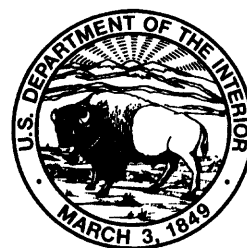


National Summary of Hydrologic Conditions and Water—Related Events—Water Year 1993

U.S. GEOLOGICAL SURVEY

Open-File Report 96-145

Reston, VA
1996



U.S. DEPARTMENT OF THE INTERIOR
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U.S. GEOLOGICAL SURVEY
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National Summary of Hydrologic Conditions and Water-Related Events— Water Year 1993

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By Gregory J. McCabe,¹ Jr., Michael Crowe,² William O. Brown,² Judy D. Fretwell,¹ and Kimberley L. Fry¹

Abstract

Surface-water conditions and many water-related events are controlled primarily by atmospheric factors. Because of this, the following annual and seasonal summaries of hydrologic conditions for water year 1993 (October 1992–September 1993) are described within a climatic context. The maps showing streamflow, precipitation, and temperature and the text provide an overview of the hydrologic conditions across the country for the water year as a whole and for each of the seasons. In addition, significant hydrologic and water-related events are described and plotted in figure 6.

The data used in preparing these summaries were taken from the following publications: the National Oceanic and Atmospheric Administration's (NOAA) "Climate Impact Assessment, United States," "Daily Weather Maps, Weekly Series," "Monthly and Seasonal Weather Outlook," "Storm Data," and "Weekly Weather and Crop Bulletin" (the last publication is prepared and published jointly with the U.S. Department of Agriculture) and the U.S. Geological Survey's (USGS) monthly "National Water Conditions". Geographic designations in this article generally conform to those used in the "Weekly Weather and Crop Bulletin" (fig. 1).

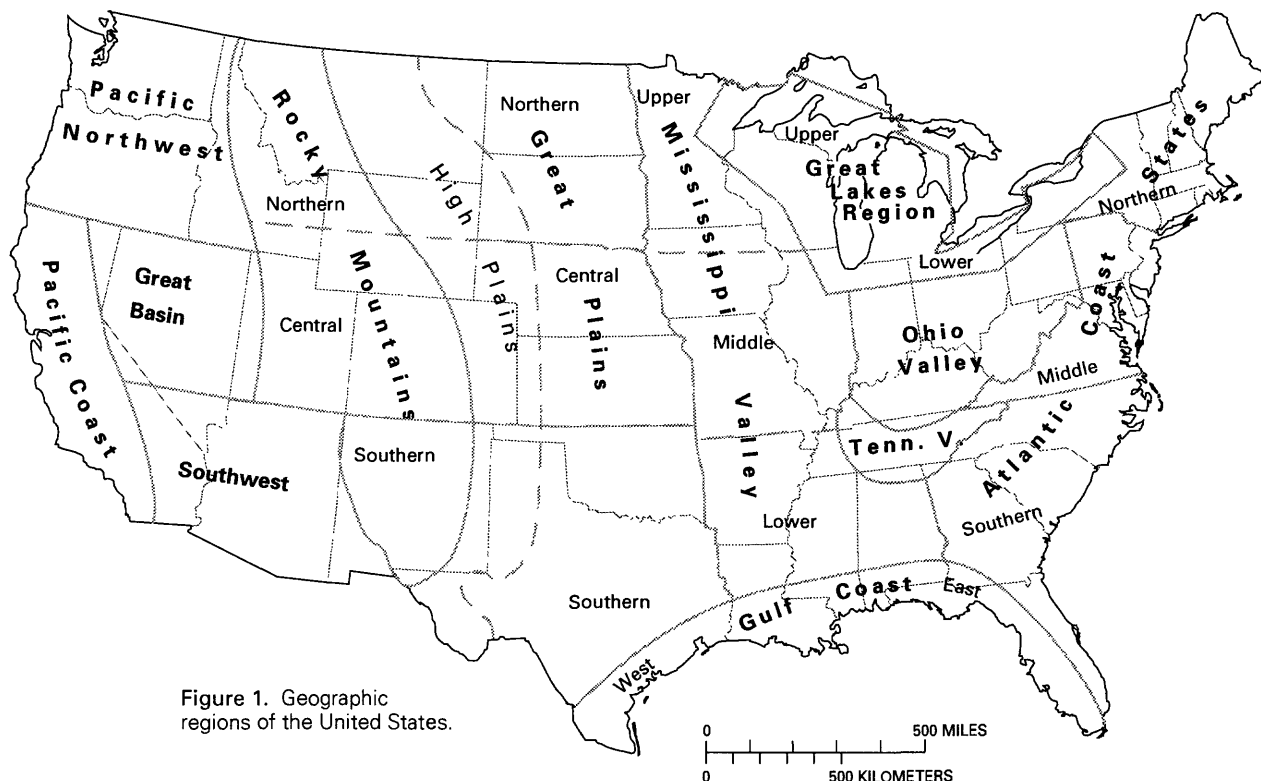


Figure 1. Geographic regions of the United States.

¹ U.S. Geological Survey.

² National Oceanic and Atmospheric Administration,
National Climatic Data Center.

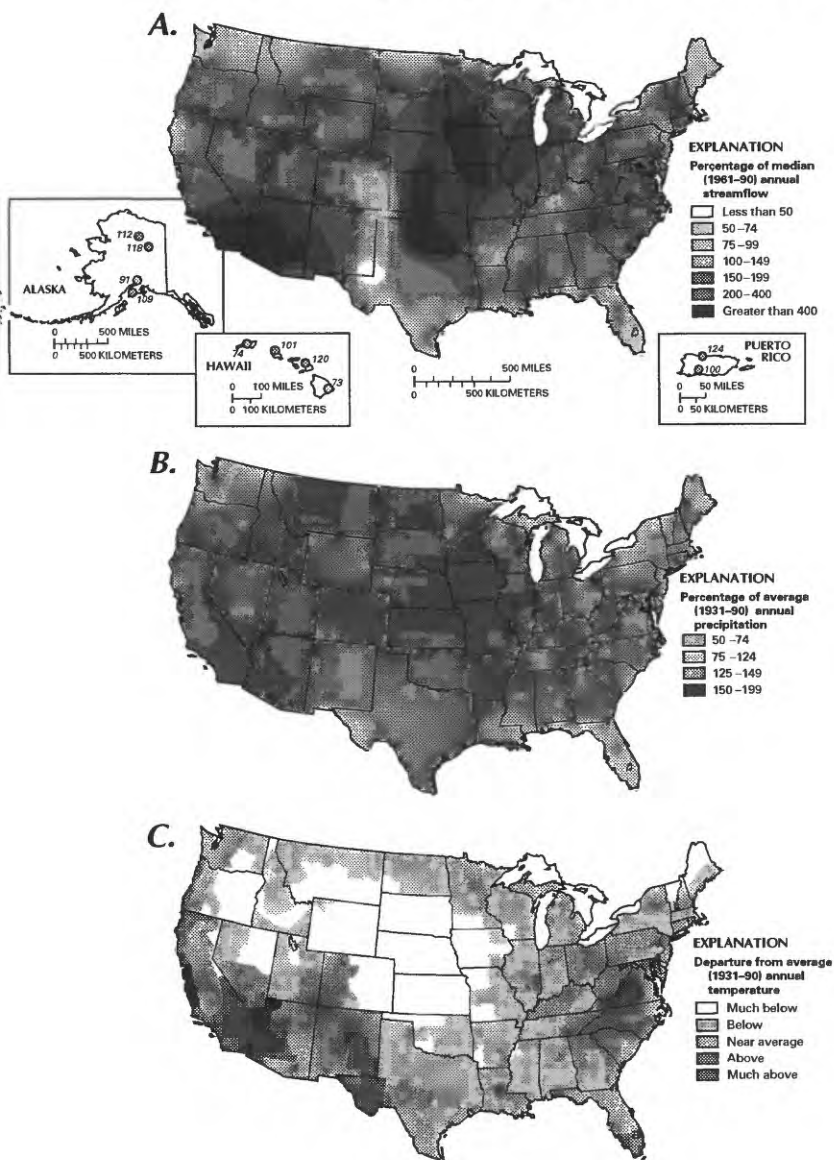


Figure 2. Hydrologic conditions during water year 1993. **A**, Streamflow in the United States and Puerto Rico; **B**, Precipitation in the conterminous United States; and **C**, Temperature in the conterminous United States. Streamflow is shown as a percentage of median streamflow, precipitation is shown as a percentage of average precipitation, and temperature is shown as a departure from average annual conditions (much below, at least 1.28 standard deviations below the average; below, between 0.52 and 1.28 standard deviations below the average; near average, between -0.52 and 0.52 standard deviations from the average; above, between 0.52 and 1.28 standard deviations above the average; and much above, at least 1.28 standard deviations above the average) (Sources: Streamflow data from U.S. Geological Survey files; precipitation data from the National Oceanic and Atmospheric Administration, National Climatic Data Center.)

Streamflow during water year 1993 was above median¹ for a large part of the conterminous United States (fig. 2A). It was above median from southern California across the Southwestern United States and into the southern Rocky Mountains, from the central and northern Great Plains through the Great Lakes region, in the northern Mississippi River Valley, and in the Appalachian Mountains of the Atlantic States. It was below median in western Washington, parts of the High Plains, and in southern Florida.

Several major weather events contributed to the above-median streamflow in much of the country. A December storm produced heavy snow and rainfall from Virginia to New York and Massachusetts and caused flooding in many coastal areas (event 16 in the chronology section of this article). At the other end of the country, a series of storms during January caused flooding from New Mexico to California—the worst in history in Arizona (events 32 and 33).

The most prominent weather event of water year 1993 was the above-average² precipitation and subsequent flooding that was recorded in the Central United States during the spring and summer. By the middle of June, the upper Mississippi River and its tributaries had risen above flood stage. As rainfall continued throughout the summer, it caused severe flooding—the highest of record for many locations and the highest in decades for others.

Annual precipitation was much above average along the southern Pacific Coast and in the Southwest, the northern Rocky Mountains, the northern and central Great Plains, the upper and middle Mississippi Valley, the western Great Lakes region, and the western Ohio Valley (fig. 2B). Annual precipitation was much below average in the Pacific Northwest along the Cascade Mountains.

Annual mean temperatures were below average in a large area extending from the Northwestern United States to the Southeast and were centered over Nebraska and Kansas, which experienced persistently low temperatures throughout the year (fig. 2C). Annual mean temperatures were three or more standard deviations below average in northwestern Kansas and northeastern Colorado. Nearly one-fourth of the country experienced much-below-average annual mean temperatures. These extremely low annual temperatures were attributed to above-average cloud cover and above-average precipitation. The Pacific Coast, the Southwest, parts of the southern Great Plains, southern Florida, and parts of the Middle Atlantic States experienced above-average annual mean temperatures.

The regional and local patterns of hydrologic conditions can be seen in the graphs of monthly discharges for selected rivers and month-end storage of selected reservoirs in the conterminous United States (figs. 3, 4). For example, the month-end reservoir storage of the Pine Flat Lake reservoir in California [fig. 4 (1)] and the Boise River reservoir in Idaho [fig. 4 (2)] indicate the end of drought conditions that had existed in many parts of the Western United States. Storage in these reservoirs rose from below average at the beginning of water year 1993 to above average during the middle and end of the water year. Other western reservoirs, such as the Hungry Horse Reservoir in Montana [fig. 4 (3)], still had below-average storage at

¹Median is the value that represents the point where as many values exist above the point as exist below the point, and average is the value determined by dividing the sum total of a set of values by the number of values.

²Average is the value determined by dividing the sum of the values by the number of values.

Annual Summary of Hydrologic Conditions and Events—cont.

the end of water year 1993; however, the levels had risen significantly from 1992 levels. River discharge records also reflect the end of the drought in parts of the Western United States. River discharge measured on the Sacramento River at Verona, Calif. [fig. 3 (1)], indicates above-normal flow for water year 1993 and shows the effect of increased precipitation.

The above-average precipitation and flooding that took place in the Central United States during water year 1993 are illustrated by the above-average discharges of several rivers—the Cannonball River at Breien, N. Dak., the Little Blue River near Barnes, Kans., the Des Moines River at Fort Dodge, Iowa, and the Fox River at Rapide Croche Dam near Wrightstown, Wis.—for most of the water year. The above-average month-end contents of the Mississippi River Headwaters System reservoirs in Minnesota for water year 1993 also reflect the above-average precipitation.

During water year 1993, many significant water-related natural and human-induced events were recorded, and the

geographic locations are plotted in figure 6. The events described represent a culling of hundreds of these hydrologic occurrences and generally omit, for example, floods for which the recurrence interval is less than 10 years, toxic spills that involve less than 2,500 gallons, and fishkills of fewer than 5,000 fish. The selection of events for inclusion in this list was affected, to some extent, by the degree of media coverage, including National Weather Service and USGS periodicals, and by communications from USGS field offices alerting the national office about significant hydrologic events. Toxic-spill data were provided by the U.S. Coast Guard National Response Center. Reporting of weather-related events and damage estimates is subjective; therefore, the list might be inconsistent with other national compilations of hydrologic events, such as the annual flood-damage report to Congress by the U.S. Army Corps of Engineers (1993). Floods were estimated to have caused damages in excess of \$16 billion, exceeding any previous year of record (U.S. Army Corps of Engineers, 1993).

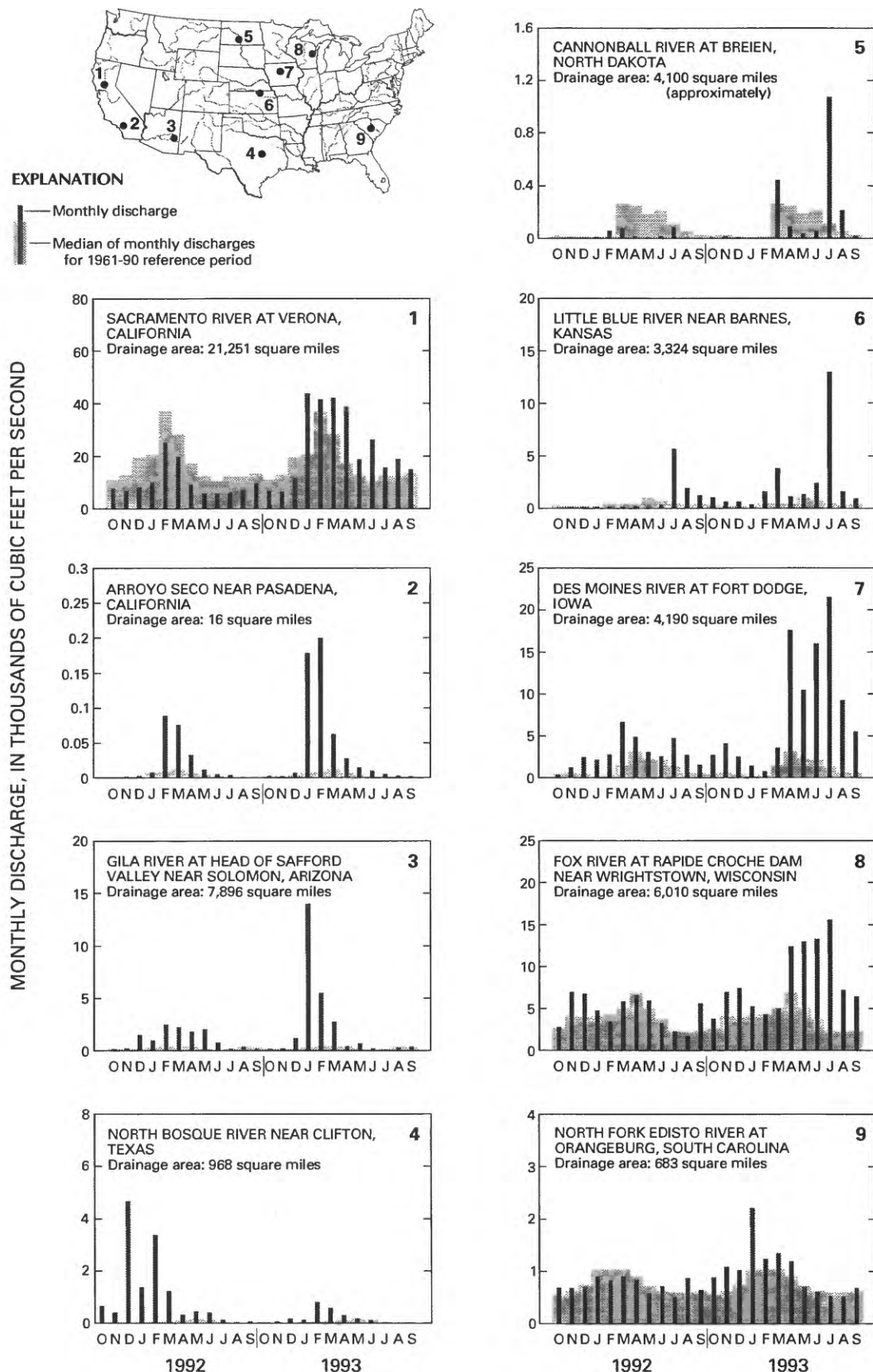


Figure 3. Monthly discharges for selected major rivers of the conterminous United States for water years 1992 and 1993 compared with monthly median discharges for the reference period water years 1961 to 1990.^a The locations of individual discharge points are shown on the map.

^a To obtain square kilometers, multiply the number of square miles by 2.59.

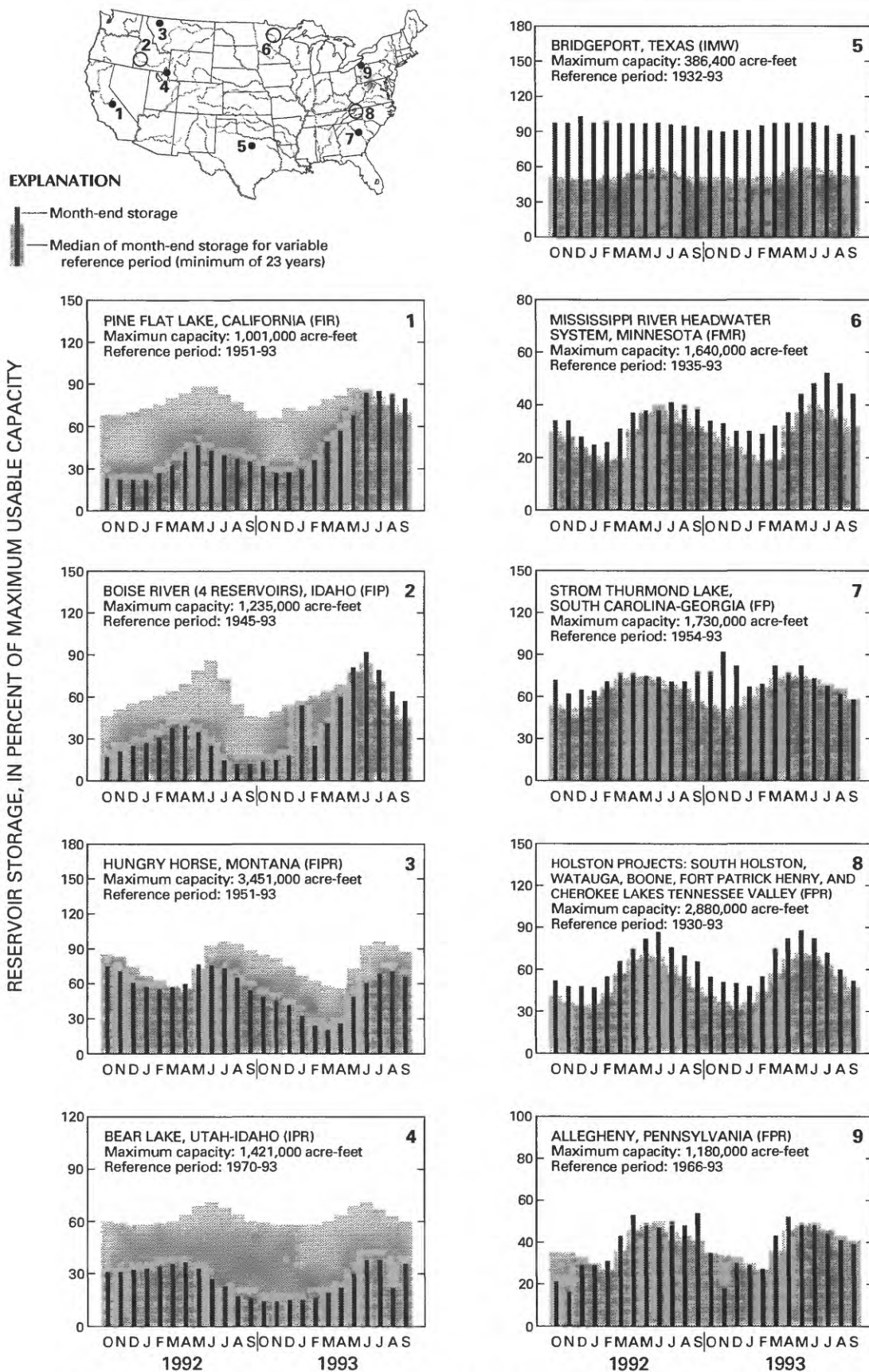


Figure 4. Month-end storage of selected reservoirs in the conterminous United States for water years 1992 and 1993 compared with median month-end storage for the reference period. The reference period, which varies but is a minimum of 20 years for each reservoir or reservoir system, is shown on the graph. The locations of individual reservoirs are shown on the map by black dots; the location of general reservoir systems (multireservoirs) are shown by open circles. Principal reservoir and water uses are shown in parentheses—F, flood control; I, irrigation; M, municipal; P, power; R, recreation; and W, industrial.^a (Source: Data from USGS files.)

^a To obtain cubic meters, multiply acre-feet by 1,233.

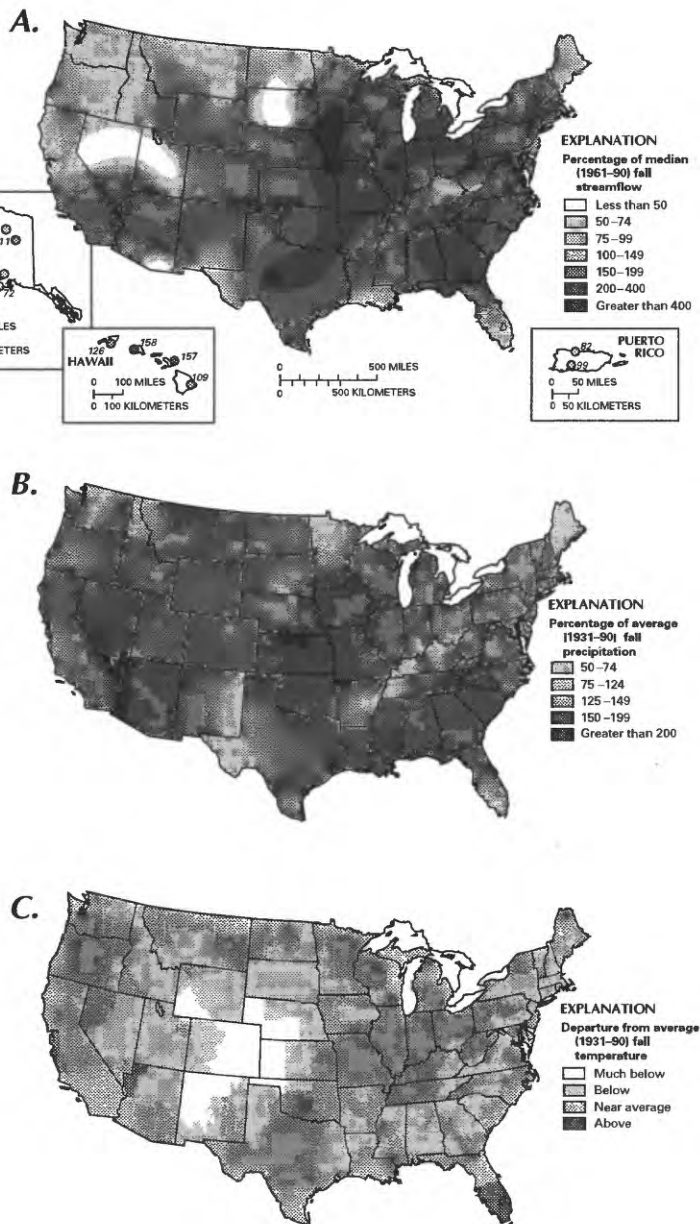


Figure 5. Hydrologic conditions—Fall, water year 1993.

A. Streamflow in the United States and Puerto Rico; **B.** Precipitation in the conterminous United States; and **C.** Temperature in the conterminous United States. Streamflow is shown as a percentage of median streamflow, precipitation is shown as a percentage of average precipitation, and temperature is shown as a departure from average annual conditions (much below, at least 1.28 standard deviations below the average; below, between 0.52 and 1.28 standard deviations below the average; near average, between -0.52 and 0.52 standard deviations from the average; above, between 0.52 and 1.28 standard deviations above the average; and much above, at least 1.28 standard deviations above the average) (Sources: Streamflow data from U.S. Geological Survey files; precipitation data from the National Oceanic and Atmospheric Administration, National Climatic Data Center.)

Streamflow from October through December 1992 was below median for much of the Western United States (fig. 5A). Below-median streamflow was recorded in most of the Pacific Northwest, the northern and central Rocky Mountains, and the northern Great Basin. The below-median streamflow in the Western United States was reflected in the flow of the Columbia River, which exhibited the third lowest December flow on record; the flow had been below median for 8 consecutive months. In addition, by the end of fall, the Lake Tahoe Reservoir, which straddles California and Nevada, had no usable storage for the 28th consecutive month. In contrast, streamflow was above median in the area from the southern Great Plains northeastward through the Great Lakes region and in the South Atlantic States, the lower Mississippi Valley, and southern Florida. Streamflow in the St. Lawrence River was the highest flow ever recorded for December.

Although dry conditions persisted in parts of the Western United States, many parts of the Eastern United States were wetter than average. In early October, rain that fell in a 25-mile-wide band across southern South Carolina caused serious flooding. Later that month, the first major winter storm hit the Pacific Coast and dropped several inches of rain in northern California and up to 30 inches of snow in the mountains near Lake Tahoe.

November was a stormy month from the Rocky Mountains eastward. Wetter-than-average conditions in many parts of the Eastern United States were reflected by above-average cloudiness in many areas. November 1992 was the fourth wettest November on record for the Nation.

Most of the extreme precipitation events during fall 1992 took place in December. A strong storm produced hurricane-force winds that hit south-central Alaska. By the end of the calendar year Juneau had experienced its second wettest year on record. Strong winter storms moved across California and produced as much as 8 feet of new snow in the Sierra Nevadas, which resulted in snow accumulations of as much as 15 feet in some places and a December snow/water content level of as much as 183 percent of normal. Precipitation during the second week of December provided from 150 to 300 percent of the average December precipitation in California and caused flooding and fatalities. In mid-December, Hawaii's western islands were inundated by heavy rains. In Lihue, on the island of Kauai, nearly 15 inches of rain fell during a single storm.

During December, heavy snowfall in some areas of the Pacific Northwest indicated a weakening of drought conditions there. Three counties in Idaho received more snow from two major winter storms than had been recorded in December during the last 50 years. In Spokane, Wash., a total of 40.2 inches of snow was recorded, which made December 1992 the second snowiest on record.

December also was a wet month for areas of the Eastern United States. A slow-moving storm caused record and near-record flooding in New Jersey, as much as 3 feet of snow from eastern West Virginia to western Massachusetts, and as much as 18 inches of rain in parts of New York and New Jersey. As the storm hit coastal Massachusetts, it produced strong winds, higher-than-average tides, intense rainfall, and flooding.

Fall precipitation was above average in three large areas from the central Gulf Coast to the South Atlantic States, from the southern Great Plains to the Great Lakes region, and in the Southwest (fig. 5B). Parts of Arizona,

Kansas, and Nevada had more than twice their average fall precipitation. About 10 percent of the conterminous United States had seasonal precipitation amounts that were much above average.

A ridge of high pressure over the Western United States during October brought above-average temperatures to parts of California and Arizona. During December, cold air pushed into the northern Great Plains and caused temperatures to drop. Seasonal mean temperatures were below average over two large

areas, one area extending from parts of the Great Basin and the Pacific Northwest to the Great Plains and the upper Mississippi Valley and the other, from parts of the southern Great Plains to the Atlantic States (fig. 5C). Fall temperatures were much below average from the southern Rocky Mountains to the central Great Plains. Only southern Florida and parts of the Southwest and the Pacific Coast had a moderately warm season.

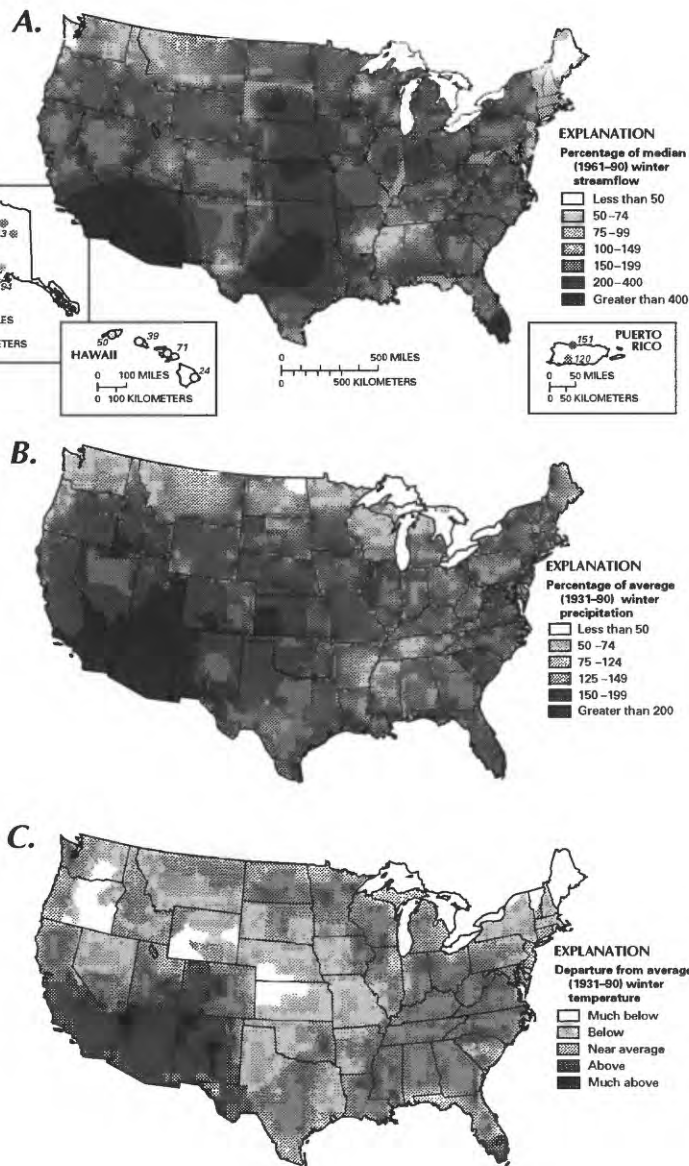


Figure 6. Hydrologic conditions—Winter, water year 1993.

A. Streamflow in the United States and Puerto Rico; **B.** Precipitation in the conterminous United States; and **C.** Temperature in the conterminous United States. Streamflow is shown as a percentage of median streamflow, precipitation is shown as a percentage of average precipitation, and temperature is shown as a departure from average annual conditions (much below, at least 1.28 standard deviations below the average; below, between 0.52 and 1.28 standard deviations below the average; near average, between -0.52 and 0.52 standard deviations from the average; above, between 0.52 and 1.28 standard deviations above the average; and much above, at least 1.28 standard deviations above the average) (Sources: Streamflow data from U.S. Geological Survey files; precipitation data from the National Oceanic and Atmospheric Administration, National Climatic Data Center.)

Streamflow from January through March 1993 was above median from the Southwest to the Great Lakes region and the Ohio Valley, as well as in the Middle and Southern Atlantic States (fig. 5A). Streamflow was below median in parts of the North Atlantic States, the northern and central Rocky Mountains, and parts of the Pacific Northwest. The flow of the Columbia River increased by 140 percent during March from that for February and was in the normal range after being in the below-normal range for 10 consecutive months. Although moisture conditions improved in some areas, by late winter, the contents of the Lake Tahoe Reservoir had no usable storage for the 31st consecutive month.

Beginning in late December 1992, a series of storms that lasted until late January caused flooding in parts of Arizona and California. The statewide flooding in Arizona during this period was the worst since recordkeeping began. Excessive precipitation across California resulted in a monthly average that was almost 200 percent of normal. Storms that passed through Nevada and Utah also produced large amounts of precipitation and some flooding. A storm along the Gulf Coast caused severe flooding in parts of Louisiana and Mississippi. Nationwide, January 1993 was the fifth wettest on record.

During February, extreme precipitation continued in California and parts of the Southwest, whereas drier-than-average conditions existed to the north in many areas from Washington to Wisconsin. February 1993 was the driest on record for most of the Columbia River Basin in Washington. Cold air affected a large part of the country during February.

During March, runoff from snowmelt and ice jams produced major flooding in Nebraska. Also, an intense low-pressure system moved along the coast of the Gulf of Mexico and produced heavy thunderstorms and tornadoes along the entire Gulf Coast. Extensive flooding resulted along the Florida Gulf Coast from wind-driven storm surges. Along the coast, nearly \$1 billion in damages and 44 deaths were attributed to the storm. The storm continued northward along the East Coast of the United States and produced numerous records for all-time-low atmospheric pressure, high monthly snowfall, and daily minimum temperatures from the Gulf Coast to the Northern Atlantic States.

Total precipitation for the winter season was above average over a large area extending from the Pacific Coast and parts of the interior Pacific Northwest to the central and southern Great Plains, as well as along the Gulf Coast and in the Southern and Middle Atlantic States (fig. 5B). Overall, one-third of the country experienced much-above-average winter precipitation.

Three areas of below-average winter precipitation were recorded in parts of the Pacific Northwest and northern Rocky Mountains, across parts of the northern Great Plains to the Great Lakes region, and from southeastern Arkansas to central Tennessee. The dryness was severe in parts of North Dakota and Michigan, which had less than one-half of their average seasonal precipitation.

Winter temperatures were above average from the southern Pacific Coast to the southern High Plains, northward to the central Rocky Mountains, and in southern Florida (fig. 5C). Seasonal temperatures were below average across much of the Pacific Northwest, the Great Basin, the northern Rocky Mountains, much of the High and the Great Plains, the middle Mississippi Valley, the eastern Great Lakes region, and the Northern Atlantic States. Parts of the Pacific Northwest, the northern Rocky Mountains, the central Plains, and the North Atlantic States experienced much-below-average temperatures.

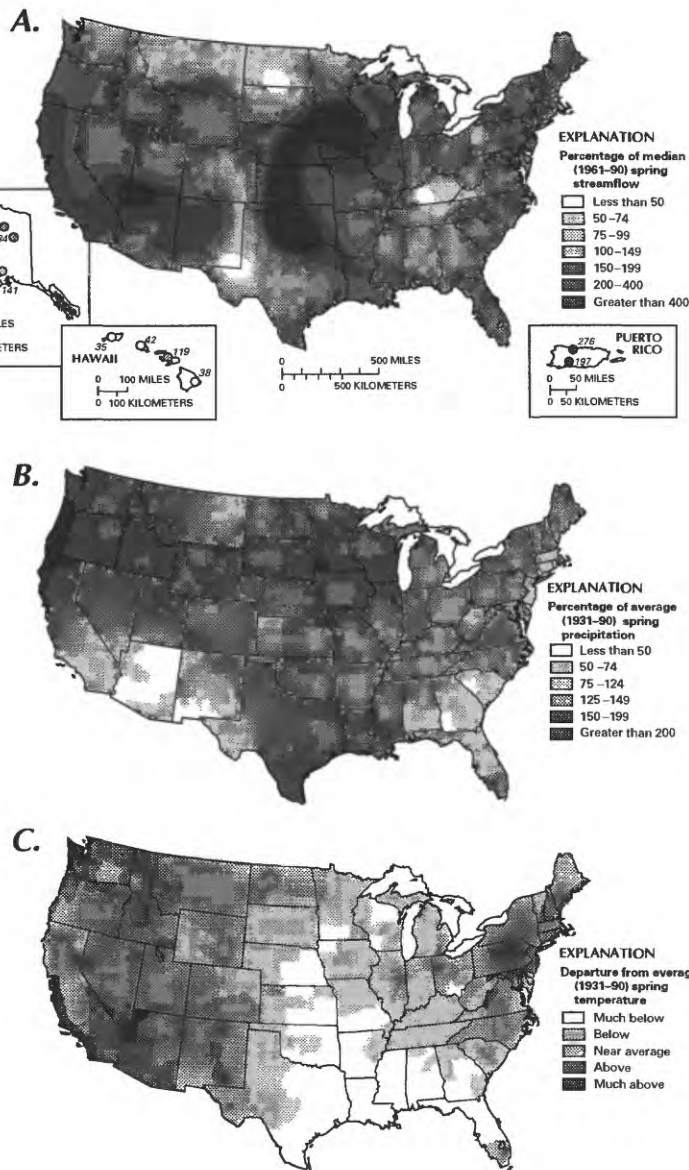


Figure 7. Hydrologic conditions—Spring, water year 1993.

A. Streamflow in the United States and Puerto Rico; **B.** Precipitation in the conterminous United States; and **C.** Temperature in the conterminous United States. Streamflow is shown as a percentage of median streamflow, precipitation is shown as a percentage of average precipitation, and temperature is shown as a departure from average annual conditions (much below, at least 1.28 standard deviations below the average; below, between 0.52 and 1.28 standard deviations below the average; near average, between -0.52 and 0.52 standard deviations from the average; above, between 0.52 and 1.28 standard deviations above the average; and much above, at least 1.28 standard deviations above the average) (Sources: Streamflow data from U.S. Geological Survey files; precipitation data from the National Oceanic and Atmospheric Administration, National Climatic Data Center.)

Streamflow from April through June 1993 was below median in much of the North- and South-Central United States and in a broad band extending from Pennsylvania and Ohio southward to northwestern Florida. In contrast, streamflow was above median from the Pacific Coast eastward across the Southwest, in the southern Rocky Mountains, in parts of the southern and central High Plains, throughout the southern and central Great Plains, in the upper and middle Mississippi Valley, in the upper Great Lakes region, and in parts of the North Atlantic States and central Florida (fig. 5A). Because of high flow, the Mississippi River was closed to barge traffic on June 28 between St. Paul, Minn., and St. Louis, Mo.

Above-average precipitation fell in many parts of the country. Intense rains fell in April, first in the central Great Plains and along the Gulf Coast and later in the southern Great Plains. The Susquehanna River at Harrisburg, Pa., had monthly and daily mean flows that were the highest in 102 years. April streamflow was in the normal or above-normal range in 96 percent of the area of the conterminous United States. In contrast, April 1993 was the driest month in Juneau, Alaska, in nearly 3 years.

During May, intense precipitation continued in parts of the Central United States. Strong thunderstorms caused rain to fall on already saturated soils in southeastern South Dakota, southwestern Minnesota, and extreme northwestern Iowa and resulted in extensive flooding. A slow-moving storm caused serious flooding in many parts of Oklahoma. By mid-May, snowmelt resulting from warm temperatures combined with rainfall had produced flooding on Rifle Creek at Rifle, Colo. In late May, intense rainfall caused flooding in central Washington. Also late in the month, the level of Lake Tahoe exceeded its natural rim, and water flowed into the Truckee River for the first time since September 15, 1990. A new maximum May streamflow was recorded for the St. Lawrence River at Cornwall, Ontario, Canada, near Messina, N.Y.

In June, the persistent weather patterns that had produced intense precipitation throughout the Central and the upper Midwestern United States continued. In early June, severe thunderstorms produced much rain and many tornadoes in South Dakota and Wisconsin. Rain in parts of southern and southwestern Chicago, Ill., caused flooding, and later as much as 6 inches of rain fell on the saturated soils of northwestern Iowa, so that by mid-month, the upper Mississippi River and its tributaries had risen above flood stage. Rainfall continued throughout the month in the Midwest. Rainfall records were reached in Illinois and Iowa. At the end of June, Tropical Storm Arlene hit Texas and produced more than 10 inches of rain in the southern part of the State.

For the season, total precipitation was above average from the Pacific Northwest and northern California to the northern High Plains, from the central and northern Great Plains to the Great Lakes region, along the western Gulf Coast, and in parts of the lower Mississippi Valley (fig. 5B). More than twice the average seasonal precipitation fell in western Oregon, northwestern California, and southwestern Minnesota. Almost one-fourth (23 percent) of the conterminous United States experienced much-above-average spring

precipitation. Below-average precipitation was recorded primarily in two areas, one extending from the southern Pacific Coast across the Southwest to the southern High Plains and the other, from the eastern Gulf Coast to the South Atlantic States.

Spring temperatures were below average across a large part of the country stretching from the Gulf Coast, the southern Great Plains, and the South Atlantic States northward to the northern Great Plains, the upper Mississippi Valley, and the

Great Lakes region, and from south-central Texas to central Florida (fig. 5C). Altogether, about 10 percent of the country experienced much-below-average spring temperatures. Above-average temperatures existed primarily in three areas—the Southwest and southern Pacific Coast, parts of the Pacific Northwest and northern Rocky Mountains, and parts of the Middle and the North Atlantic States.

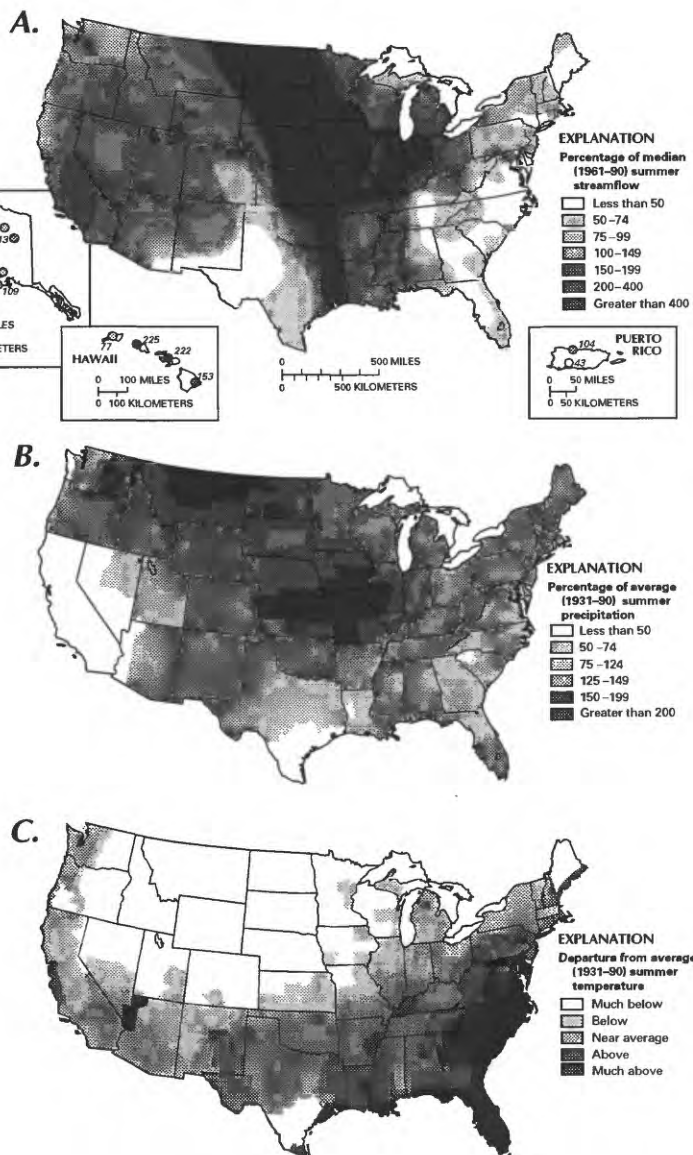


Figure 8. Hydrologic conditions—Summer, water year 1993. **A**, Streamflow in the United States and Puerto Rico; **B**, Precipitation in the conterminous United States; and **C**, Temperature in the conterminous United States. Streamflow is shown as a percentage of median streamflow, precipitation is shown as a percentage of average precipitation, and temperature is shown as a departure from average annual conditions (much below, at least 1.28 standard deviations below the average; below, between 0.52 and 1.28 standard deviations below the average; near average, between -0.52 and 0.52 standard deviations from the average; above, between 0.52 and 1.28 standard deviations above the average; and much above, at least 1.28 standard deviations above the average) (Sources: Streamflow data from U.S. Geological Survey files; precipitation data from the National Oceanic and Atmospheric Administration, National Climatic Data Center.)

Streamflow from July through September 1993 was above median in much of California and in the southern part of the Pacific Northwest, as well as in a broad band extending from Montana to the Great Lakes region and southward through the middle of the country to the Gulf Coast (fig. 5A). Streamflow was much below median in a large part of the Eastern United States and from the Gulf Coast of Texas westward to Arizona and north into central Colorado. The Mississippi River had above-average flow during the entire summer and the flow was the highest of record for the river reach between Keokuk, Iowa, and St. Louis, Mo.

During July, dry weather in much of the Southern and the Eastern United States broke records. In parts of eastern and central Texas, no measurable rain fell during the entire month. In contrast, Concordia, Kans., had its greatest 1-month total rainfall on record (16.75 inches).

During July and August, severe flooding in much of the northern and the central Great Plains and Mississippi Valley caught the attention of the Nation. The flooding was the highest of record and the highest in many decades for many locations. In August, the highest stage and discharge since 1844 were measured on the Mississippi River at St. Louis, Mo. Downstream at Vicksburg, Miss., the monthly mean flow and the daily mean flow on August 11 were the highest for the month of August in the 64 years of record. In contrast to the flooding in the central part of the country, drought existed in much of the Eastern United States. Also during August, Hurricane Emily moved northward along the coast of North Carolina and caused considerable damage to the beaches.

During September, runoff from intense rains caused severe flooding in southwestern Missouri. Later that month, rainfall produced another period of severe flooding in southeastern Kansas, southwestern Missouri, and northeastern Oklahoma. In contrast to the wet weather in the central Great Plains, dry weather in the Southwestern United States was reflected by the reservoir contents of the Lake Tahoe Reservoir, which had no usable storage by late September.

The extreme weather conditions that existed during the summer were the result of a persistent atmospheric circulation pattern. A low-pressure trough that dipped over the Northwestern United States and then moved north-eastward over the Great Lakes region produced wet, cool weather in the Northwest, extremely wet weather in the Central United States, and dry, hot weather in the East. A persistent high-pressure ridge over the Southeastern United States suppressed thunderstorm activity and produced hot, dry weather. Although similar weather patterns have been observed over the United States during the summer, never before has the pattern been so persistent and produced such extreme summer weather conditions.

The summer precipitation pattern was one of extremes. A large area of above-average rainfall stretched from the central High and Great Plains, the middle Mississippi Valley, and the western Ohio

Valley to the upper Mississippi Valley, the northern Great and High Plains, the northern Rocky Mountains, and parts of the Pacific Northwest (fig. 5B). Parts of the central and northern Great Plains had more than 2.5 times the average summer precipitation. July precipitation in some parts of the northern Great Plains was more than 400 percent of the average. Total summer precipitation for one-fifth of the country was much-above average. In contrast, below-average precipitation predominated in several broad areas extending from California and the Great Basin into the central Rocky Mountains and in the coastal and northwestern parts of the Pacific Northwest, in much of Texas and Louisiana, and in the South and Middle Atlantic States. Altogether, one-sixth of the country experienced much-below-average summer precipitation.

The summer temperature pattern also was one of extremes. Above-average temperatures dominated parts of Texas and New Mexico, the lower Mississippi Valley, the Atlantic States, and

parts of the Tennessee and Ohio Valleys (fig. 5C). In the Southeastern United States, several locations experienced temperatures that were at or above 90°F every day in July. The record heat reached as far north as the Middle Atlantic States. Greenville and Spartanburg, S.C., experienced the hottest and driest (only 0.75 inch of rain) July on record. More than 440 daily high-temperature records were set from July through September 1993. One-tenth of the country experienced much-above-average summer temperatures. In contrast, below-average temperatures dominated the upper two-thirds of the country in an area stretching from the Great Lakes region westward to the interior Pacific Northwest and eastward from central California to northern Missouri. More than 200 daily low-temperature records were set during the summer season. In all, one-third of the country experienced much-below-average summer temperatures.

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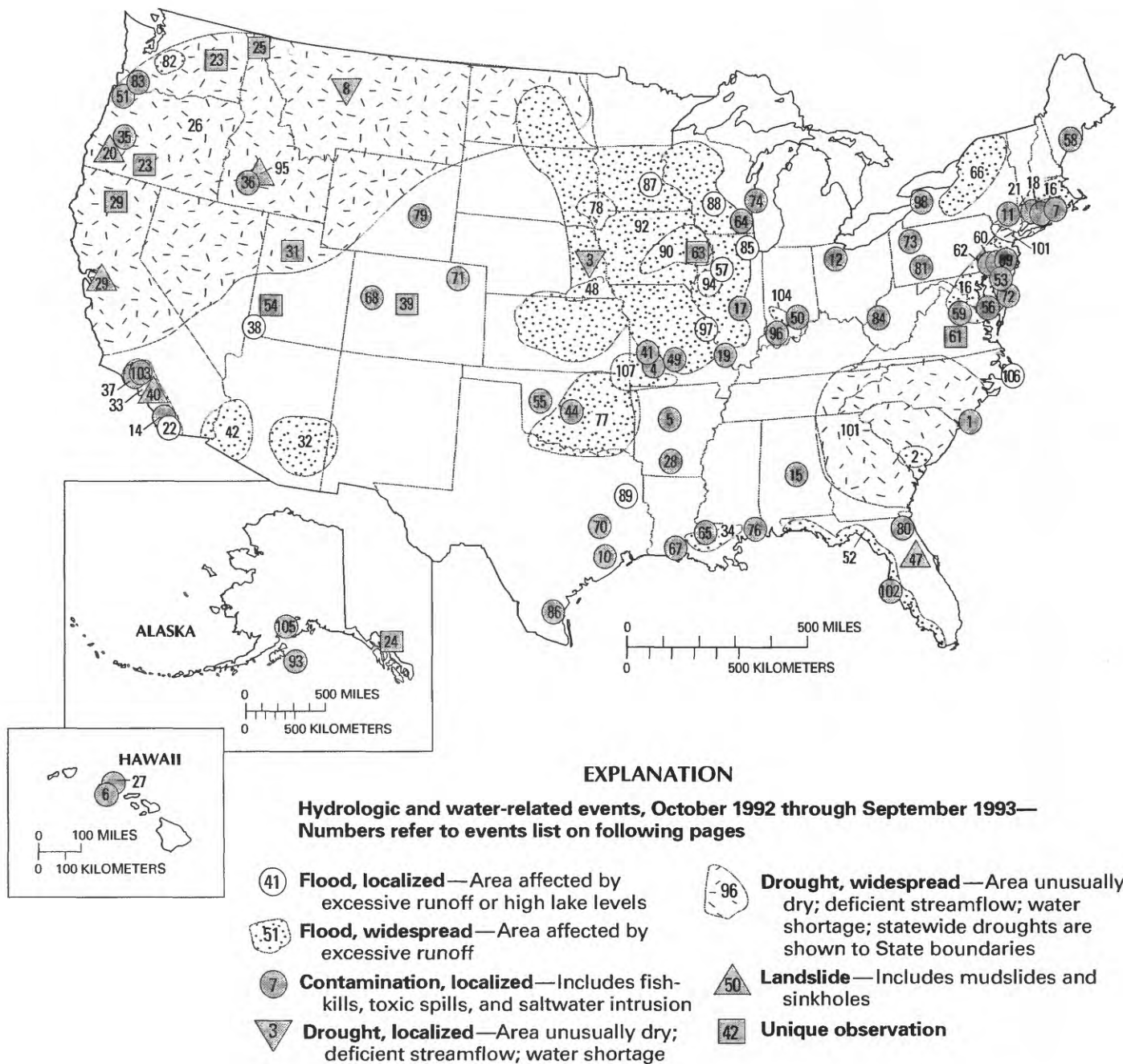


Figure 9. Location or extent of significant hydrologic and water-related events in the United States, October 1992 through September 1993.

[Abbreviations used: ft³/s, cubic feet per second; mi², square miles; mph, miles per hour; gal/d, gallons per day; Mgal/d, million gallons per day; USGS, U.S. Geological Survey.]

October 1992

- 1 NORTH CAROLINA—Early in October, the Lockwood Folly and the Shallotte Rivers were closed to shell fishing because of high bacteria levels. The rivers were reopened on October 16.
- 2 SOUTH CAROLINA—Heavy rains caused floods, three deaths, and damages. During the night of October 8–9, 5.0 to 7.4 inches of rain fell during a 24-hour period in a 25-mile-wide band in Allendale and Hampton Counties in southern South Carolina, which caused serious flooding in those counties and in Colleton and Bamberg Counties to the east. The Coosawhatchie River near Hampton had a peak discharge of 8,820 ft³/s that exceeded the peak of record and had a recurrence interval in excess of 100 years, as well as a stage of 7.92 feet. Flooding on the Salkehatchie River near Miley had a recurrence interval of about 100 years.
- 3 NEBRASKA—At Omaha, the Missouri River navigation season ended on October 11, 5 weeks earlier than usual, because of the continued drought in the river basin.
- 4 MISSOURI—On October 13, residents of Republic were told to boil their water after high levels of coliform bacteria were found in the public supply system. Residents were able to resume drinking the water on October 16.
- 5 ARKANSAS—Organic material from moldy grain ran off into the Black River near Black Rock. On October 21, State health officials temporarily advised against eating fish caught in that river because it depleted oxygen was depleted and caused a fishkill.
- 6 HAWAII—On October 21, officials in Honolulu warned residents not to eat fish from the Ala Wai Canal and from Manoa, Kalihi, and Kaelepu Streams because of elevated levels of insecticides.
- 7 RHODE ISLAND—On October 28, residents of the University of Rhode Island were ordered by the Rhode Island Department of Health to boil water or drink bottled water. Samples taken 1 week earlier had contained unacceptable levels of total coliform bacteria.
- 8 MONTANA—At the end of October, streamflows in the Missouri and the upper Columbia River Basins continued as record-low flows as a result of the drought.
- 9 CALIFORNIA (not shown)—By late October, water storage in the reservoirs was 56 percent of normal, down about 50 percent from the predrought levels of 1986. As a result of the increased ground-water pumping, California's Central Valley experienced land subsidence.

November 1992

- 10 TEXAS—On November 8, 4,200 gallons of crude oil spilled at a tank farm in Webster when a valve failed on a pipeline during product transfer. The oil leaked out of the containment area and spilled into Clear Creek. About 4,000 gallons of oil was recovered by using a boom, vacuum trucks, and sorbent material.
- 11 NEW YORK—Health officials found a gasoline additive in 30 wells along Route 6 in the Union Valley Road section of Mahopac on November 8. Residents and businesses in the area were told to use bottled water.
- 12 OHIO—On November 21, a major gasoline spill took place on Otter Creek near Oregon when an underground pipeline ruptured and released an estimated 32,000 gallons of gasoline into the creek. The spill was contained with booms and vacuum trucks at six locations on the creek, and about 28,000 gallons was recovered. The ruptured pipeline was returned to service by November 30.
- 13 THE WEST (not shown)—Drought in the West continued at the end of November. The President had made \$30 million in emergency drought-relief funds available earlier in the month. Included in the Reclamation States Emergency Drought Relief Act of 1991, of which the funding was a supplement, were Oregon, Washington, Idaho, Montana, Utah, Wyoming, Nevada, California, the Dakotas, Nebraska, and the Yakima Indian Nation.

California reservoir levels were 56 percent of average, the lowest level since the drought began 6 years earlier. Tree-ring data indicated that California had entered its seventh year of drought for the first time in at least four centuries. On November 30, the level of Lake Tahoe, on the California–Nevada State line, fell to a record low of 6,220.26 feet, 2.7 feet below the natural rim of the lake. This was the lowest level since the records began in 1900 as northwestern Nevada entered its seventh year of drought. Reservoirs were at their lowest levels since 1977. Nevada's Governor declared 14 of 17 counties drought disaster areas.

In the Utah, the Colorado, and the Wyoming watersheds of the Colorado River, which provides water for five States, runoff into the river had averaged two-thirds of historical norms for the past 6 years.

Idaho suffered from the drought, too. The Idaho Power Corp., which provides power in Idaho, Oregon, and Nevada, incurred tremendous costs from having to limit the use of hydroelectric generating equipment because of a lack of adequate water to keep the turbines turning. Coal was burned as a supplementary fuel, and power costs increased to about \$90 million above the normal annual costs.

- 14 CALIFORNIA—In late November, leaks from a 24-million-gallon tank farm in San Diego were reported to be contaminating ground water at several different depths.

December 1992

- 15 ALABAMA—On December 1, 10,000 gallons of sulfuric acid and sodium chlorate spilled into Tallatchee Creek at Hybart after tank cars derailed following the collision of a freight train and a logging truck. Residents within a 2-mile radius were evacuated from their homes for 2 hours. Cleanup was completed in February 1993.
- 16 ATLANTIC COAST—On December 11, a furious Nor'easter pummeled the eastern seaboard from Virginia to Massachusetts. The storm brought as much as 5.4 inches of rain to parts of New York and New Jersey over 3 days; as much as 30 inches of snow in less than 24 hours to Massachusetts, West Virginia, and western Pennsylvania; and record tides, some up to 20 feet high in many places. The storm paralyzed Metropolitan New York, and 20 deaths were blamed on the weather. Near-record flooding was reported from Ocean County to Bergen County, N.J. The National Ocean Service tide-gaging station at Sandy Hook, N.J., recorded a high tide of 8.68 feet above sea level, which was the highest in over 60 years of record. The USGS tide-gaging station at Perth Amboy, N.J., recorded a new record tide level of 10.4 feet above sea level. The President declared 11 New Jersey counties to be disaster areas. Estimated damage in New Jersey exceeded \$750 million, and two deaths resulted. Elsewhere, outlying coastal areas such as Dewey Beach in Maryland, suffered beach erosion as rising waters wiped out sand dunes and destroyed homes. On December 12, the storm turned into a blizzard over much of New England and dumped more than 2 feet of snow. A record 27 inches of snow fell in 24 hours in Worcester, Mass. During the 3-day storm, the USGS tide-gaging station on the Saugus River near Lynn, Mass., recorded a peak stage of 9.23 feet above sea level. Sustained high winds from the northeast caused flooding along much of the Massachusetts coastline and resulted in a Federal declaration of emergency. The Governors of New York, Connecticut, Virginia, and West Virginia also issued disaster declarations.
- 17 ILLINOIS—High nitrate levels on December 15 in Lake Decatur, a source of public water supply for the city of Decatur, caused public officials to distribute bottled water to families with infants younger than 6-months. Nitrate can prevent blood from carrying oxygen throughout the body and can be especially harmful to infants. This was the second time this happened during 1992.
- 18 CONNECTICUT—On December 21, a barge carrying oil ran aground near the entrance to New London Harbor near New London. Because of a 3-inch hole and several cracks in a cargo tank, an estimated 27,000 gallons of oil leaked into Long Island Sound. An 18-inch boom around the barge contained much of the spill, but a 2.5- by 0.5-mile sheen from the barge was visible toward Fisher's Island. On December 28, the most affected area was from Black Point to Niantic Harbor, where cleanup efforts were concentrated.
- 19 MISSOURI—On December 22, two towboats collided on the Mississippi River at Cape Girardeau, and scattered 20 barges, sank 1, and caused 700 tons of liquid fertilizer to spill into the river.
- 20 OREGON—After hitting a rock slide, three engines and five freight cars derailed near Glendale on December 22. Diesel fuel (3,800 gallons) spilled into the South Umpqua River, where high winter streamflows caused the fuel to dissipate quickly.
- 21 CONNECTICUT—On December 28, about 12,700 gallons of oil leaked from an underground storage tank into the ground and a storm drain leading to the Mill River near New Haven. The release came from a frozen and cracked fuel line over a 4-day period. The rocks at the river outfall and in New Haven Harbor revealed a light sheen, but no recoverable product. The remaining oil was pumped out of the storage tank, and absorbent materials were used to recover the ground spill. A boom was placed at the storm drain outfall to contain any further release into the river.
- 22 CALIFORNIA—In southern California, 1992 ended with torrential rains primarily at the Mexico-California border, where at least 14 people died as a result of flooding.
- 23 OREGON, WASHINGTON—The drought in these two States showed signs of weakening during late December. A record 39.2 inches of snow fell at Klamath Falls, Oreg., where normal December snowfall is 8.5 inches. Spokane, Wash., which received 40.2 inches of snow, experienced its second most snowy December on record.
- 24 ALASKA—By the end of 1992, Juneau finished its second wettest year on record. Juneau received normal to above-normal precipitation for 23 of the preceding 24 months, and the total 1992 precipitation was 79.49 inches.
- 25 IDAHO—Kootenai, Bonner, and Bounding Counties received more snow from two major storms during December than had been recorded in the previous 50 years.
- 26 THE WEST—By late December, much of the West remained in drought as indicated by low reservoir storage. Reservoir storage was below average in California (155 reservoirs), Idaho (16), Montana (25), Nevada (7), North Dakota (7), Oregon (24), Utah (24), Washington (7), and Wyoming (13). Reservoir storage in the Missouri River main-stem dams was much below normal (44.6 million acre-feet).

January 1993

- 27 HAWAII—On January 4, a wastewater pump station spilled 7,000 gallons of raw sewage into Kaneohe Bay, Oahu, when a pipeline broke. Swimmers were warned to avoid the bay until repairs had been completed.
- 28 ARKANSAS—High mercury levels were discovered on January 5 in fish from eight sites within the Ouachita River Basin in the southern part of the State, including Champagnolle and Moro Creeks. This discovery prompted the testing of 15 private lakes in the area, and State health officials issued fish-consumption advisories for the affected water bodies.
- 29 CALIFORNIA—At five of the Department of Water Resources' Sierra snowfall stations, snow was 7 feet deep on January 6, about twice the normal and four times higher than in January 1992. Snowfall at McCloud in Siskiyou County in the northern part of the State had not been that heavy in the previous 40 years. Higher temperatures during the middle of the week began melting snow at lower elevations, which caused high flow in foothill rivers. Mudslides crossed highways near San Francisco.
- 30 FLORIDA (not shown)—On January 6, officials issued a mercury health advisory for 32 waterways in the State and warned consumers not to eat large quantities of largemouth bass. This brought to a total 68 waterways in the State under a mercury health advisory.
- 31 UTAH—More than 40 inches of snow fell in Salt Lake City between January 6 and 12, the worst snowstorm since 1928. A record 42 inches of snow fell within 1 month. A record 26 inches of snow was on the ground in Salt Lake City on January 12, 3 inches more than the record set in 1949. Utah's government offices, schools, and many businesses closed, and the Governor declared a state of emergency.
- 32 ARIZONA, NEW MEXICO—Between January 8 and 15, excessive rains, as much as three times the normal, caused extensive flooding in Arizona. The Verde River (below Tangle Creek, above Horseshoe Dam, and upstream from Phoenix) exceeded the peak discharge of record (94,800 ft³/s in 1980) by an estimated 50,000 ft³/s on January 8. Flooding along the Salt River in Phoenix destroyed the USGS streamflow-gaging station at the 24th Street Bridge. Near Tucson, the Rillito and the Santa Cruz Rivers flooded. Flood frequencies for peak discharges were generally in the 10- to 50-year range, with the exception of discharge on the Verde River, which exceeded the 50-year flood. In New Mexico, the peak discharge of the Gila River near Redrock was 25,500 ft³/s on January 19; a peak discharge of 12,700 ft³/s was recorded at the San Francisco River near Glenwood on January 19. Reservoir operators adjusted releases in anticipation of more rainfall, and some of the controlled releases caused flooding. Arizona was declared a Federal disaster area on January 20. Flows from the San Carlos Reservoir were at 31,000 ft³/s and still rising. From 1928, when the dam was completed, until this time, the highest release had been 5,020 ft³/s. Releases from the Salt-Verde River reservoir system exacerbated problems associated with erosion of a municipal landfill operated by the Salt River Indian Tribe. Flooding on a statewide basis in Arizona was the worst in recorded history. Eight people were killed, and damage was estimated to be than \$400 million. Many precipitation records were set. In 6-weeks' time, more than 7.2 inches of rain had fallen on Phoenix, more than normally falls in a year.
- 33 CALIFORNIA—January precipitation in the southern part of the State was about 300 percent of normal by midmonth. Heavy rains on January 17–18 accounted for much of the total and caused flooding. By January 17, Los Angeles had received more than 15 inches of rain since the beginning of the season in July, slightly more than its normal average for an entire year. Mudslides closed roads and toppled walls near Los Angeles. Flooding and mudslides closed sections of the Pacific Coast Highway in Orange County. Many dams and reservoirs spilled over. Authorities declared a state of emergency in Riverside, Los Angeles, Orange, and Santa Barbara Counties. The most severe flooding was in the Santa Margarita and the San Luis Rey River Basins. Floodwaters overtopped the USGS gage shelter at Murrieta Creek near Temecula, where the previous peak stage of record was exceeded by more than 5 feet, as was the stage of the Santa Margarita River near Temecula, downstream from Murrieta Creek. The Marine Corps Air Station at Camp Pendleton was closed to traffic as mud and water caused millions of dollars in damages. Floods and mudslides killed 11 people in southern California.
- Average precipitation in northern California was 118 percent of normal for the water year. Water content of the Sierra snowpack was 150 percent of a normal year as of January 11. Residents along the Russian River in Honeydew were evacuated after 7.60 inches of rain fell in 24 hours on January 20. Mudslides triggered by rains closed highways near Point Arena, and more than 100 people were evacuated from their homes along the rain-swollen Petaluma River northwest of San Francisco. Water was released from Folsom Reservoir near Sacramento because of flood danger, the first release since 1986 when the drought began.
- Total damages from January floods in the State were estimated to be \$60 million. The President declared parts of California major disaster areas, which made the State eligible for more than \$1 million in relief.
- 34 LOUISIANA, MISSISSIPPI—More than 10 inches of rain fell in the Lafayette Parish area in southern Louisiana on January 20 and flooded streets and homes from Lafayette to Bogalusa. The southeastern part of Mississippi also was flooded after from 7 to 10 inches of rain fell in a 36-hour period. In Mississippi, a peak of record was recorded on West Hobolochitto Creek near McNeill, where the peak discharge (27,600 ft³/s) and the peak stage (23.43 feet) exceeded those of previous record (April 1983) by 3,600 ft³/s and 0.18 foot, respectively. The 1993 peak discharge was about 1.1 times greater than the 100-year flood. Nine counties in the two States were declared major disaster areas by the President.

- 35 OREGON—On January 29, 16 cars of a freight train derailed about 30 miles north of Roseburg and spilled about 3,000 gallons of diesel fuel into Yoncalla Creek.
- 36 IDAHO—Late in January, residents living northwest of Mountain Home were advised to boil or chlorinate their water because of high levels of coliform bacteria in samples taken from wells.

February 1993

- 37 CALIFORNIA—About 4 miles of beach at Long Beach was closed when 400,000 gallons of raw sewage spilled from a collapsed Los Angeles County pipeline in early February. Sulfuric acid had weakened the concrete sewer pipe.
- 38 UTAH—Major flooding resulted when 2 to 3 inches of rain fell on top of a heavy snowpack in southwestern Utah on February 20. The USGS streamflow-gaging station on the Virgin River at Bloomington was destroyed. In addition, releases from the Gunlock Reservoir produced high flows in the Santa Clara River.
- 39 COLORADO—Blizzards over the weekend of February 20–21 caused about 300 snowslides in the Colorado Rockies. Snowslides clogged Castle and Maroon Creeks, which supply water to Aspen, and the town was down to a 24-hour reserve for a time on Saturday.
- 40 CALIFORNIA—On February 23, a mudslide in San Clemente toppled one house and carried four others 50 feet onto a railroad track and the Pacific Coast Highway. The houses were among nine declared unsafe following 13 days of rain in January, which had weakened the hillside. Passenger trains resumed running on March 9. By February 22, 22.31 inches of rain had fallen during the season in Los Angeles.
- 41 MISSOURI—Diesel fuel spilled from a pipeline into Motley Creek near Joplin on February 23 and killed 1,500 fish and other aquatic life along a 2.5-mile stretch of the creek.
- 42 ARIZONA—In southwestern Arizona on February 23, about 5,200 people were urged to leave their homes in the Wellton–Mohawk Valley along the usually dry Gila River in Yuma County because heavy rains had caused water to flow over spillways at the Painted Rock Dam. By late February, record winter rains had built a 150-mi² lake above the Painted Rock Dam. Despite levees hastily built to minimize flooding, about 20,000 acres of farmland was eroded along the river, which extended 2 miles outside its channel in some places, and \$70 million worth of crops were destroyed. Total damages were estimated at \$400 million.
- 43 CALIFORNIA (not shown)—The Governor announced on February 25 that the drought in California was officially over. The 6-year drought was the most severe in the State's recorded history and cost \$4 billion in lost agriculture and hydroelectric power revenues. Snow and rain had filled 90 percent of the State's reservoirs.
- 44 OKLAHOMA—On February 25, residents of Washington were ordered to boil water for 20 minutes before drinking or cooking with it because of higher-than-normal levels of bacteria.
- 45 MONTANA (not shown)—Parts of the State remained in a severe drought at the end of February. Only the south-central part of the State was in a near-normal condition.
- 46 WASHINGTON (not shown)—February was the driest February on record for most of the Columbia River Basin. Many work-ers near Spokane were laid off because not enough water was available to generate hydroelectric power for aluminum smelting.

March 1993

- 47 FLORIDA—Two sinkholes destroyed property and threatened two houses in Orange City on March 8. The largest sinkhole was 165 feet across and 125 feet deep. The second sinkhole, about 300 feet from the first, was about 25 feet in diameter.
- 48 NEBRASKA—Snowmelt runoff and icejams caused major flooding along the Elkhorn and the Platte Rivers in the eastern part of the State in early March. A 48-inch pipeline for Lincoln's water supply was washed out along the Platte River near Ashland. Two people were killed in flood-related incidents in the Lincoln area, and 1,400 people were evacuated from their homes along the two rivers. The March 10 peak discharge of the Platte River at Louisville was 142,000 ft³/s and had a recurrence interval of about 50 years. On the Elkhorn River at West Point, the peak stage of the March 1993 flood was the highest of record and exceeded that of 1978 by about 3 feet, but the peak discharge had a recurrence interval of only 10 years. Damage was estimated to be from \$15 million to \$16 million in the eastern and central parts of the State.
- 49 MISSOURI—On March 9, Fairplay residents were ordered by the State Department of Natural Resources to boil their water before drinking or cooking because of high levels of bacteria found in the supply after a supply well malfunctioned.
- 50 INDIANA—A 65,000-gallon toluene spill into the Ohio River at New Albany on March 10 resulted from the rupture of an underground pipeline during transfer operations from a barge to a storage tank. The lower Ohio River was at high stage at the time of the spill, which aided in diluting the soluble chemical that was left after cleanup efforts. Officials were able to fill storage facilities to capacity before the slick reached Evansville. (The city supply is drawn from the river.)

- 51 OREGON—On March 11, Monmouth residents were warned that the city's tap water was tainted with amounts of asbestos exceeding Federal and State limits. National Guard tanker trucks provided water to residents.
- 52 FLORIDA—On March 12–13, high winds exceeding 50 mph, gusts of close to 100 mph, and tornadoes hit the Gulf Coast of Florida. They caused an estimated \$1 billion in damages, 44 deaths, and extensive flooding along the coast. About 1 million people were without electric power. The storm created wind-driven tides of a maximum of about 7 feet above normal high tide at Aripeka. Wind-driven storm surges reached almost 12 feet above sea level. The tide extended a maximum of about 1.5 miles farther inland than normal. Thousands of people evacuated their coastal homes, and many had to be rescued from rooftops and attics. One USGS tide-gaging station on Cedar Creek was lost. The President declared 21 counties in the State disaster areas. This same storm system was responsible for the "Blizzard of '93" along the entire East Coast.
- 53 NEW JERSEY—Shellfishing was banned in the Great Sound near Stone Harbor after 500,000 gallons of untreated sewage spilled into the sound on March 14. The ban was lifted on March 25 after the bacteria counts returned to normal.
- 54 UTAH—On March 17, four people were injured on Interstate Highway 15 near the Kolob area of Zion National Park when an 8- to 10-foot wall of water hit their vehicles. A natural impoundment on the Taylor Creek drainage in the Park collapsed suddenly and released the water.
- 55 OKLAHOMA—On March 24, crude oil spilled from a broken 6-inch pipeline under the South Canadian River near Union City and about 1,500 barrels of oil entered the river. Stress on the pipes from heavy rain and erosion was blamed for the break.
- 56 DELAWARE—On March 24, the State issued warnings against eating white perch, carp, white mouth bass, and catfish from the St. Jones River because of PCB's found there; PCB is a carcinogen.
- 57 ILLINOIS—Record flooding in the northwestern part of the State resulted from the addition of from 4 to 7 inches of snow on March 21 and 1 to 2 inches of rain on March 22 to 3 to 5 inches of snow on frozen or saturated ground. On March 26, the Rock River at Joslin had a peak discharge of 46,500 ft³/s and a stage of 18.35 feet, which exceeded the previous records of 46,200 ft³/s and 17.81 feet set in March 1948. The March 1993 discharge had a recurrence interval of about 25 years. A levee break also contributed to the peak discharge and caused two deaths.
- 58 MAINE—About 63,000 gallons of jet fuel spilled into a marshy area through a storm drain near Brunswick from March 26 through 28, when two fuel lines were inadvertently left open. The fuel was burned from the marshy area.
- 59 VIRGINIA—On March 29, fuel oil spilled from a broken 36-inch pipeline near Herndon; about 100,000 gallons entered Sugarland Run, a tributary to the Potomac River. Oil was as much as 8 inches thick in parts of the creek. Oil reached the Potomac River, the source of water for many area communities, 8 miles downstream from the spill. Fairfax County shut down the Algonquin Potomac intake, which supplies water to 45 percent of the residents in the county. Wetlands were severely affected, and hundreds of fish and other animals died. Diesel fuel odors caused the closing of the Great Falls Park. Because of bad weather, some oil washed over a boom and caused a sheen over about 4 miles of the Potomac River. Oily debris also was found along the river as far as 20 miles downstream from the spill.
- 60 PENNSYLVANIA—On March 31, 20,000 gallons of cumene, an additive used in high-octane motor fuel, nail polish, and paints, was spilled from a tanker into the Delaware River near Philadelphia. A sheen spread from the Tacony–Palmyra Bridge to Camden, N.J. Cumene near the vessel was contained by a boom and removed with absorbent pads. The rest of the spilled product evaporated quickly.
- 61 VIRGINIA—Streamflows in many areas of the State were the highest ever for the month of March owing to record snows and rains that made it the wettest March on record statewide. All the USGS streamflow index stations in Virginia recorded flows that were above their long-term averages.

April 1993

- 62 PENNSYLVANIA—On April 3, about 80 million gallons of raw sewage flowed into the Delaware River after a power failure shut down pumps at a sewage-treatment plant near Philadelphia.
- 63 IOWA—On April 6, a riverboat casino enroute to St. Charles, Mo., was stalled on the Mississippi River near Davenport because the river was too high for the boat to pass under a bridge. The high flow was caused by recent rains and snowmelt in the Midwest.
- 64 WISCONSIN—From April 8 to 14, residents of Milwaukee were advised to boil their water before drinking or washing food. Many residents had suffered from flulike symptoms caused by the microscopic parasite cryptosporidium in the water supply. The parasite, carried in the intestines of livestock, probably got into the water supply by being washed from farm pastures and barns into the Milwaukee River and then into Lake Michigan during heavy rains in March. Lake Michigan is the source of public water supply for Milwaukee. Hundreds of people visited hospital emergency rooms, and 47 deaths were blamed on the cryptosporidium outbreak.
- 65 LOUISIANA—On April 9, about 235,000 gallons of fuel oil spilled into the Mississippi River from a tank barge when it struck a bridge at Donaldsonville. The spill threatened some drinking water supplies, and the river was closed to vessel traffic for 72 miles until April 11. A boom was deployed around the barge, and fuel remaining in the barge was removed. On

April 13, many environmentally sensitive areas were reported affected by the spill and tar balls and sheens were sighted throughout the Mississippi Delta area. Cleanup was completed by May 2.

- 66 NEW YORK—Streams and lakes in many parts of the State began rising over the weekend of April 10–11 following heavy rains combined with snowmelt. On April 12, the Black River at Watertown reached a peak discharge of 42,000 ft³/s, which was the maximum discharge since at least 1869 and had a recurrence interval of more than 100 years. Hundreds of homes in Cicero began flooding on April 18 when Oneida Lake, north of Syracuse, rose. The peak elevation of the lake, 373.14 feet above sea level on April 24, was the maximum for the period of record, from 1951 through 1993. In northeastern New York, Lake Champlain reached its maximum level, 101.88 feet above sea level, since at least 1871 on April 25. New York officials blamed four deaths on the flooding.
- 67 LOUISIANA—On April 13, a diesel fuel spill on the Intercoastal Waterway near Forked Island resulted when a barge ran aground and damaged its cargo tanks. An estimated 18,000 gallons of fuel was released into the waterway, which was closed for 2 days along a 7-mile stretch. Skimming operations recovered a small amount of the oil from the water, and booms blocked all cuts and inlets along the waterway for 5 miles. About one-half of the fuel oil dissipated within 24 hours of the spill. Cleanup was completed on April 18.
- 68 COLORADO—On April 13, Grand Junction officials warned about 10,000 city water customers to boil their water before drinking it because of unacceptable levels of water-borne bacteria. The city added more chlorine to the water.
- 69 NEW JERSEY—Residents of Bayonne were advised to boil drinking water because of the possibility of contamination from a broken water main on April 16.
- 70 TEXAS—A major crude oil spill occurred on the Neches River near Neches on April 20. An estimated 88,000 gallons of oil was released from an overflowing sump. Booms were deployed around the release area near Gray's Bayou. Most of the product was contained or recovered within 12,000 feet of the containment boom. However, an oil sheen progressed about 3 miles downstream from the initial spill site. Cleanup was completed by April 25.
- 71 COLORADO—The water supply at Fort Morgan was treated with large amounts of chlorine on April 20 after high levels of fecal coliform bacteria were measured in the water. Residents were advised to boil their water.
- 72 DELAWARE—On April 22, an oil sheen was observed surrounding a tank vessel on the Delaware Bay near Milford. Although an absorbent boom was deployed astern the vessel, it had little effect, and the sheen extended for 7 miles on April 25. Patchy oil was dissipated by winds and tides. The oil had leaked from a 1-inch hole in the cargo hold of the vessel, and about 4,000 gallons of crude oil was spilled before the hole could be plugged.
- 73 PENNSYLVANIA—On April 23, residents of Meadville were told to boil their water because fecal coliform bacteria had been found in the city's supply.
- 74 WISCONSIN—On April 26, residents of Sheboygan were urged to boil their water because of the presence of the microscopic parasite cryptosporidium in their water supply. This was the same parasite that was responsible for many illnesses in Milwaukee earlier in the month (event 64).
- 75 PENNSYLVANIA (not shown)—The mean monthly discharge for the Susquehanna River at Harrisburg for April 1993 was the highest for 103 years of record.

May 1993

- 76 MISSISSIPPI—On May 3, about 5,200 gallons of fuel oil spilled into the Gulf of Mexico near Pascagoula when a tank barge developed a leak.
- 77 OKLAHOMA—From May 5 through 10, a slow-moving storm system caused serious flooding over the eastern three-fourths of the State. Most of the rain fell in a 24-hour period, including 7.06 inches at Oklahoma City. The worst flood damage in 32 years took place on May 8 along Lightning, Brock, and Twin Creeks in south Oklahoma City, where four people died. Peak discharges on each of these creeks exceeded that of the 100-year flood. A fifth flood victim was found near Sentinel. Statewide, more than 2,700 homes were damaged, and more than 60 bridges were heavily damaged or destroyed. The wheat crop on more than 5 million acres of farmland was damaged or destroyed. Of the 77 counties in the State, 43 were declared eligible for emergency assistance.

Record peak discharges or stages were recorded at nine stream-gaging stations. Peak discharge of the Arkansas River near Ponca City was 50 percent higher than the flood of October 1986 and exceeded that of the 100-year flood. Peak discharges and stages of Cottonwood Creek near Seward, the Cimarron River near Ripley, Sand Creek at Okesa, the North Canadian River at Britton Road at Oklahoma City, and Cobb Creek at Eakly exceeded those of record, their peak discharges having recurrence intervals at or exceeding 25 years. The peak stage of the Chikaskia River near Blackwell exceeded that of record by about 1 foot, but the peak discharge was much less than that of record. Peak discharges of the North Fork of the Red River near Headrick and Tipton had recurrence intervals exceeding 100 years and 50 years, respectively, although the peaks of record were not exceeded on either stream. Peak discharge of the Washita River at Anadarko also had a recurrence interval exceeding 25 years. Many of the rivers and their tributaries in the flooded area are regulated by reservoirs. Large amounts of runoff produced new maximum water levels and contents for the period of record at four lakes: Kaw, Keystone, and Eufaula Lakes, and Lake Altus.

- 78 SOUTH DAKOTA, MINNESOTA, IOWA—Major flooding took place from May 7 through 9 in southeastern South Dakota, southwestern Minnesota, and northwestern Iowa after successive thunderstorms dropped excessive rain on already wet soil and caused flooding. Hail, damaging winds, and at least five tornadoes were reported as well, and as much as 9 inches of rain fell at Brandon, S. Dak. The most severe floods were on Split Rock Creek at Corson, S. Dak., the Redwood River near Marshall, Minn., and the Rock River at Luverne, Minn., where peak discharges exceeded those of the 100-year flood and peak stages and discharges exceeded those of record. At Marshall, 70 people were evacuated from their homes in a low-lying area, and four houses were destroyed from floodwaters. Peak stage and discharge also exceeded those of record on West Fork Vermillion River near Parker, S. Dak., Chanarambri Creek near Edgerton, Minn., and the Big Sioux River at Akron, Iowa, where the recurrence intervals varied from 15 to 25 years.
- 79 WYOMING—On May 17, officials warned people not to eat rainbow trout caught near the Oregon Trail Dam near Casper because of high selenium levels.
- 80 FLORIDA—About 10,000 gallons of oil spilled into the St. Johns River in Jacksonville during loading operations on May 19. Although a containment boom was placed around the spill, a 1-mile-long section of oily shoreline was spotted the next day along the eastern side of the St. Johns River beginning at Reddie Point. By May 23, most of the oil had been removed from the shores, but some oil remained in the wetland areas, where cleanup efforts continued.
- 81 PENNSYLVANIA—All aquatic life, including tens of thousands of fish, died along a 42-mile stretch of the Casselman River near Boynton when acid was flushed out of abandoned coal mines by melting snow. The kill was discovered on May 24.
- 82 WASHINGTON—Intense thunderstorms on May 31 caused widespread flooding along small streams in Douglas County in the central part of the State. The most serious damage was in East Wenatchee along Sand Creek. About 100 homes and many area roads were damaged.

June 1993

- 83 WASHINGTON, OREGON—On June 3, a fuel oil spill at Longview, Wash., released an estimated 6,000 gallons of oil into the Columbia River from the overfilled tank of a motor vessel. An oil slick extended downriver to Steamboat Slough, and large concentrations of oil were found between Puget Island and Wauna, Oreg. Cleanup was finished on June 9.
- 84 WEST VIRGINIA—Diesel fuel spilled into the Ohio River near Mason County when a tug boat released 3,000 gallons from an overfilled tank on June 6. A boom was deployed to contain the spill. Heavy concentrations of fuel were noted near the intake of a powerplant in the vicinity. Cleanup was completed on June 8.
- 85 ILLINOIS—Intense rainfall flooded parts of the southern and southwestern suburbs of Chicago on the afternoon of June 7. Rainfall commonly amounted to 3 to 3.5 inches in 2 hours. The most intense rainfall measured, 4.6 inches within 2 hours at Burr Ridge, was the highest ever recorded at that station. The 9.1-mile-long Calumet leg of the Deep Chicago Tunnel, used for flood control, filled for the first time. Discharge at Sawmill Creek near Lemont exceeded the previous peak of record and the 100-year recurrence interval flood.
- 86 TEXAS—On June 12, a pipeline ruptured and released about 17,000 gallons of black crude oil into the surrounding soil near Corpus Christi. The oil reached a ditch and flowed to the Tule Lake basin and the Corpus Christi ship channel. Vacuum trucks, booms, and absorbent pads were immediately deployed to recover the oil. A dam was constructed to replace one that had been previously destroyed during a flash flood. Large areas of marsh grass and mud flats affected by the spill were cleaned. All recoverable oil had been removed from the spill area by June 28.
- 87 MINNESOTA—On June 16–17, the southern one-third of the State received from 2 to more than 6 inches of rain. Record flash floods resulted on many small streams on June 17 followed by near-record floods on larger streams during the next several days. Flooding on the larger streams was exacerbated by additional rain from June 18 to 21. On June 21, the Minnesota River at Mankatoa had a peak flow of 75,600 ft³/s, the fourth highest since the record-high flow of 110,000 ft³/s was recorded in April 1881. At Jordan, near Minneapolis, the flow of the Minnesota River on June 24 was 92,200 ft³/s, the second largest since recordkeeping began in 1934. The Mississippi River at St. Paul crested on June 26 at 19.15 feet. The maximum daily flow of 104,000 ft³/s on that date was the highest for any June day in 102 years of record.
- 88 WISCONSIN—Intense rainfall, which began on June 19, contributed to flooding in central Wisconsin. More than 8 inches of rain fell during the week ending June 20. More than 700 people were evacuated in Jackson and Clark Counties, and the two counties were declared to be in a state of emergency by the Governor. On June 21, the Black River near Galesville had a peak discharge greater than the 100-year flood. A near-record peak discharge of 64,000 ft³/s was recorded for the Black River at Galesville, and many streams in the southern part of the State had peaks ranging from 10- to 50-year recurrence intervals.
- 89 TEXAS—Tropical Storm Arlene hit the Texas coast on June 20, and more than 10 inches of rain fell over much of the State. Thousands of homes were flooded, and at least one person was killed.
- 90 IOWA—On June 30, the Mississippi River at McGregor flowed at 178,000 ft³/s, the largest flow since April 1965, when a flow of 276,000 ft³/s was recorded. Local runoff and the discharge of 12,000 ft³/s from the Coralville Reservoir upstream

increased the flow of the Iowa River at Iowa City to 14,700 ft³/s. The level of the reservoir was less than 0.5 foot below its record crest set in July 1969. In central Iowa, the level of the Saylorville Reservoir on the mainstem of the Des Moines River west of Des Moines was close to the previous record pool elevation of 889.25 feet recorded in June 1984.

- 91 THE MIDWEST (not shown)—During June, parts of the Dakotas, Minnesota, Wisconsin, Michigan, Illinois, and Indiana received two times the normal rainfall. As much as 50 percent above-normal rainfall also fell in parts of Nebraska, Kansas, Iowa, and Ohio. In the Missouri River Basin, near-record flows had been recorded since late March on the Big Sioux River and the downstream part of the James River. The volume of runoff at the Big Sioux River at Akron, Iowa, from March through June was about eight times the average March through June volume for the period from 1929 to 1992.

July 1993

- 92 THE MIDWEST—Storms along a stationary front that extended from New Mexico to Michigan funneled heavy rains to an area from southern Iowa to Lake Michigan during early July. These rains caused extreme flooding on the Mississippi and the Missouri Rivers and on many other streams in Missouri, Iowa, North Dakota, South Dakota, Nebraska, Kansas, Illinois, Minnesota, and Wisconsin. Parts of the Dakotas, Iowa, Nebraska, Kansas, Illinois, Minnesota, and Wisconsin had been inundated by above-normal rainfall during June (see event 91). Flooding in the Mississippi and the Missouri River Basins had begun in June, and the flooding intensified with the increased rainfall and inflow from tributaries during July.

Floods closed the Missouri River from Sioux City, Iowa, to St. Louis, Mo., on July 6. On July 7, the Mississippi River crested at a record of 22.6 feet above normal at Davenport, Iowa, and much of that city was under water. The Grand River at Gallatin, Mo., exceeded the previous peak stage of record by about 2 feet, the discharge on July 8 peaking at 1.3 times the 1947 peak of record and 1.2 times the 100-year flood.

Record flows were recorded on the Mississippi River in the reach from Keokuk, Iowa, to St. Louis between July 9 and 14. At Keokuk, the highest daily discharge of record was 464,000 ft³/s on June 10, about 1.5 times the previous daily high, and the July mean was almost 400,000 ft³/s.

On July 16, the Missouri River broke through a levee and joined the Mississippi River about 20 miles north of the usual confluence at St. Louis. Locks on the Mississippi River north of St. Louis were closed, which stranded all barge traffic.

Reservoirs located in the Kansas River basin experienced record water levels in July as a result of attempts to reduce flooding on the Missouri River main stem. Several of these reservoirs were forced to spill during the last of July and first of August because water levels reached the crests of emergency spillways. Also, many streamflow records were set in the Kansas, the Arkansas, and the Little Arkansas River Basins during July.

- 93 ALASKA—On July 22, 16,000 gallons of diesel fuel spilled from a vessel when it went aground in Knoll Bay near Kodiak. The hull of the vessel was badly damaged, and the ship sank in 24 hours. The vessel was declared a total loss, towed out to sea, and scuttled. About 9,000 gallons of fuel were removed from the vessel before it sank.
- 94 ILLINOIS—Between July 24 and 26, torrential rains over west-central Illinois flooded all roads into the Henderson County town of Oquawka and turned it into an island. Summer thunderstorms had kept soils saturated throughout the State. At Galesburg, 8.6 inches of rain fell on July 23–24. This storm covered a large area that extended to Peoria and caused record high stages on the Spoon River and Henderson Creek. The peak discharge of Henderson Creek near Oquawka exceeded the previous record and also exceeded that of the 100-year flood. The peak discharge of the Spoon River at Seville was slightly less than that of record and had a recurrence interval of about 50 years.
- 95 IDAHO—Beginning on July 25 and continuing for several days, about 100 acres of hillside slid into the Snake River near Bliss. A segment of road was destroyed, the river was temporarily dammed, and water was muddied for 50 miles downstream. Excessive rainfall during the spring probably caused the conditions that triggered the massive slide.
- 96 INDIANA—A water emergency was declared in Boonville on July 26 because of hot, dry weather, a broken water main, and power loss to a municipal well. Residents were ordered to boil cooking and drinking water.
- 97 MISSOURI—Storms in the Missouri River Basin caused huge increases in Missouri River discharges, the maximum daily discharge at Hermann reaching 739,000 ft³/s on July 31. That daily discharge exceeded the previous all-time daily high of July 1951 by about one-fifth. The Missouri River flow, combined with the flow coming down the Mississippi River upstream from the Missouri River, caused a maximum daily flow of 1.03 million ft³/s at St. Louis on August 2. That daily flow exceeded the previous daily high of record (April 1973) and was about equal to the peak discharge of record (June 1903).

August 1993

- 98 NEW YORK—On August 7, about 2,500 gallons of fuel oil spilled from a storage tank into the Buffalo River at Buffalo. Booms were placed in the river near the spill, and pockets of oil were recovered.
- 99 GUAM (not shown)—On August 8, an earthquake of 8.1 on the Richter scale hit Guam the strongest quake on Guam since 1909. Sixty people were treated for minor injuries, but no deaths were reported. Some water lines broke, which left the island without potable water for several days. The quake was centered about 55 miles northeast of Agana. Damage, estimated in the

millions of dollars, forced the Joint Typhoon Warning Center to close while monitoring Tropical Storm Steve, which struck the Northern Mariana Islands during the tremor.

- 100 NORTHERN MARIANA ISLANDS** (not shown)—Tropical Storm Steve struck the islands at the same time that the earthquake struck Guam (event 99). The storm dropped about 20 inches of rain in less than 24 hours on Saipan and caused considerable flooding in low-lying areas. Water levels at the USGS stream gage at South Fork Talofofo on Saipan rose 5.5 feet in 5-1/2 hours. The flow was estimated at 2,400 ft³/s (more than 1 million gallons per minute), which was the largest flow since August 1978.
- 101 THE EAST**—Much of the Eastern United States was affected by severe to extreme drought during the summer. Agricultural losses in South Carolina were estimated to be \$264 million. In Georgia, more than \$250 million was lost on crops; the Governor requested that all 159 counties be declared disaster areas because of the extensive crop losses. On August 10, all 46 counties of South Carolina, 154 of 159 counties in Georgia, and 89 of 100 counties in North Carolina were declared drought disaster areas by the U.S. Department of Agriculture. Rhode Island residents were ordered to ration water.
- 102 FLORIDA**—On August 10, about 328,000 gallons of fuel oil leaked from a barge when the barge, two tugboats, and a motor vessel collided in Egmont Channel west of the Sunshine Skyway Bridge at the mouth of Tampa Bay near St. Petersburg. The tank barge and one of the tugs caught fire. A sheen extended 1.5 nautical miles west of the incident, and the main ship channel was closed for 3 miles seaward of the bridge. A containment boom and cooling foam were placed around the vessels. The Intracoastal Waterway was closed to all vessels except those involved in cleanup efforts. Booms were deployed at Blind Pass in Boca Ciega Bay and at John's Pass, which was closed to vessels except those going to home port. Oil washed onto an 11-mile stretch of beach in Pinellas County. Three hundred and fifty-four oiled birds, mostly pelicans, were cleaned and rehabilitated. Offshore skimming recovered about 282,500 gallons of oily water, and inshore skimming recovered about 103,500 gallons. About 3,000 truckloads of oiled sand was removed from beaches.
- 103 CALIFORNIA**—A 4-mile stretch of coastline in Long Beach remained closed for 2 days after 35,000 gallons of raw sewage leaked into the Los Angeles River and contaminated nearby beaches.
- 104 INDIANA**—Flash flooding on August 17 resulted from heavy rains that fell overnight on August 16–17, including 11.33 inches of rain in southern Putnam County. One lane of U.S. Highway 231 and the supporting embankment were destroyed when they were overtopped by Doe Creek. Croys Creek inundated Interstate Highway 70 in Putnam County, and railroad tracks were washed away near Paragon, Quincy, Fontanet, and Cloverdale. Emergency evacuations took place in some communities in Vermillion, Parke, Putnam, Clay, Owen, Morgan, and Brown Counties.
- 105 ALASKA**—On August 23, 13,600 gallons of diesel fuel spilled into Cook Inlet near Anchorage from a fuel tank aboard one of two vessels that collided. Booms were used to contain the fuel. A U.S. Coast Guard overflight revealed a 1-mile by 2-mile sheen initially but only small patches on subsequent flights. Rough seas and heavy winds caused most of the fuel to dissipate quickly.
- 106 NORTH CAROLINA**—On August 31, Hurricane Emily moved northward along the Outer Banks of North Carolina and damaged beachfront development. The communities of Hatteras and Buxton, at the southern end of Hatteras Island, suffered considerable damage from 115-mph winds and severe sound side flooding. In some areas, 30-year high tides were reported, and the storm surge flooded some parts of the island to depths exceeding 6 feet.

September 1993

- 107 CENTRAL UNITED STATES**—Intense rains in southeastern Kansas and southwestern Missouri produced flooding in those States and in the northeastern corner of Oklahoma. The Missouri and the Mississippi Rivers once again rose above flood stage and remained there throughout September. The renewed flooding in the Midwest forced hundreds of people from their homes on September 25. In Kansas, 15.34 inches of rain fell in 24 hours at Pittsburgh and put the town's wastewater-treatment plant out of service. The mean annual streamflow for the 1993 water year exceeded the greatest mean annual streamflow for the period of record at 68 stream-gaging stations in Kansas—more than one-half of all Kansas stations.
- Rainfall of from 8 to 15 inches in many areas in southwestern Missouri during the week of September 19 caused major flooding throughout that part of the State. As much as 7 inches of rain fell overnight on September 25, in addition to that from the previous 2 days. Several mobile homes were washed away by the James River and three deaths resulted from the flooding. In southern Missouri, 12 USGS stream-gaging stations recorded new peaks of record.
- In Oklahoma, peaks of record were reported on Tar Creek at Miami, where the southern one-half of the town was flooded, and on Spring River near Quapaw. Tar Creek had a peak stage of 14.70 feet and a discharge of 12,400 ft³/s (25-year recurrence interval) on September 25. Spring River had a peak stage of 46.60 feet and a discharge of 230,000 ft³/s (exceeding the 100-year recurrence interval) on September 26.