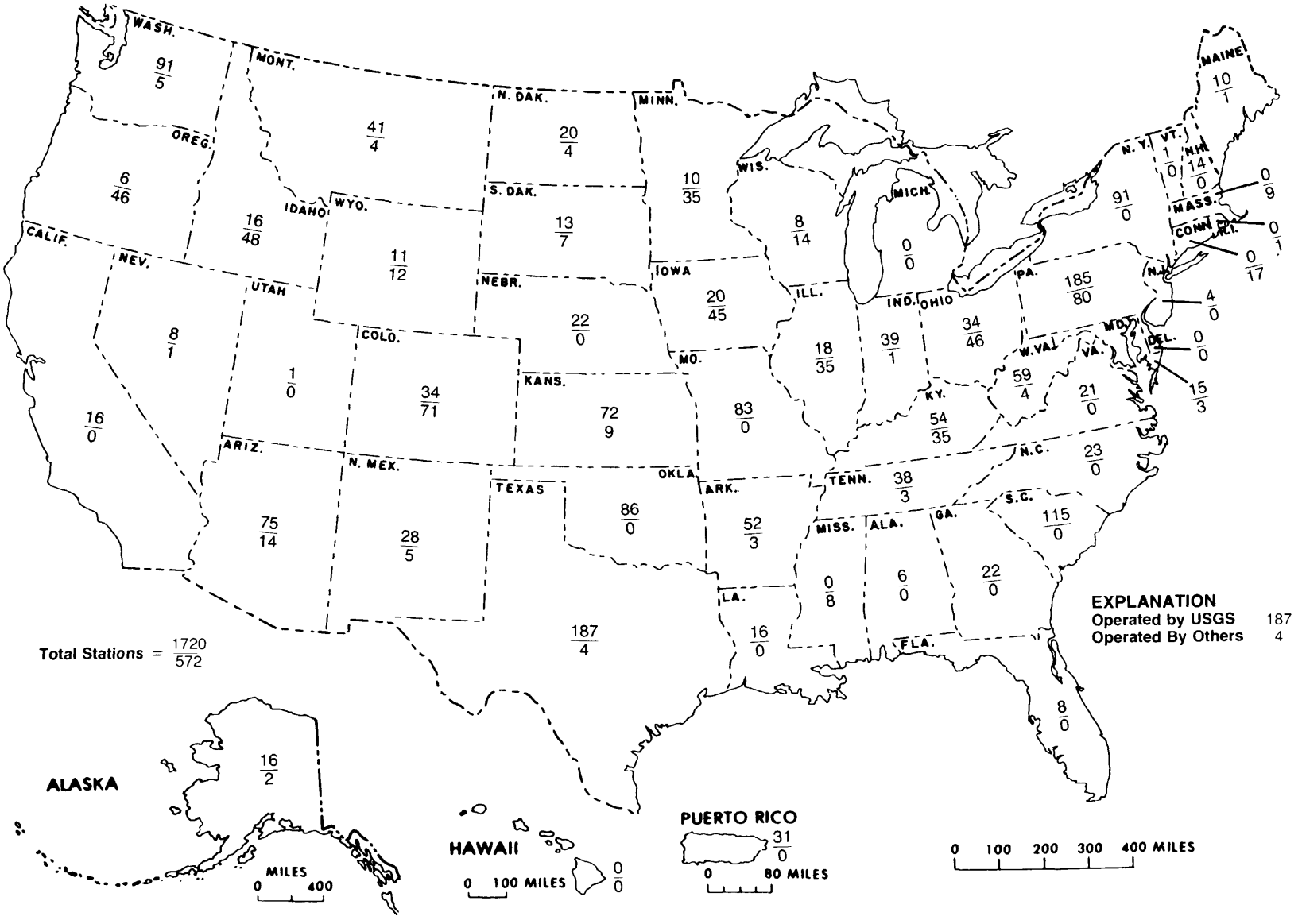
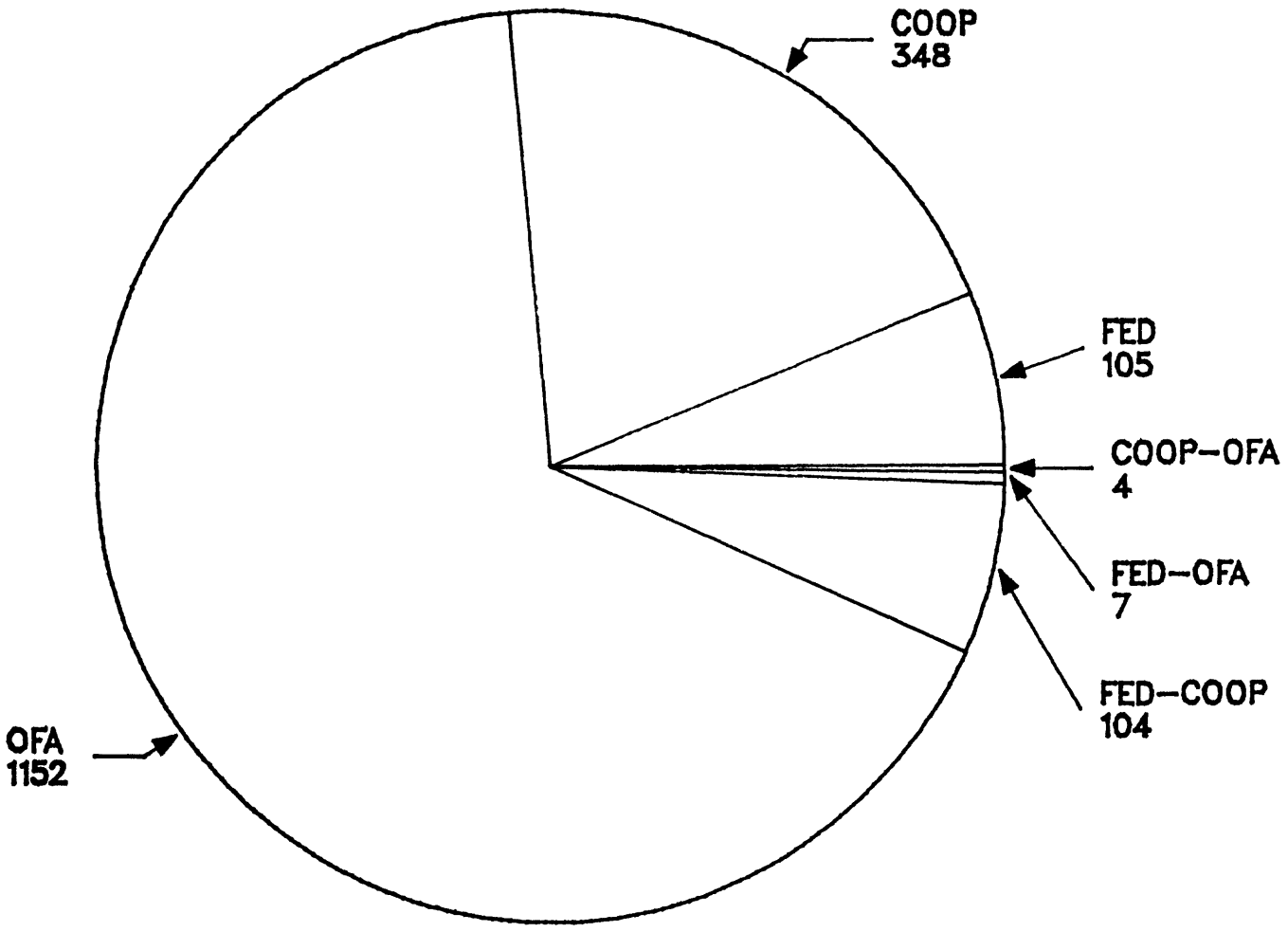


Figure 33.--Number of U.S. Geological Survey stations, by State, at which data-collection platforms for satellite telemetry were operated in fiscal year 1987.



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 Program and Other
    Federal Agencies
  FED-OFA = Federal and Other Federal Agencies

TOTAL STATIONS = 1720

Figure 34.--Number of stations at which data-collection platforms for satellite telemetry were operated by the U.S. Geological Survey, and sources of funding support, fiscal year 1987.

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