Update on Revisions to the Massachusetts Drought Management Plan

July 13, 2017
Presentation Overview

• Review key components of current plan
  – Drought Regions, Indicators and Levels
  – What data do we use and how?
  – History of drought declarations

• Update on revisions to drought plan
  – Feedback from stakeholders
  – Anticipated revisions to Indicators
  – Anticipated addition of Actions
  – Include enhanced section on Communications

• Next Steps
MA Drought Management Plan (DMP), 2001 (revised 2013)

**Drought Indicators**
- Precipitation
- Streamflow
- Groundwater
- Reservoirs
- Crop Moisture
- Fire Danger

**Drought Levels**
- Normal
- Advisory
- Watch
- Warning
- Emergency

Massachusetts Drought Regions

Western
Connecticut River Valley
Central
Northeast
Southeast
Cape and Islands

[www.mass.gov/eea/wrc-dmtf](http://www.mass.gov/eea/wrc-dmtf)
Summary of Current Methods

- Precipitation – cumulative months (2,3,6,12) below thresholds
  - SPI – normalized standard deviation
  - Percent of normal – specific percent thresholds

- Streamflow and Groundwater
  - Count of months below 25th percentile of historical values

- Reservoirs – size of reservoir below average

- KBDI (Fire Danger) – 0 to 800 units

- Crop Moisture Index – standard deviations
Precipitation and Reservoir Networks

Reservoir

Precipitation
KBDI and Crop Moisture

KBDI

Crop Moisture

Keetch-Byram Drought Index Data
For May 4, 2017

Source:
Calculated at DCR Fire Districts or RAWS Wx Stations

Legend:
-3.0 or less (Severely Dry)
-2.0 to -2.9 (Excessively Dry)
-1.0 to -1.9 (Abnormally Dry)
-0.9 to +0.9 (Slightly Dry/Favorably Moist)
+1.0 to +1.9 (Abnormally Moist)
+2.0 to +3.0 (Wet)
3.0 and above (Excessively Wet)
# Data Points for Decision Making

<table>
<thead>
<tr>
<th>Region</th>
<th>West</th>
<th>CT Valley</th>
<th>Central</th>
<th>North-east</th>
<th>South-east</th>
<th>Cape &amp; Islands</th>
<th>Totals</th>
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</thead>
<tbody>
<tr>
<td>Precipitation</td>
<td>4</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>3</td>
<td>31</td>
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<tr>
<td>Groundwater</td>
<td>5</td>
<td>11</td>
<td>10</td>
<td>17</td>
<td>12</td>
<td>13</td>
<td>68</td>
</tr>
<tr>
<td>Streams</td>
<td>6</td>
<td>11</td>
<td>16</td>
<td>19</td>
<td>6</td>
<td>n/a</td>
<td>58</td>
</tr>
<tr>
<td>Reservoirs</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>7</td>
<td>3</td>
<td>1</td>
<td>19</td>
</tr>
<tr>
<td>Totals</td>
<td>17</td>
<td>30</td>
<td>36</td>
<td>49</td>
<td>27</td>
<td>17</td>
<td>176</td>
</tr>
</tbody>
</table>
### RECENT DROUGHT HISTORY

| Year   | Begin Date | End Date | Comment       | Western | CT River | Central | Northeast | Southeast | Cape & Islands |
|--------|------------|----------|---------------|---------|----------|---------|-----------|-----------|-------------|----------------|
| 2002   | 12/28/2001 |          | February 2002 | Advisory| Watch    | Watch   | Watch     | Watch     | Advisory    |                |
| 2002   |            |          | March 2002    | Advisory| Watch    | Watch   | Watch     | Watch     | Watch       |                |
| 2002   |            |          | April 2002    | Watch   | Watch    | Watch   | Watch     | Watch     | Watch       |                |
| 2002   |            |          | May 2002      | Watch   | Watch    | Watch   | Watch     | Watch     | Watch       |                |
| 2002   |            |          | June 2002     | Advisory| Advisory | Advisory| Advisory  | Advisory  | Advisory    |                |
| 2002   |            |          | July 2002     | Advisory| Advisory | Advisory| Advisory  | Advisory  | Advisory    |                |
| 2002   |            |          | August 2002   | Advisory| Advisory | Advisory| Watch     | Watch     | Watch       |                |
| 2002   |            |          | September 2002| Advisory| Advisory | Advisory| Watch     | Watch     | Watch       |                |
| 2002   |            |          | October 2002  | Advisory| Advisory | Advisory| Advisory  | Advisory  | Advisory    |                |
| 2002   |            |          | December 2002 | Normal  | Normal   | Normal  | Normal    | Normal    | Advisory    |                |
| 2003   |            | 1/31/2003 | As of January 31, 2003| Normal | Normal | Normal | Normal | Normal | Normal |                |
| 2008   | 3/18/2008  |          |               | Normal  | Normal   | Normal  | Normal    | Normal    | Normal | Normal | Normal |
| 2010   | 8/1/2010   | 11/19/2010|               | Normal  | Normal   | Advisory| Advisory | Normal    | Normal | Normal | Normal |

2010       11/19/2010  As of November 19, 2010

| 2014   | 10/1/2014  | 11/30/2014|               | Normal  | Normal   | Normal  | Normal    | Advisory | Advisory |                |
| 2014   | 11/30/2014 |          | As of December 1, 2014| Normal | Normal | Normal | Normal | Normal | Normal |                |
| 2016   | 7/1/2016   |       | June 2016     | Normal  | Advisory | Watch   | Watch     | Advisory  | Normal |

2016       7/1/2016  July 2016

2016       7/1/2016  August 2016

2016       7/1/2016  September 2016

2016       7/1/2016  October 2016

2016       7/1/2016  November 2016

2016       7/1/2016  December 2016

2017       7/1/2017  January 2017

### Drought Level by Regions

- **Western**
- **CT River**
- **Central**
- **Northeast**
- **Southeast**
- **Cape & Islands**

### Notes

- **Advisory**
- **Watch**
- **Warning**
- **Normal**
Revisions to DMP

The Need for Revision

• 2016/17 Drought 1st time MA hit Warning - we learned a lot
• Plan not “operationalized”, per MEMA
• Plan lacks actions
• Some indicators didn’t track severity
• Indicators did not catch early drought onset
• Need better communication
• Drought level names unclear
Revision Process

• Intent to revise announced in fall of 2016 with request for comment letters from DMTF and stakeholders

• Listening sessions held with key stakeholders:
  – Water Suppliers (Jan 2017)
  – Mass Rivers Alliance Members (Feb 2017)
  – Agricultural Community members (April 2017)
  – DMTF Meetings
  – 8 comment letters received

• Drought Indicators Technical Workgroup
  – EEA staff + NWS + USGS; 8 meetings to date

• Drought Actions workgroup
  – EEA staff, 4 meetings to date
Stakeholder Comments on Indices

- Naming of drought levels
- Drought regions
- Timing of drought declarations especially at onset
- Meet human and environmental needs for water
- Longer look back periods
- Indices should reflect severity not just duration
- Consider effect of inaccurate data or outliers
Indicators Workgroup

Goal: To accurately and comprehensively provide information on onset, severity and end of droughts.

1. Indicator review
   – Do we have the right indicators?
   – Are the data networks sufficient for our indicators?

2. Method review
   – Consider US Drought Monitor (USDM) methods which indicates severity better, standardizes data,
   – Compare to previous droughts and historic data

3. What to call the drought levels for clarity
   – Current nomenclature doesn’t convey condition or order of severity

4. How to “roll up” each indicator within a region
   – Majority/median/mean per region? Weighted for worst condition?

5. How to make overall drought determination by region

6. Review of drought region boundaries
Indicator Review

• Keep only one precipitation index to eliminate double weighting
  – SPI for drought determination, add 9, 24 month lookbacks
  – Report percent of normal for public communication

• Replace Crop Moisture Index with an index that better reflects effect of temperature & ET on precipitation
  – CMI comes from national scale modeling with few Massachusetts data points
  – Still reviewing alternatives

• All other indices remain (KBDI, streamflow, reservoirs, groundwater)
Data Network Review

• Monitoring networks
  – Looked at spread of all data points across all regions
  – USGS conducting network analysis for groundwater and streamflow
  – Need to expand geographic coverage of networks, especially reservoirs
  – Increase real-time data and/or timeliness of data
Method Review

• Following USDM approach, use percentiles for all indicators to,
  – Standardize data independent of indicators’ distributions
  – Improve capture of severity which also allows for earlier detection of drought onset
• Keep 4 drought levels but re-name for clarity and mostly align with USDM percentiles
U.S. Drought Monitor (USDM), est. 1999

<table>
<thead>
<tr>
<th>Names</th>
<th>Recurrence</th>
<th>Percentiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>D0: Abnormally Dry</td>
<td>once per 3 to 5 years</td>
<td>21 to 30</td>
</tr>
<tr>
<td>D1: Moderate</td>
<td>once per 5 to 10 years</td>
<td>11 to 20</td>
</tr>
<tr>
<td>D2: Severe Drought</td>
<td>once per 10 to 20 years</td>
<td>6 to 10</td>
</tr>
<tr>
<td>D3: Extreme Drought</td>
<td>once per 20 to 50 years</td>
<td>3 to 5</td>
</tr>
<tr>
<td>D4: Exceptional Drought</td>
<td>once per 50 to 100 years</td>
<td>0 to 2</td>
</tr>
</tbody>
</table>

- Evidence based (not a model)
- Looks at climatic, hydrologic and soil conditions
  - Does not consider groundwater and reservoirs for Northeast
- 11 rotating Authors from NOAA, USDA, NDMC
USDM Methods, cont.

- Frequency-based drought levels and indicators
  - Percent of time a value or range of values is experienced
  - Experience most of the time $\rightarrow$ intuitive “normal”
  - Puts on common scale

Figure 1.1  Density Function for a Lognormal Distribution

Figure 1.2  Density Function for a Normal Distribution
USDM Methods, cont.

• “...the final drought category tends to be based on what the majority of the indicators show and on local observations.

• The analysts producing the map also weigh the indices according to how well they perform in various parts of the country and at different times of the year.

• It is this combination of the best available data, local observations and experts’ best judgment that makes the U.S. Drought Monitor more versatile than other drought indicators.”
### Proposed MA Drought Levels

#### US Drought Monitor

<table>
<thead>
<tr>
<th>Names</th>
<th>Recurrence</th>
<th>Percentile Range</th>
</tr>
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#### Proposed State Drought Levels

<table>
<thead>
<tr>
<th>Level</th>
<th>Percentile Range</th>
<th>US Drought Monitor Equivalence</th>
<th>New Nomenclature</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&gt;20 and ≤30%</td>
<td>D0</td>
<td>Dry</td>
</tr>
<tr>
<td>2</td>
<td>&gt;10 and ≤20%</td>
<td>D1</td>
<td>Very Dry</td>
</tr>
<tr>
<td>3</td>
<td>&gt;2 and ≤10%</td>
<td>D2 and D3 combined</td>
<td>Critically Dry</td>
</tr>
<tr>
<td>4</td>
<td>≤2%</td>
<td>D4</td>
<td>Emergency</td>
</tr>
</tbody>
</table>

#### Current State Drought Levels

- Advisory
- Watch
- Warning
- Emergency
Method Review - region “roll up”

- Options at site (assessed for streamflow & groundwater)
  - Median or mean of daily for month at site
- Options within a region
  - Median/50th percentile across sites
  - 25th percentile across sites
- Evaluated sensitivity of methods to drought levels using streamflow and groundwater data
  - Compared new options vs. current method for historical droughts
- Preliminary selection
  - Median of month and 25th percentile across region to provide earlier indication of emerging conditions
Method Review - Overall Drought Determination

• For each region, roll up indices to overall drought determination
  – DMTF to consider all indices available for the time of year
  – ONSET: Expect to see precipitation, streamflow and soil moisture to show deficits first
  – END: Maintain requirement to see recovery in long term precipitation and/or groundwater levels
  – DMTF uses their professional expertise to make recommendation to Secretary
Drought Regions – Align with Counties
7 Drought Regions
Next steps on Indices

• Complete assessment of new soil moisture/ET index
• Calculate all indices using new methods for all available historical data
• Assess implications on drought levels - number and severity of droughts
Feedback we received:

• Current plan lacks specific actions, especially local
• Plan is not “operationalized”
• Plan should include preparedness, not just response
• Some actions should be mandatory, plan needs authority
• Public outreach (more from State, enable local)
• Technical & financial assistance

Process included review of:

• Drought plans across the nation
• Materials from national associations
• Massachusetts policies and guidelines

Proposed Changes:

1. Add Local and State Preparedness to plan
2. Expand Local and State Response Actions during drought
3. User friendly format with menu of options and resources
Menu of Local Preparedness Actions

Major Themes:

1. Local Drought Management Plan (DMP) as part of Emergency Response Plan (including supply side actions)
2. Land Use Planning to Minimize Water Use & Increase Recharge
3. Water Conservation Program (WCP)
4. Water Rates
5. Nonessential Outdoor Water Use Restrictions

Q: We think these are the most important actions to prepare for drought… what do you think?
# Example Local Drought Response Matrix

<table>
<thead>
<tr>
<th>State Drought Level and Description</th>
<th>Level 1: Dry</th>
<th>Level 2: Very Dry</th>
<th>Level 3: Critically Dry</th>
<th>Level 4: Emergency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reservoir Trigger(s)</td>
<td>Fill in if establishing local reservoir triggers for staged drought response</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Groundwater Trigger(s)</td>
<td>Fill in if establishing local groundwater triggers for staged drought response</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Demand Management Actions

### Nonessential Outdoor Watering
- 1 day per week watering, before 9 am and after 5 pm.
- Hand-held watering only, before 9 am and after 5 pm.
- No nonessential outdoor water use
- No nonessential outdoor water use

### New sod, seeding, and landscaping
- Follow best management practices for efficient watering.
- Installation of new sod, seeding, and landscaping is discouraged
- Installation of new sod, seeding, and landscaping is strongly discouraged
- Installation of new sod, seeding, and landscaping is prohibited

### Water Savings Goal
- 55 gallons per person per day, or reduce use by __%
- 50 gallons per person per day, or reduce use by __%
- 45 gallons per person per day, or reduce use by __%
- 40 gallons per person per day, or reduce use by __%

## Water Supply Actions

### Interconnection/Backup and Emergency Supplies
- n/a
- Prepare activation of interconnections/backup supplies
- Activate interconnections/backup supplies
- Activate interconnections/backup supplies

## Communication Actions

### Website/Press/Social Media
- Update website/social media with latest information on drought status and restrictions/tips
- Weekly Tweets on Water Conservation
- Press Events and Weekly Social Media Updates
- Daily Communication using all tools

## Coordination Actions

### Drought Management Team
- Convene Drought Team, Monthly Meetings
- Weekly Drought Team Meetings
- Weekly or Daily Drought Team Meetings
- Daily Drought Team Meetings
Statewide Guidance:
Avoid Watering During a Drought

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.

<table>
<thead>
<tr>
<th>State Drought Level</th>
<th>Nonessential Outdoor Water Use Restrictions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level 1 (Dry)</td>
<td>1 day per week watering, after 5 p.m. or before 9 a.m. (to avoid evaporative losses)</td>
</tr>
<tr>
<td>Level 2 (Very Dry)</td>
<td>Outdoor watering should be limited to hand held hoses or watering cans, to be used only after 5 p.m. or before 9 a.m.</td>
</tr>
<tr>
<td>Level 3 (Critically Dry)</td>
<td>Ban on all nonessential outdoor water use</td>
</tr>
<tr>
<td>Level 4 (Emergency)</td>
<td>Ban on all nonessential outdoor water use</td>
</tr>
</tbody>
</table>
Menu of Local Actions During Drought
“Top Ten”

1. **Adopt and implement the state’s nonessential outdoor water use restrictions** – *This should be included in all plans.*
2. **Limit or prohibit:**
   - installation of new sod, seeding, and/or landscaping
   - watering during or within 48 hours after rainfall
   - washing of hard surfaces (sidewalks, patios, driveways, siding)
   - personal vehicle or boat washing
   - operation of non-recirculating fountains
   - filling of swimming pools, hot tubs, and rinks
3. **Promote or offer loans or rebates for removal of high-water-use plants**
4. **Provide incentives for installing efficient irrigation technologies**
5. **Establish water-use reduction targets** for all water users
6. **Implement drought surcharge** or seasonal water rates
7. **Targeted outreach to top water users** to help curb their use
8. **Reduce or eliminate hydrant flushing**, unless essential for public safety
9. **Implement or increase incentives for indoor and/or outdoor water audits**
10. **Provide assistance with installation of water-efficient fixtures and appliances**, and leak repair
State Actions - Key Functions

• Data gathering and analysis
  – Automate analysis, increase real-time data & reporting frequency

• Communication and Public Outreach
  – Develop Communications Strategy, Drought Portal, impact reporting

• Demand Management
  – Improve water-use efficiencies at state facilities

• Supply Management
  – Review Emergency Plans in light of drought

• Technical Assistance
  – Support local development of DMPs, WCPs

• Policy
  – Review/update WCS and DMP every 5 years, consider new policies
Communication

• Include enhanced set of communication strategies
  – Ongoing actions during normal conditions
  – Enhanced actions during a drought

• Target communication strategies to four sectors:
  – The General Public
  – Cities & Towns
  – Media
  – Businesses, including Agriculture
Next Steps

• July/August 2017: Proposed Revisions will be presented to the Drought Management Task Force
• Fall 2017: Draft Report release for comment anticipated
• Winter 2017: Final Report
• Spring 2018: begin implementing preparedness
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