



Natural Hazards, Climate Change & DCR

DCR's 2018 vulnerability assessment survey
for the
State Hazard Mitigation & Climate Adaptation Plan

What is climate change?

A statistically significant variation in climate data or patterns over a given period of time, due to either natural climate variability or human activity.

King tide in Saugus, MA
on 3-3-18
From MyCoast website



U.S. Selected Significant Climate Anomalies and Events for 2017



The AK annual average temperature was 29.4°F, 3.4°F above average and the 7th warmest year on record. Much-above-average temperatures were present across western and northern AK.



The CONUS had its third warmest year on record. Every state was warmer than average. Precipitation was above-average for the year.



The worst drought to impact the Northern Plains in decades rapidly developed in summer decimating crops across the region.



A significant lake effect snow event dropped 66" of snow on Erie, PA the last week of Dec, potentially breaking the 2-day state snowfall record.



A wet winter alleviated long-term drought in the West. Vegetation flourished, creating abundant wildfire fuel the following dry season. CA experienced its most destructive fire season on record.



A record-breaking flood event impacted the mid-Mississippi Valley in the spring causing damage to homes, businesses, infrastructure and agriculture.



AZ, GA, NM, NC and SC had their warmest year on record while MI was record wet in 2017.



Much of HI was warmer than average in 2017, especially the leeward coasts. Drought conditions expanded across the islands throughout the first half of 2017, peaking at 71% of the state in drought at the end of summer.



Cat 4 Hurricane Harvey made landfall near Rockport, TX in Aug ending a record-long streak of no major hurricanes hitting the U.S. Harvey moved slowly across the region dropping historic rain with catastrophic flooding across the Houston metro area.



Cat 4 Hurricane Irma made landfall at Cudjoe Key, FL in Sep damaging 65% of buildings in the FL Keys. Strong winds and storm surge caused much of the damage.



Cat 4 Hurricane Maria made landfall in southeast PR in Sep with widespread devastation to transportation, agriculture, communication and energy infrastructure. This was the strongest hurricane to impact PR since 1928.

Climate driver



The manifestation of a change in climatic conditions through one or more weather variables, such as a change in precipitation or sea level rise, to create an impact.

The Deerfield River in Shelburne Falls during Hurricane Irene in 2011.
Photo by John Elder Robison

Climate Drivers

| Primary Climate Driver | Natural Hazard | Related Climate Change Impacts |
|--------------------------------|---|--|
| Sea Level Rise and Storm Surge | Coastal Flooding (including daily tidal flooding from sea level rise) | Beach erosion, marsh migration, inundation of coastal and marine ecosystems, elimination of wetlands |
| | Hurricanes/ Tropical Storms | |
| | Nor'easter | |
| | Coastal Erosion | |
| Precipitation | Extreme Precipitation | Flash flooding, urban flooding, public health impacts from mold, worsened indoor air quality, vector-borne diseases from stagnant water |
| | Inland/Riverine Flooding | |
| | Severe Winter Storm | |
| | Ice Storms | |
| | Landslide | |
| | Dam Failure | |
| Temperature | Increase in Average Summer Temperature | Shifting in seasons (longer summer, early spring including earlier timing of spring peak flow), increase in length of growing season, increase of invasive species, frequent energy brown-outs from higher energy demands, public health impacts from high heat exposure, poor outdoor air quality |
| | Extreme Temperatures/Heat Waves | |
| | Drought | |
| | Wildfires | |
| Other Extreme Events | Tornadoes | Damage to property, infrastructure, and loss of life |
| | Tsunami | |
| | Earthquake | |

Climate Science

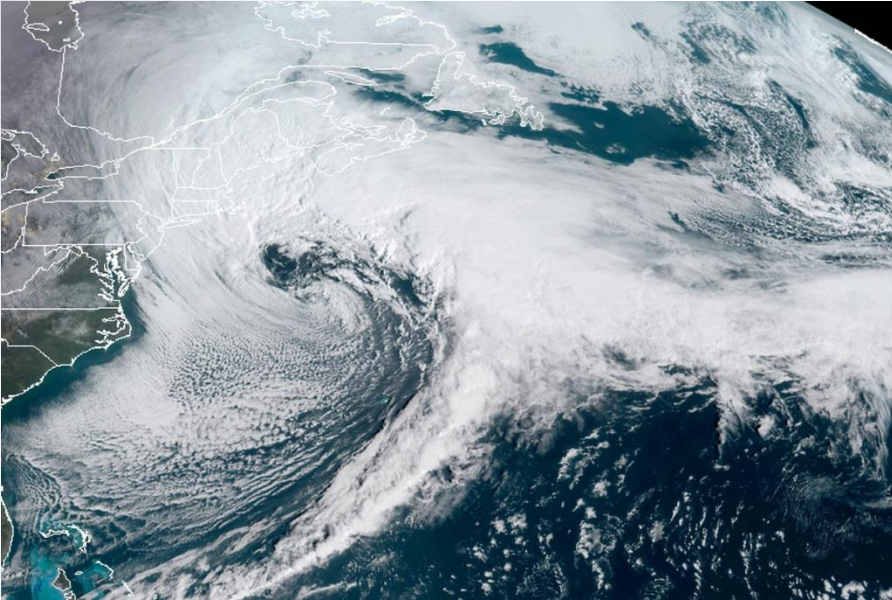
- Daily maximum temperature (F),
- Daily minimum temperature (F),
- Daily average temperature (F),
- Growing degree day accumulation, base 50 F,
- Heating degree day accumulation, base 65 F,
- Cooling degree day accumulation, base 65 F,
- Counts of days with maximum temperature above 90 F,
- Counts of days with maximum temperature above 95 F,
- Counts of days with maximum temperature above 100 F,
- Counts of days with minimum temperature below 0 F,
- Counts of days with minimum temperature below 32 F,
- Total precipitation (inches),
- Counts of days with precipitation greater than 1 inch,
- Counts of days with precipitation greater than 2 inches,
- Counts of days with precipitation greater than 4 inches,
- Growing season length (station data only)

Inland Flooding



Deerfield River scene
Tropical Storm Irene 2011

- More intense and frequent downpours
- Increased frequency of severe storms
- Changes in precipitation can lead to increased periods of drought
 - Between 1954 and 2017, Essex County experienced the most FEMA flood disaster declarations (18), followed by Norfolk County (16.)
 - Based only upon historical disaster declarations, the Commonwealth experiences a substantial flood event once every 3 years (2017 data.)



March 21, 2018 Nor'easter
NOAA photograph

Winter storms

- Rising temperatures lead to warmer oceans
- Warming air creates changes in global and regional circulation patterns
 - Warmer oceans offer additional moisture to forming storms, leading to more severe impacts
 - Research has found that increasing water temps and reduced sea ice in the Arctic are producing circulation patterns that favor the development of winter storms in the eastern US.

Wildfire



- Rising temps & changes in precipitation can lead to prolonged drought conditions
- Rising temps can lead to more frequent lightning
 - Ecosystems most susceptible to wildfire are pitch pine, scrub oak, and oak forests.
 - According to a US Forest Service study, Barnstable and Plymouth Counties are the most fire-prone due to their vegetation and the presence of a drying wind.



Adjacent to Route 3A in Cohasset
Summer 2016
Photo: Jonathan Wiggs/Boston Globe

Drought

- Drought in the northeast is projected to increase during summer and fall as higher temps lead to greater evaporation and earlier winter and spring snow melt.
- Rising temps and changes in precipitation are expected to lead to reduced snowpack.



Project Completed: How Fish Populations are Affected by Climate Change

Thursday, February 15, 2018

The final report, "Characterization of spatial and temporal variability in fishes in response to climate change" is now available. PI: Brian Irwin, USGS Georgia Cooperative Fish and Wildlife Research Center

Read more »



New Report: Vulnerability of Northeast Forests

Monday, February 12, 2018

A new assessment is available of the vulnerability of forest ecosystems across the New England region (Connecticut, Maine, Massachusetts, New Hampshire, northern New York, Rhode Island, and Vermont) under a range of future climates.

Read more »



Two New Publications about Climate Impacts on color-changing mammals

Friday, March 9, 2018

NE CSC Graduate Fellow, Marketa Zimova, published two papers on how the worldwide decrease in snow cover already may have dramatic impacts on animals that change coat colors with the seasons. Marketa has been working towards a PhD studying species' responses to climate change, investigating hares and adaptation to decreasing snow cover.

Read more »



<https://necsc.umass.edu/>



New Publication: Tipping Points of Coastal Fish, Wildlife, and Plants

Wednesday, September 27, 2017

A team of scientists from US Fish and Wildlife Service, North Atlantic Landscape Conservation Cooperative, and the NE CSC synthesized information on thresholds – or "tipping points" – for 45 focal species of fish, wildlife, and plants in response to sea-level rise and coastal storms.

Read more »



Using Models to Predict Complex Wildlife Responses to Climate

Thursday, October 19, 2017

NE CSC Postdoctoral Fellow Tom Bonnot looked into the varying population size and distribution of two critical bird species, the prairie warbler and wood thrush, by modeling their population distribution across the central hardwoods and then predicting how these variables will change up to the year 2100.

Read more »

Governor Baker's EO 569

I. Greenhouse gas emissions reduction & mitigation

II. Regulations for Chapter 21N, Section 3(d)- the Climate Protection & Green Economy Act

III. **Adaptation and Resiliency**

IV. Climate change coordinators in each Executive Office

V. Timeline for implementation



NASA photo from
<https://climate.nasa.gov/>

Section 3- Adaptation & Resiliency

“... to strengthen the resilience of our communities, prepare for the impacts of climate change, and to prepare for and mitigate damage from extreme weather events.”



- statewide Climate Adaptation Plan
- framework for agency vulnerability assessment
- strategies for local communities to adapt
- requirements for implementation

The state hazard mitigation planning process



1. Risk assessment of natural hazards (and climate change impacts)

- What are our natural hazards? How will climate change affect us?
- Where are the hazards located?
- What “things” could be impacted? (Buildings, infrastructure, people, the natural environment...)
- How badly would they be impacted? (How much damage?)

2. Goals for minimizing or eliminating either the risk or the resulting damage (mitigation)

What results do we want to see?

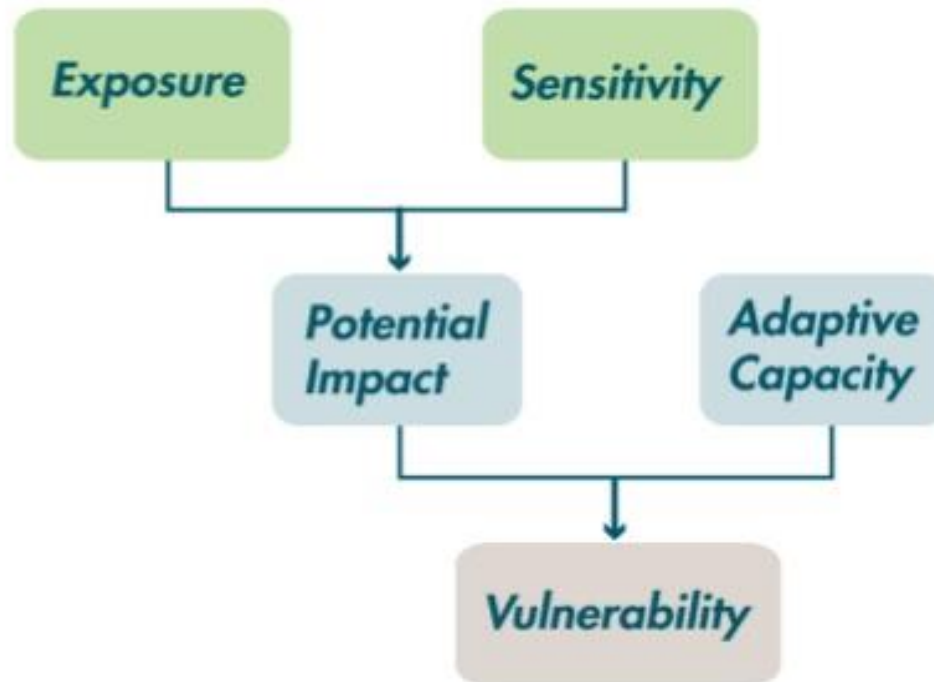
How will we know if we've been effective?

3. Strategies for dealing with the hazards (and climate impacts)

Mitigation actions such as building stronger, building in the right places being prepared, public awareness, insurance, etc.



Assessing Vulnerability



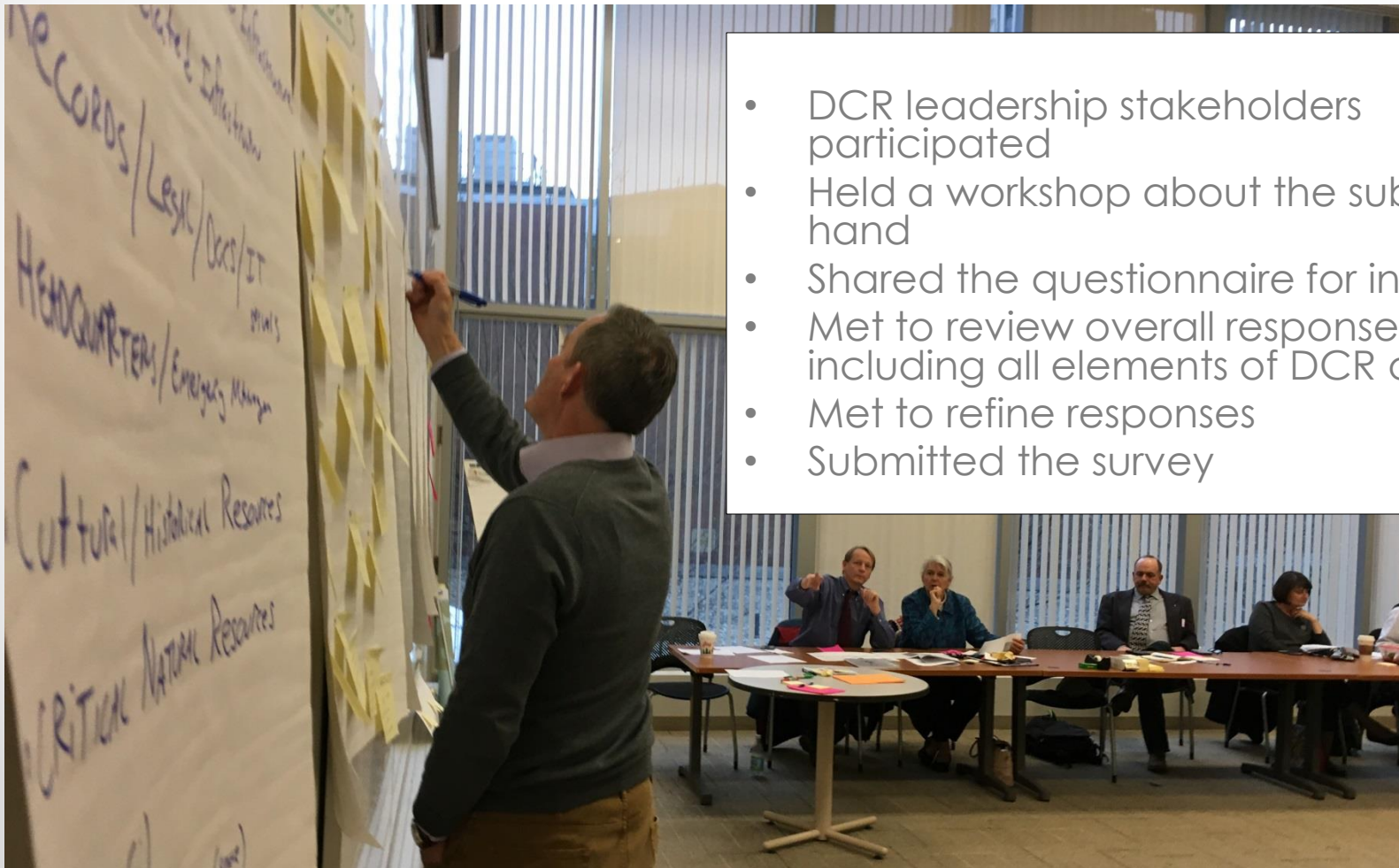


DCR mission

DCR manages over 450,000 acres of parks, forests, watersheds, beaches, parkways and roads, long distance bike corridors, dams and other public infrastructure throughout Massachusetts on behalf of the people of the Commonwealth. DCR's mission is to protect, promote and enhance our common wealth of natural, cultural, historic and recreational resources for the well-being of all.



DCR's agency assessment survey process



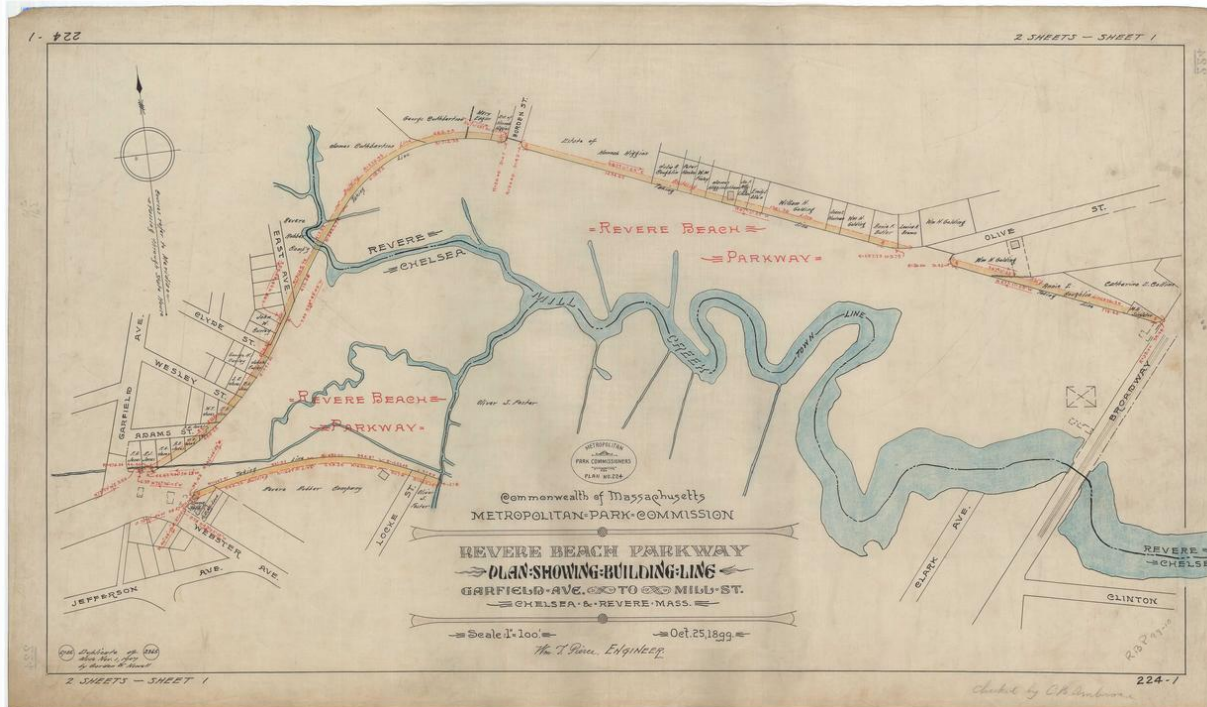
- DCR leadership stakeholders participated
- Held a workshop about the subject at hand
- Shared the questionnaire for input
- Met to review overall responses, including all elements of DCR operations
- Met to refine responses
- Submitted the survey

DCR Survey Elements

- Critical assets, functions, and populations
- Hazard/ climate change impacts
- Sensitivity of impacts to operations, facilities and populations served
- Agency interdependencies
- Agency capacity & adaptability



What do you think?



What types of DCR assets might be vulnerable to some extent to natural hazards or climate change impacts?

DCR Survey Results: Assets

Examples of potentially vulnerable assets include:

- Certain dams & reservoirs
- DCR parkways, roads, bridges, dams
- Forestry high ground communications towers
- Beaches, piers, seawalls, islands, coastal marshes & wetlands
- Coastal and inland flood control structures (dams, levees, pump stations)
- Urban and non-urban forests
- Cultural & historical resources
- Historic records, engineering plans, IT servers, equipment, legal documents

DCR Survey Results: Functions

Examples of potentially vulnerable functions include:

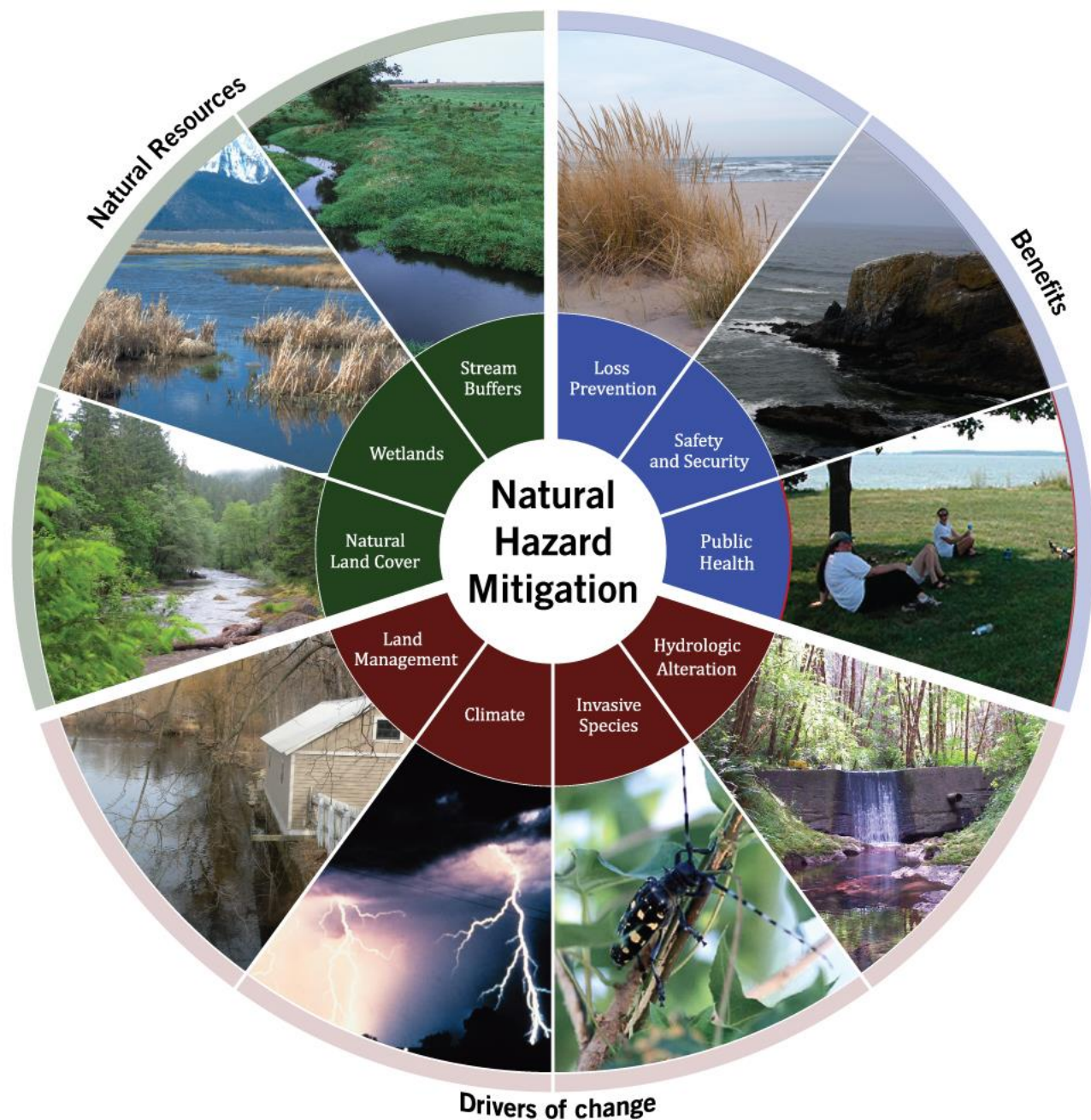
- Provision of drinking water to Boston metro area
- Flood protection
- High ground communications operability
- Debris/ snow removal post-storm emergency management
- Forestry/ wildfire management
- Transportation

DCR Survey Results: Populations

Examples of potentially vulnerable populations include:

- People protected by flood control infrastructure
- Drinking water customers; includes hospitals, schools, residents, commercial/ restaurants, emergency, etc.
- Law enforcement & emergency personnel
- Parkway drivers, including hospitals, emergency vehicles, school buses, workers, etc.
- All DCR recreational residents and visitors

Why does this matter to you?



This EnviroAtlas eco-wheel was created by Jessica Jahre, EPA contractor


Mitigation measures?

- Sea level rise: coastal flooding, coastal erosion
- Changes in precipitation: inland flooding, landslides
- Rising temperatures: extreme heat, drought, wildfire, invasive species
- Extreme weather: hurricanes, tropical storms, nor'easters, tornadoes, heavy ice events

What if the Nutria began to invade New England wetlands like they have in Louisiana?

Photo: National Park Service





Status of Dam Removal in Massachusetts

**Beth Lambert, River Restoration
Program Coordinator**

Division of Ecological Restoration

February 10, 2011

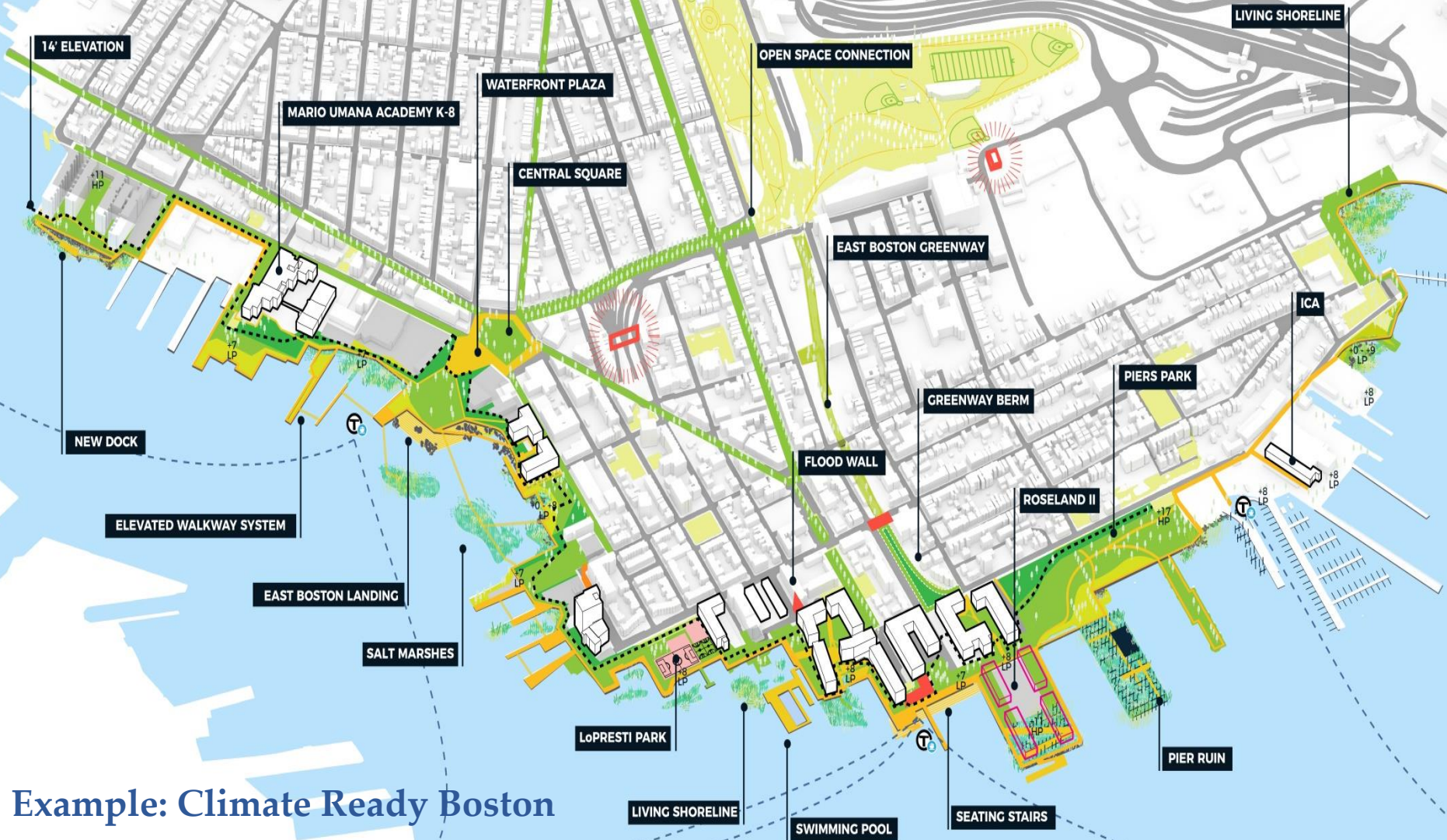
Water Resources Commission



Mission:

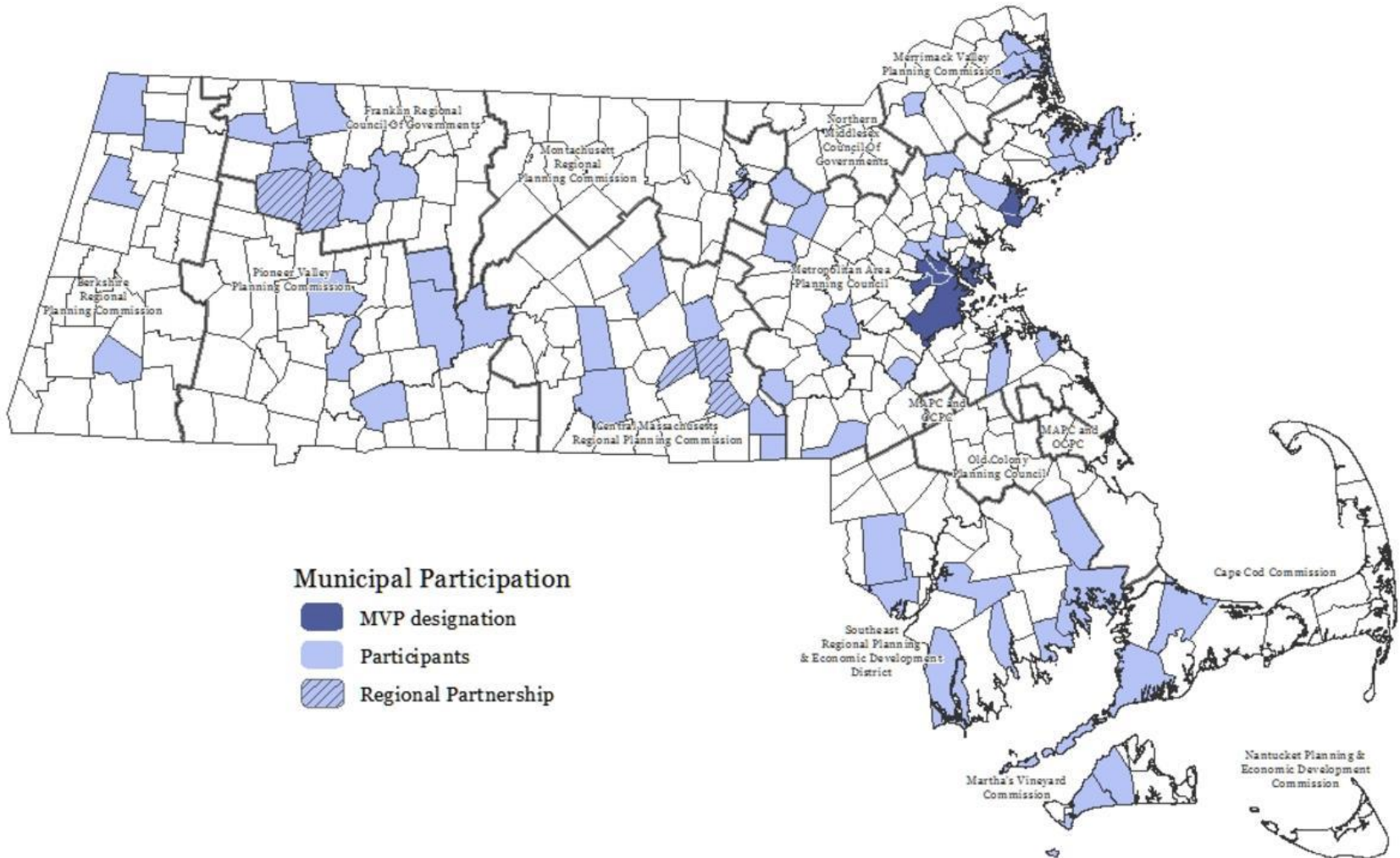
**To promote the restoration, protection &
ecological integrity of the Commonwealth's
rivers, streams and adjacent lands**

LONG TERM VISION (CURRENT TO 2070 FLOOD PROTECTION)



Example: Climate Ready Boston

Mass EEA M.V.P. program



Example: Spaulding Rehabilitation Hospital

- In April 2013, Spaulding opened a new 132-bed facility in Charlestown which is a national model for environmental and inclusive design.
- Certified LEED Gold for its commitment to renewable energy and sustainability it also is a national model for inclusive design.

LEED Scorecard

Gold 44/69

▶ SUSTAINABLE SITES

9 OF 14



▶ WATER EFFICIENCY

3 OF 5



▶ ENERGY & ATMOSPHERE

9 OF 17



▶ MATERIAL & RESOURCES

6 OF 13



▶ INDOOR ENVIRONMENTAL QUALITY

12 OF 15



▶ INNOVATION

5 OF 5



Governor Baker's Resilience Bond legislation

Baker-Polito administration files legislation committing over \$1.4 billion to climate change, environmental protection, and community investments

- \$170 million- improvements and repairs to dams/seawalls and to implement coastal resiliency strategies
- \$50 million- planning and action grants to communities through the Municipal Vulnerability Preparedness (MVP) Program
- \$60 million- to implement the Commonwealth's Integrated State Hazard Mitigation and Climate Adaptation Plan.
- \$125 million- community investment grant programs
- \$25 million- tree planting and forest land protection programs
- \$50 million- Mass DOT Complete Streets Program
- \$270 million- environmental programs at Mass DEP and other agencies, ranging from air and water quality monitoring to hazardous waste cleanup and the restoration of rivers, wetlands, streams, and lakes
- \$580 million- investment in deferred maintenance and recreational resource stewardship, including \$25 million for expansion and interconnection of trails through the MassTrails program

Future DCR steps, actions

Crew leaders brief the Mass Wildfire Crew on the day's assignment, tactics and safety concerns | Photo Mass DCR



The DCR Ecology Program focuses on the identification, conservation, and stewardship of ecological resources on DCR properties | Photo Mass DCR



Links to resources & data

- Mass State Hazard Mitigation & Climate Adaptation Plan
<https://resilientma.com/>
- UMass Northeast Climate Science Center
<https://necsc.umass.edu/>
- Mass Climate Change Clearinghouse- coming soon
- Mass Climate Change Adaptation Coalition
<https://www.massadapt.org/resources.php>
- NOAA Center for Environmental Information
<https://www.ncei.noaa.gov/news/national-climate-201712>

Thank you

For additional information about the Commonwealth's integrated Hazard Mitigation and Climate Adaptation Plan:



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