OPERATION OF HYDROLOGIC DATA-COLLECTION STATIONS BY THE U. S. GEOLOGICAL SURVEY IN 1995

U.S. Geological Survey
Open-File Report 96-132

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Compiled by Melvin Lew and Betty Dodds

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Reston, Virginia
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U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

Gordon P. Eaton, Director

For additional information write to:

Chief, Branch of Operational Support
U.S. Geological Survey
405 National Center
12201 Sunrise Valley Drive
Reston, Virginia 22092

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ABSTRACT

The U.S. Geological Survey operates hydrologic data-collection stations nationwide to serve the needs of all levels of government, the private sector, and the general public for water-resources information. During fiscal year 1995, surface-water discharge was determined at 9,639 stations; stage data on streams, reservoirs, and lakes were recorded at 2,037 stations; and various surface-water quality characteristics were determined at 2,979 stations. In addition, ground-water levels were measured at 31,011 sites, and the quality of ground water was determined at 6,280 sites. Data on sediment were collected daily at 148 stations and on a periodic basis at 1,032 stations. Information on precipitation quantity was collected at 1,354 stations and the quality of precipitation was analyzed at 47 stations. Data-collection platforms for satellite telemetry of hydrologic information were used at 3,920 U.S. Geological Survey stations. Funding for the hydrologic stations was derived, either solely or in combination, from three major sources--the U.S. 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 U.S. Geological Survey has varied from year to year since fiscal year 1983. Comparing fiscal year 1983 with 1995, the number of continuous-record surface-water discharge stations in 1995 was greater by 33; the total number of surface-water discharge stations, both continuous and partial record, was lower by 1,437; surface-water quality stations were lower by 847; ground-water level stations were lower by 2,628; and ground-water quality stations were down by 1,368.

INTRODUCTION

The U.S. Geological Survey operates hydrologic data-collection stations throughout the United States, Puerto Rico, and several Trust Territories. These hydrologic data-collection 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 data-collection stations operated during fiscal year (FY) 1995. Similar reports have been prepared previously for fiscal years 1983, 1985, 1987, 1989, 1991 and 1993 (Condes de la Torre, 1983, 1985, 1987, 1989, 1991 and 1993). A summary and analysis is provided of the number of hydrologic stations operated from FY 1983 to FY 1995. The sources of funding support for the stations are the U.S. Geological Survey's Federal Program appropriation, the Federal-State Cooperative Program (Gilbert and Mann, 1993), and reimbursements from other Federal agencies, or a combination of these (table 1).

TABLE 1 -- Types and number of hydrologic data-collection stations operated by the U.S. Geological Survey during the 1995 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	550	4,098	1,921	47	109	391	69	7,185
Partial Record	33	2,079	306	12	13	11	0	2,454
Stage Only - Streams								
Continuous Record	20	170	382	0	36	2	0	610
Partial Record	2	244	43	1	0	108	0	398
Stage Only - Lakes & Reservoirs								
Continuous Record	21	369	337	0	0	6	0	733
Partial Record	8	191	97	0	0	0	0	296
Quality								
*Continuous Record	80	441	207	6	1	3	0	738
Scheduled, Long-term Operation	271	995	279	103	14	5	2	1,669
Short-term or Project Stations	494	672	105	39	0	0	0	1,310
GROUND WATER								
Water Levels								
*Continuous Record	134	1,822	299	11	0	5	0	2,271
Scheduled, Long-term Operation	1,724	23,225	1,100	8	0	0	0	26,057
Short-term or Project Stations	610	3,250	1,005	64	0	25	0	4,954
Quality								
Scheduled, Long-term Operation	72	1,886	307	22	0	12	0	2,299
Short-term or Project Stations	632	1,815	1,069	87	314	35	29	3,981
SEDIMENT								
Daily Sampling	4	61	70	1	6	6	0	148
Periodic Sampling	474	343	111	98	1	4	1	1,032
PRECIPITATION								
Quantity	87	684	564	3	9	7	0	1,354
Quality	33	12	1	1	0	0	0	47

* The stations at which a continuous record is maintained in this type are also counted as either (a) scheduled long-term operation stations, or (b) short-term project stations; therefore, the sum of (a) and (b) represents the total stations of this type.

In 1983, the U.S. Geological Survey established a standard system for counting hydrologic stations so that the type of stations being counted and compared would be consistent from year to year. In 1985, the items to be counted were increased to include stations operated to collect daily and periodic sediment sampling data and information on the number of data-collection platforms. For this reason, the information presented in this report beings in either 1983 or 1985.

For the purpose of this report, "project" refers to a hydrologic investigation 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. Also, "continuous" and "continuous record" are used interchangeably.

HYDROLOGIC DATA-COLLECTION STATIONS

Surface-Water Data

Surface-water discharge (flow) was determined by the U.S. Geological Survey at 9,639 stations in FY 1995. At 7,185 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 2,454 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 pre-determined level. The number of stations in each State where continuous surface-water discharge data were collected ranged from 18 in Delaware to 719 in California (figure 1). The Federal-State Cooperative Program funded operation of the largest number of continuous surface water discharge stations; it provided sole support for 4,098 stations, and in combination with other sources, provided support for (47, +391, +69) 507 more (table 1). The Federal-State Cooperative Program also funded the largest number of partial-record discharge stations; it provided sole support of 2,079 stations (table 1), and in combination with other sources, 23 more.

The number of continuous-record surface-water discharge stations varied from 7,152 stations in FY 1983 to 7,185 stations in FY 1995 (figure 2), with a low of 7,000in FY 1987 and a high of 7,363 in FY 1990. The change reflects decreases in some States and increases in others (table 2). During the same period, the number of partial record surface-water discharge stations decreased by 1,470 to 2,454 stations in FY 1995. In Nebraska, the number of discharge stations decreased by 36 from 1994 to 1995 when a State cooperator terminated funding stations in the Federal-State Cooperative Program (table 2).

Stage-only data were collected by the U.S. Geological Survey in FY 1995 at 1,008 stream stations. The number of stage-only data stations on streams ranged from none in several States to 116 in Louisiana (figure 3). The reimbursement from other Federal agencies supported the largest number of continuous stage-only stream stations--382, while the Federal State Cooperative Program supported the most partial-record stage-only stations--244 (table 1). The number of continuous-record stations collecting stage-only data on streams increased from 419 in 1983 to a high of 610 in 1995 (figure 4), whereas the number of partial-record stations decreased by 73.

Stage data were also collected at 1,029 stations on lakes and reservoirs by the U.S. Geological

Table 2. -- Number of continuous surface-water discharge stations, by State and year, from fiscal year 1983 to 1995

	NUMBER OF STATIONS												
STATE/YEAR	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
Alabama	88	86	79	75	75	80	93	103	98	95	101	99	103
Alaska	103	101	104	100	83	76	79	86	78	106	87	78	74
Arizona	169	199	194	204	182	187	189	191	202	199	197	198	200
Arkansas	49	48	45	46	40	48	53	54	58	56	58	57	49
California	690	639	641	631	605	619	757	766	768	780	763	741	719
Colorado	357	331	342	331	283	281	267	269	250	268	286	323	291
Connecticut	47	47	46	48	46	51	50	48	47	48	51	50	46
Delaware	12	12	12	12	13	13	13	13	14	15	17	18	18
Florida	284	287	282	299	339	342	295	355	342	341	330	331	314
Georgia	98	99	107	86	108	108	109	109	109	109	105	111	112
Hawaii	126	129	134	113	107	112	112	105	117	117	120	118	118
Idaho	149	157	201	214	212	215	224	218	212	214	214	153	224
Illinois	145	139	140	160	135	142	136	146	155	149	153	152	156
Indiana	175	171	177	181	175	177	178	177	181	170	178	169	173
Iowa	110	108	113	116	116	117	117	117	119	116	114	119	119
Kansas	142	144	138	140	140	140	141	136	133	134	145	151	157
Kentucky	123	114	106	106	108	108	115	114	116	115	99	100	94
Louisiana	75	68	80	71	61	63	62	63	62	62	62	59	57
Maine	51	49	47	44	44	47	49	49	48	45	44	45	43
Maryland	85	89	91	104	104	104	84	80	76	74	75	75	75
Massachusetts	82	81	78	76	79	77	84	79	64	59	68	74	82
Michigan	136	128	128	129	129	140	140	141	144	140	145	140	154
Minnesota	93	85	89	97	98	93	91	86	85	88	88	88	85
Mississippi	72	68	67	74	79	78	79	76	77	79	80	82	54
Missouri	110	108	104	105	105	105	113	120	118	104	111	108	114
Montana	188	184	189	164	206	202	211	209	210	211	183	198	201
Nebraska	142	145	145	144	144	141	144	141	143	142	121	121	85
Nevada	90	90	94	90	96	111	134	167	142	154	160	177	171
New Hampshire	37	38	36	36	36	38	38	38	36	30	32	33	35
New Jersey	101	101	95	97	108	101	95	96	91	91	101	103	93
New Mexico	158	147	147	160	176	172	172	168	131	133	137	150	151
New York	182	185	172	167	186	184	194	203	209	205	212	224	214
North Carolina	151	154	154	167	173	205	192	186	175	170	170	177	183
North Dakota	81	75	74	103	100	101	98	104	104	107	105	102	100
Ohio	200	130	109	127	122	133	136	132	164	126	121	121	116
Oklahoma	136	123	123	122	113	123	120	127	149	156	164	150	157
Oregon	278	278	277	280	268	246	244	237	236	184	191	189	178
Pennsylvania	236	235	251	249	243	250	236	241	235	230	223	222	225
Puerto Rico	43	58	58	56	49	60	61	66	78	92	94	82	83
Rhode Island	15	15	15	15	16	16	16	16	16	16	19	19	19
South Carolina	84	107	104	102	118	114	119	132	130	129	131	136	135
South Dakota	107	113	109	105	102	132	137	133	127	131	132	130	121
Tennessee	90	105	99	89	97	86	92	83	108	118	119	119	114
Texas	400	399	397	384	365	361	368	369	341	336	328	337	319
Utah	214	201	194	193	157	176	165	157	157	179	184	188	176
Vermont	32	31	31	31	30	33	33	33	39	32	33	33	35
Virginia	95	100	85	86	82	84	80	85	84	83	85	83	90
Washington	185	182	215	239	240	199	191	197	203	204	203	223	207
West Virginia	85	73	64	79	77	72	73	73	77	74	72	62	59
Wisconsin	98	97	100	95	93	109	112	117	121	121	117	133	144
Wyoming	153	149	137	137	135	138	148	153	167	156	144	140	143
Total	7,152	7,002	7,019	7,079	7,000	7,110	7,239	7,363	7,346	7,293	7,272	7,291	7,185

Survey. Continuous records of stage were collected at 733 lake and reservoir stations, ranging from 133 in California to none in several States (figure 5). Reimbursements from the Federal-State Cooperative Program and other Federal agencies supported over 95% of the continuous-record stations and partial-record stage stations on lakes and reservoirs (table 1). The number of stage stations on lakes and reservoirs decreased from 1,246 in FY 1983 to 1,029 in FY 1995 (figure 6).

Stream samples were collected and analyzed for water-quality characteristics at 2,979 stations across the Nation (figure 7). The types of chemical constituents and physical properties measured vary from site to site. Field determinations could include those for temperature, specific conductance, pH, dissolved oxygen, fecal coliform, and fecal streptococci. Laboratory determinations could include those for common constituents such as calcium, magnesium, fluoride, sodium, potassium, dissolved solids, silica, chloride, sulfate, hardness, bicarbonate, carbonate, and turbidity; for 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 for selected radiochemical parameters. A continuous record was maintained at 738 of these sites, mainly for water temperature and conductance, but other properties, such as dissolved oxygen concentrations and pH, were also recorded continuously at times. The surface-water quality stations at which a continuous record is maintained are also counted as either (a) scheduled long-term operation stations, or (b) short-term project stations; therefore, the sum of (a) and (b) represents the total stations of this type.

There were 1,310 stations in FY 1995 which were sampled as short-term or project stations. The collection of surface-water quality data received its largest funding support from the Federal-State Cooperative Program for all types of stations. Water quality data were collected at 1,669 stream sites as part of a scheduled, long-term operation (table 1). These include 142 stations, supported in the U.S. Geological 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 water in the United States streams. In 1993 there were 386 stations that measured an identical suite of water-quality characteristics at each NASQAN station using the same set of procedures concerning sample-collection techniques, frequency of sampling, and analytical methods (Briggs and Ficke, 1977). Because of funding considerations, measurement of additional constituents such as pesticides, and upgraded quality assurance/quality control measures, the number of stations in the NASQAN network has been in decline.

The number of stations at which surface-water quality data were collected on a scheduled, long-term basis increased in some States, but he overall total declined from 2,906 in FY 1983 to 1,669 in FY 1995 (figure 8). The decline includes the changes in the NASQAN program. In Wyoming, for example, the number of scheduled, long-term sampling stations was reduced from FY 1983 to FY 1995 when the State's emphasis changed from analyses for major dissolved constituents to more expensive analyses for pesticides and herbicides. Thus, in order to accommodate to a static level of available funds, the number of sampling stations had to be decreased.

Ground-Water Data

Ground water is one of the most widely available of the Nation's natural resources. It is estimated that 79 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 (Solley and others, 1993). Water-level fluctuations are indicators of the stresses (both natural and man-induced) 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 31,011 sites in 1995 and water levels were recorded continuously at 2,271 sites, of which 1,822 were funded in total by the Federal-State Cooperative Program. The stations at which a continuous record of ground-water levels is maintained are also counted as either (a) scheduled, long-term operation stations, or (b) short-term project stations; therefore, the sum of (a) and (b) represents the total stations of this type. Ground-water levels were measured at 26,057 stations as part of a scheduled, long-term operation to assess long-term trends (figure 9). When special area studies were conducted, water levels were at times measured at short-term or project stations to supplement the information available in the area from the long-term stations. In 1995, water-level data were collected at 4,954 stations for these investigations. The Federal-State Cooperative Program provided total funding support for 85 percent of the long and short-term stations (table 1). Nebraska has the greatest number of ground-water level stations (figure 9).

From FY 1983 to FY 1995, the number of scheduled, long-term operation ground-water level stations increased from 24,047 in FY 1983 to 26,057 in FY 1995 (figure 10). The number of stations at which ground-water levels were measured continuously also increased from 1,982 in FY 1983 to 2,271 in FY 1995. Meanwhile, the short-term or project stations increased from 9,592 in FY 1983 to 11,994 in FY 1985, and then decreased 4,954 in FY 1995.

In FY 1995, samples of ground water from 6,280 stations nationwide were analyzed (figure 11). To maintain information on the changes in quality of critical ground-water bodies, samples were collected at 2,299 stations as part of a scheduled long-term operation. Of these, sampling at 1,886 stations was funded in total by the Federal-State Cooperative Program. Ground-water quality data were also collected at 3,981 stations to provide information needed for short-term, generally site-specific, studies (table 1).

Across the country, the number of stations at which ground-water quality samples were collected has varied from a low of 5,671 in FY 1984 to a high of 9,756 in FY 1986 (figure 12).

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 environment impact assessment, water treatment problems of sediment-associated

nutrients and pollutants, and evaluation of the precise impacts of humans."

Field techniques to collect suspended sediment samples were tested to determine whether or not they produce a representative sample of sediment for chemical analysis. The collection methods were found to produce representative sediment samples for chemical analyses; however, new protocols are needed for equipment cleaning and identifying noncontaminated equipment. These new protocols are being written. These techniques will be of use in determining the fate of toxic subtances 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 U.S. Geological Survey collected daily sediment data at 148 stations, and periodic data at 1,032 other stations in FY 1995 (figure 13). From FY 1985 to FY 1995 the number of stations has varied from the high in FY 1985 of 1,239 (figure 14).

Precipitation Data

Precipitation data are collected by the U.S. Geological Survey 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 U.S. Geological Survey investigations. Precipitation data were collected at 1,354 sites nationwide (figure 15). At 47 of these sites, quality of precipitation was determined. The largest support for the collection of precipitation quantity and quality data came from the Federal-State Cooperative Program and the Federal Program, respectively (table 1). The number of sites at which precipitation data were collected increased from 800 in FY 1983 to 1,354 in FY 1995 (figure 16).

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 data-collection platform (which is a small battery-operated radio), and 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). In FY 1995, data-collection platforms were located in 3,920 U.S. Geological Survey hydrologic data-collection stations and were transmitting data for one, or a combination, of the following parameters: stream stage, reservoir stage, water quality, and precipitation (figure 17). There were 3,404 stations at which data-collection platforms were operated by the U.S. Geological Survey and 516 U.S. Geological Survey stations at which the data-collection platforms were operated by others. Over half of the funding for the U.S. Geological Survey operation of the data-collection platforms is provided by other Federal agencies (figure 18). The number of data-collection platforms located in U.S. Geological Survey hydrologic stations increased from 1,520 in FY 1985 to 3,920 in FY 1995 (figure 19).

SUMMARY

The U.S. Geological Survey operates an extensive, nationwide network 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. From FY 1983 to FY 1995 the total number of surface-water discharge stations declined. The number of continuous-record discharge stations increased, surface-water quality stations declined, and ground-water level and ground-water quality stations both decreased.

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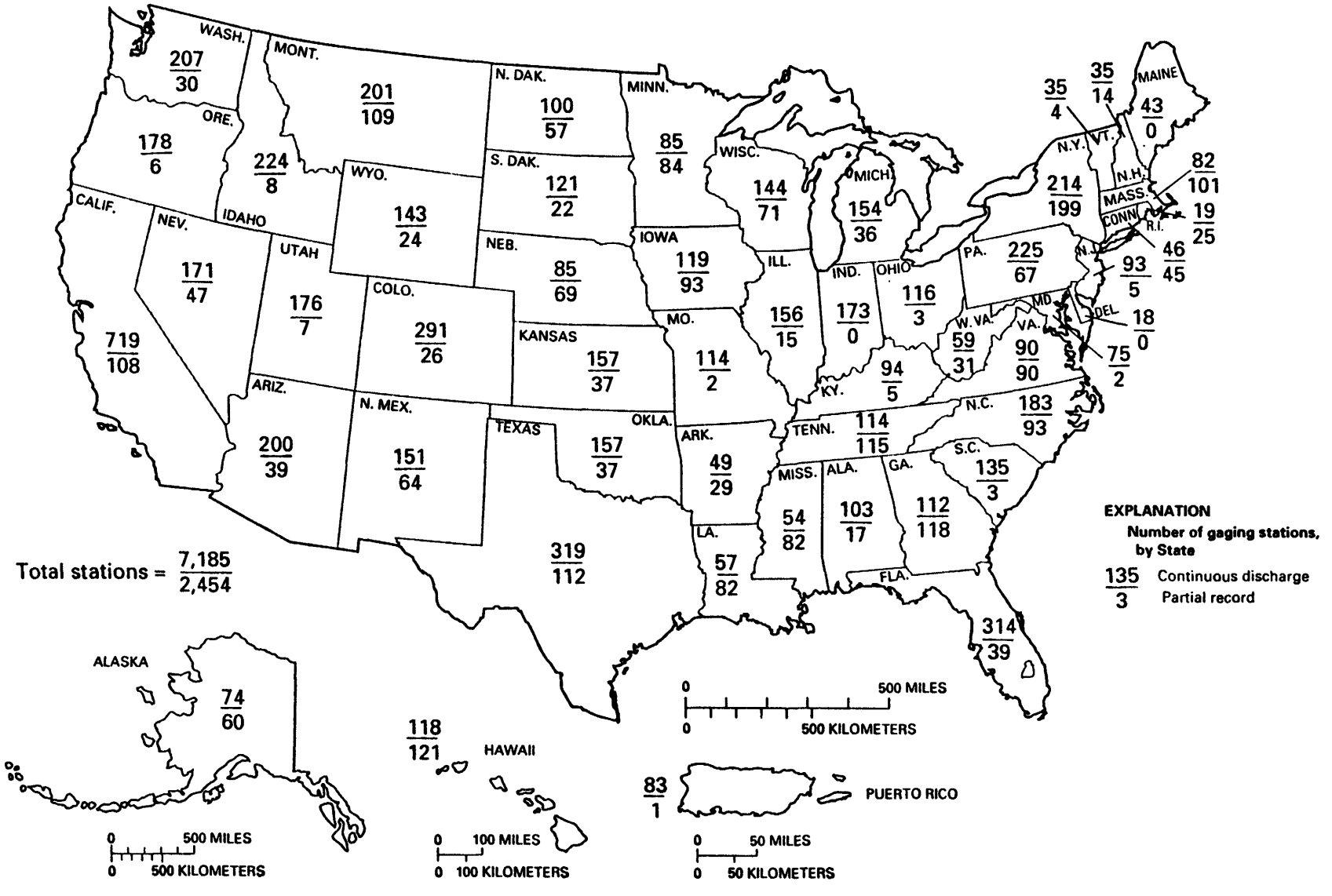


Figure 1.--Number of stations, by state, at which surface-water discharge data were collected in fiscal year 1995.

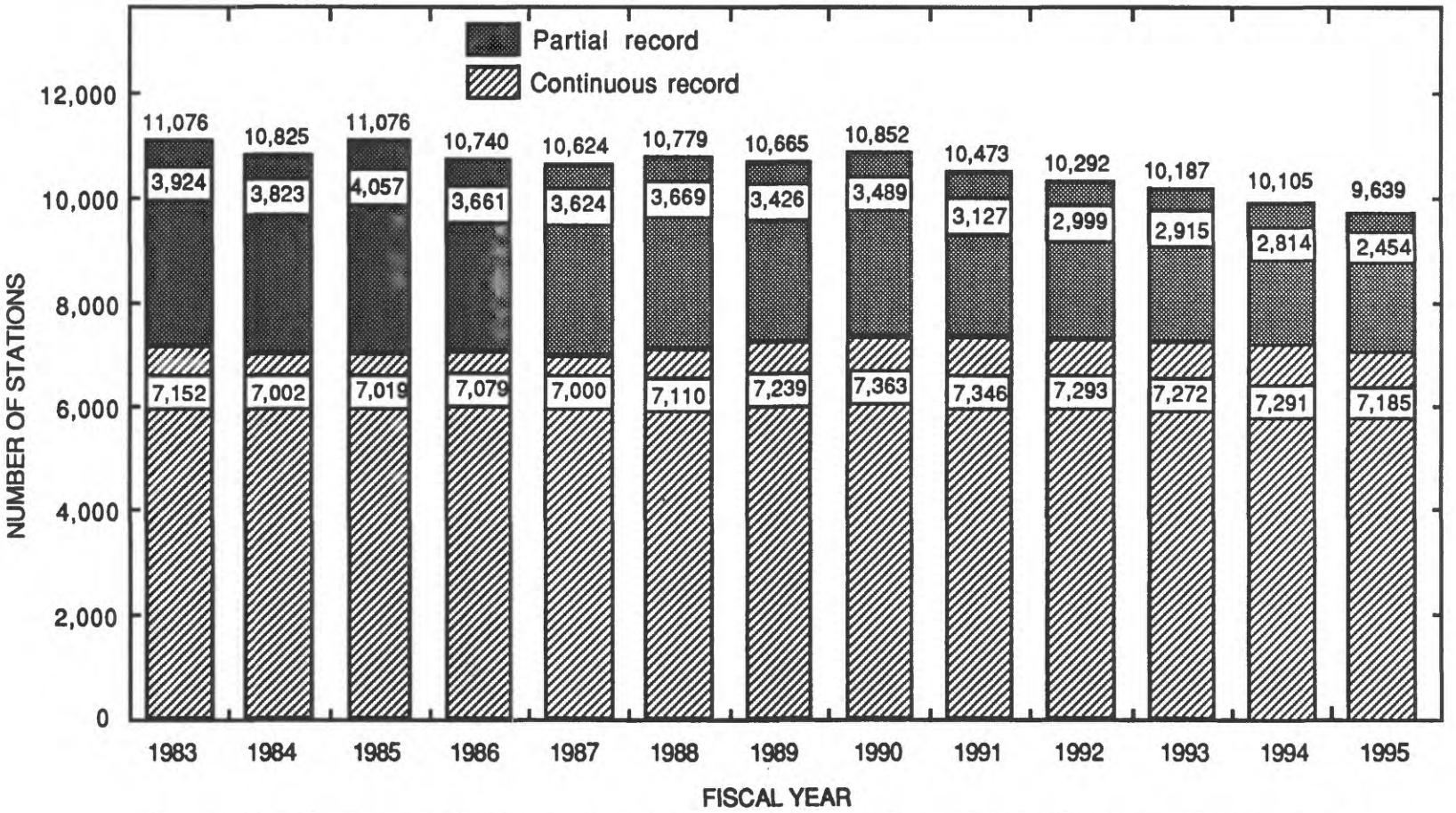


Figure 2:--Number of stations, by year, at which surface-water discharge data were collected from fiscal year 1983 to 1995.

Figure 3.--Number of stations, by state, at which stage-only data were collected on streams in fiscal year 1995.

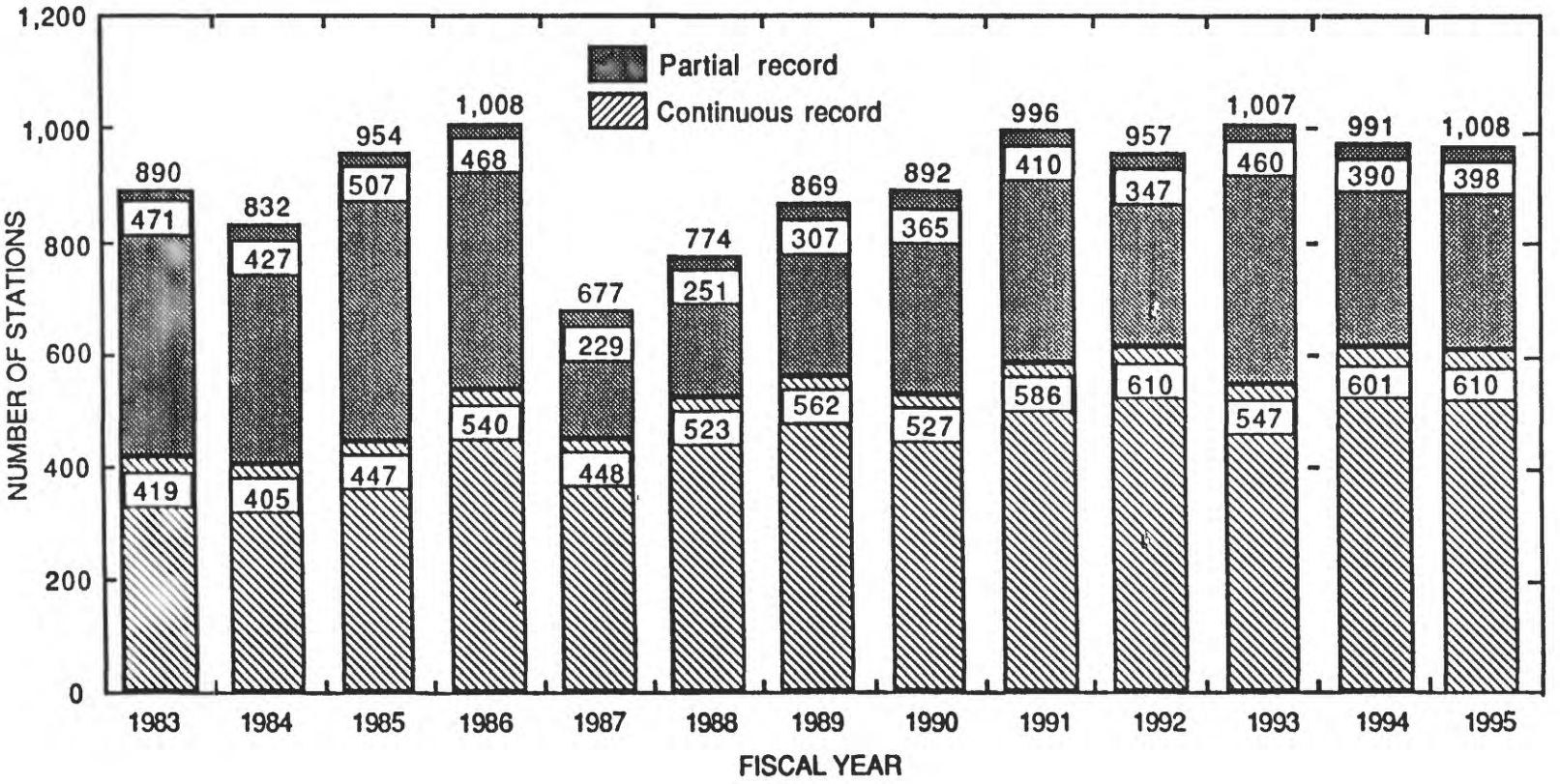


Figure 4.--Number of stations, by year, at which stage-only data were collected on streams from fiscal year 1983 to 1995.

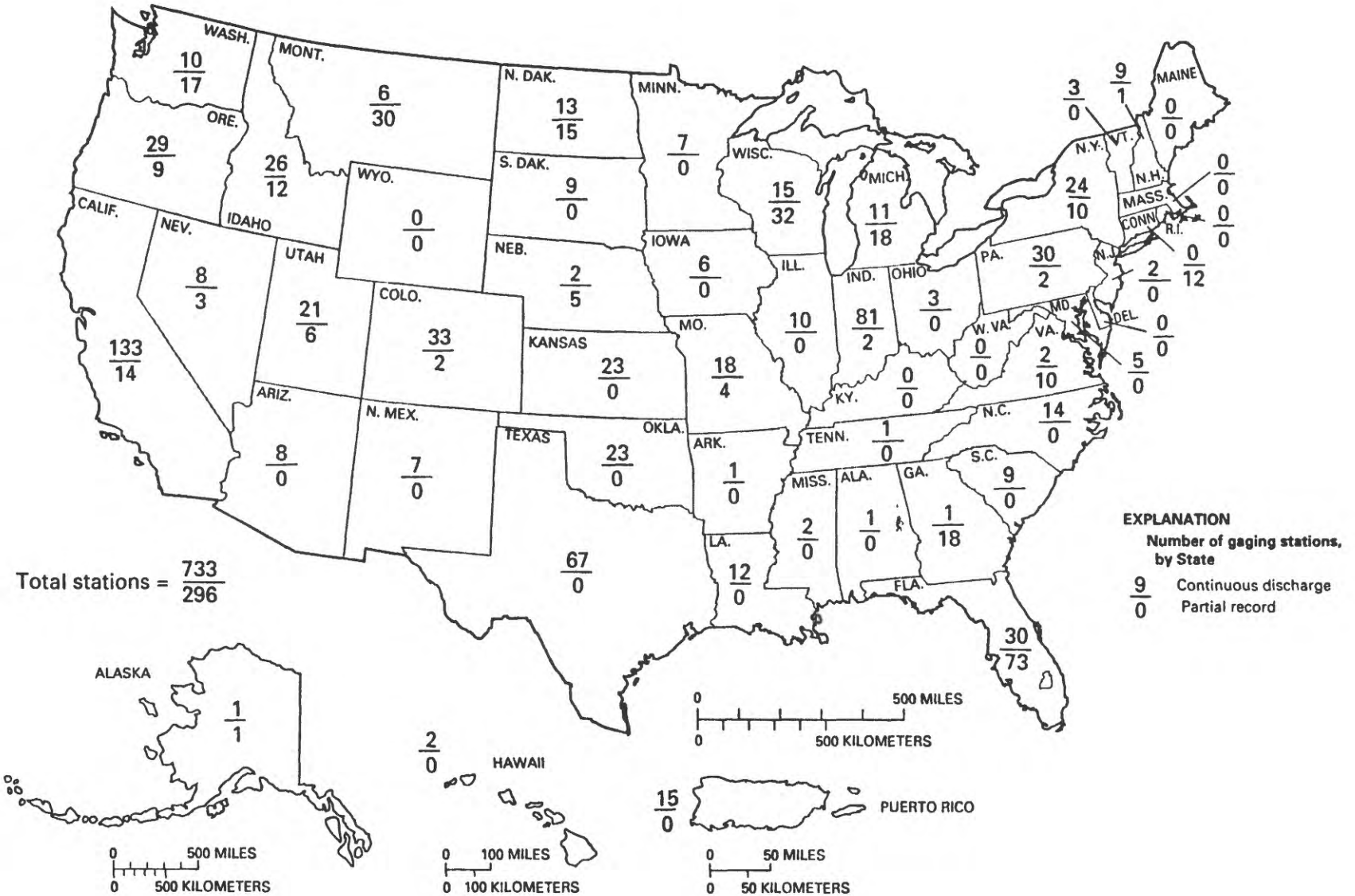


Figure 5.--Number of stations, by state, at which stage data were collected on lakes and reservoirs in fiscal year 1995.

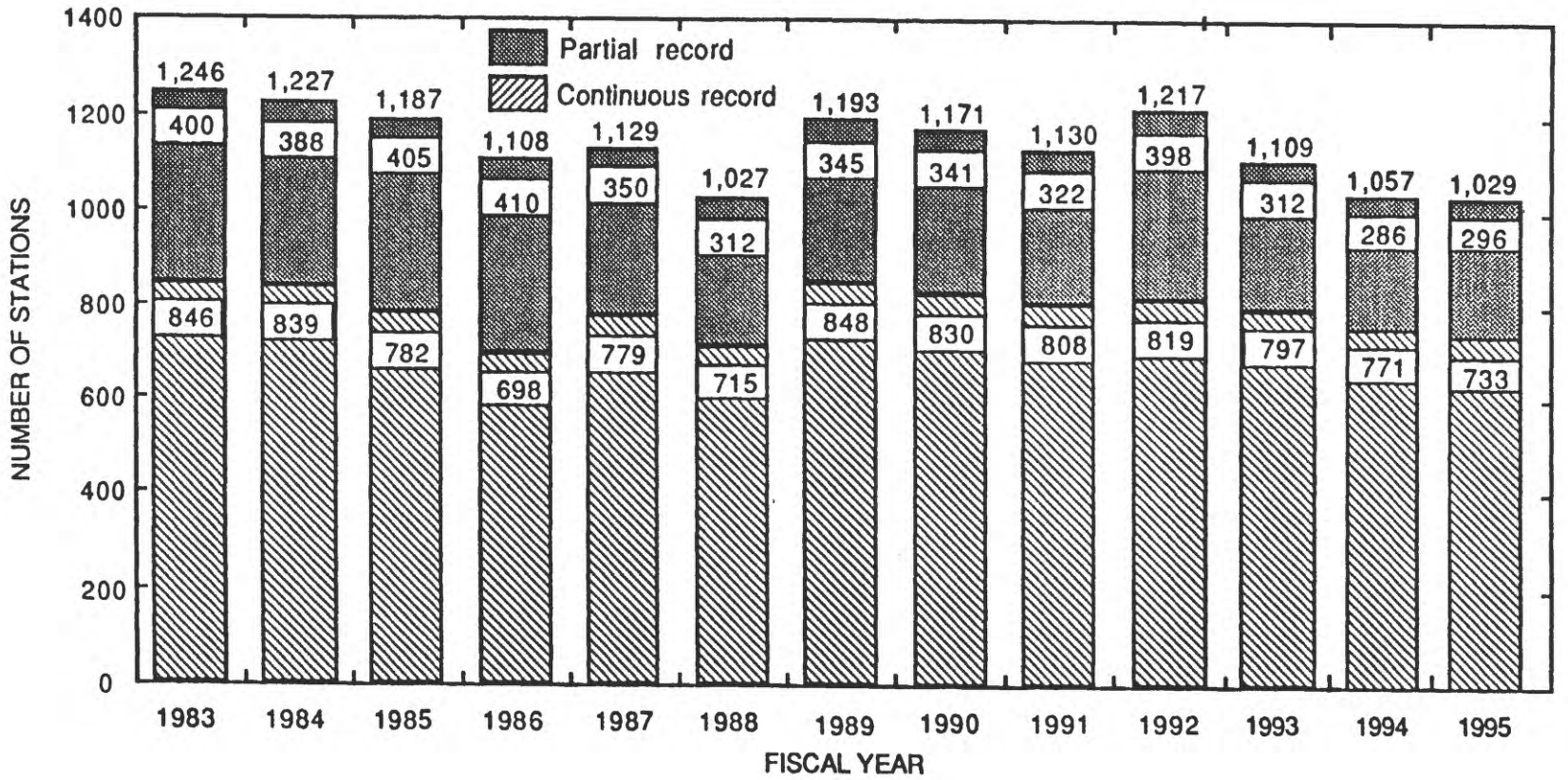


Figure 6.--Number of stations, by year, at which surface-water stage data were collected on lakes and reservoirs from fiscal year 1983 to fiscal year 1995.

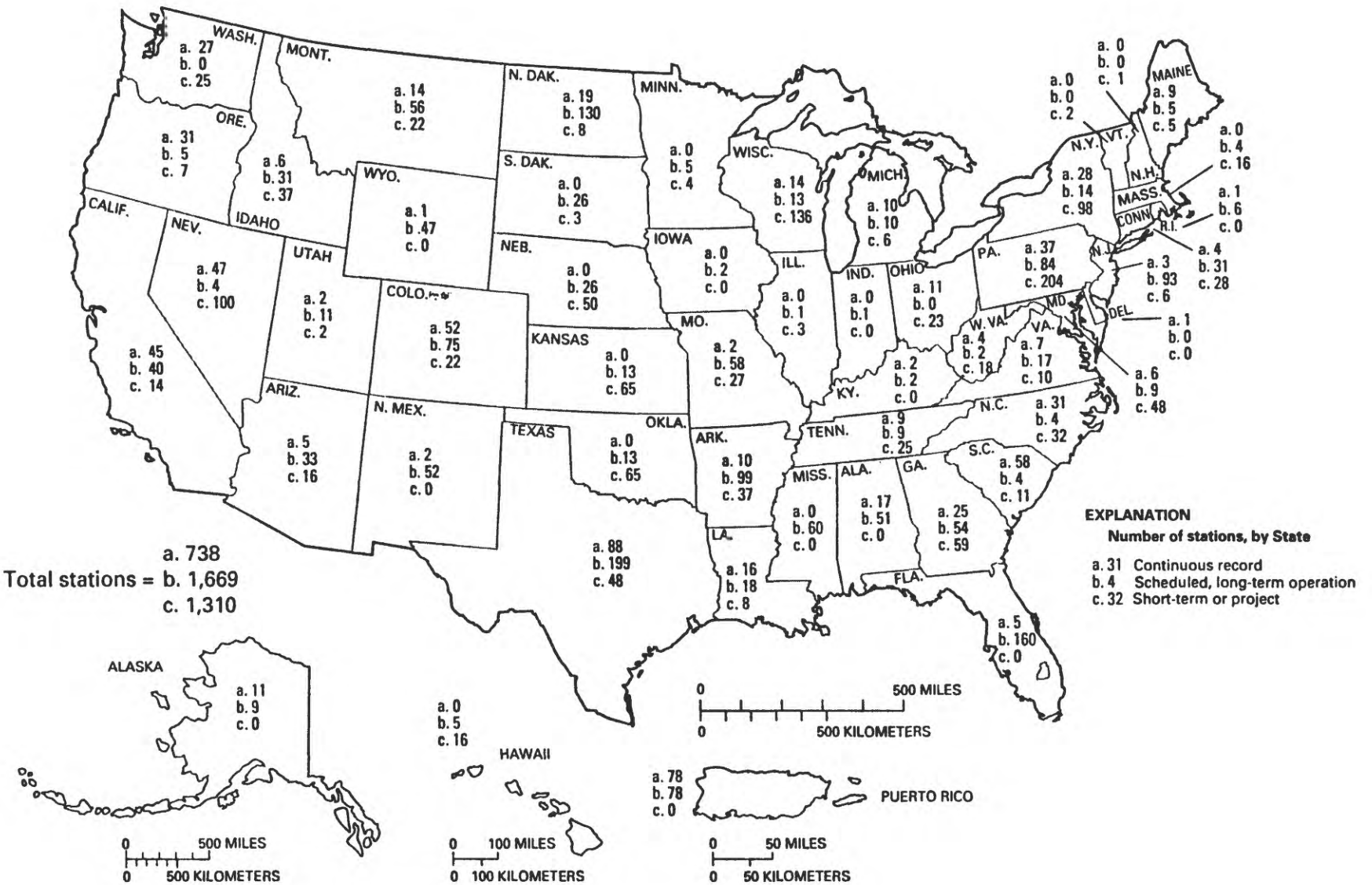
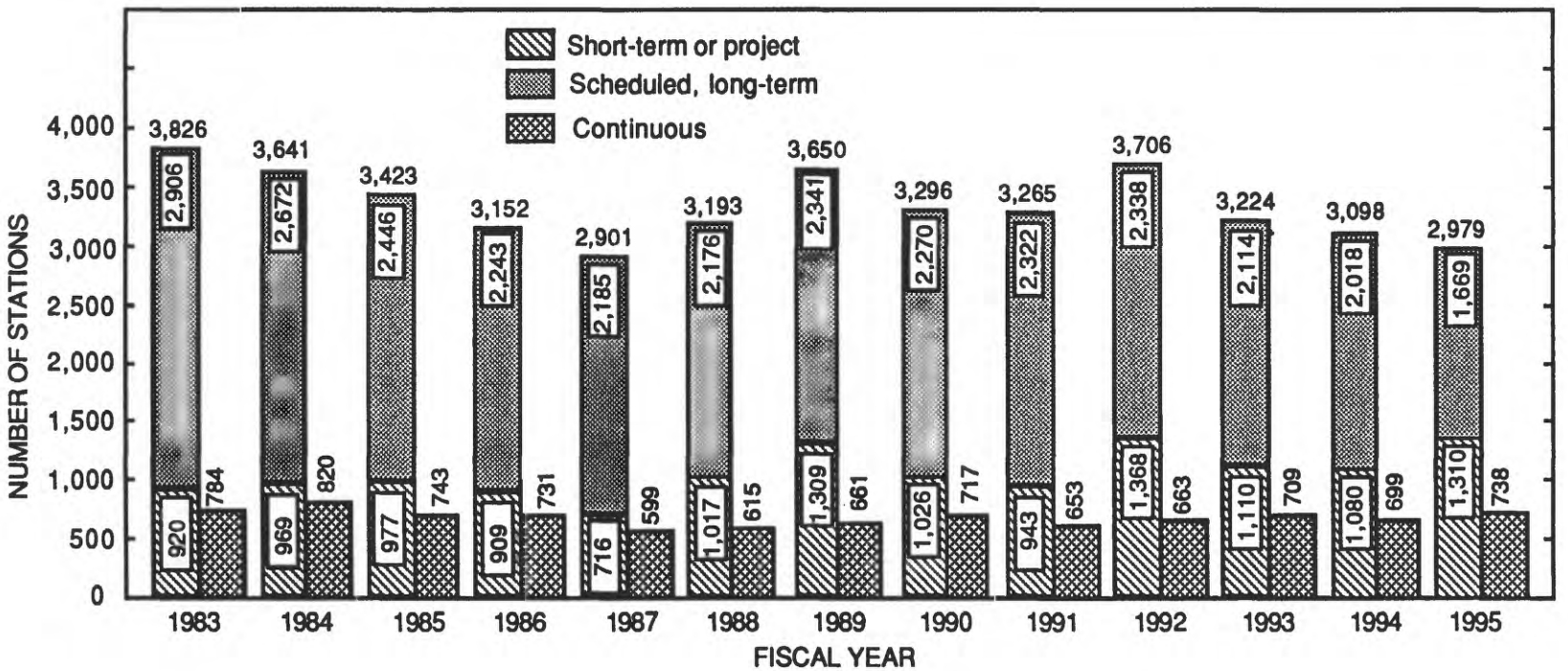


Figure 7.--Number of stations, by state, at which surface-water quality data were collected in fiscal year 1995.



NOTE: The annual totals shown reflect that the number of stations in the "continuous" category are counted in either the "scheduled, long-term" or the "short-term, or project" categories.

Figure 8.--Number of stations, by year, at which surface-water quality data were collected from fiscal year 1983 to fiscal year 1995.

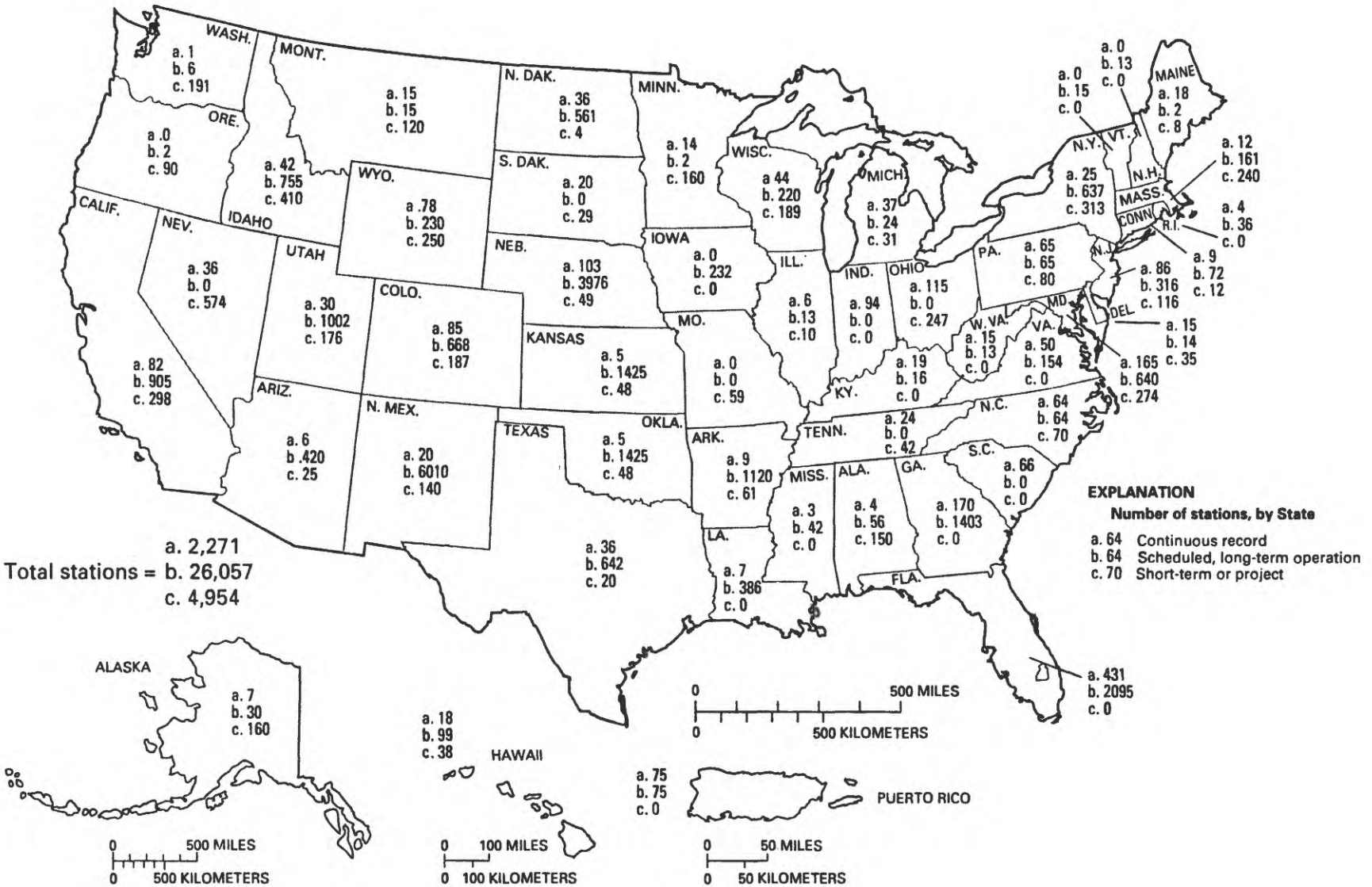
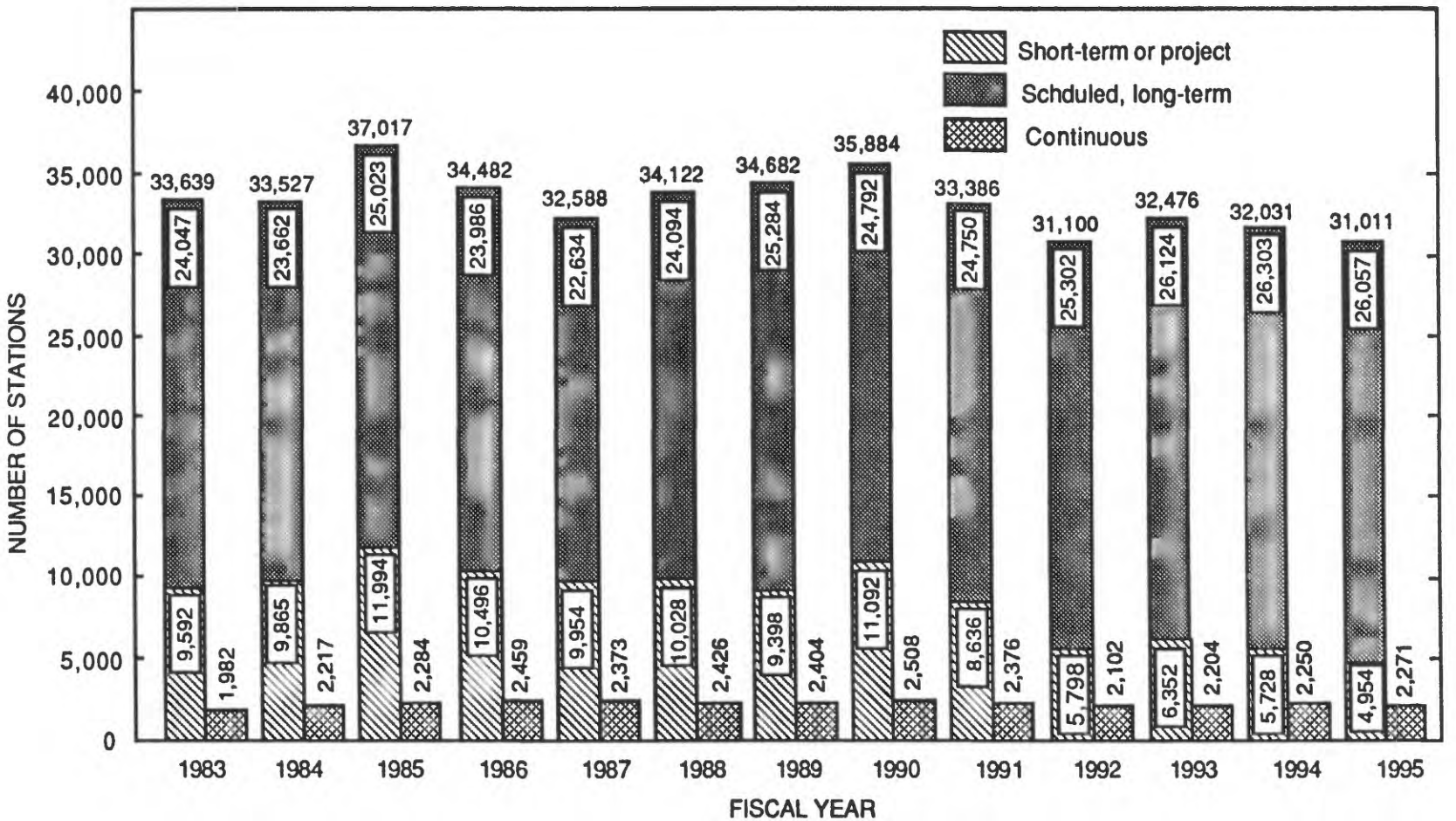


Figure 9.--Number of stations, by state, at which ground-water levels were collected in fiscal year 1995.



NOTE: The annual totals shown reflect that the number of stations in the "continuous" category are included in either the "scheduled, long-term" or the "short-term, or project" categories.

Figure 10.--Number of stations, by year, at which ground-water levels were collected from fiscal year 1983 to fiscal year 1995.

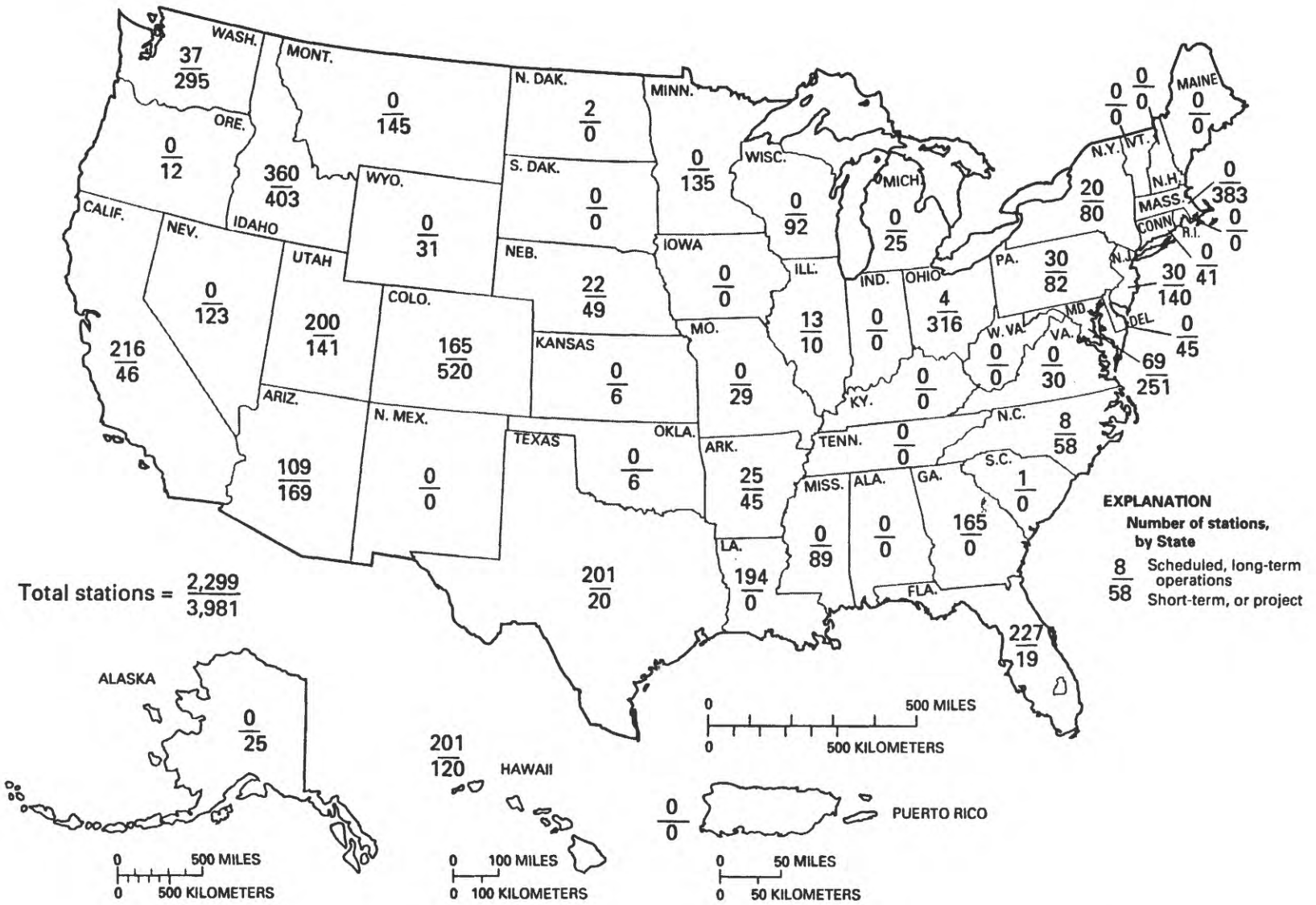


Figure 11.--Number of stations, by state, at which ground-water quality data were collected in fiscal year 1995.

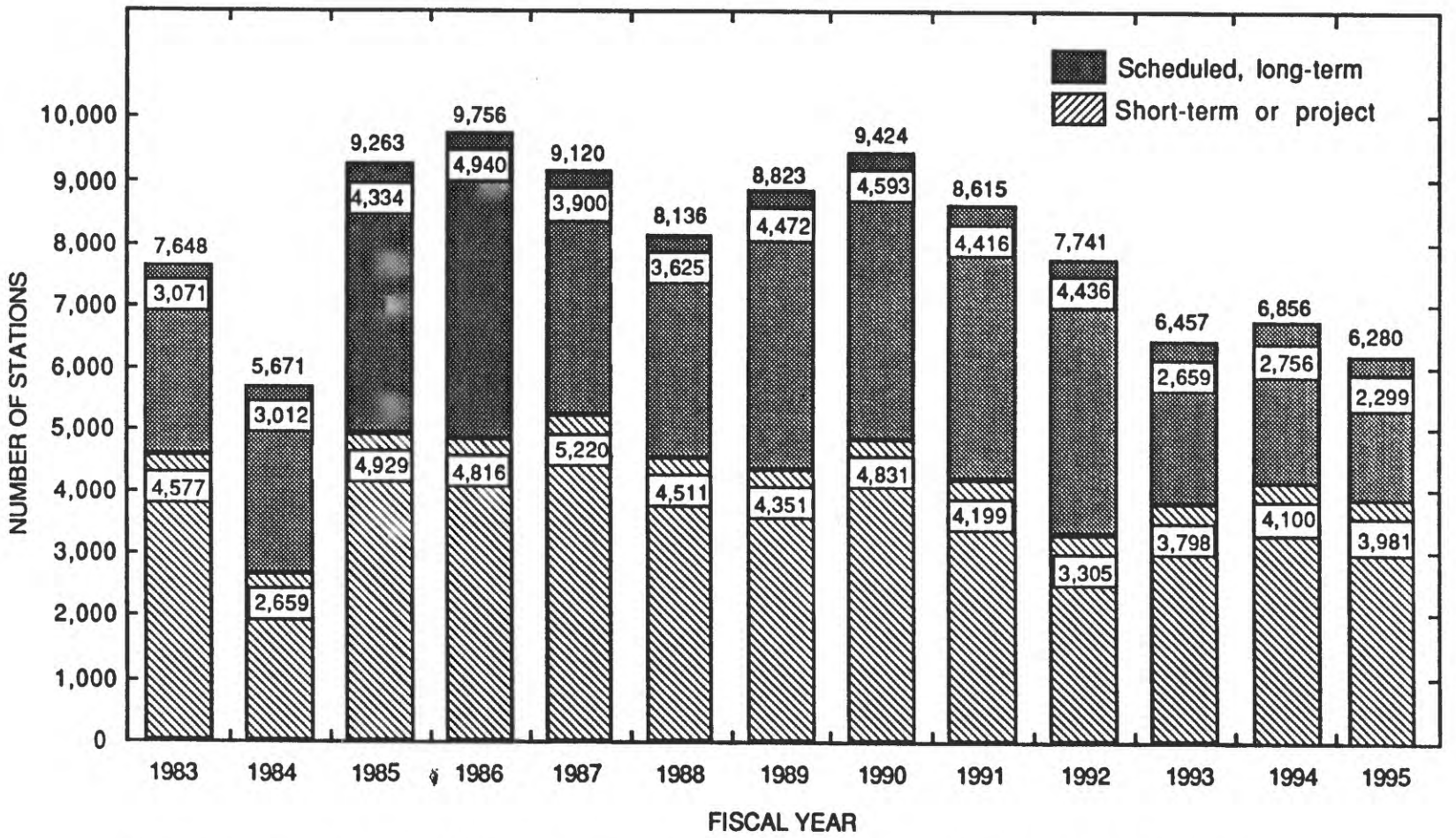


Figure 12.--Number of stations, by year, at which ground-water quality data were collected from fiscal year 1983 to fiscal year 1995.

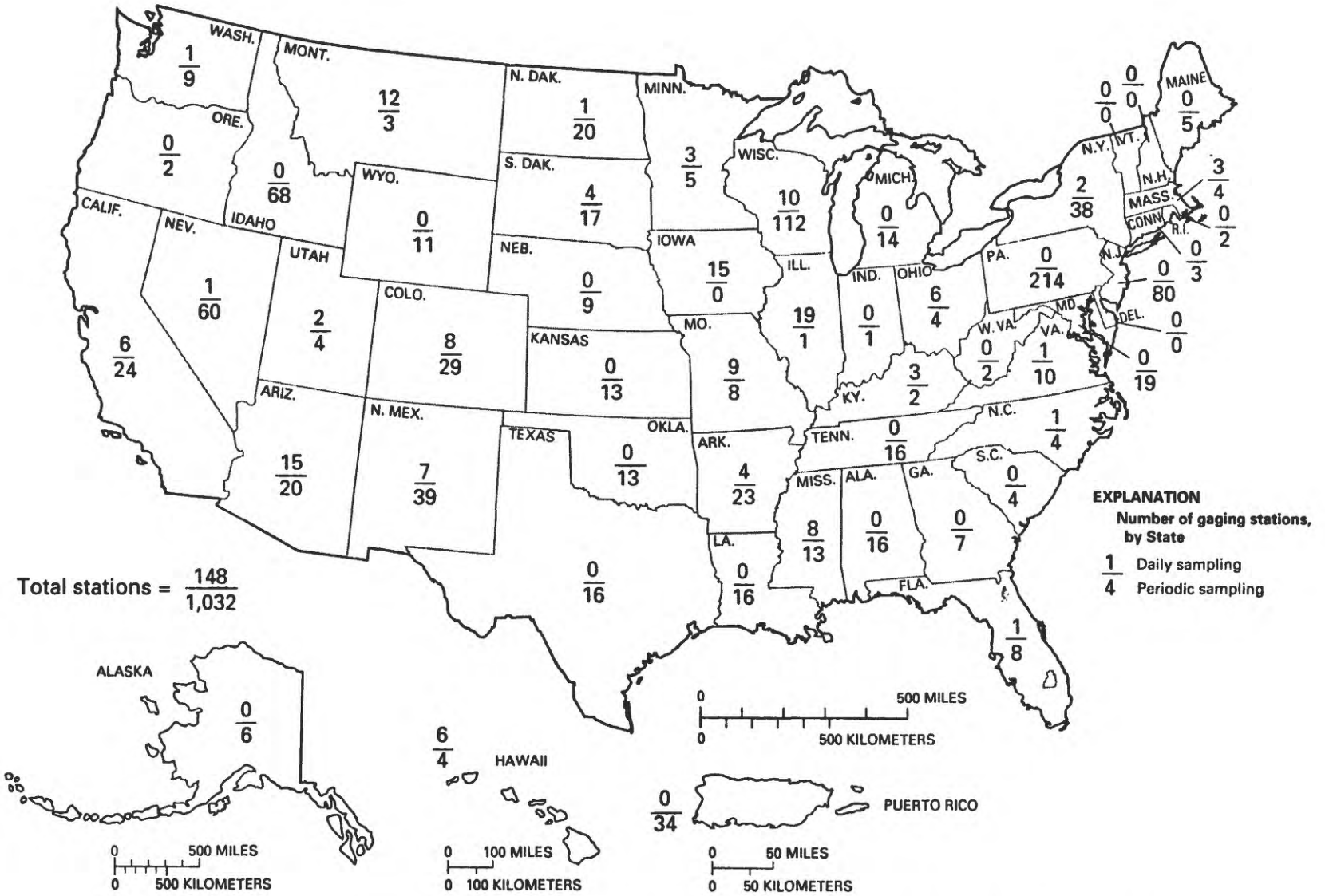


Figure 13.--Number of stations, by state, at which sediment data were collected in fiscal year 1995.

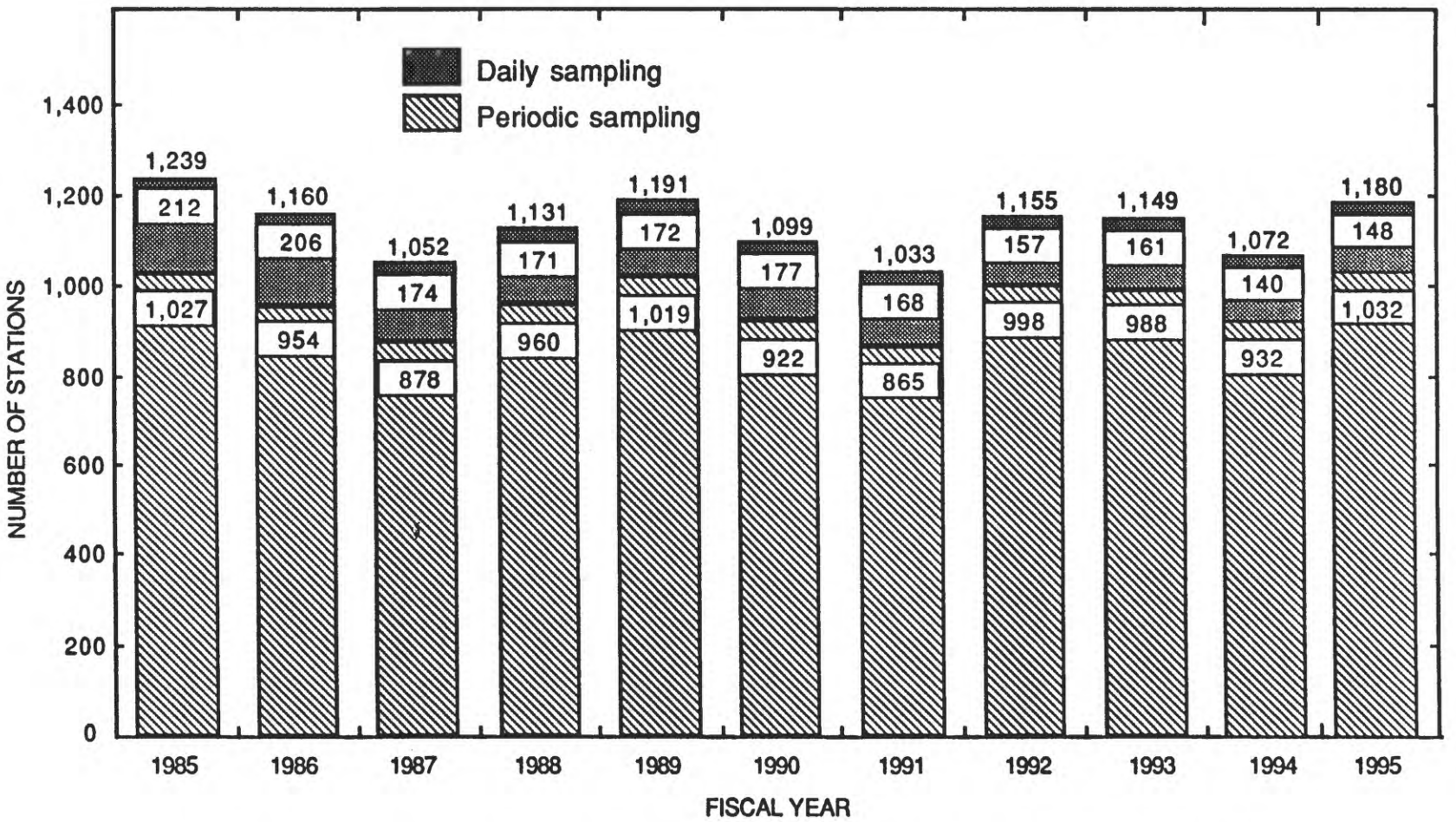


Figure 14.--Number of stations, by year, at which sediment data were collected from fiscal year 1985 to fiscal year 1995.

Figure 15.--Number of stations, by state, at which precipitation data were collected in fiscal year 1995.

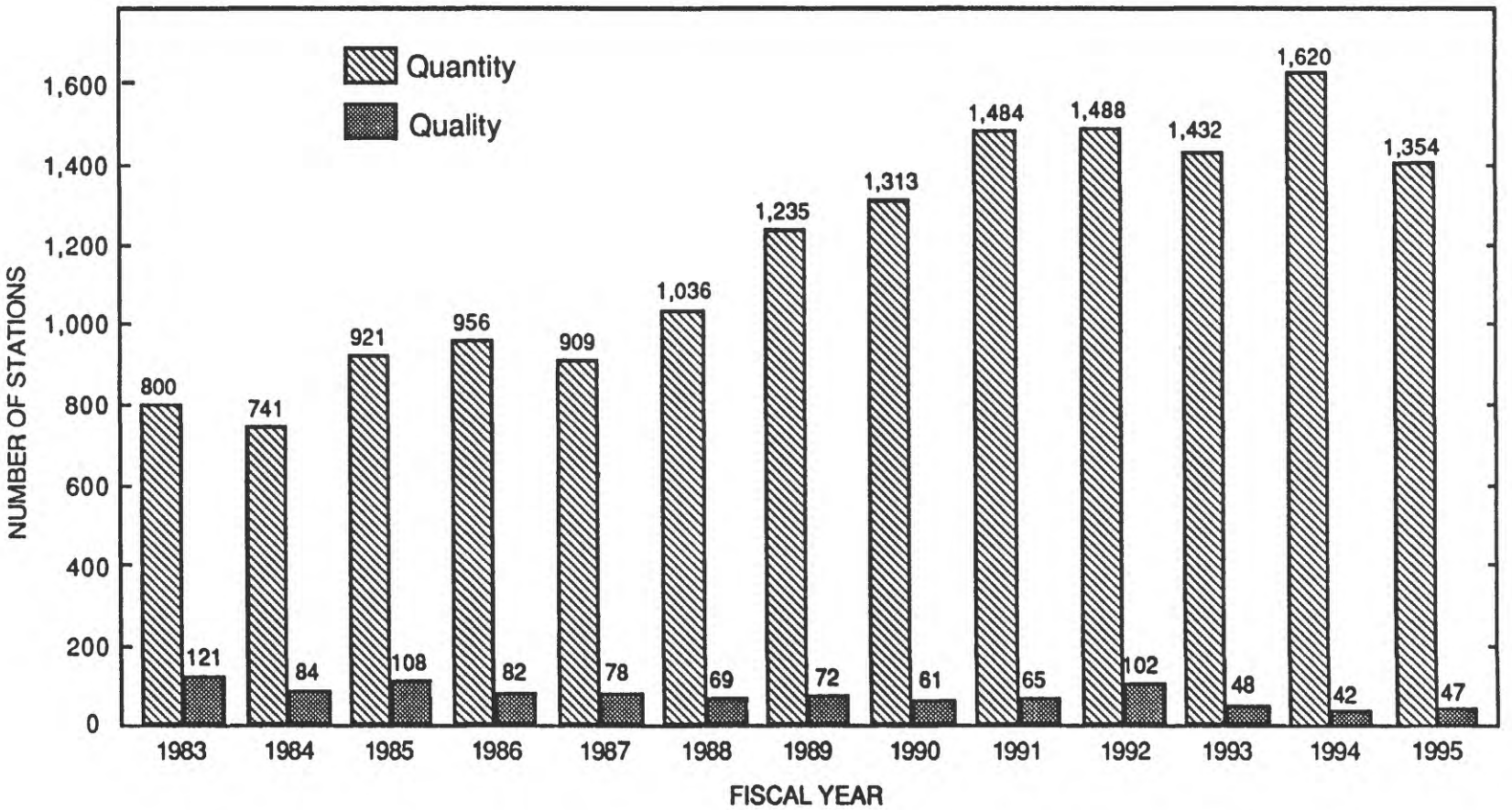


Figure 16.--Number of stations, by year, at which precipitation data were collected from fiscal year 1983 to fiscal year 1995.

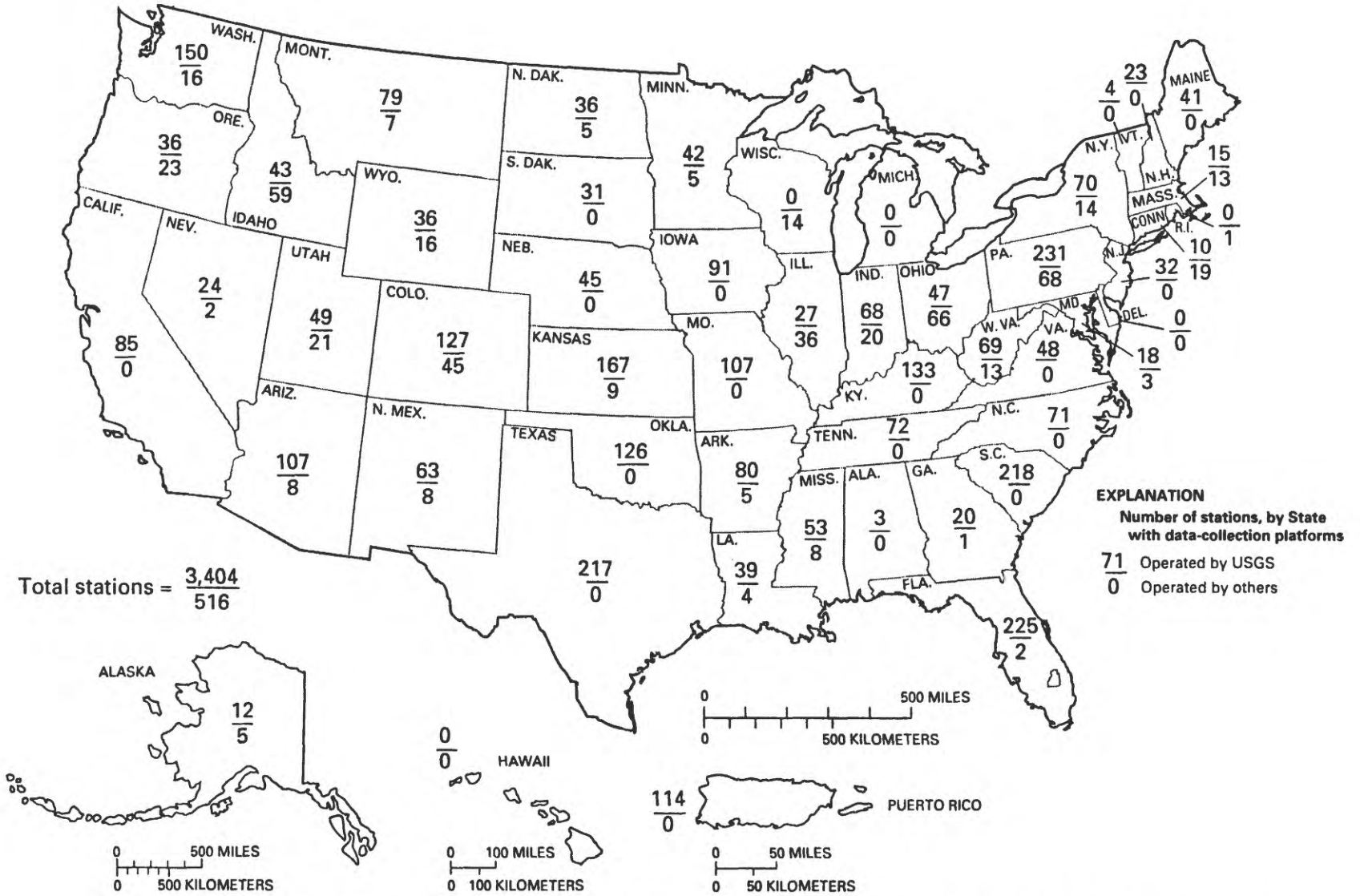
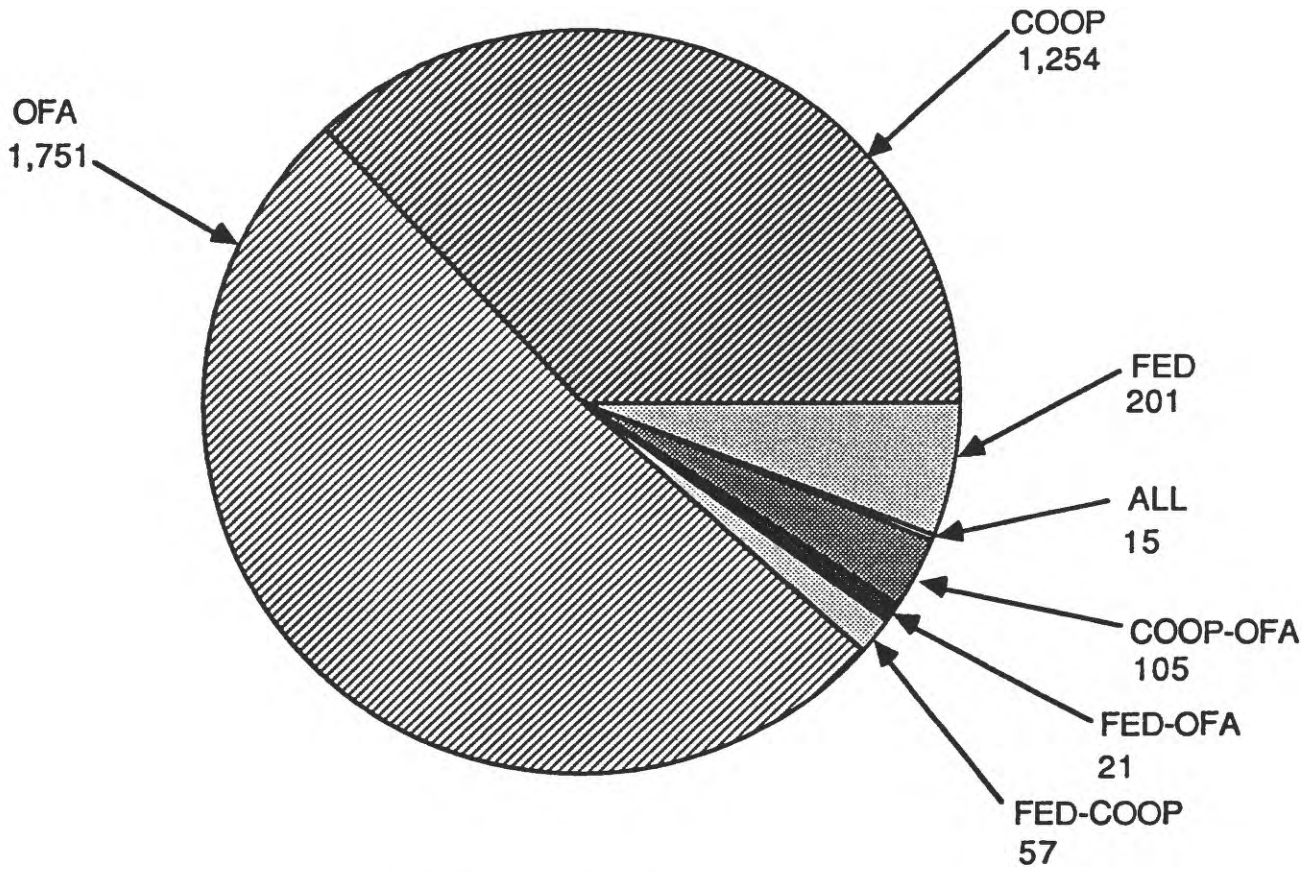


Figure 17.--Number of U.S. Geological Survey Stations, by state, at which data-collection platforms for satellite telemetry were operated in fiscal year 1995.



TOTAL STATIONS = 3,404

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
ALL = FED and OFA and COOP

Figure 18.--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 1995.

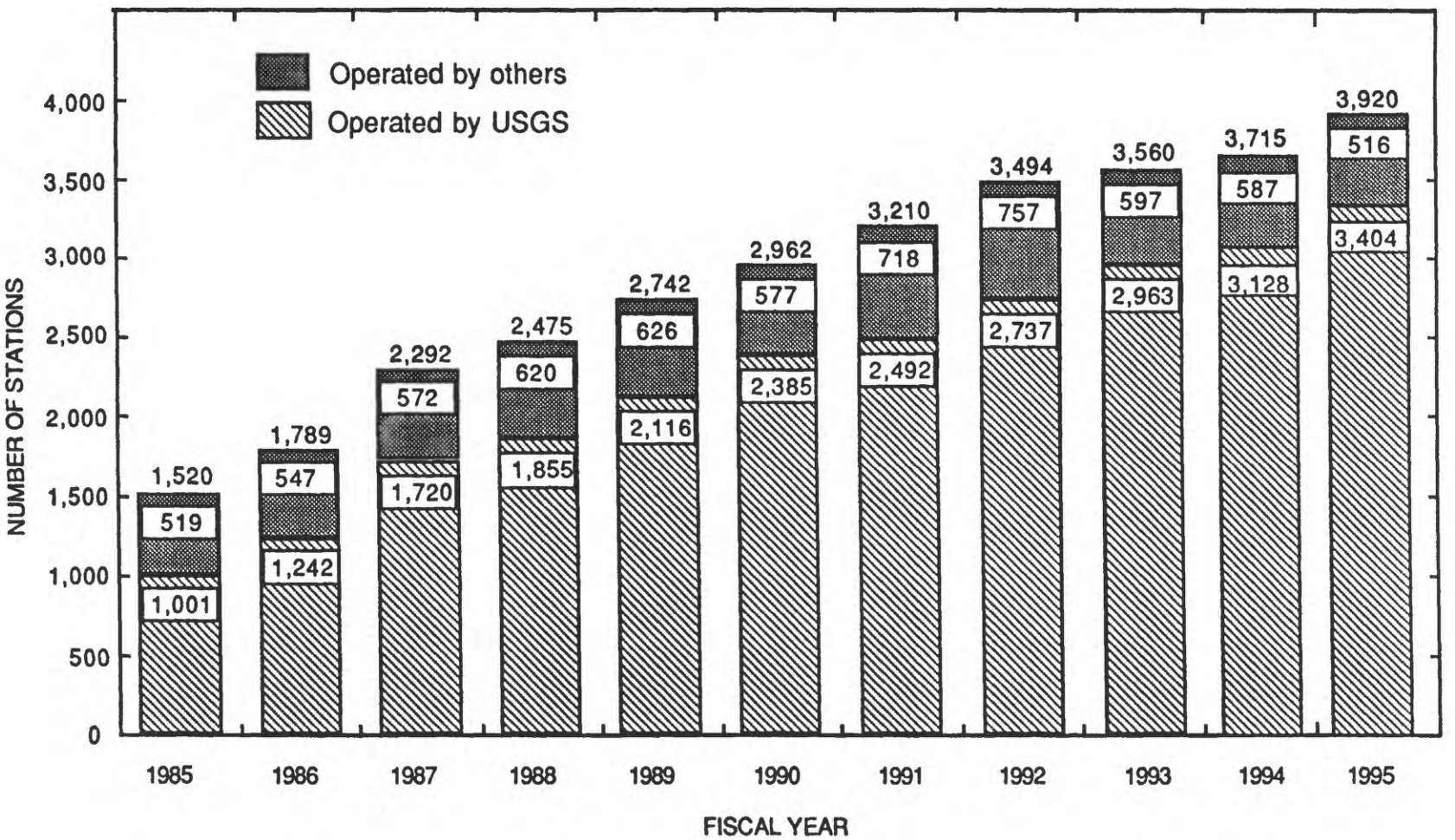


Figure 19.--Number of U.S. Geological Survey Stations, by year, at which data-collection platforms for satellite telemetry were operated from fiscal year 1985 to fiscal year 1995.