MASSACHUSETTS
Floods and Droughts

Frequent weather changes and abundant precipitation in Massachusetts result from frontal systems or storms that move across the continent and exit through the northeastern United States. Dominant airmasses that affect national weather patterns are polar continental, tropical maritime, and, to a lesser degree, polar maritime. Widespread flooding is caused by intense rainfall and snowmelt, northeasters, and tropical storms. A combination of intense rainfall and snowmelt caused the floods of March 1936, March 1968, and March–April 1987. Hurricanes or tropical storms caused the floods of November 1927, September 1938, and August 1955. The floods of 1936 and 1938 affected the largest area of the State. Droughts of 1929–32, 1939–44, and 1980–83 were widespread but not as severe as the 1961–69 drought, which was the severest on record. Evaluation of the present drought (1985–88) in the Housatonic River basin is incomplete because this event may continue; however, it presently ranks equal in severity to the drought of 1929–32.

Floods and droughts have affected the water-management and planning activities of several State and Federal agencies. Water management at the State level is coordinated by the Massachusetts Water Resources Commission, which recently adopted water-use and supply-management measures. Potential drought conditions are reviewed by State and Federal agencies. Development in the flood plain is controlled by the State and most local governments.

GENERAL CLIMATOLOGY

The climate of Massachusetts is predominantly continental, modified by proximity to the Atlantic Ocean, altitude, and terrain. Frontal systems moving across the continent and through the northeast affect Massachusetts. The State has frequent weather changes and abundant precipitation.

Airmasses that dominate climate include: cold and dry from the Canadian and Arctic areas (polar continental), cool and damp from the northern Atlantic (polar maritime), and warm and moist from the Gulf of Mexico and the adjacent subtropical Atlantic Ocean (tropical maritime). Airmasses having less effect on the State are subtropical continental airmasses from the southwestern United States and Mexico and maritime airmasses from the Pacific Ocean that are modified during movement across the continent.

In addition to the oceans, important moisture sources include local and upwind land surfaces, as well as lakes and reservoirs, from which moisture evaporates into the atmosphere. Typically, as a moisture-laden ocean airmass moves inland, it is modified to include some water that has been recycled one or more times through the land-vegetation-air interface.

Tropical maritime air brings the greatest moisture (fig. 1). Most precipitation occurs in conjunction with frontal systems, where either the moist air is pushed over a wedge of cold air (warm front) to cause precipitation or an advancing wedge of cold air (cold front) lifts the warm air above condensation levels. Convective showers, commonly thunderstorms, contribute considerable summertime inland precipitation.

Average annual precipitation ranges from about 40 inches in the Connecticut River valley to about 50 inches in the higher altitudes of the Berkshire Hills. Precipitation in coastal areas averages about 45 inches annually because the Atlantic Ocean and coastal storms provide additional moisture. Precipitation exhibits no distinct seasonality. Most winter precipitation is in the form of snow, and average seasonal snowfall totals range from about 30 inches on Cape Cod to about 75 inches in the Berkshire Hills.

Although disastrous and extensive floods are rare, they are possible if intense spring rains combine with warm, humid winds to release water rapidly from a thick snowpack. Widespread flooding also is caused by major hurricanes or tropical storms. Localized street and basement flooding occurs occasionally from severe thundershowers; flooding of larger areas can result from coastal "northeasters."

Droughts are caused by the prevalence of dry northern continental air and a decrease in coastal- and tropical-cyclone activity. During the 1960's, a cool drought occurred because dry air from the north caused lower temperatures in the spring and summer of 1962–65. The northerly winds drove frontal systems to sea along the Southeast Coast and prevented the Northeastern States from receiving moisture (Harkness and others, 1986, p. 30).

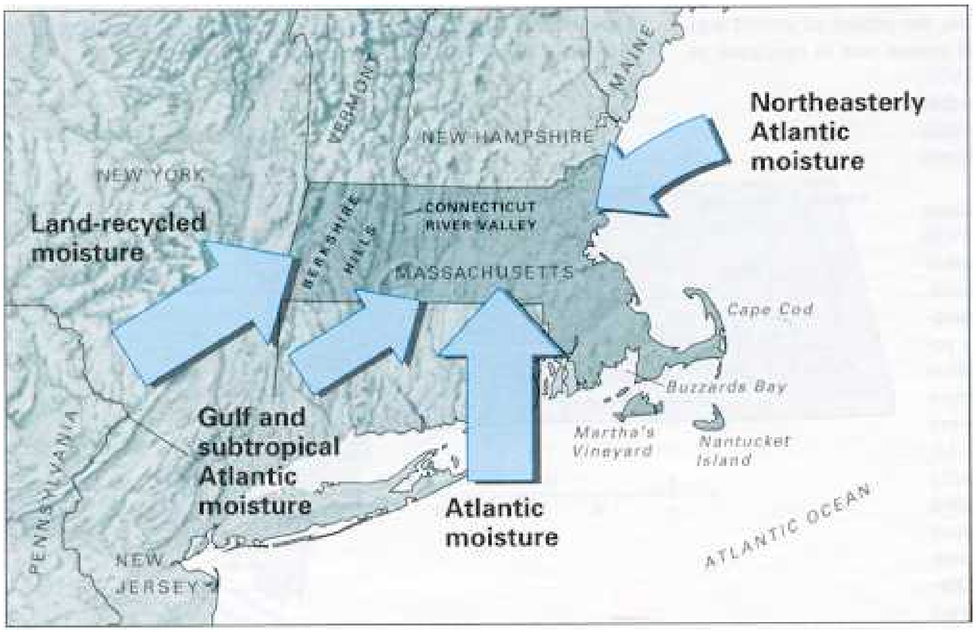


Figure 1. Principal sources and patterns of delivery of moisture into Massachusetts. Size of arrow implies relative contribution of moisture from source shown. (Source: Data from Douglas R. Clark and Andrea Lage, Wisconsin Geological and Natural History Survey.)

MAJOR FLOODS AND DROUGHTS

Floods and droughts adversely affect agriculture, tourism, industry, water supply, and waste disposal. Widespread floods can occur at any time. Although floods are of short duration, the property damage inflicted can take years to repair. Prolonged droughts, caused by successive years of less than average precipitation, affect water-supply systems that rely on surface water. Short-term droughts may have a noticeable effect on public water supplies because water use has increased in recent years, whereas water supplies have decreased. All major urban areas and 68 percent of the population use surface water. In 1980, 84 percent of the water used in the State was from surface water (U.S. Geological Survey, 1986, p. 271).

The most significant floods and droughts in Massachusetts are listed chronologically in table 1; rivers and cities are shown in figure 2. Floods and droughts, as discussed herein, are documented by streamflow and precipitation records. Establishment of a few streamflow-gaging stations in Massachusetts began in 1900. Streamflow data are collected, analyzed, stored, and reported by water year (a water year is the 12-month period from October 1 through September 30 and is identified by the calendar year in which it ends). Precipitation records are useful to identify droughts that occurred before streamflow records became available. Information on historical floods in New England between 1620 and 1955 that includes comparative flood stages for selected sites has been documented by Thompson and others (1964). Reports on droughts are few in comparison to the many reports by State and Federal agencies concerning floods occurring in the 1900's. The major floods and droughts selected for analysis are those that affected an extensive area and exceeded a recurrence interval of 25 years for floods and 10 years for droughts.

FLOODS

Flood-frequency data computed for as many as 36 gaging stations in Massachusetts and adjacent States were used to evaluate the severity of the floods and to delineate the extent of flooding. Six stations were selected from the statewide gaging-station network to depict the major floods (fig. 3). Peak discharge at each station was minimally affected by human activities, the period of record was sufficient for documentation, and each station was in operation as of 1988. Major floods of 1936, 1938, 1955, 1968, and 1987 were selected for further discussion because these significant events affected large areas and caused significant loss of life or property damage.

A series of meteorologic conditions produced flooding during the winter of 1936 (Grover, 1937, p. 7–62, 332). Cold weather early in the winter caused frozen ground. Subsequent snowstorms and low temperatures without the usual winter thaws resulted in an unusually large accumulation of snow. Rainfall totals from two major storms during March 9–22, 1936, were record maximums. During March 9–13, rainfall of 2–3 inches occurred mostly within 24 hours. The rain, in combination with warm temperatures, melted the snow and ice cover and released ice floes into river channels, causing flooding. Discharge on streams in the east and southeast peaked on March 13–15. The storm of March 16–19 produced an additional 1–8 inches of rain, which combined with snowmelt runoff from the first storm and resulted in flooding in the rest of the State from March 18–20. Total rainfall and water content of snow were greatest in the headwaters of the Connecticut and Merrimack Rivers in Vermont and New Hampshire.

Advance forecasts allowed evacuation of dangerous areas during the March 1936 flood. Damage to buildings and structures was caused by ice and floodwater. Flooding of the upper Deerfield River (fig. 2) was minimized because runoff from 184 square miles was controlled by reservoirs operated for hydroelectric power. The flood was the largest in recorded history on the Connecticut and Merrimack Rivers in Massachusetts, as a result of the runoff generated in areas of these river basins outside the State. Mills and factories in Haverhill, Lowell, and Lawrence received the most damage. The peak discharge of 16,300 ft^3/s (cubic feet per second) for the North Nashua River near Leominster (fig. 3, site 1) exceeded the 100-year recurrence interval. Damage in Massachusetts was estimated at about $36 million (Uhl, 1937, p. 471).

Flood flows, hurricane winds, and an ocean storm wave combined in September 1938 to form the "Great Hurricane of 1938"—the worst disaster in the history of New England (Paulsen and others, 1940, p. 2–61). Intense rainfall during September 18–20, 1938, was followed by a hurricane that moved up the Connecticut River valley. The arrival of the ocean storm wave associated with the flood flows and hurricane of September 1938 at high tide caused extreme tidal stages in Buzzards Bay and southern Cape Cod. The hurricane brought additional rainfall of about 3 inches on September 21. Total rainfall exceeded 10 inches in most of central Massachusetts. A maximum of nearly 17 inches occurred along the eastern edge of the Connecticut River basin at Barre.

Flood stages on the Connecticut River during the September 21–23, 1938, flood were 4.5 and 2.2 feet lower, respectively, than those of the flood of March 1936 near the northern and southern borders of the State. The peak discharge of 3,000 ft^3/s for Priest Brook near Winchendon (fig. 3, site 4) was about 2 times the 100-year recurrence interval. The flood of September 21–23, 1938 (11,520 ft^3/s), was exceeded only by the flood of 1949 (12,200 ft^3/s) on the Housatonic River near Great Barrington (fig. 3, site 6). In the Northeastern United States, an estimated 500 lives were lost, and damage was about $330 million (Paulsen and others, 1940, p. 2–3). Although most loss of life and damage were in the coastal areas, the extent of coastal flooding could not be shown in figure 3.

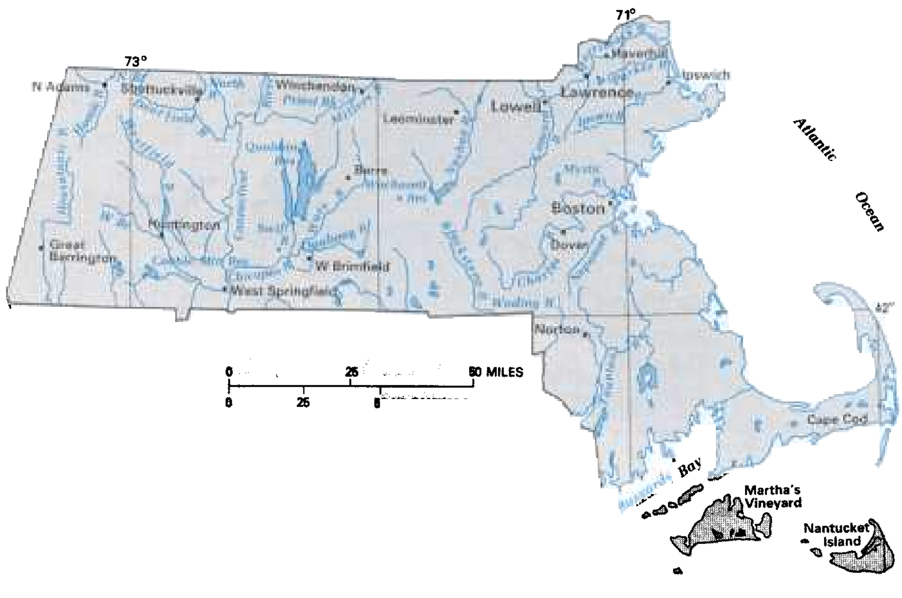


Figure 2. Selected geographic features, Massachusetts.

The flood of August 18–23, 1955, was caused by Hurricanes Connie and Diane, which occurred days apart; the result was loss of life and extensive property damage from North Carolina to Massachusetts (Bogart, 1960, p. 12–16, 28–29). Hurricane Connie ended what had been an extended dry spell. During August 11–16, total rainfall ranged from 2 to 9 inches. This storm was followed by rainfall of from 2 to 19 inches from Hurricane Diane during August 17–20. Flood stages were increased because of the failures of dams. Flood peaks, which were increased by these dam failures, are the maximum known peak discharges along the Blackstone River. The most damaging floods occurred from the Blackstone River west to the New York State line; recurrence intervals ranged from 5 years to greater than 100 years. Flooding in the Housatonic River basin to the west was relatively minor—6,060 ft^3/s for the Housatonic River near Great Barrington (fig. 3, site 6). In the Westfield River basin, where maximum measured rainfall was almost 20 inches, high flows were generated along the main stem downstream from Knightville Dam and in the southern part of the basin. The peak discharge of 26,100 ft^3/s for the West Branch Westfield River at Huntington is the maximum for the period of record and had a recurrence interval greater than 50 years. In Massachusetts, this flood caused 12 deaths and damage of about $133 million (U.S. Army Corps of Engineers, 1956, p. 1).

Several climatic events combined to cause severe flooding during March 18–22, 1968, in eastern Massachusetts and Rhode Island. Extended cold weather during January and February froze the ground and created a thick ice cover on streams and rivers; snow cover was greater than normal (U.S. Army Corps of Engineers, 1968, p. 1). These antecedent conditions combined to fill swamps and lowland areas and to decrease the capacity of streams to carry high flows. Much of the snow cover was melted by rain on March 12–13. Rainfall of 4–7 inches during March 17–19 resulted in record totals for 24-hour periods (Wood and others, 1970, p. 1–4). Flood-peak discharges exceeded those of August 1955 on some streams. The peak discharge of 1,460 ft^3/s for the Wading River near Norton (fig. 3, site 3) exceeded the 100-year recurrence interval. Flood losses were estimated at $35 million (U.S. Army Corps of Engineers, 1968, p. 11–14). Damage to private residences exceeded damage to industrial, commercial, or public facilities because many flood-prone areas had been urbanized in the 1960's.

Two storms caused major flooding from March 31 to April 10, 1987, in northeastern and north-central Massachusetts (Fontaine, 1987). A seasonally dry weather pattern and high air temperatures decreased the snow cover that had reached near-record levels in January (U.S. Army Corps of Engineers, 1987b). Rainfall during the first fast-moving storm of March 30–April 2 ranged from 1 to 4 inches. Rainfall quantities were smaller in the mountains of central and western Massachusetts, where melting of the snowpack increased the runoff. Peak discharge of 10,200 ft^3/s for the North River at Shattuckville was the fourth largest since 1940. Intense rainfall from

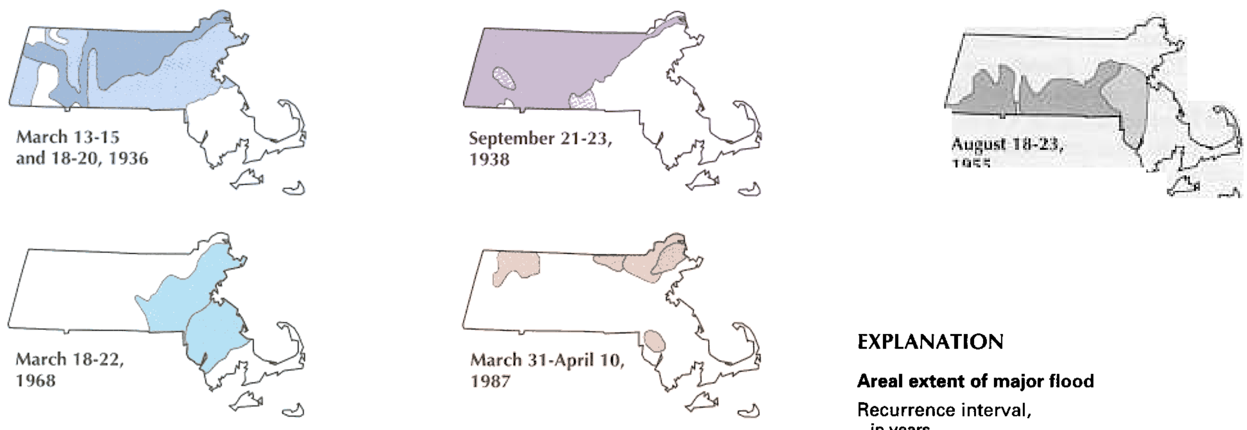
Table 1. Chronology of major and other memorable floods and droughts in Massachusetts, 1927–88

[Recurrence interval: The average interval of time within which streamflow will be greater than a particular value for floods or less than a particular value for droughts. Symbol: >, greater than. Sources: Recurrence intervals calculated from U.S. Geological Survey data; other information from U.S. Geological Survey, State and local reports, and newspapers]

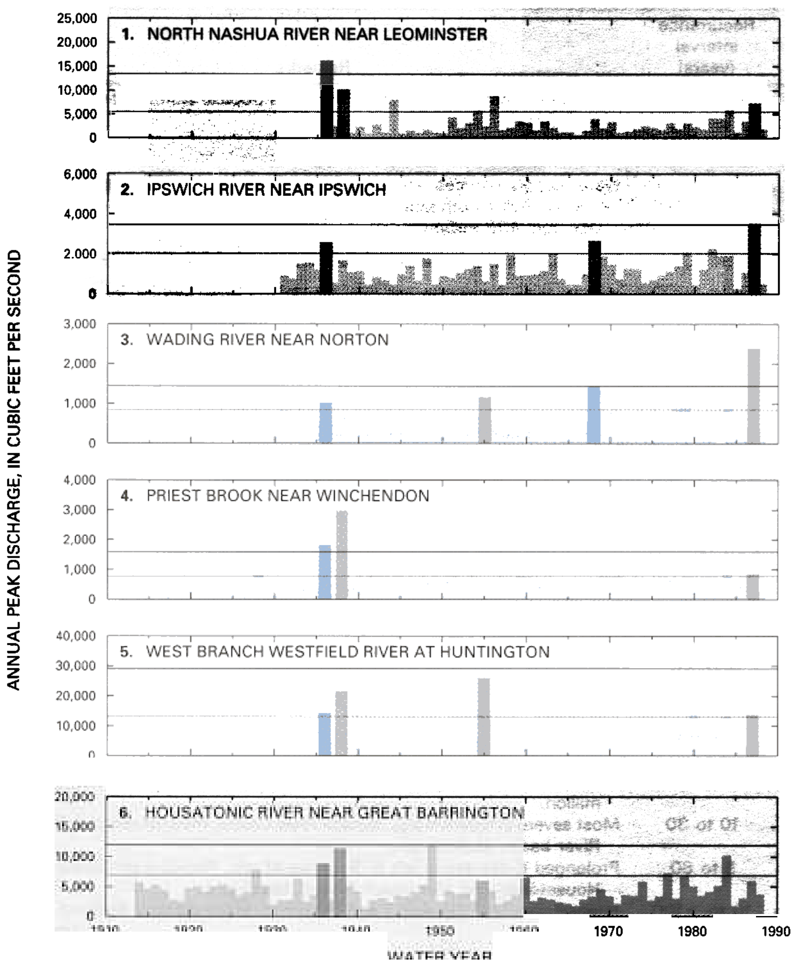
Flood or drought	Date	Area affected (fig. 2)	Recurrence interval (years)	Remarks
Flood	Nov. 3-6, 1927	Hoosic, Housatonic, Westfield, and Farmington River basins; Connecticut and Merrimack Rivers.		Conditions created by torrential rains from tropical storm and Oct. rainfall. Multistate.
Drought	1929-32	Statewide	10 to >50	Water-supply sources altered in 13 communities. Multistate.
Flood	Mar. 13-15, 18-20, 1936	Statewide	5 to >100	Large snowfall, frozen ground, and two major rainstorms in Mar. Multistate. Damage, $36 million.
Flood	July 24-29, 1938	Concord, Ipswich, Charles, and Blackstone River basins.	5 to 40	Series of showers and thunderstorms July 17-25 produced 10 inches of rain. Multistate.
Flood	Sept. 21-23, 1938	Central and western Massachusetts and Merrimack River; Buzzards Bay and south shore of Cape Cod.	40 to >100	Intense rains, hurricane, and tidal surge. Estimated deaths, 500; damage, $330 million in Northeastern United States.
Drought	1939-44	Statewide	15 to >50	More severe in eastern and extreme western Massachusetts. Multistate.
Flood	Sept. 14, 1944	South shore of Cape Cod and outer islands.	Unknown	Hurricane wave surge arrived before low tide but produced record tidal levels along the southern coast.
Flood	Dec. 31, 1948, to Jan. 1, 1949	Housatonic and Hoosic River basins and western tributaries of Connecticut River basin.	5 to >100	Intense rainfall of 5-12 inches. Snow cover did not affect peak flows. Multistate. Deaths, 5.
Flood	Aug. 31, 1954	Coastal areas south of Cape Cod.	Unknown	Hurricane Carol.
Flood	Aug. 18-23, 1955	Southern Massachusetts	5 to >100	Hurricanes Connie and Diane. Multistate. Deaths, 12; damage, $133 million.
Flood	Oct. 15-16, 1955	Deerfield, Nashua, Ware, Farmington, and Westfield River basins.	5 to 30	Intense rainfall from localized storms. Damage, $790,000.
Drought	1957-59	Statewide	5 to 25	Record low water levels in observation wells, northeastern Massachusetts.
Drought	1961-69	Statewide	35 to >50	Water-supply shortages common. Record drought. Multistate.
Flood	Mar. 18-22, 1968	Eastern Massachusetts	5 to >100	Multistate. Damage, $35 million.
Flood	Feb. 6-7, 1978	Coastal areas, Cape Cod north to New Hampshire border.	Unknown	Record tidal levels. Multistate. Deaths, 54 in New England. Major disaster declared.
Flood	Jan. 25-28, 1979	Central and eastern Massachusetts.	5 to 40	Intense rains Jan. 21-25. Multistate. Disaster declared. Damage, $30 million.
Drought	1980-83	Statewide	10 to 30	Most severe in Ipswich and Taunton River basins; minimal effect in Nashua River basin. Multistate.
Flood	May 29-June 5, 1984	Statewide except southeastern Massachusetts.	5 to 80	Prolonged 6-day storm left 5-9 inches of rain. Flooding on Connecticut, Housatonic, and Merrimack Rivers. Multistate.
Flood	Mar. 31-Apr. 10, 1987	Northeastern and northwestern Massachusetts.	10 to >100	Intense rains Mar. 30-Apr. 2 and snowmelt. Major disaster declared. Multistate.
Drought	1985-88	Housatonic River basin	25	Duration and severity as yet unknown. Streamflow showed mixed trends elsewhere.

the second slow-moving storm during April 4–8 occurred in the northwestern and northeastern parts of the State. Maximum measured rainfall was almost 9 inches, with most areas receiving more than 3 inches. Intense rainfall on the steep slopes of western Massachusetts produced flash flooding that damaged roads, bridges, culverts, public facilities, and farmland. Major flooding of low-lying areas in the eastern part of the State inundated homes and businesses and closed roads. Record peak discharges were recorded: 3,550 ft^3/s on the Ipswich River near Ipswich (fig. 3, site 2) and 14,200 ft^3/s on the North River. The peak discharge on the North River exceeded the peak recorded 5 days earlier at the same site. At Lowell, the Merrimack River reached its highest level since September 1938. These two storms produced record or near-record flood-control storage in reservoirs.

Areal Extent of Floods



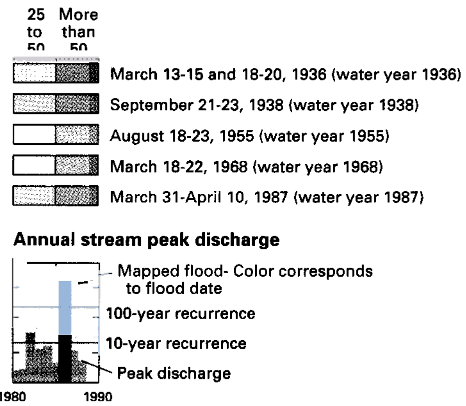
Peak Discharge

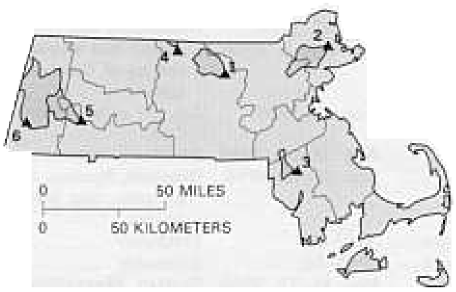


EXPLANATION

Areal extent of major flood

Recurrence interval, in years





U.S. Geological Survey streamflow-gaging stations and corresponding drainage basins — Numbers refer to graphs

Figure 3. Areal extent of major floods with a recurrence interval of 25 years or more in Massachusetts, and annual peak discharge for selected sites, water years 1914–88. (Source: Data from U.S. Geological Survey files.)

DROUGHTS

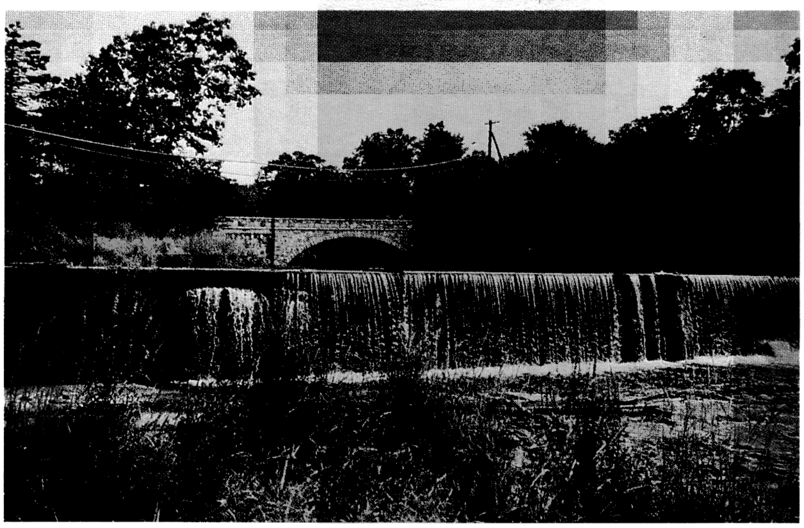
Multiyear droughts are identified by analyzing annual and cumulative departures from long-term average streamflow. Streamflow deficits were analyzed and recurrence intervals computed for selected droughts. The droughts of 1929–32, 1939–44, 1961–69, and 1980–83 were significant because of their severity and areal extent. Data for as many as 24 gaging stations and drought information from adjacent States were used to define the severity and extent of these events (fig. 4). Annual departures of average discharge from long-term averages are shown by bar graphs for six selected sites (fig. 4). The selection process for these sites was similar to that used in the flood analysis. Droughts are identified by consecutive bars having a negative departure; the greater the departures and the more consecutive years they occur, the more severe the drought. Periods of greater than average streamflow are indicated by consecutive bars having a positive departure.

Kinnison (1931, p. 148–153, 162–163) identified the three most severe droughts on record as those of 1879–83, 1908–12, and 1929–30. Kinnison compared runoff for the three periods from two regulated lake basins; runoff during the 1908–12 and 1929–30 droughts was about equal and less than the runoff during the 1879–83 drought. Later analysis indicated that the 1929–30 drought extended for 2 more years and thus became the 1929–32 drought.

During the 1929–32 drought, new or emergency water-supply sources were developed in six communities in central and western Massachusetts. The following year, 10 communities, including 3 located in eastern Massachusetts, sought additional water from adjacent communities or from emergency sources. The intake works of three water-supply systems were modified to permit withdrawals at lower water levels. Recurrence intervals ranged from 10 to greater than 50 years for the Quaboag River at West Brimfield (fig. 4, site 4), where the greatest departure from average flow occurred in 1930. Areal extent of this drought is based on an analysis of the records at eight gaging stations.

The 1939–44 drought had a recurrence interval greater than 25 years throughout the State, except in the western tributaries of the Connecticut River and smaller eastern tributaries. Streamflow records for 16 gaging stations were available to evaluate the severity of this event. The drought affected eastern, central, and extreme western Massachusetts to a greater extent than the 1929–32 drought. Recurrence intervals ranged from 45 years to greater than 50 years in the eastern part of the State. Annual departures in streamflow for the Charles River at Dover (fig. 4, site 1) and the Wading River near Norton (fig. 4, site 2) followed a similar pattern.

The severest drought on record in the Northeastern United States was during 1961–69. Water supplies and agriculture were affected because of the severity and long duration of the drought. Precipitation was less than average beginning in 1960 in western Massachusetts and beginning in 1962 in eastern Massachusetts (Copeland, 1966, p. 7–8). Streamflow had the greatest negative departure during 1965 in the west and 1966 in the east (fig. 4, sites 1–6). In 1965, the Massachusetts Water Resources Commission reported that emergency water supplies were being used by 23 communities. Water-supply emergencies were declared by the Massachusetts Department of Public Health for 37 communities, and 3 water districts invoked water-use restrictions. Voluntary water-use restrictions were adopted by about 30 communities. Ten communities had water supplies that were in a critical condition, that had less than 90 days of surface-water supply, or that required a decrease in ground-water pumpage (U.S. Army Corps of Engineers, 1965, p. 3–4). Southeastern Massachusetts was declared critical for agriculture because of the water needs by the cranberry industry. The Massachusetts Civil Defense and Office of Emergency Preparedness provided eight communities with

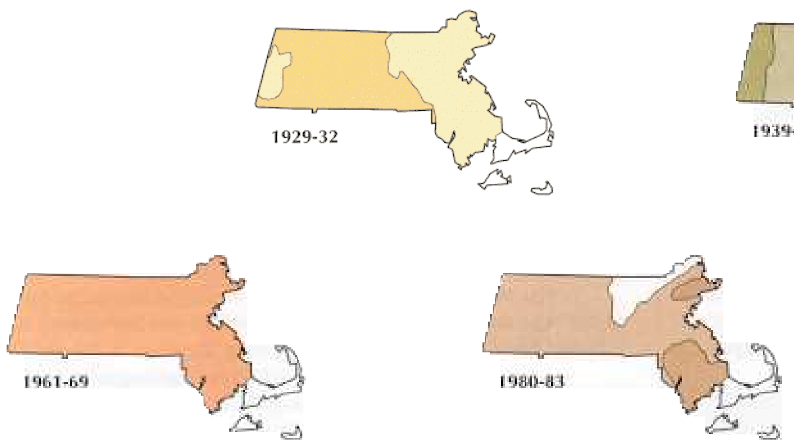


Extremes in streamflow during 1987 on the Charles River at Dover, Mass. Flow over the Cochrane Dam 0.25 miles upstream of the gaging station (fig. 4, site 1) during high flow on April 8 (above) and during low flow on July 24 (right). (Photographs courtesy of the Massachusetts Department of Environmental Management.)

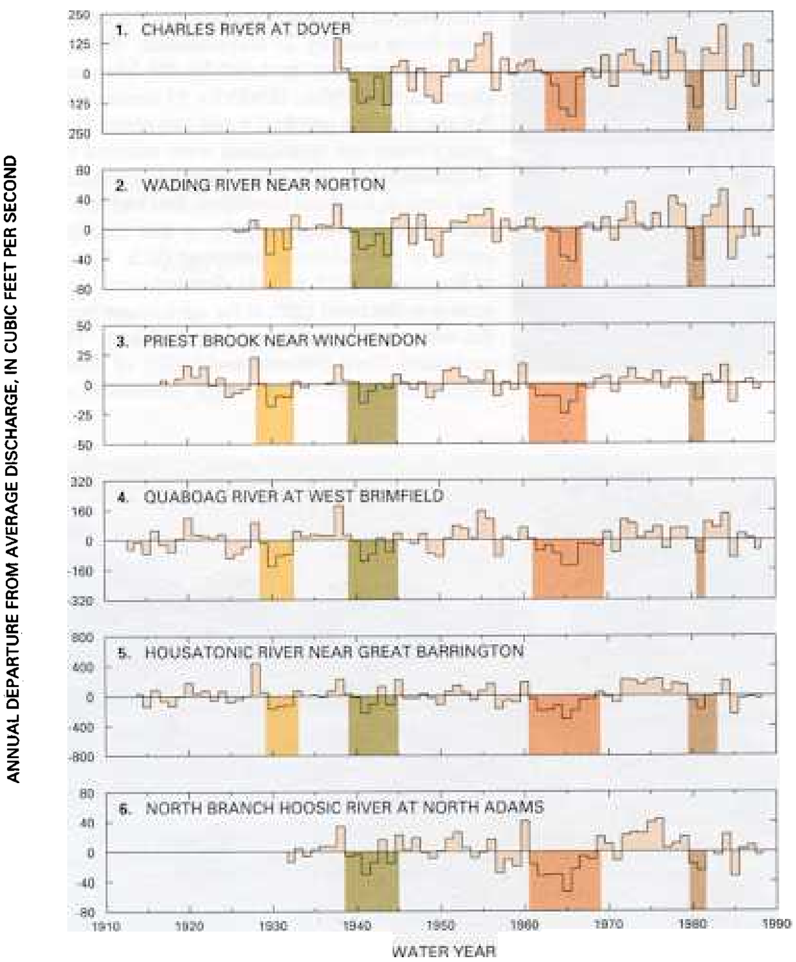
pumps and pipes to augment water supplies. Quabbin Reservoir, the major water source for the metropolitan Boston area, reached 45 percent of capacity in 1967; however, mandatory water-use restrictions were not required during this drought. In the Chicopee River basin, less than average streamflow in 1971 in the Quaboag River at West Brimfield (fig. 4, site 4) caused renewed concern for the declining water levels in Quabbin Reservoir.

On the basis of streamflow records, the 1980–83 drought was the least severe of the four major droughts (fig. 4). However, the increase in population, water use, and abandoned water-supply sources are important to the analysis of this event. Forty-two communities or water districts had water emergencies, and 19 communities had voluntary restrictions on the outside use of water in November 1981. This drought had the greatest effect in the

Areal Extent of Droughts



Annual Departure



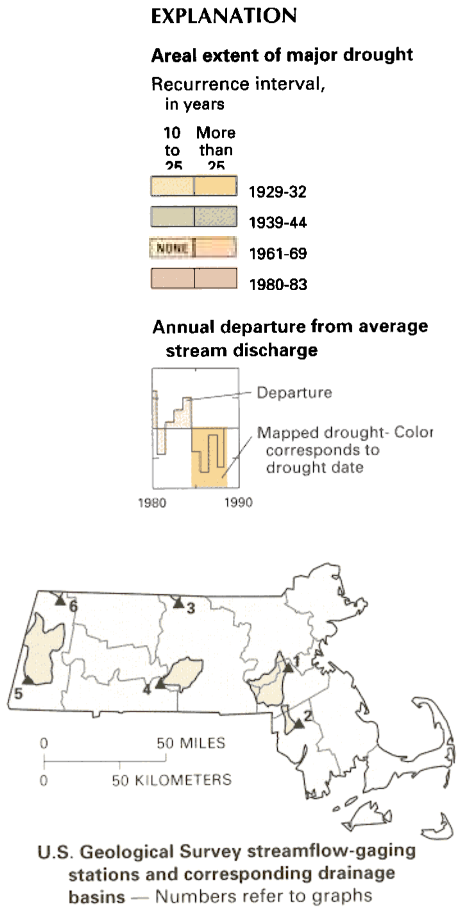


Figure 4. Areal extent of major droughts with a recurrence interval of 10 years or more in Massachusetts, and annual departure from average stream discharge for selected sites, water years 1913–88. Extent of drought is not shown on Cape Cod, Martha's Vineyard, and Nantucket Island. (Source: Data from U.S. Geological Survey files.)

Ipswich and Taunton River basins and the least effect in the Nashua River basin. Annual streamflow was less than average for only 1 year in the Chicopee River basin in the Quaboag River at West Brimfield (fig. 4, site 4).

WATER MANAGEMENT

Statewide water-resources policy and planning activities are the responsibility of the Massachusetts Water Resources Commission within the Executive Office of Environmental Affairs. Membership consists of the Secretaries of the Executive Office of Environmental Affairs and Executive Office of Communities and Development; Commissioners of the Department of Environmental Management; Department of Environmental Protection; Department of Food and Agriculture; Department of Fisheries, Wildlife, and Recreational Vehicles; Metropolitan District Commission; and six public members. The Massachusetts Water Supply Statement (Massachusetts Water Resources Commission, 1984, p. 2–8) defines the water-resources planning and policy-making activities of these State agencies. Water-use and supply management measures were adopted by the Water Resources Commission in this policy statement.

Flood-Plain Management.—Flood-plain development is regulated by the State and most local governments. The Flood Hazard Management Program was created in 1981 by the Division of Water Resources of the Department of Environmental Management, in cooperation with the Federal Emergency Management Agency. This program provides planning and information services on flood-plain management to municipal officials, the general public, and consulting firms. The purpose is to promote the adoption of local land-use bylaws and to enable community participation in the National Flood Insurance Program. Of the 352 communities in the State, 27 are not participating in the flood insurance program. Section 744 of the State Building Code requires certain design criteria for structures on flood plains. Community conservation commissions ensure that flood-plain or wetland projects are in accordance with local conservation laws and with the Massachusetts Wetlands Protection Act. Many communities require variances or special permits for development on a flood plain. Development in unsewered areas is further restricted because State regulations do not permit degradation of water quality.

The U.S. Army Corps of Engineers has built 11 flood-control dams, 27 local protection projects, including preservation of natural valley-storage areas along the Charles River, and 1 hurricane-protection barrier (U.S. Army Corps of Engineers, 1987a, p. 54–55, 96–97). Thirty flood-control structures constructed by the U.S. Soil Conservation Service are operated and maintained under the jurisdiction of the Department of Environmental Management. The Metropolitan District Commission controls flooding in the Boston metropolitan area through the Amelia Earhart Dam and Charles River Dam and flood-operation rights on several private dams on the Charles, Mystic, and Neponset Rivers. In addition, the Metropolitan District Commission has constructed and maintained numerous major riverine and tidal flood-control conduits and structures in the same area.

Interstate Flood Control Commissions were established following the floods of 1955 to solve common flood problems and to share costs associated with the economic and tax losses from lands acquired for reservoirs. These compacts are in existence for the Connecticut, Merrimack, and Thames River basins (most of the Thames River basin is in Connecticut).

Flood-Warning Systems.—The River Forecast Center of the National Weather Service located in Connecticut prepares flood forecasts by using a hydrologic-forecast model to compute flood heights for points along the major rivers. Flood warnings and watches for smaller streams are developed on a regional basis. Information is disseminated to the public by television and radio stations. The U.S. Army Corps of Engineers, in cooperation with the National Weather Service and the town of West Springfield, has developed an automated flood-forecasting system that can provide the town with timely and accurate forecasts of potential flooding along the Connecticut and Westfield Rivers.

Water-Use Management During Droughts.—The Massachusetts Water Management Act gives the Division of Water Supply of the Department of Environmental Protection the authority to manage public water-supply emergencies. A contingency plan that outlines water-supply emergency procedures is required from the water supplier. The Massachusetts Water Resources Authority and the Metropolitan District Commission have prepared a drought-management plan as part of the Declaration of Water-Supply Emergency by the Department of Environmental Protection in 1989 (Massachusetts Water Resources Authority and Commonwealth of Massachuusetts Metropolitan District Commission, 1989, p. 2–4). The storage level in Quabbin Reservoir throughout the year is used as an index to initiate water-use restrictions and other programs. Communities with drought-related water-supply problems that threaten public health and welfare can seek assistance from the U.S. Army Corps of Engineers. In addition to constructing wells and transporting water to stricken areas, on request from State officials, the Corps can augment water supplies of communities near their reservoirs (U.S. Army Corps of Engineers, 1987a, p. 38).

Potential drought conditions are evaluated by State agencies. The Division of Water Resources of the Massachusetts Department of Environmental Management monitors monthly precipitation with a network of 125 rain gages. Status of the available water supply from Quabbin and Wachusett Reservoirs is reported by the Massachusetts Water Resources Authority and the Metropolitan District Commission.

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