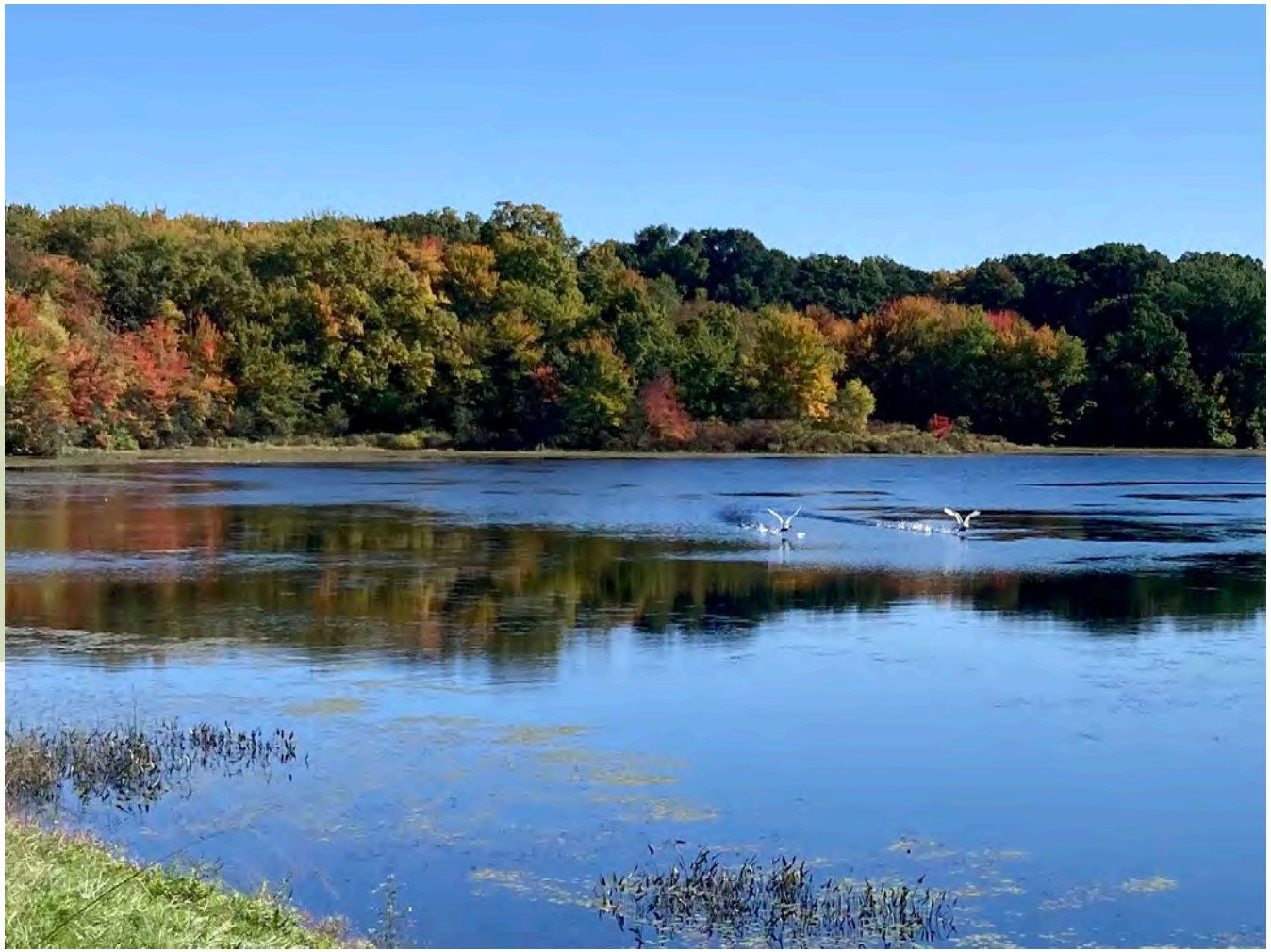
MASSACHUSETTS WATER RESOURCES COMMISSION

HYDROLOGIC CONDITIONS IN MASSACHUSETTS



SEPTEMBER
2023

The Commonwealth of Massachusetts

Maura T. Healey, Governor

Rebecca L. Tepper, Secretary
Executive Office of Energy and Environmental Affairs

SEPTEMBER 2023 HYDROLOGIC CONDITIONS

SUMMARY OF CONDITIONS

- Monthly average temperatures were normal to above normal.
- Precipitation was mostly above to much above normal with multiple intense events.

- Crop Moisture Index showed Wet and Excessively Wet conditions across the state at the end of the month. The 1-month and 2-month Evaporative Demand Drought Index maps showed normal to below normal.

- The Keetch-Byram Drought Index showed normal soil moisture conditions at the end of the month.

- Streamflow was much above normal except for the Cape Cod Region where it was normal. Some new, daily record highs were set. Major flooding occurring in central Massachusetts.

- Groundwater was below normal to much above normal. The Islands Region is the only region with elevated is an elevated ISL at ISL 3.
- Lake and impoundment levels were above their 30th percentile and/or were at or near 100% full.

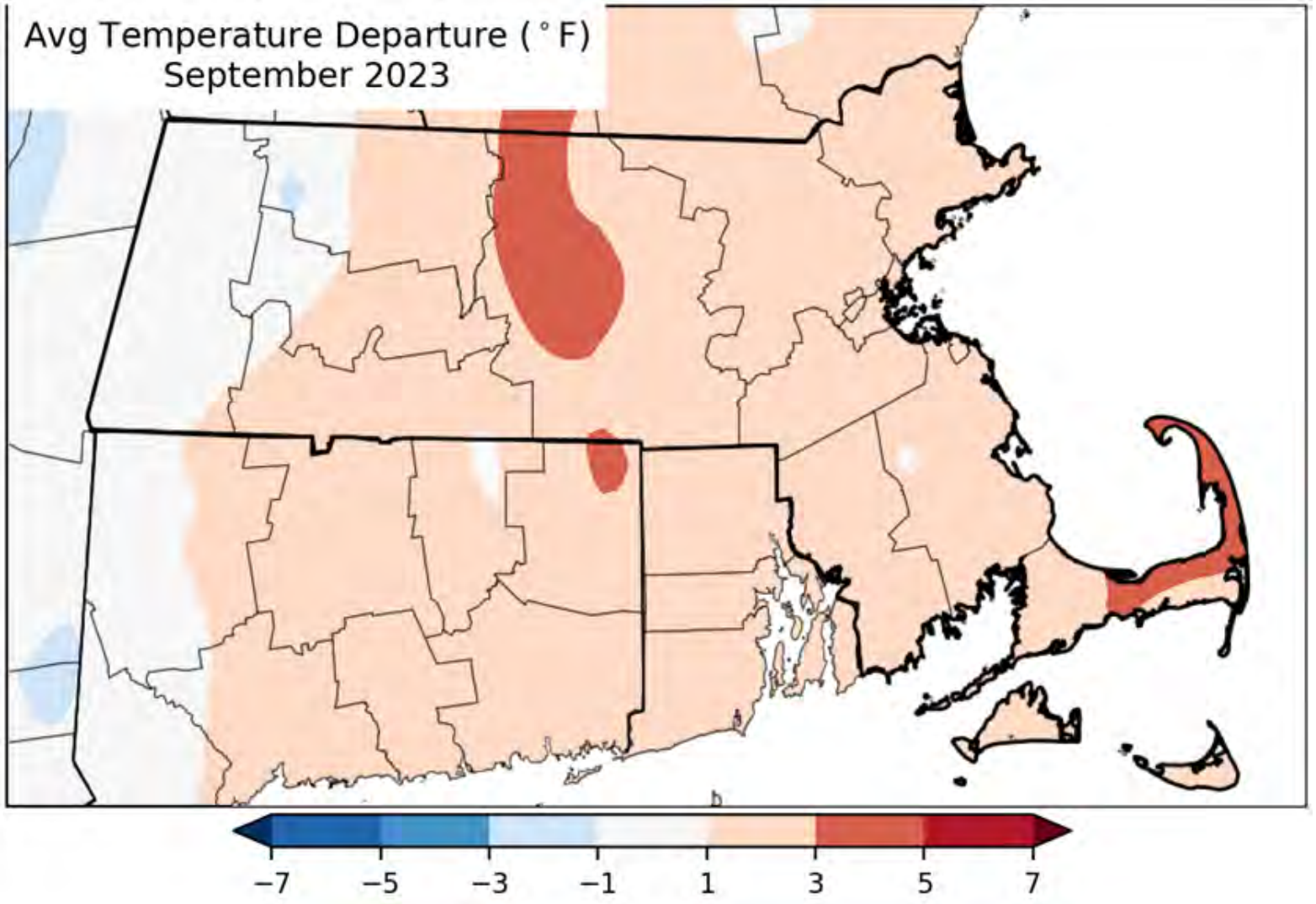
- NOAA's October outlook shows chances leaning for above-normal temperatures and chances leaning for below-normal precipitation.

- NOAA's 3-month outlook shows chances leaning for above-normal temperatures, chances leaning for above-normal precipitation in the southeastern part of the state, and equal chances for below-normal, normal, or above-normal precipitation for the remainder of the state.

- Appendix II provides information on the Massachusetts Drought Management Plan (DMP) including ISL thresholds used in this report.

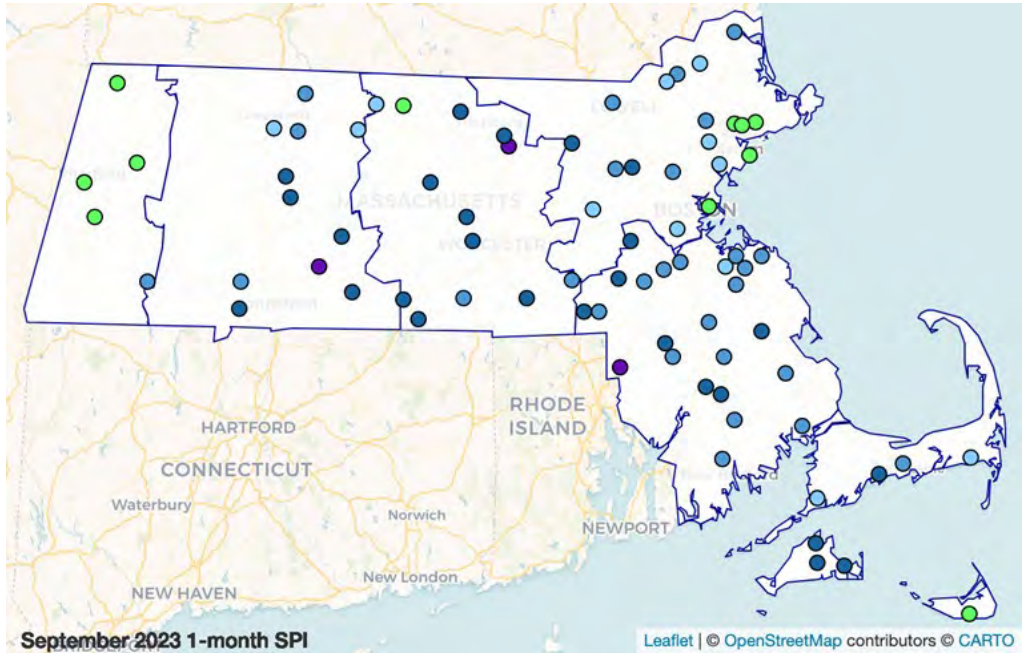
This report was prepared by the Massachusetts Department of Conservation and Recreation. Data may be preliminary. Analysis reflects automated calculations done 10/10/2023. Additional information, previous reports, and the Massachusetts Drought Dashboard with weekly updates to the drought indices can be found at: https://www.mass.gov/drought-monitoring

Monthly average temperatures were normal to above normal. According to the Northeast Regional Climate Center (NRCC) Monthly/Season Climate Summary Table, Massachusetts had its 8th warmest September on record. http://www.nrcc.cornell.edu/regional/monthly/monthly.html



STANDARDIZED PRECIPITATION INDEX (SPI) AS A PERCENTILE

September precipitation was mostly above normal. According to the NRCC, the Worcester climate site had its 9th wettest September on record. Several heavy rainfall events occurred during September including one on September 11th that brought extreme precipitation to central Massachusetts, especially to the town of Leominster. See the Flooding section for more details. In addition to the table below, Appendix I provides all the look-back periods.



≥0 to ≤2	>2 to ≤10	>10 to ≤20	>20 to ≤30	>30 to ≤70
>70 to ≤80	>80 to ≤90	>90 to ≤98	>98 to ≤100	

REGION	NUMBER OF SITES REPORTING	SEPTEMBER MONTHLY AVERAGE (IN)	DEPARTURE FROM HISTORICAL (IN)	SPI PERCENTILE 1-MONTH	SPI PERCENTILE 3-MONTH	SPI PERCENTILE 6-MONTH
WESTERN	5	4.82	0.44	57	90	83
CTRV	11	8.07	4.01	91	99	95
CENTRAL	13	8.32	4.29	94	99	99
NORTHEAST	19	5.23	1.64	79	98	97
SOUTHEAST	24	7.66	3.70	88	97	93
CAPE COD	4	5.92	2.28	82	92	86
ISLANDS	4	6.82	3.12	92	87	62

SPI is the Standardized Precipitation Index used in the Drought Management Plan (DMP) expressed here as a percentile and represents the variation from long-term precipitation.

DMP Index Severity Levels			
1	2	3	4

CROP MOISTURE INDEX (CMI)

Weekly values for the period ending September 30, 2023 from NOAA's National Weather Service Climate Prediction Center were in the Wet range in the western and coastal climate divisions and in the Excessively Wet range in the central climate division.

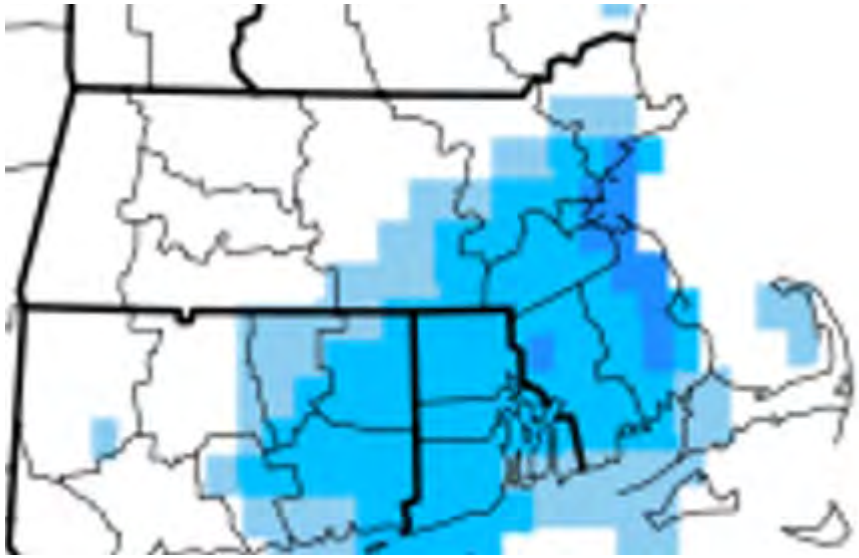
https://www.cpc.ncep.noaa.gov/products/monitoring_and_data/drought.shtml

CLIMATE DIVISION	CROP MOISTURE INDEX
WESTERN	2.95
CENTRAL	3.81
COASTAL	2.58

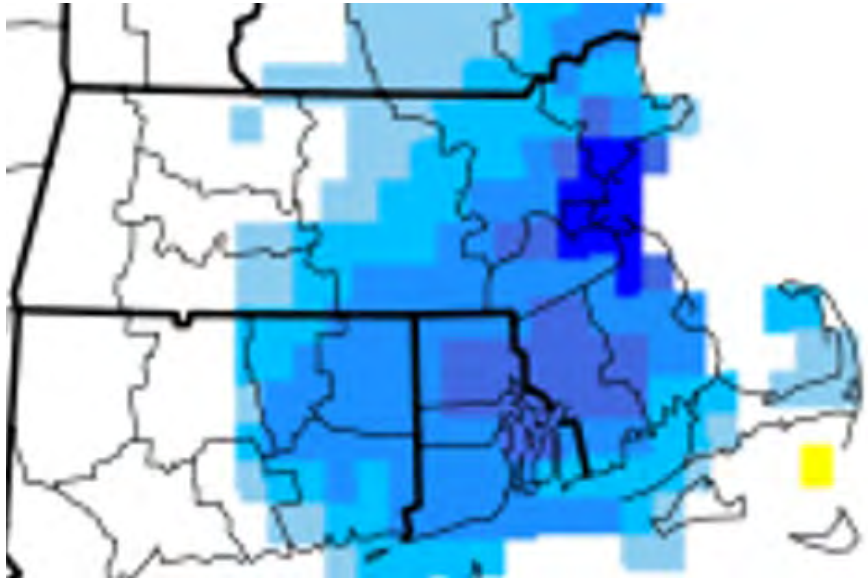
EVAPORATIVE DEMAND DROUGHT INDEX (EDDI)

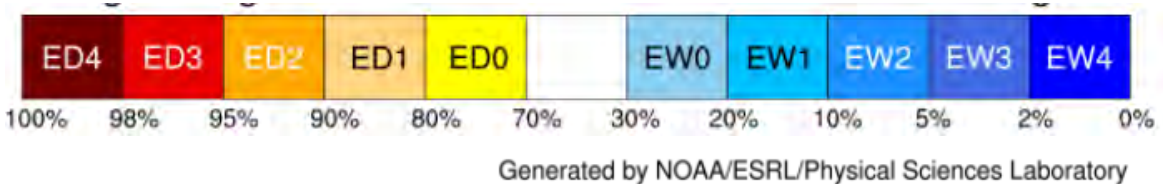
The 1-month and 2-month EDDI categories for September 30, 2023 were normal to below normal.

1-month EDDI

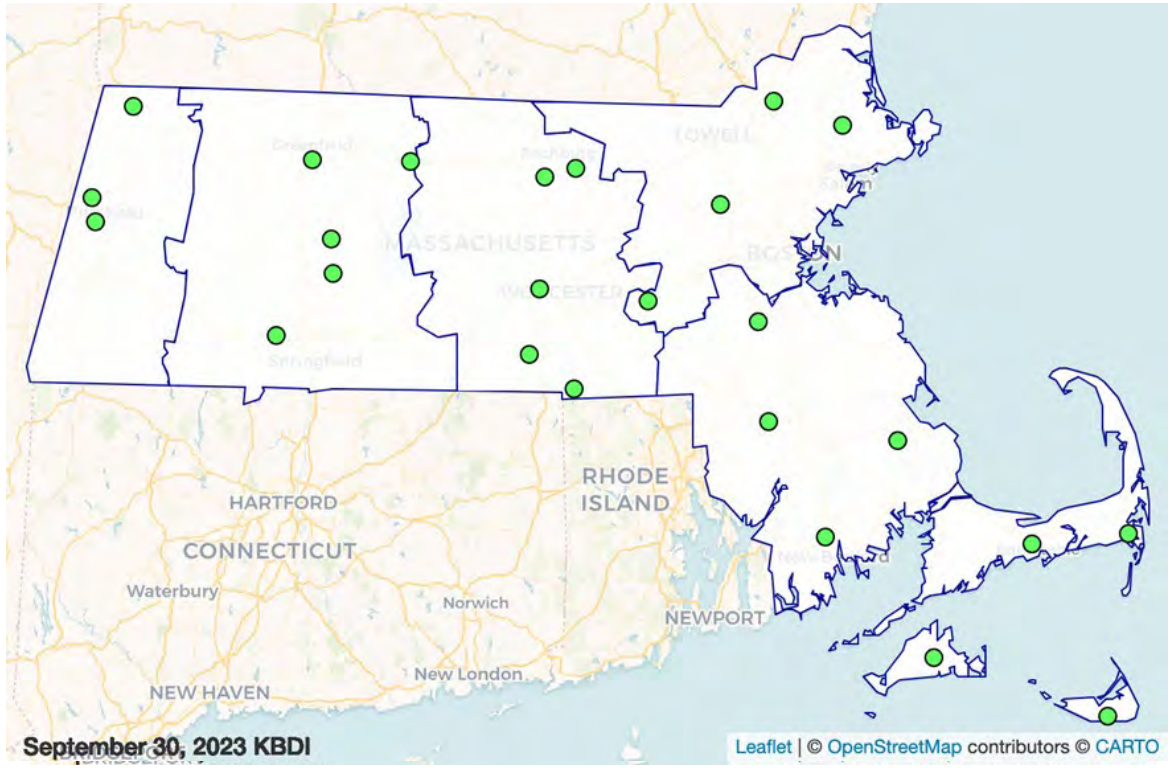


2-month EDDI





At the end of September, the Keetch Byram Drought Index (KBDI) was in the normal range in all Regions.



REGION	NUMBER OF SITES REPORTING	HIGHEST OF SITE VALUES
WESTERN	3	96
CTRV	5	4
CENTRAL	5	8
NORTHEAST	4	34
SOUTHEAST	4	0
CAPE COD	2	77
ISLANDS	2	94

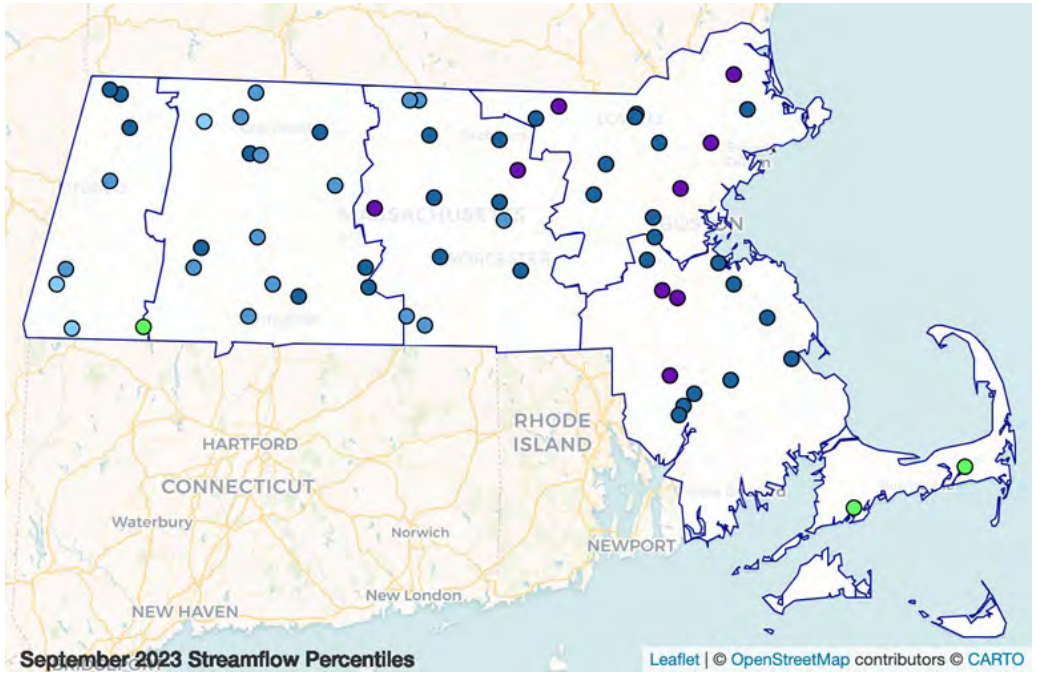
DMP Index Severity Levels

1	2	3	4

Point Values - KBDI Range				
≥700 to ≤800	≥600 to <700	≥400 to <600	≥200 to <400	≥0 to <200

During September, streamflow was high across the state except for Cape Cod. Most percentiles of individual streamflow gages were above normal to much above normal. Some gages recorded new, daily record highs (see timeseries graph on the next page). Flooding occurred in Central Massachusetts (see flooding page).

MEDIAN MONTHLY STREAMFLOW PERCENTILES COMPARED TO HISTORICAL VALUES



≥0 to ≤2	>2 to ≤10	>10 to ≤20	>20 to ≤30	>30 to ≤70
>70 to ≤80	>80 to ≤90	>90 to ≤98	>98 to ≤100	

REGION	NUMBER OF GAGES REPORTING	≥0 TO ≤2 PERCENTILE	>2 TO ≤10 PERCENTILE	>10 TO ≤20 PERCENTILE	>20 TO ≤30 PERCENTILE	>90 PERCENTILE	MEDIAN OF INDIVIDUAL GAGE PERCENTILES
WESTERN	8	0	0	0	0	3	85
CTRV	15	0	0	0	0	6	89
CENTRAL	13	0	0	0	0	8	95
NORTHEAST	13	0	0	0	0	13	98
SOUTHEAST	12	0	0	0	0	12	98
CAPE COD	2	0	0	0	0	0	49

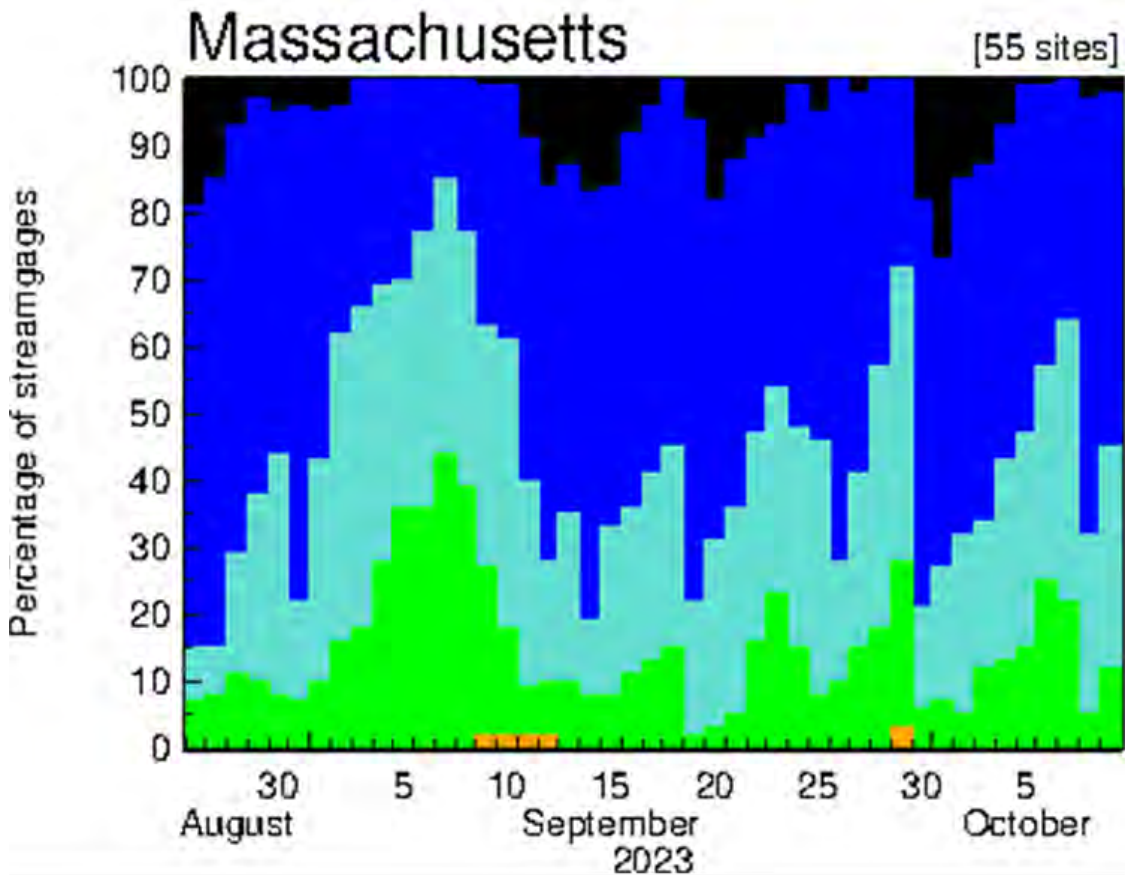
Note: Not all gages report in all months due to ice, beaver dams or other conditions. Streamflow index is not applicable to the Islands.

DMP Index Severity Levels			
1	2	3	4

USGS TIME SERIES OF THE PERCENT OF GAGES AT THEIR RESPECTIVE PERCENTILE FLOWS FOR AVERAGE DAILY STREAMFLOWS COMPARED TO HISTORICAL VALUES

https://waterdata.usgs.gov/nwis/sw

Explanation - Percentile classes							
Low	<10	10-24	25-75	76-90	>90	High	No Data
	Much below normal	Below normal	Normal	Above normal	Much above normal		



A search of the Local Storm Report App database on the Iowa State University Iowa Environmental Mesonet website produced 172 storm reports for Massachusetts in September of which 51 were flooding reports for urban/drainage (pluvial) and stream (fluvial) flooding.

According to the NRCC September narrative Overview, on September 11th “The National Weather Service issued a Flash Flood Emergency for part of central Massachusetts due to significant flash flooding from 9.50 inches of rain. There were dozens of evacuations and water rescues as floodwaters swamped buildings and roads. Hundreds of homes were damaged in the event.” https://www.nrcc.cornell.edu/regional/narrative/narrative.html Leominster was hit particularly hard as was North Attleborough. https://www.wbur.org/news/2023/09/12/flash-flooding-leominster-providence-sinkhole

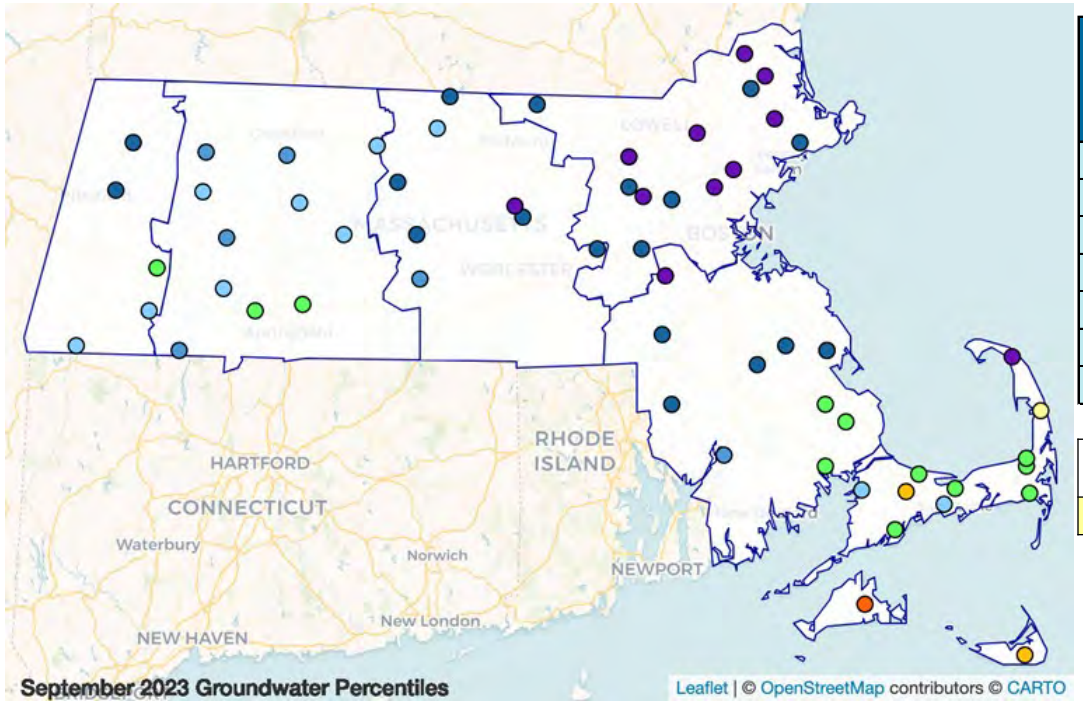
According to the September Norton/Boston NWS E-5 Monthly Report of Hydrologic Conditions, on September 20 the Shawsheen River at Andover forecast gauge reached minor flood stage levels. There were no significant impacts associated with this event.

Image: Courtesy of NASA/JPL-Caltech

https://mesonet.agron.iastate.edu/vtec/search.php#eventsbypoint/-93.6530/41.5300

September groundwater levels ranged from below normal to much above normal. Regional medians were in the much above-normal range in the Central, Northeast, and Southeast Regions. Levels in the Islands Region were below normal and the Region is at ISL 3.

END OF MONTH GROUNDWATER COMPARED TO HISTORICAL IN THE CLIMATE RESPONSE NETWORK WELLS



≥0 to ≤2	>2 to ≤10	>10 to ≤20	>20 to ≤30	>30 to ≤70
>70 to ≤80	>80 to ≤90	>90 to ≤98	>98 to ≤100	

REGION	NUMBER OF WELLS REPORTING	≥0 TO ≤2 PERCENTILE	>2 TO ≤10 PERCENTILE	>10 TO ≤20 PERCENTILE	>20 TO ≤30 PERCENTILE	>90 PERCENTILE	MEDIAN OF INDIVIDUAL WELL PERCENTILES
WESTERN	5	0	0	0	0	2	78
CTRV	11	0	0	0	0	0	79
CENTRAL	8	0	0	0	0	6	92
NORTHEAST	14	0	0	0	0	14	99
SOUTHEAST	11	0	0	0	0	7	95
CAPE COD	11	0	0	1	1	1	41
ISLANDS	2	0	1	1	0	0	9

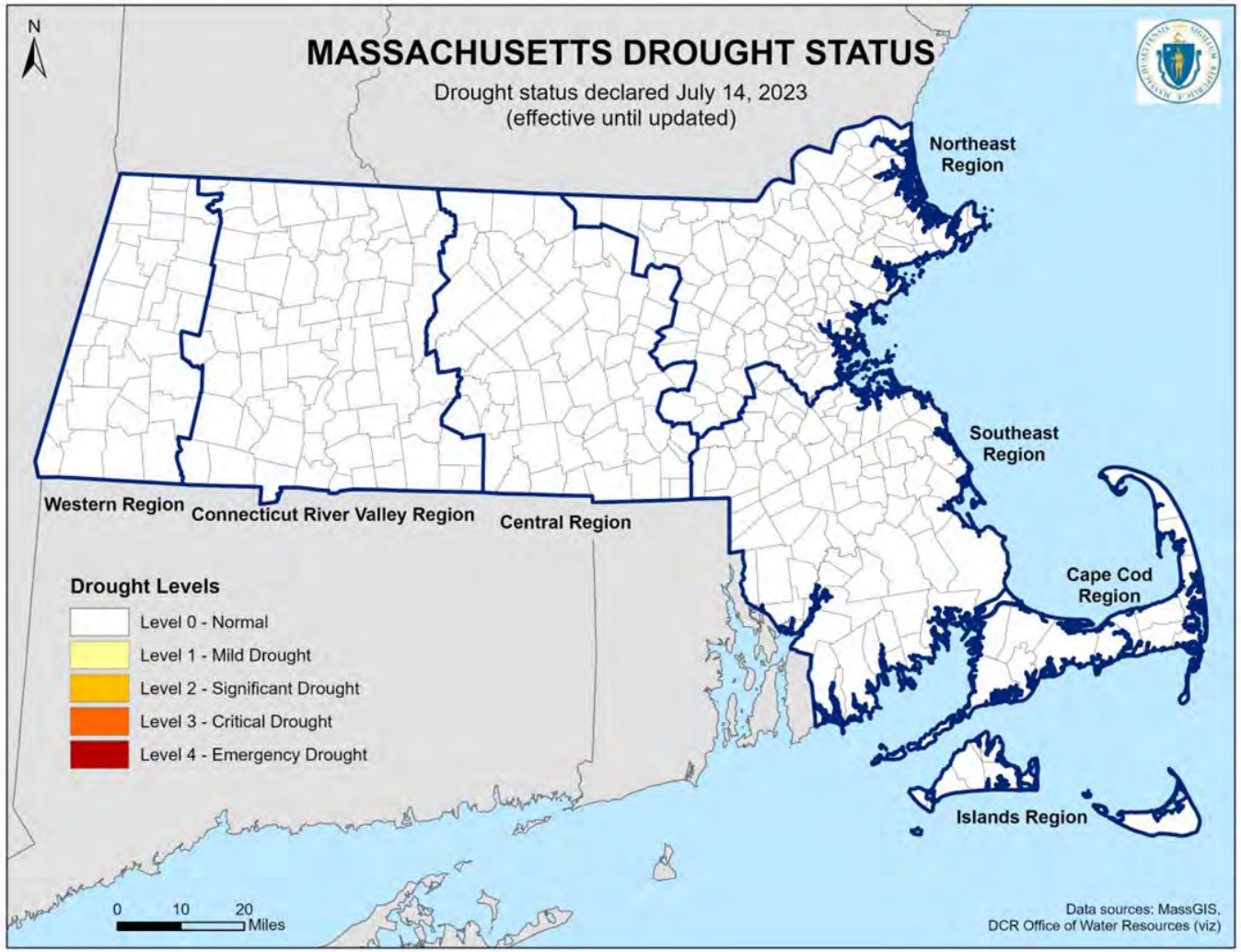
DMP Index Severity Levels			
1	2	3	4

At the end of September, reporting lake and impoundment levels were above their 30th percentile and/or were at or near 100% full.

REGION	NUMBER OF SITES REPORTING	MEDIAN OF INDIVIDUAL PERCENTILES OR PERCENT FULL
WESTERN	2	97th
CTRV	2	85th
CENTRAL	4	92nd
NORTHEAST	5	95th
SOUTHEAST	2	87th
CAPE COD	1	52nd

DMP Index Severity Levels do not necessarily reflect water supply status.

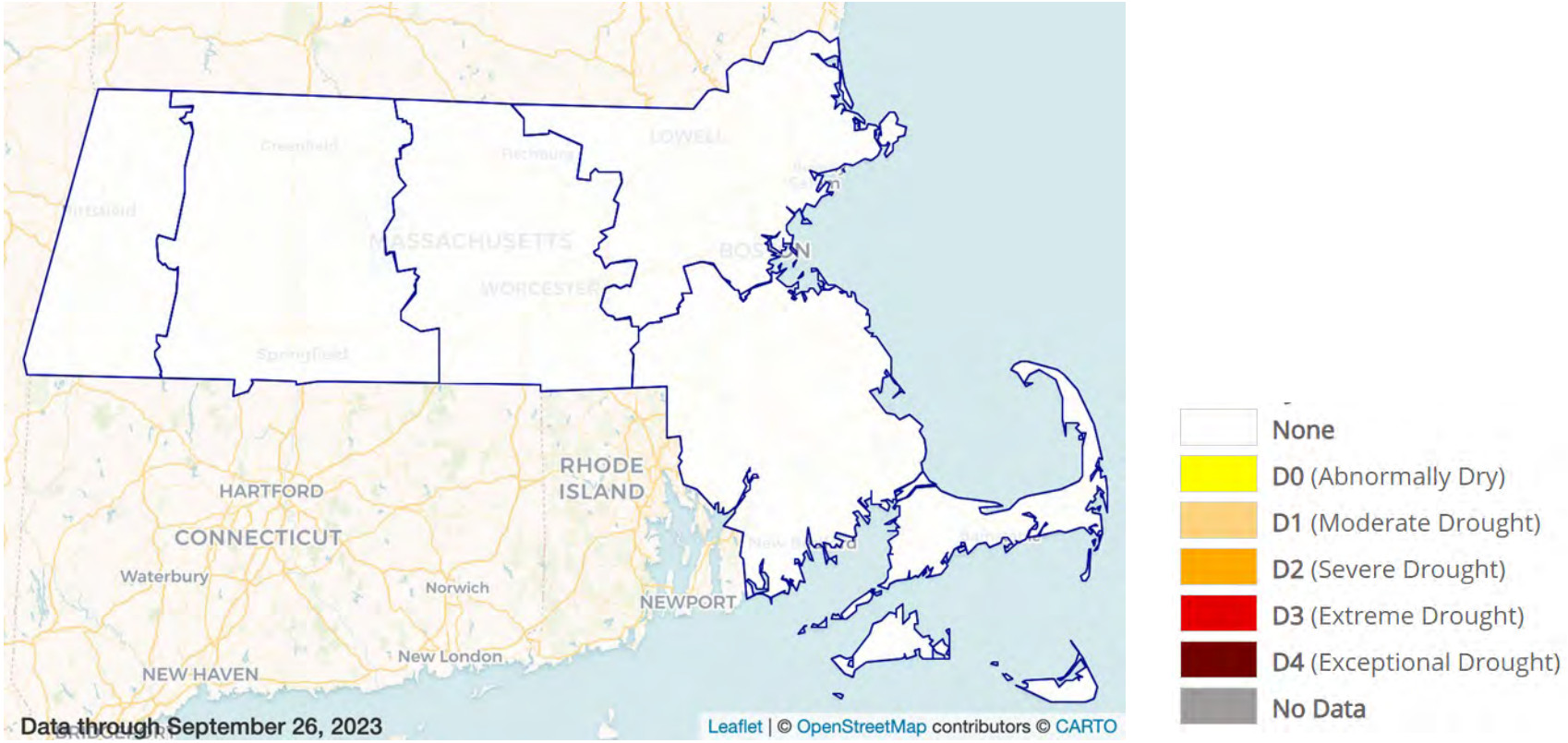
MASSACHUSETTS DROUGHT STATUS



U.S. DROUGHT MONITOR (USDM)

At the end of September, the USDM showed no areas of drought.

USDM maps are produced by the National Drought Mitigation Center (NDMC). For methods, weekly updates, and past maps see: https://droughtmonitor.unl.edu

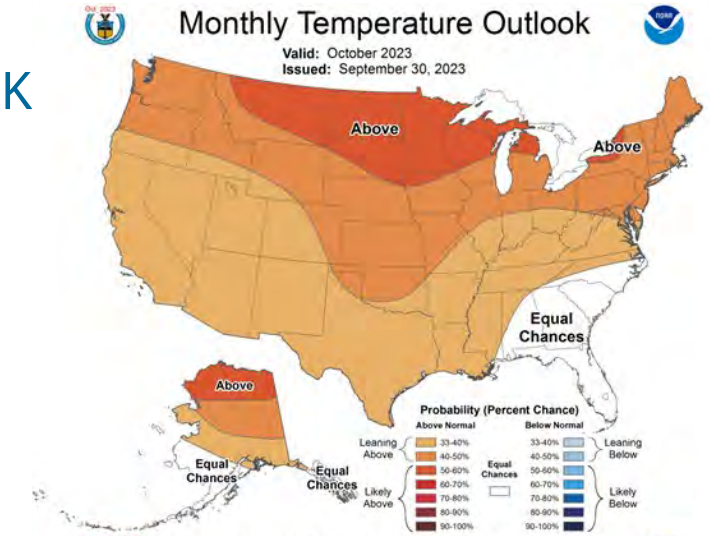


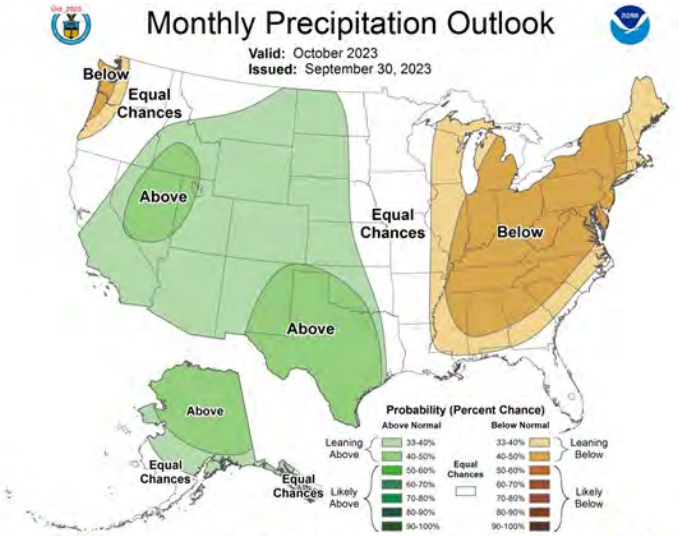
TEMPERATURE AND PRECIPITATION OUTLOOK

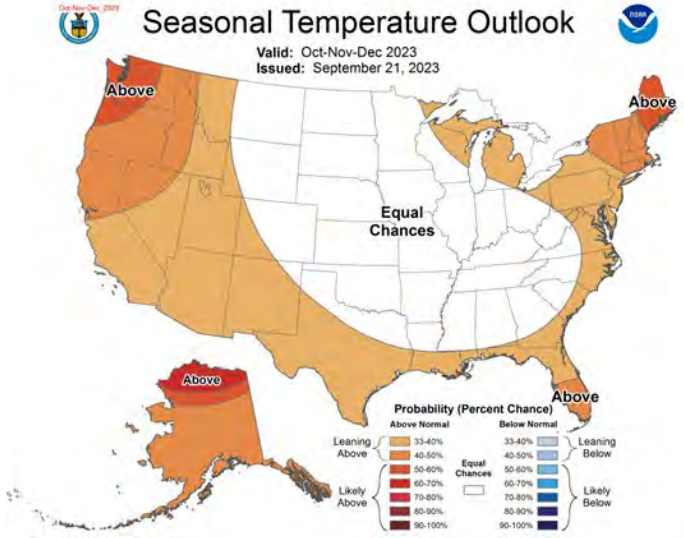
October: The outlook issued 9/30 shows a 40-50% chance of above-normal temperatures, a 33-40% chance of below-normal precipitation for the eastern half of the state, and a 40-50% chance for below-normal precipitation for the western half of the state.

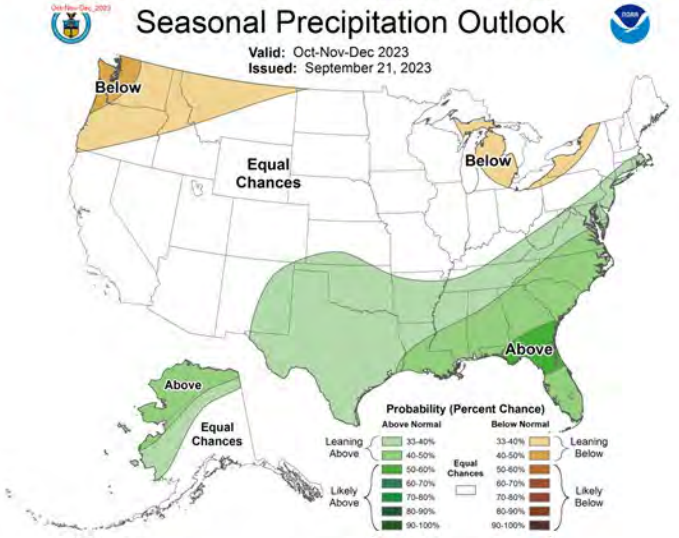
October through December: The seasonal outlook issued 9/21 shows a 40-50% chance of above-normal temperatures, a 33-40% chance of above-normal precipitation in the southeastern part of the state, and equal chances for above-normal, normal, or below-normal precipitation for the remainder of the state.

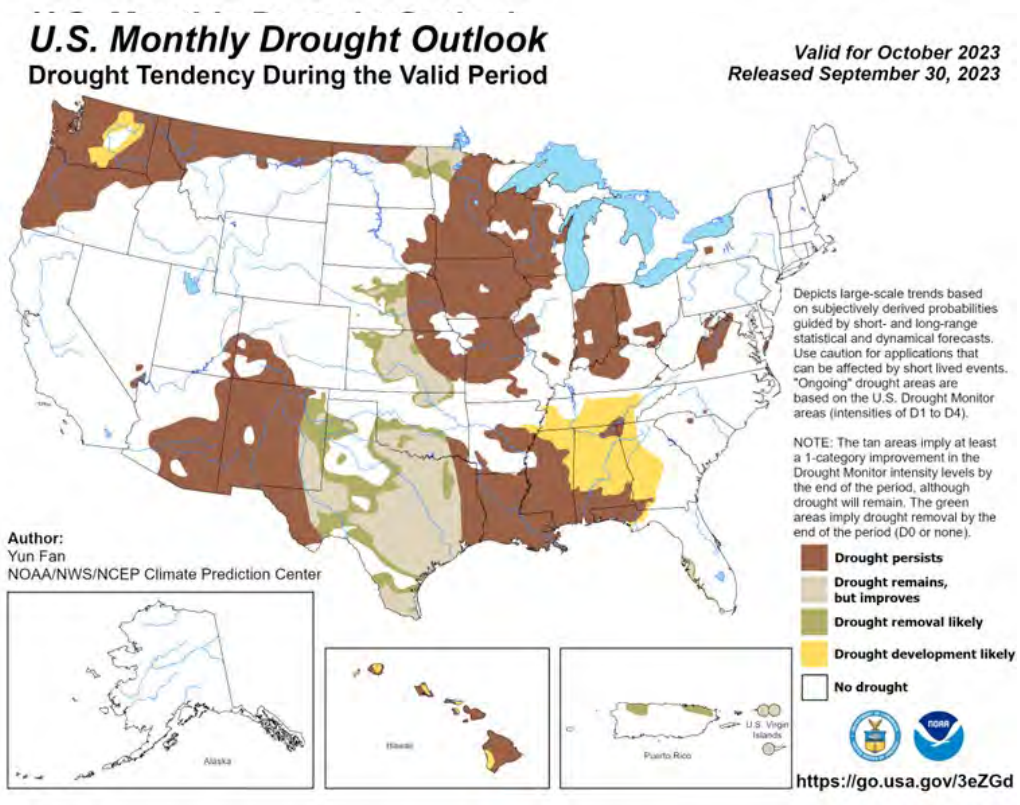
https://www.cpc.ncep.noaa.gov/

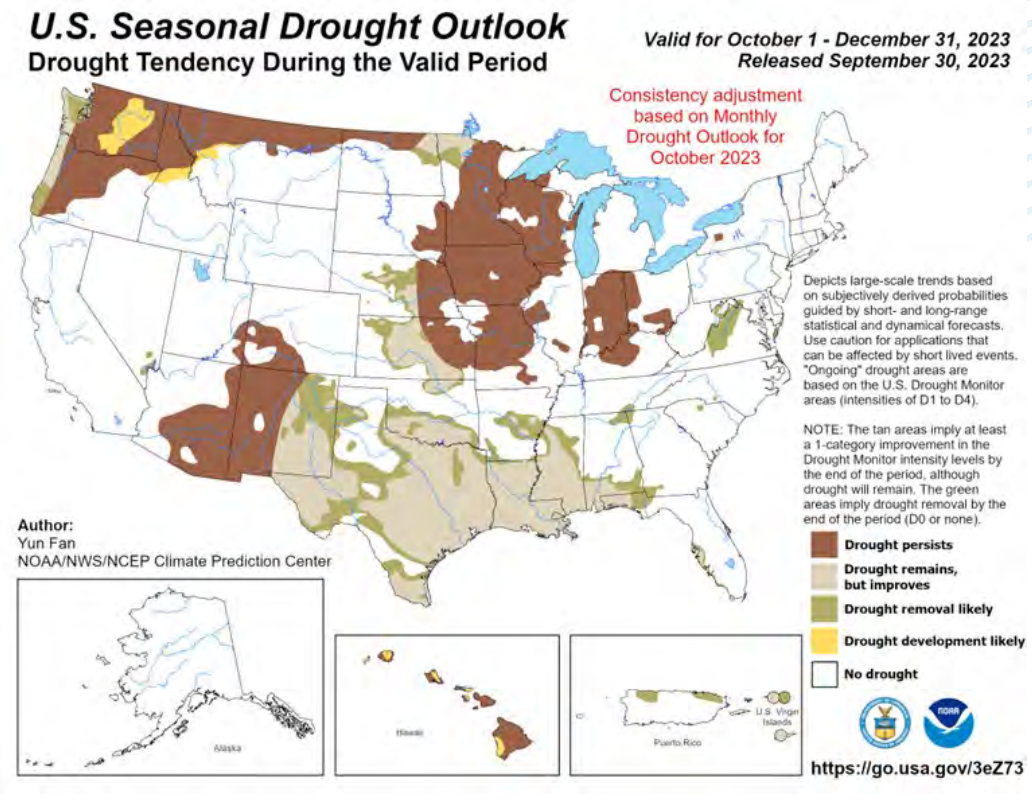












MONTHLY AND SEASONAL DROUGHT OUTLOOK

The monthly outlook for October released on 9/30 shows no drought development in Massachusetts.

The seasonal outlook for October through December issued on 9/30 shows no drought development in Massachusetts.

http://www.cpc.ncep.noaa.gov/products/Drought

APPENDIX I

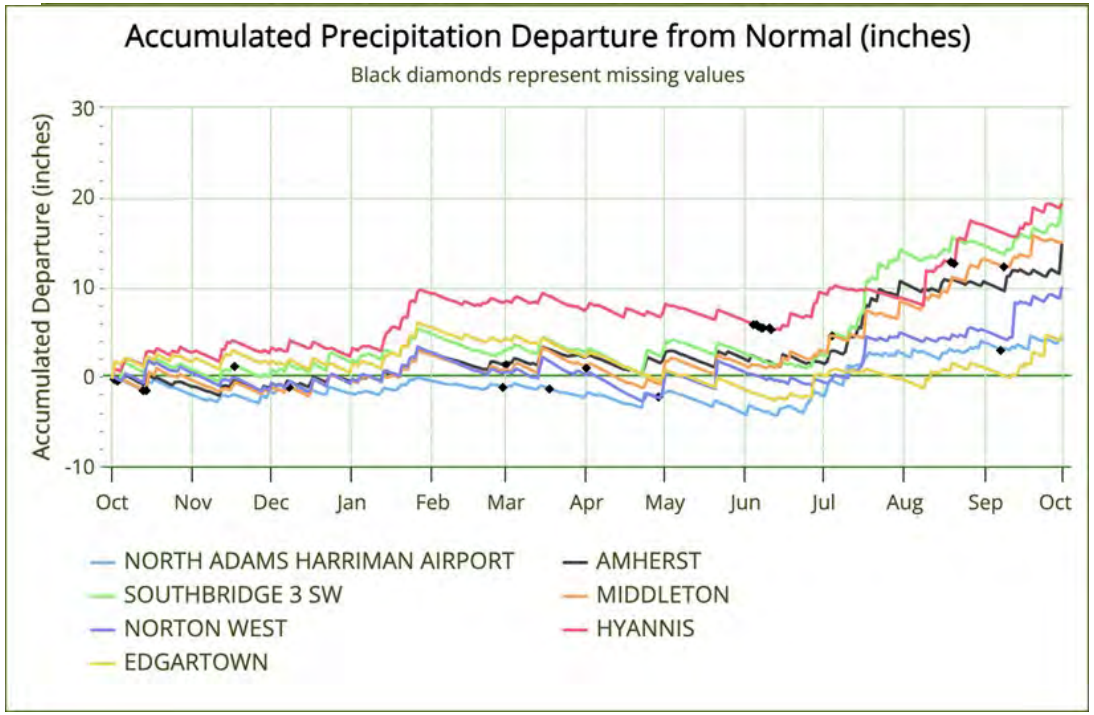
ADDITIONAL PRECIPITATION DATA

Standardized Precipitation Index—September 2023 as percentiles

REGION	NUMBER OF SITES	1-mo	2-mo	3-mo	6-mo	9-mo	12-mo	24-mo	36-mo
WESTERN	5	57	69	90	83	84	80	78	85
CTRV	11	91	86	99	95	96	93	77	92
CENTRAL	13	94	90	99	99	98	97	88	96
NORTHEAST	19	79	95	98	97	98	96	73	89
SOUTHEAST	24	88	89	97	93	92	91	70	88
CAPE COD	4	82	92	92	86	92	94	84	87
ISLANDS	4	92	90	87	62	68	75	13	51

DMP Index Severity Levels

1	2	3	4



Accumulated Precipitation Departure from 30-Year Normals in Inches

Graph does not consider starting condition's wetness/dryness; does not show summer heat waves with high evapotranspiration; and shows only one station per Drought Region. https://xmacis.rcc-acis.org/

ADDITIONAL PRECIPITATION DATA (CONT.)

Percent of Average Historical Precipitation—September 2023

REGION	NUMBER OF SITES REPORTING	HISTORICAL AVERAGE	SEPTEMBER AVERAGE (IN)	DEPARTURE FROM HISTORICAL AVERAGE (IN)	PERCENT OF NORMAL
WESTERN	5	4.38	4.82	0.44	110%
CTRV	11	4.06	8.07	4.01	199%
CENTRAL	13	4.03	8.32	4.29	206%
NORTHEAST	19	3.59	5.23	1.64	146%
SOUTHEAST	24	3.96	7.66	3.70	193%
CAPE COD	4	3.64	5.92	2.28	163%
ISLANDS	4	3.70	6.82	3.12	184%

DROUGHT MANAGEMENT PLAN INFORMATION

The Massachusetts Drought Management Plan (DMP) can be found at https://www.mass.gov/doc/massachusetts-drought-management-plan/download. The document provides details on the Drought Indices, how Drought Levels are determined, and actions associated with each drought level.

Index Severity Levels (Section 3.4 of the DMP)

SEVERITY LEVEL	STANDARDIZED PRECIPITATION INDEX (SPI)	STREAMFLOW	LAKES AND IMPOUNDMENTS	GROUNDWATER	KEETCH-BRYAM DROUGHT INDEX (KBDI)	CROP MOISTURE INDEX
0	> 30th percentile				< 200	> -1.0
1	≤ 30 and > 20				200-400	≤ -1.0 and > -2.0
2	≤ 20 and > 10				400-600	≤ -2.0 and > -3.0
3	≤ 10 and > 2				600-700	≤ -3.0 and > -4.0
4	≤ 2				700-800	≤ -4.0

Drought Levels (Section 3.1 of the DMP)

Level 0 Normal
Level 1 Mild Drought
Level 2 Significant Drought
Level 3 Critical Drought
Level 4 Emergency Drought

Massachusetts Water Resources Commission

Executive Office of Energy and Environmental Affairs

www.mass.gov/conservemawater

www.mass.gov/drought-management