

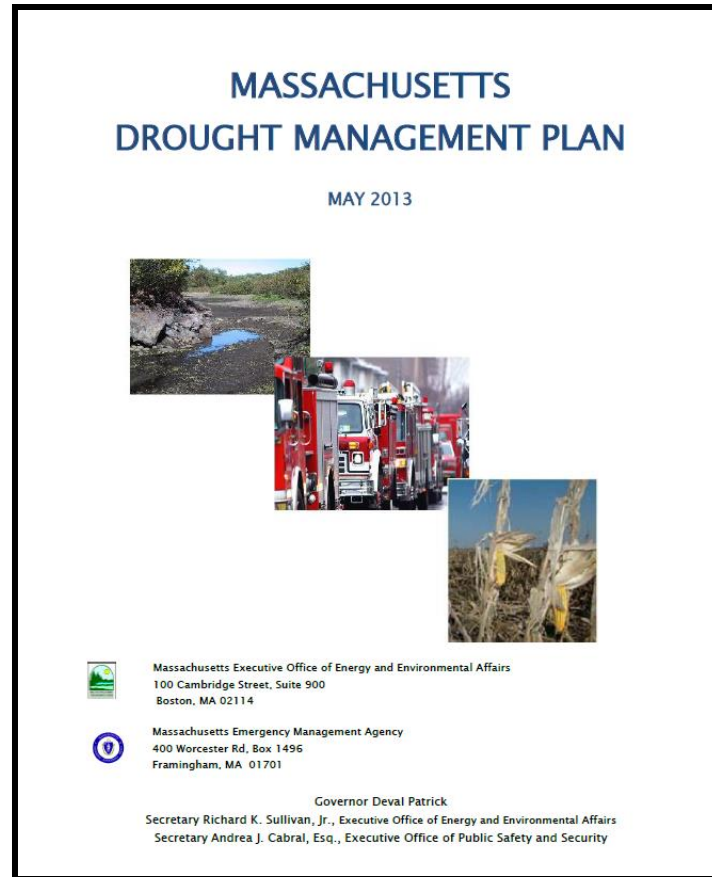
Current Hydrologic Conditions in Massachusetts

Drought Management Task Force

Jonathan Yeo and Viki Zoltay
DCR Office of Water Resources
Division of Water Supply Protection

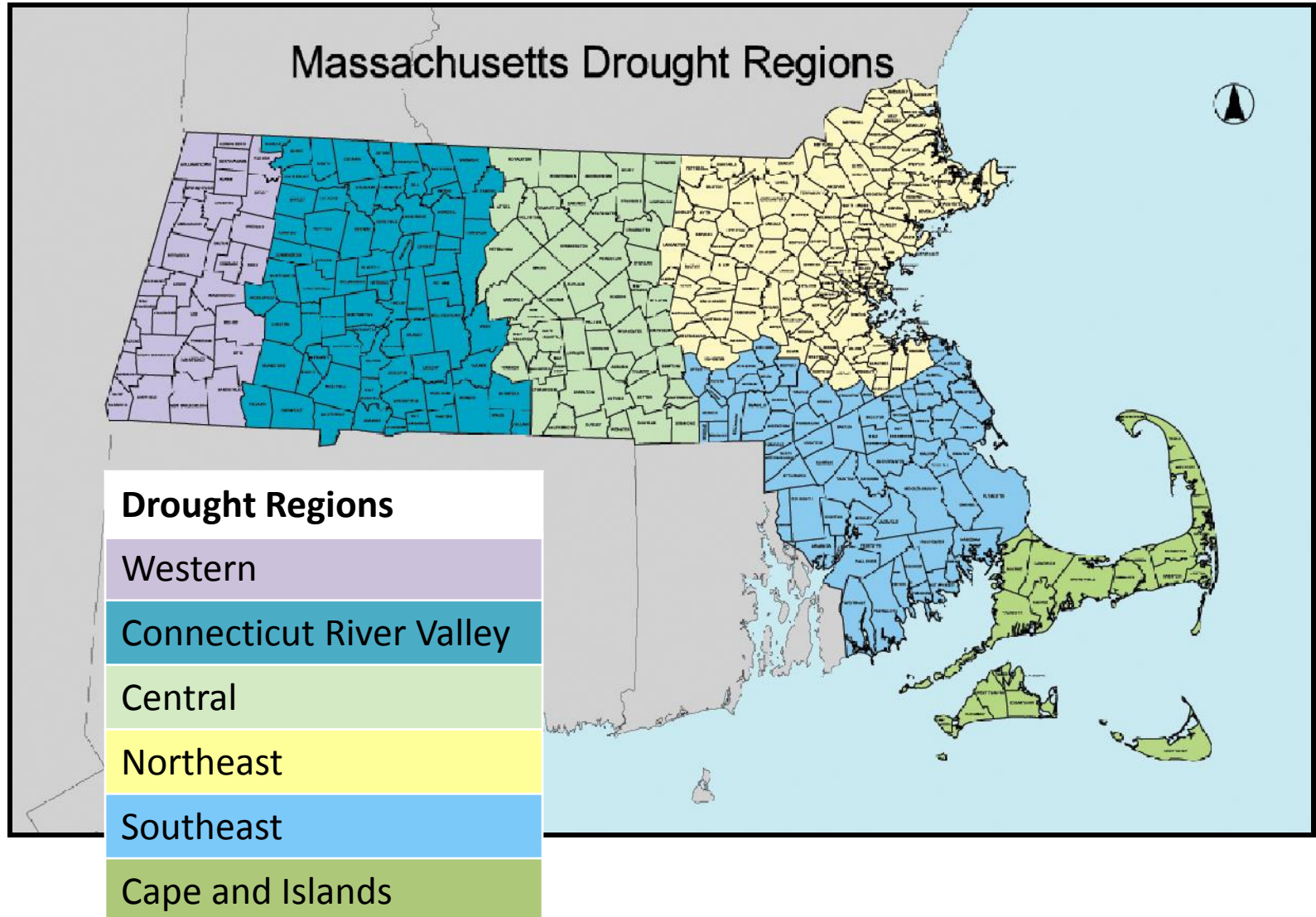
December 7, 2016

MA Drought Management Plan Summary / Review



www.mass.gov/eea/wrc-dmtf

Massachusetts Drought Regions



Massachusetts Drought Indicators and Levels

| Drought Indicator | Indicator Type |
|--|----------------|
| Standardized Precipitation Index | Precipitation |
| Precipitation Percent Below Normal | Precipitation |
| Streamflow Months Below Normal | Streamflow |
| Groundwater Level Months Below Normal | Groundwater |
| Size of Reservoir (S, M, L) Below Normal | Reservoirs |
| Crop Moisture Index | Crop Moisture |
| Keetch-Byram Drought Index | Fire Danger |

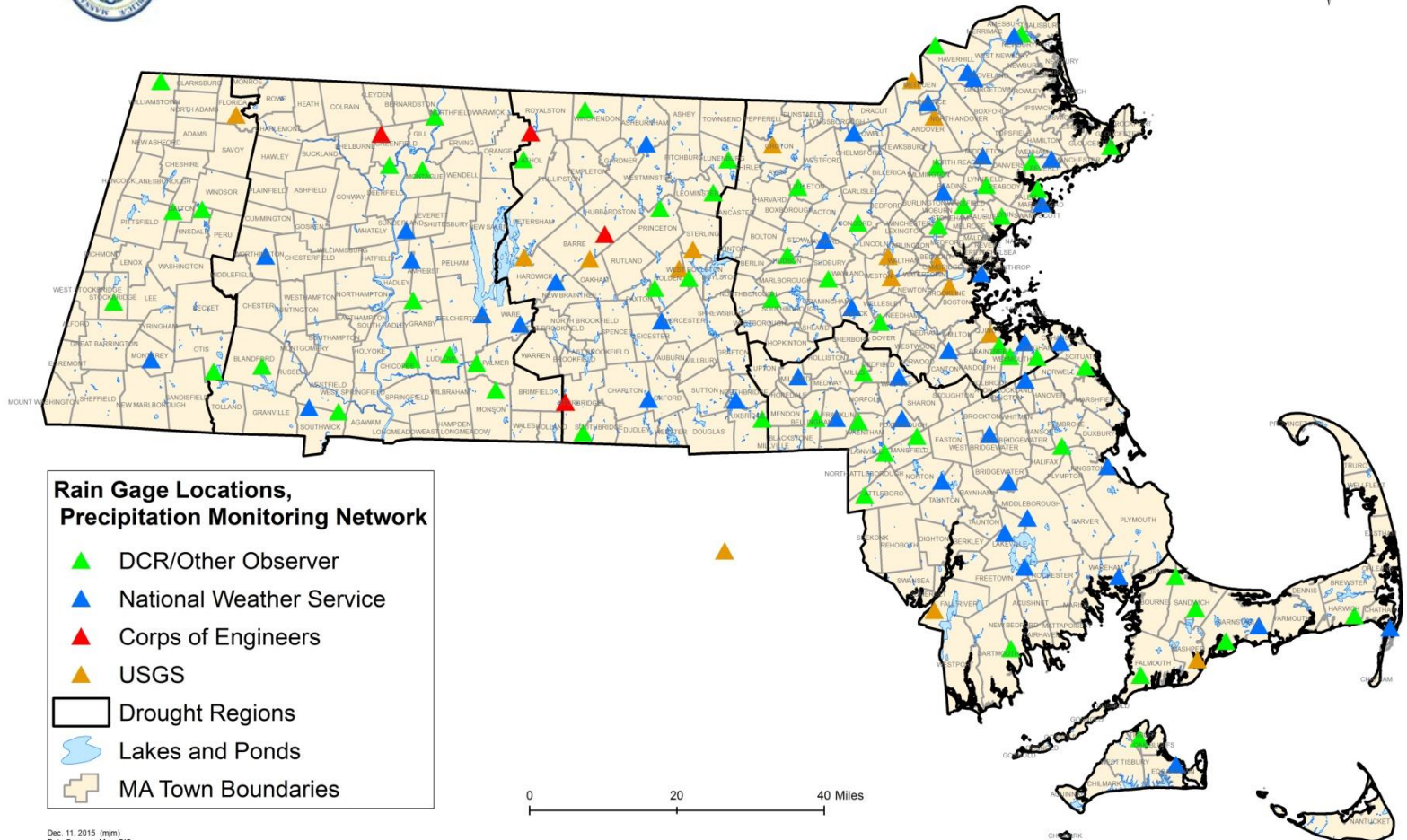
| Drought Levels: |
|-----------------|
| Normal |
| Advisory |
| Watch |
| Warning |
| Emergency |

Drought declaration based on majority of indices

Precipitation Data Sources



Massachusetts Precipitation Monitoring Network



Precipitation

| Region | Estimated Rainfall (inches) | Departure from Average November (inches) | MA Drought Plan Levels | |
|--------------------|-----------------------------|--|--|-------------------------|
| | | | Standardized Precipitation Index (SPI) | Percent of Normal Index |
| Western | 3.12 | -0.51 | Normal | Normal |
| CT River Valley | 2.24 | -1.63 | Watch | Watch |
| Central | 2.79 | -1.25 | Advisory | Normal |
| Northeast | 3.09 | -0.81 | Advisory | Normal |
| Southeast | 2.36 | -1.73 | Advisory | Normal |
| Cape Cod & Islands | 2.43 | -1.91 | Advisory | Watch |

Reservoir Index

| Drought Level | Reservoir Index* |
|---------------|---|
| Normal | Reservoir levels at or near normal for the time of year |
| Advisory | Small index reservoirs below normal |
| Watch | Medium index reservoirs below normal |
| Warning | Large index reservoirs below normal |
| Emergency | Continuation of previous month's conditions |

*Water suppliers should be consulted to determine if below normal reservoir conditions are due to operational issues

Reservoirs

| General Reservoir Levels in Massachusetts at the end of November 2016 | | | |
|--|---------------------------------------|------------------------------------|---|
| Region | Number of Reservoirs Monitored | Reservoir Levels (majority) | MA Drought Management Plan Reservoir Index |
| Western | 2 | Below | Watch |
| CT River Valley | 2 | Below | Warning* |
| Central | 3 | Below | Watch |
| Northeast | 7 | Below | Watch |
| Southeast | 3 | Below | Watch |
| Cape Cod & Islands | 1 | Below | Advisory |

*Quabbin reservoir is slightly below normal. This is a large reservoir which jumps the index from normal to warning. The other monitored reservoir in the CT River Valley region is normal.

Streamflow Index

| Drought Level | Streamflow Index* |
|---------------|---|
| Normal | 1 month below normal |
| Advisory | At least 2 out of 3 consecutive months below normal |
| Watch | At least 4 out of 5 consecutive months below normal |
| Warning | At least 6 out of 7 consecutive months below normal |
| Emergency | Greater than 7 months below normal |

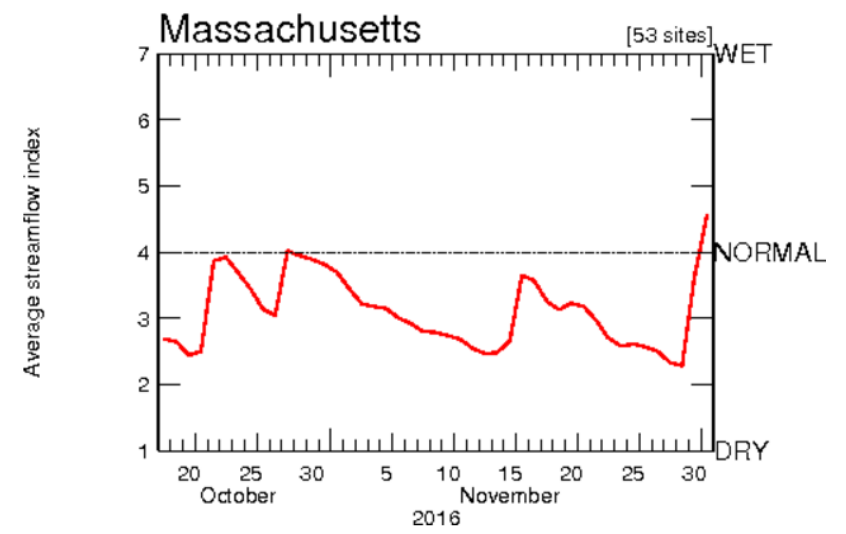
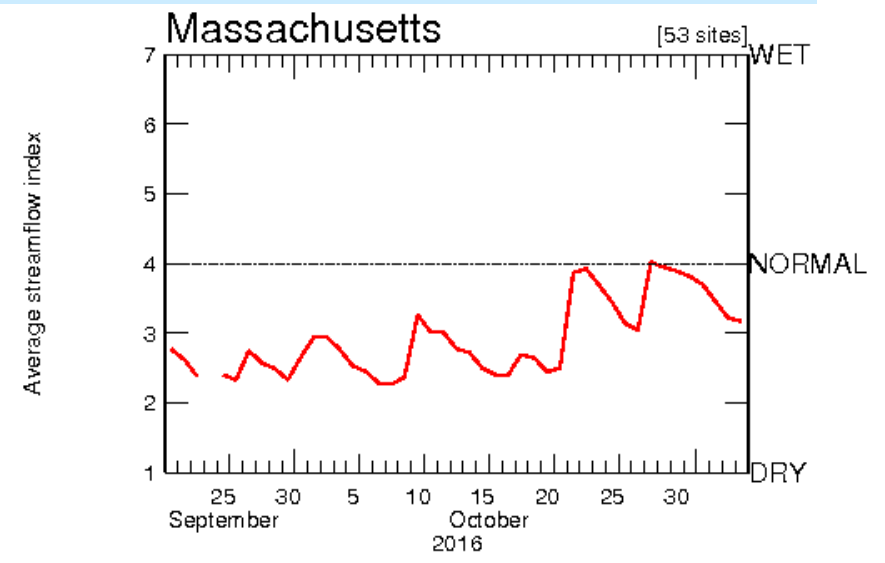
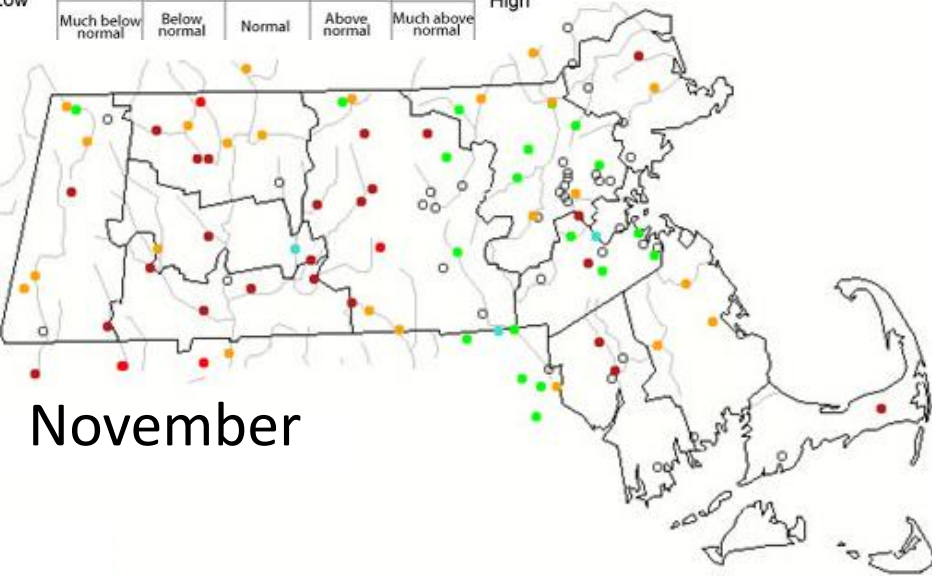
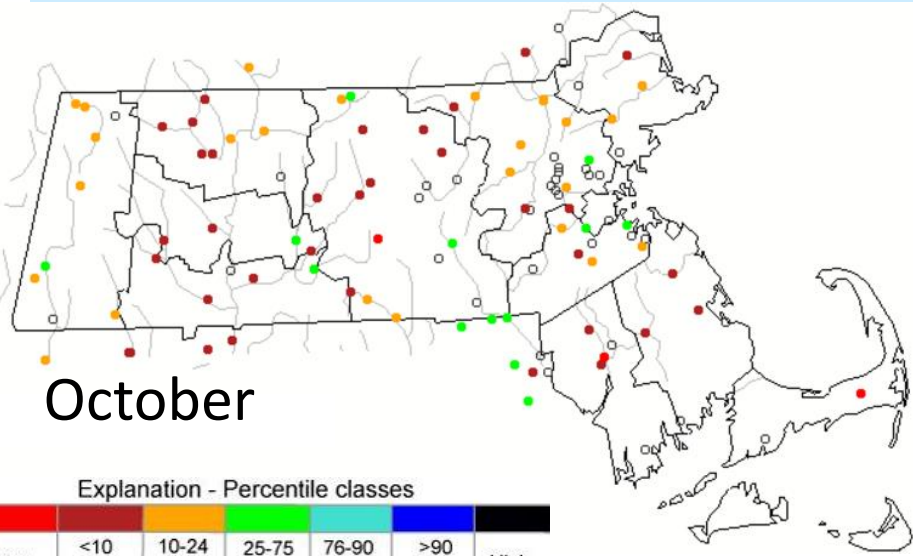
*Below normal for streamflow is defined as being within the lowest 25th percentile of the period of record

Streamflow Compared to Historical for November



Average Monthly

Average Daily



Streamflow

| Region | Month | Number of wells | | | | MA Drought Plan Index (# <u>consecutive</u> months majority below 25 th percentile) |
|-----------------|----------|-----------------|-----------------------------------|-----------------------------------|---------------|---|
| | | Total | Below 25 th percentile | Below 10 th percentile | At Record Low | |
| Western | October | 7 | 7 | 3 | 0 | 6 of 7 |
| | November | 7 | 6 | 0 | 0 | 6 of 7 |
| | | | | | | |
| CT River Valley | October | 16 | 15 | 10 | 1 | 7 of 7 |
| | November | 16 | 14 | 12 | 0 | 8 of 8 |
| | | | | | | |
| Central | October | 16 | 10 | 7 | 1 | 8 of 8 |
| | November | 16 | 11 | 8 | 1 | 8 of 8 |
| | | | | | | |
| Northeast | October | 19 | 8 | 3 | 0 | 7 of 7 |
| | November | 19 | 16 | 5 | 0 | 6 of 7 |
| | | | | | | |
| Southeast | October | 5 | 5 | 2 | 0 | 7 of 7 |
| | November | 5 | 5 | 5 | 1 | 7 of 7 |

Groundwater Index

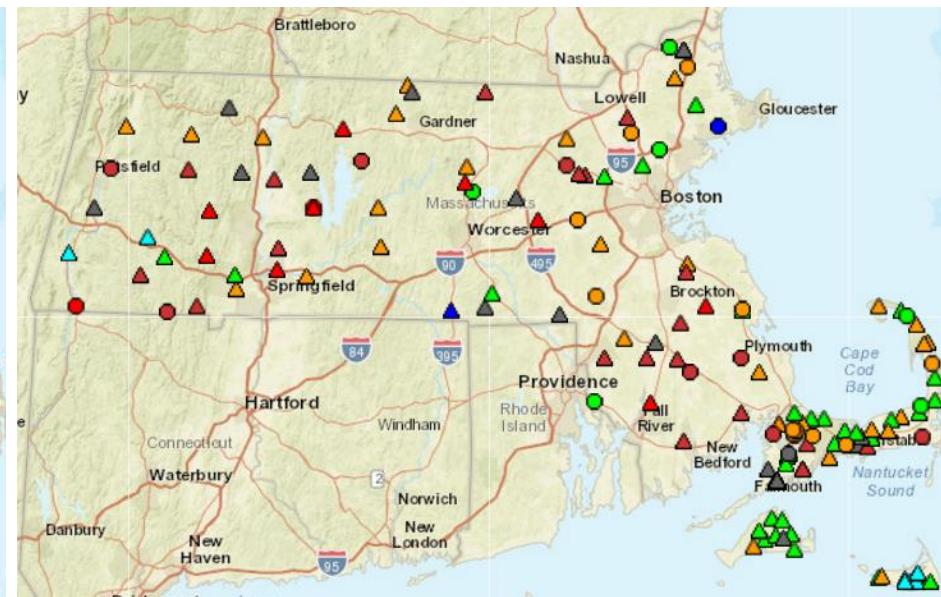
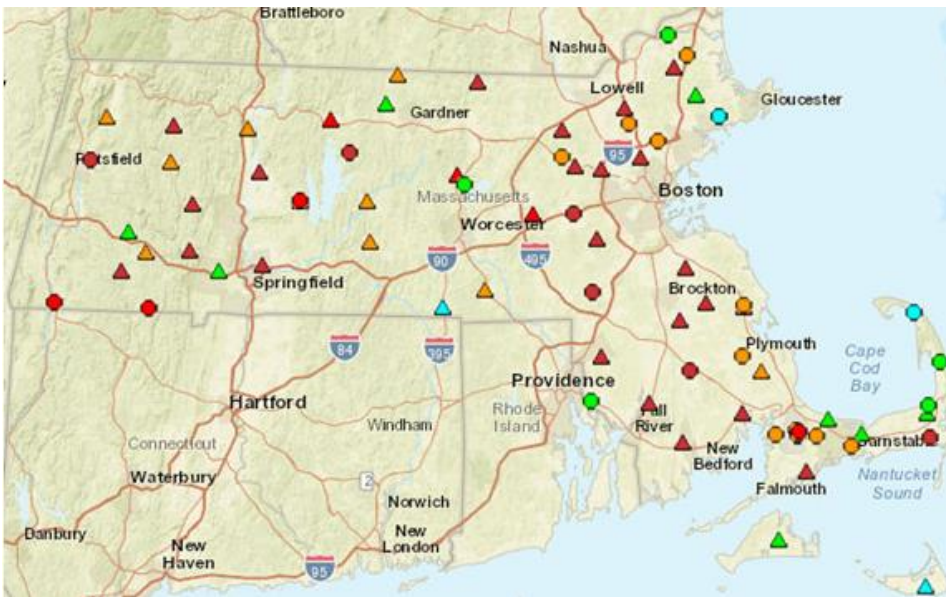
| Drought Level | Groundwater Index* |
|---------------|--|
| Normal | 2 consecutive months below normal |
| Advisory | 3 consecutive months below normal |
| Watch | 4 to 5 consecutive months below normal |
| Warning | 6 to 7 consecutive months below normal |
| Emergency | Greater than 8 months below normal |

*Below normal for groundwater is defined as being within the lowest 25th percentile of the period of record

Groundwater

October

November



Explanation - Percentile classes

| | | | | | | | | |
|---------|--------------------------|-----------------------|-----------------|-----------------------|--------------------------|----------|------------|---|
| | | | | | | | | ○ Real Time □ Continuous △ Periodic Measurement |
| New Low | <10 Much Below Normal | 10-24 Below Normal | 25-75 Normal | 76-90 Above Normal | >90 Much Above Normal | New High | Not Ranked | |

Groundwater

| Region | Month | Number of wells | | | | MA Drought Plan Index (# consecutive months majority below 25 th percentile) |
|------------------|----------|-----------------|-----------------------------------|-----------------------------------|---------------|--|
| | | Total | Below 25 th percentile | Below 10 th percentile | At Record Low | |
| Western | October | 5 | 4 | 4 | 1 | 9 |
| | November | 5 | 4 | 3 | 1 | 8 |
| | | | | | | |
| CT River Valley | October | 11 | 10 | 10 | 9 | 7 |
| | November | 11 | 9 | 7 | 4 | 8 |
| | | | | | | |
| Central | October | 10 | 7 | 3 | 1 | 7 |
| | November | 10 | 7 | 2 | 1 | 8 |
| | | | | | | |
| Northeast | October | 17 | 10 | 5 | 2 | 7 |
| | November | 17 | 8 | 3 | 0 | 0 |
| | | | | | | |
| Southeast | October | 12 | 10 | 5 | 0 | 6 |
| | November | 12 | 11 | 9 | 2 | 7 |
| | | | | | | |
| Cape and Islands | October | 13 | 6 | 1 | 0 | 0 |
| | November | 13 | 6 | 2 | 0 | 0 |

Crop Moisture and Fire Danger Indices

| Drought Level | Crop Moisture Index* | Keetch-Byram Drought Index (KBDI) |
|---------------|-------------------------------|-----------------------------------|
| Normal | 0 to -1.0 Slightly dry | less than 200 |
| Advisory | -1 to -1.9 Abnormally dry | 200 to 400 |
| Watch | -2 to -2.9 Excessively dry | 400 to 600 |
| Warning | < -2.9 Severely dry | 600 to 800 |
| Emergency | < -2.9 Severely dry | 600 to 800 |

* The Crop Moisture Index is subject to frequent change. The drought level for this indicator is determined based on the repeated or extended occurrence at a given level.

Crop Moisture



| Region | MA Drought Plan Index |
|------------------|-----------------------|
| Western | Normal |
| CT River Valley | Normal |
| Central | Normal |
| Northeast | Normal |
| Southeast | Normal |
| Cape and Islands | Normal |



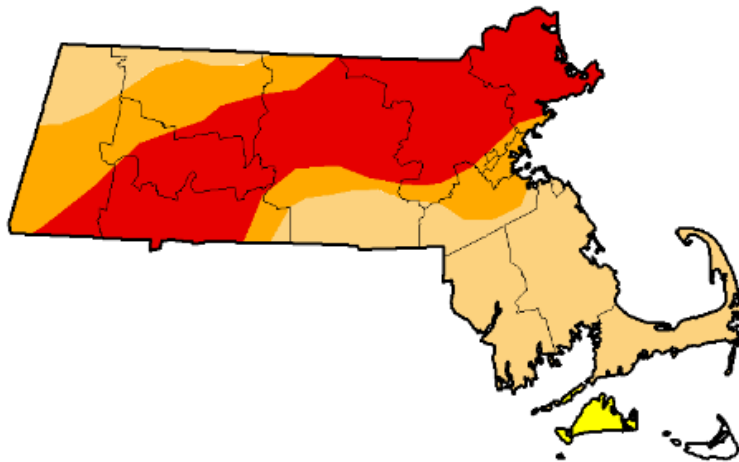
* The Crop Moisture Index is subject to frequent change. The drought level for this indicator is determined based on the repeated or extended occurrence at a given level.

Keetch-Byram Drought Index

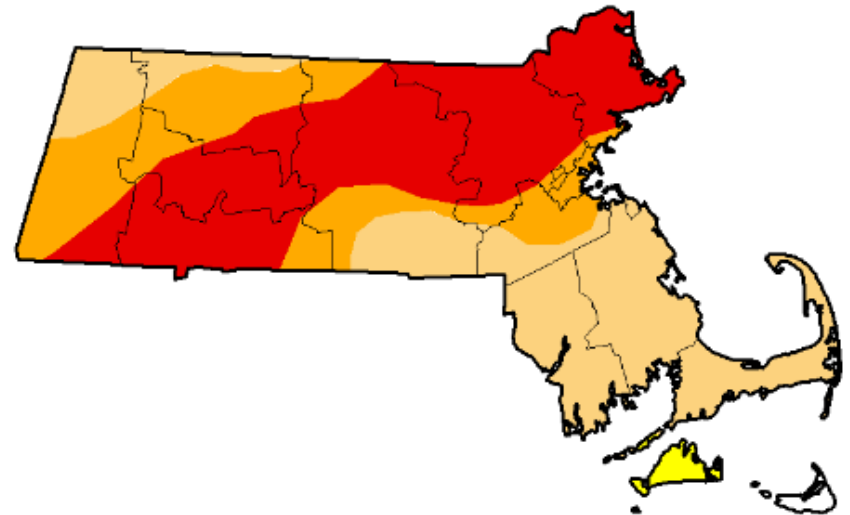
| REGION | MA Drought Plan Index |
|-------------------------|------------------------------|
| Western | Normal |
| CT River Valley | Normal |
| Central | Normal |
| Northeast | Normal |
| Southeast | Normal |
| Cape and Islands | Normal |

US Drought Monitor


November 22, 2016




November 29, 2016





Intensity:

 D0 (Abnormally Dry)

 D2 (Severe Drought)

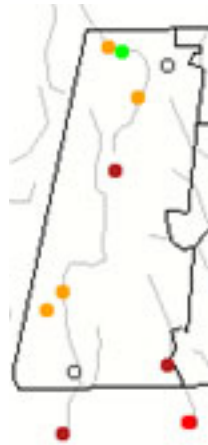
 D4 (Exceptional Drought)

 D1 (Moderate Drought)

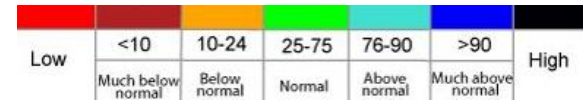
 D3 (Extreme Drought)

WEST - Summary of Drought Indices

| | |
|-----------------------------|----------------|
| | West |
| <i>October</i> | Warning |
| <i>Recommended November</i> | Warning |



Streamflow



Groundwater



| Indicator | |
|------------------------------|------------------|
| Standard Precipitation Index | Normal |
| Precipitation as % of Normal | Normal |
| Streamflow | Warning |
| Groundwater | Emergency |
| Reservoirs | Watch |
| Crop Moisture | Normal |
| Fire Danger | Normal |

| Drought Region | Water System | Pop. Served | DMP Class | Nov-16 |
|----------------|--------------|-------------|-----------|--------------|
| West | Lenox | 9,800 | Small | Normal |
| | Pittsfield | 43,000 | Medium | Below |

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CT RIVER VALLEY - Drought Indices

CT River Valley

October

Warning

Recommended November

Warning

Indicator

Standard Precipitation Index

Watch

Precipitation as % of Normal

Watch

Streamflow

Emergency

Groundwater

Emergency

Reservoirs

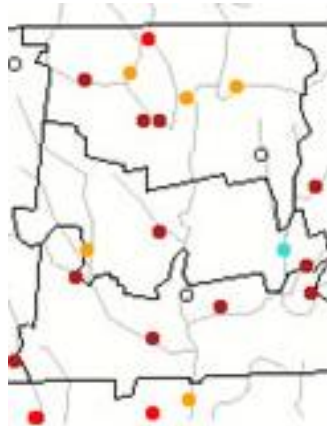
Warning

Crop Moisture

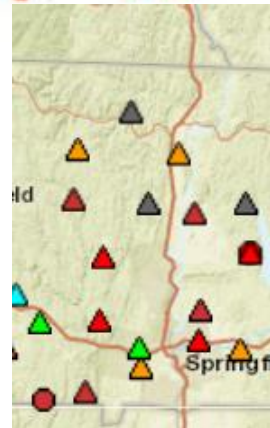
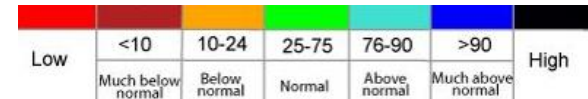
Normal

Fire Danger

Normal



Streamflow



Groundwater

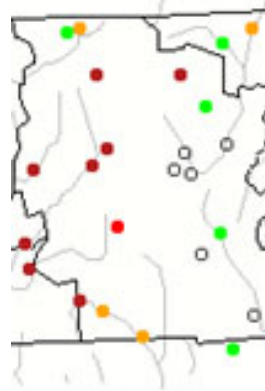


| Drought Region | Water System | Pop. Served | DMP Class | Nov-16 |
|----------------|--------------|-------------|-----------|--------|
| CT River | Springfield | 260,000 | Medium | Below |
| | Quabbin/MWRA | 2,200,000 | Large | Below |

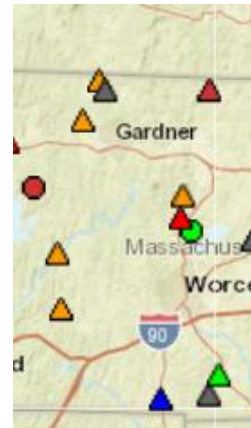
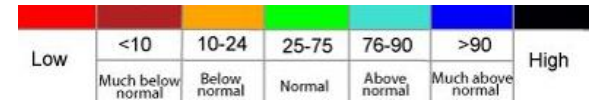
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CENTRAL - Summary of Drought Indices

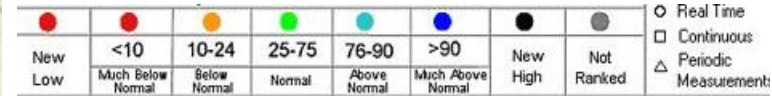
| | |
|-----------------------------|----------------|
| | Central |
| <i>October</i> | Warning |
| <i>Recommended November</i> | Warning |



Streamflow



Groundwater



| Indicator | |
|------------------------------|------------------|
| Standard Precipitation Index | Advisory |
| Precipitation as % of Normal | Normal |
| Streamflow | Emergency |
| Groundwater | Emergency |
| Reservoirs | Watch |
| Crop Moisture | Normal |
| Fire Danger | Normal |

| Drought Region | Water System | Pop. Served | DMP Class | Nov-16 |
|----------------|---------------------|-------------|-----------|--------------|
| Central | Rutland Muschopauge | 4,512 | Small | |
| | North Brookfield | | Small | Below |
| | Southbridge | 17,000 | Medium | |
| | Worcester | 176,000 | Medium | Below |

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NORTHEAST - Summary of Drought Indices

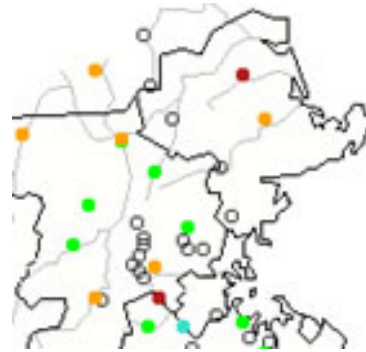
Northeast

October

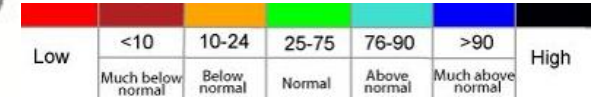
Warning

Recommended November

Warning



Streamflow



Indicator

Standard Precipitation Index

Advisory

Precipitation as % of Normal

Normal

Streamflow

Warning

Groundwater

Normal

Reservoirs

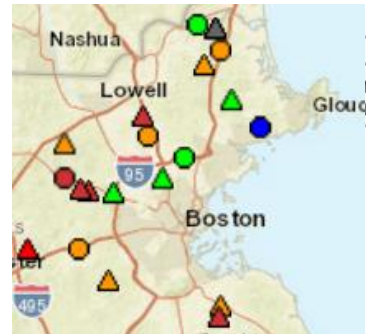
Watch

Crop Moisture

Normal

Fire Danger

Normal



Groundwater



| Drought Region | Water System | Pop. Served | DMP Class | Nov-16 |
|----------------|-------------------|-------------|-----------|--------|
| Northeast | Breakheart/Pearce | - | Small | |
| | Rockport | 9,875 | Small | |
| | Hudson | 18,000 | Medium | Normal |
| | North Andover | 30,000 | Medium | Below |
| | Hingham | 32,000 | Medium | |
| | Gloucester | 45,000 | Medium | |
| | Salem/Beverly | 82,000 | Medium | Below |
| | Lynn | 89,000 | Medium | Below |
| | A-1 | - | Small | |
| | Cambridge | 101,000 | Medium | Below |

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SOUTHEAST - Summary of Drought Indices

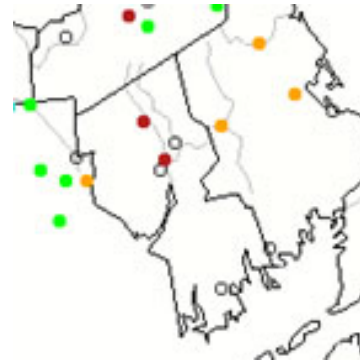
Southeast

October

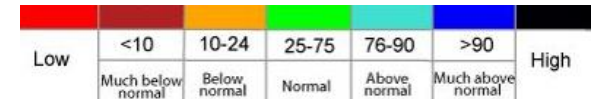
Warning

Recommended November

Warning



Streamflow



Indicator

Standard Precipitation Index

Advisory

Precipitation as % of Normal

Normal

Streamflow

Warning

Groundwater

Warning

Reservoirs

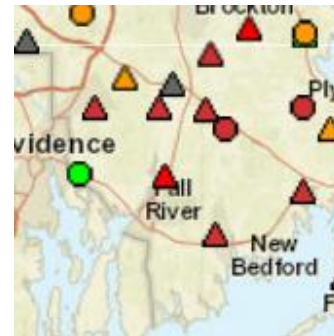
Watch

Crop Moisture

Normal

Fire Danger

Normal



Groundwater



| Drought Region | Water System | Pop. Served | DMP Class | Nov-16 |
|----------------|--------------|-------------|-----------|--------|
| Southeast | Watson | - | Small | |
| | Cohasset | 6,187 | Small | Below |
| | Milford | 27,000 | Medium | Below |
| | Assawompsett | 150,000 | Medium | Below |

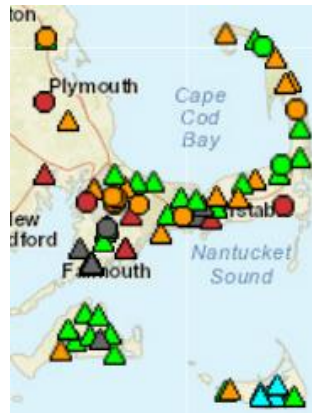
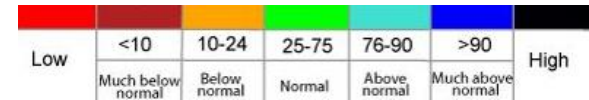
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CAPE & ISLANDS - Summary of Drought Indices

| | |
|-----------------------------|-------------------------|
| | Cape and Islands |
| <i>October</i> | Advisory |
| <i>Recommended November</i> | Advisory |



Streamflow



Groundwater



| Indicator | |
|------------------------------|-----------------|
| Standard Precipitation Index | Advisory |
| Precipitation as % of Normal | Watch |
| Streamflow | N/A |
| Groundwater | Normal |
| Reservoirs | Advisory |
| Crop Moisture | Normal |
| Fire Danger | Normal |

| Drought Region | Water System | Pop. Served | DMP Class | Nov-16 |
|----------------|------------------|-------------|-----------|--------------|
| Cape/Islands | Falmouth Ashumet | - | Small | Below |

This summary is provided for informational purposes. No changes in drought status are official until the Drought Management Task Force convenes and makes a recommendation accepted by the Secretary of the Executive Office of Energy and Environmental Affairs.

Summary of Drought Indices as of November 30, 2016

| | West | CT River Valley | Central | Northeast | Southeast | Cape and Islands |
|------------------------------|-----------|-----------------|-----------|-----------|-----------|------------------|
| <i>October</i> | Warning | Warning | Warning | Warning | Warning | Advisory |
| <i>Recommended November</i> | Warning | Warning | Warning | Warning | Warning | Advisory |
| Indicator | | | | | | |
| Standard Precipitation Index | Normal | Watch | Advisory | Advisory | Advisory | Advisory |
| Precipitation as % of Normal | Normal | Watch | Normal | Normal | Normal | Watch |
| Streamflow | Warning | Emergency | Emergency | Warning | Warning | N/A |
| Groundwater | Emergency | Emergency | Emergency | Normal | Warning | Normal |
| Reservoirs | Watch | Warning | Watch | Watch | Watch | Advisory |
| Crop Moisture | Normal | Normal | Normal | Normal | Normal | Normal |
| Fire Danger | Normal | Normal | Normal | Normal | Normal | Normal |

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Walden Pond, November 30, 2016



Avoid Watering During a Drought¹

Limits on outdoor water use are critical to help ensure that enough water is available for essential needs, including drinking water and fire protection, crop irrigation, and our natural resources.

| Drought Level | Recommended Water Use Restrictions for Everyone ^{1,2} |
|---------------|---|
| Advisory | <i>1 day per week at the most, outside the hours of 9AM – 5PM</i> |
| Watch | <i>hand-held only or drip irrigation outside the hours of 9AM – 5PM</i> |
| Warning | <i>Outdoor water use should be banned</i> |

1. Certain water uses are not subject to mandatory restrictions, such as water used:

- for health or safety reasons;
- for the production of food and fiber;
- for the maintenance of livestock;
- to meet the core functions of a business (for example, irrigation by plant nurseries as necessary to maintain stock).

2. If your water supplier has stricter restrictions in place, abide by those.