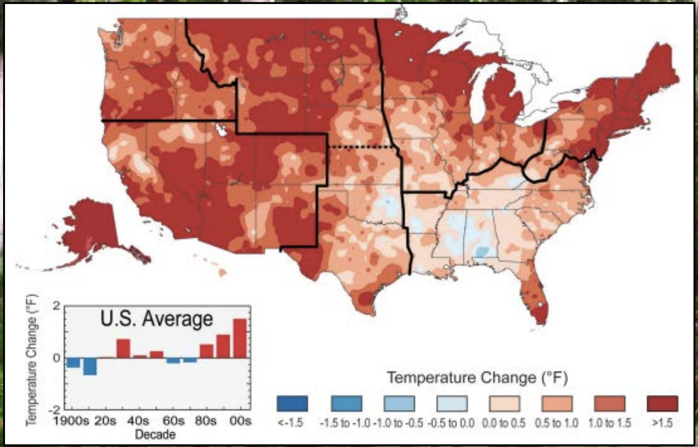
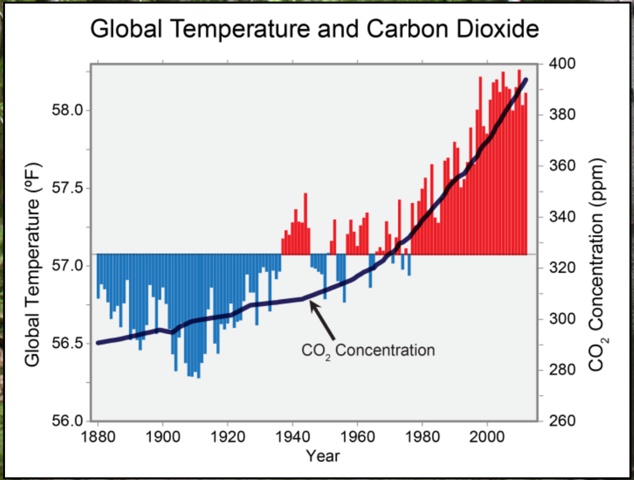
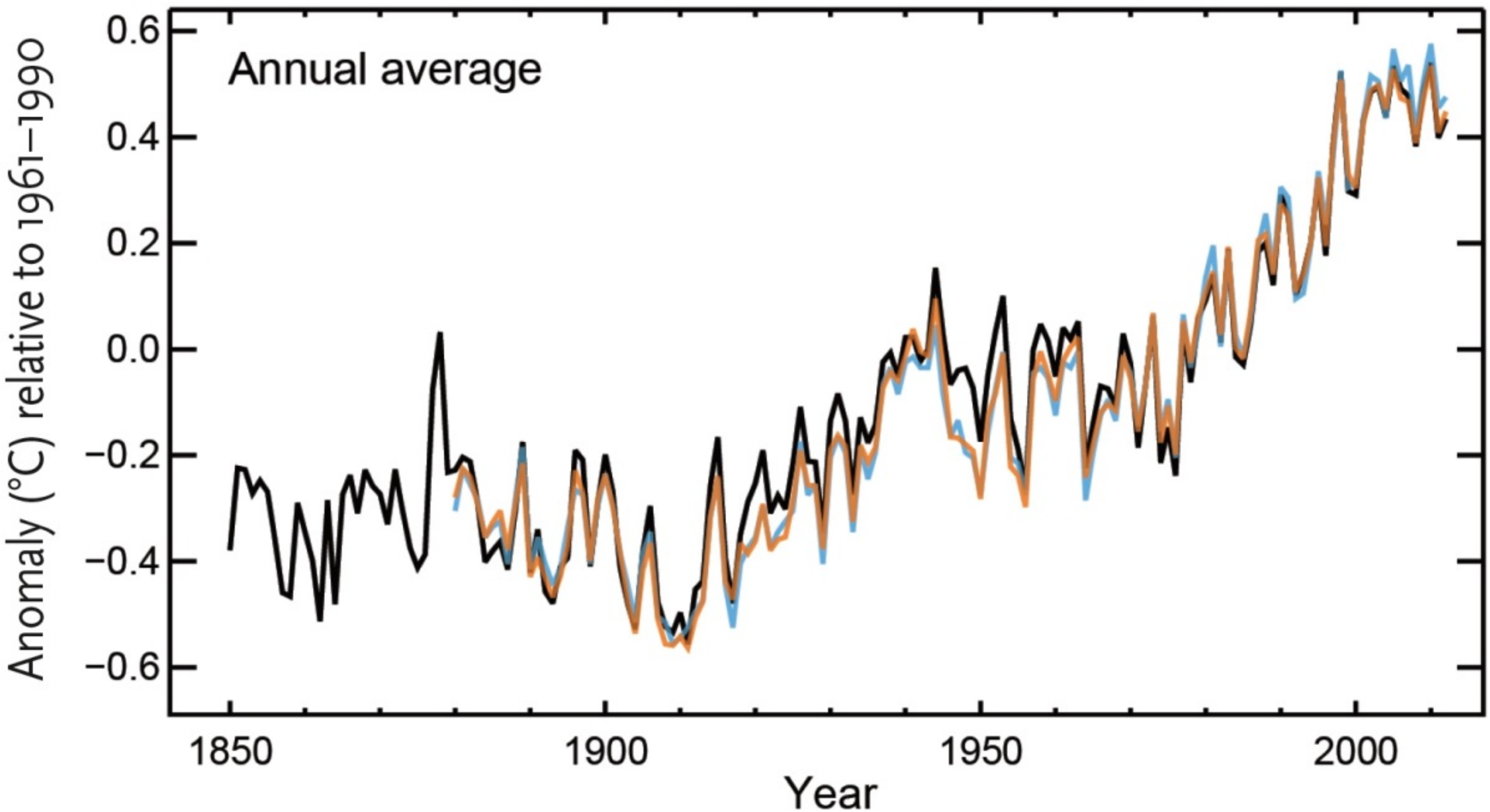
Climate Change Adaptation Education



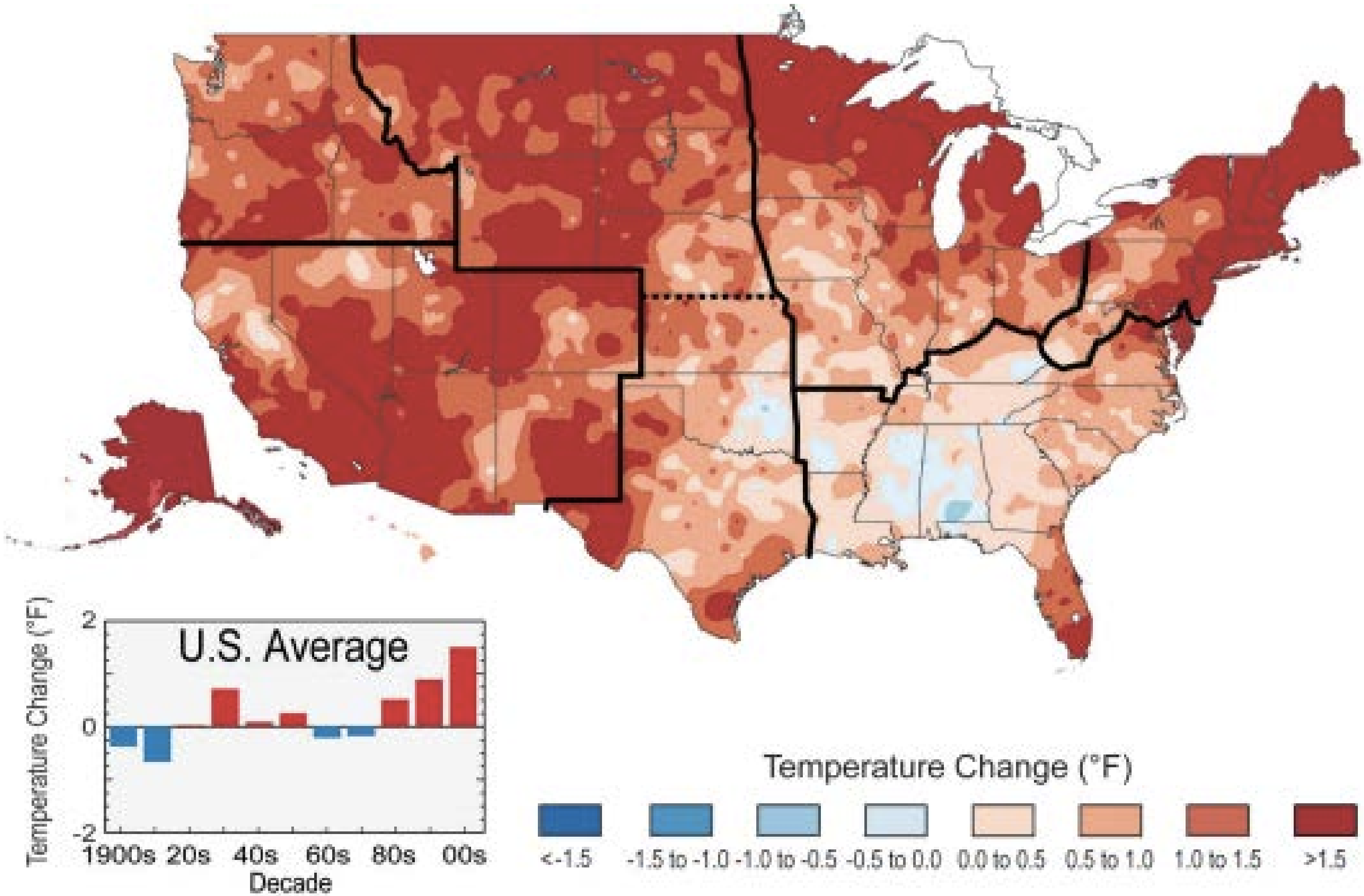


Earth's global average surface temperature

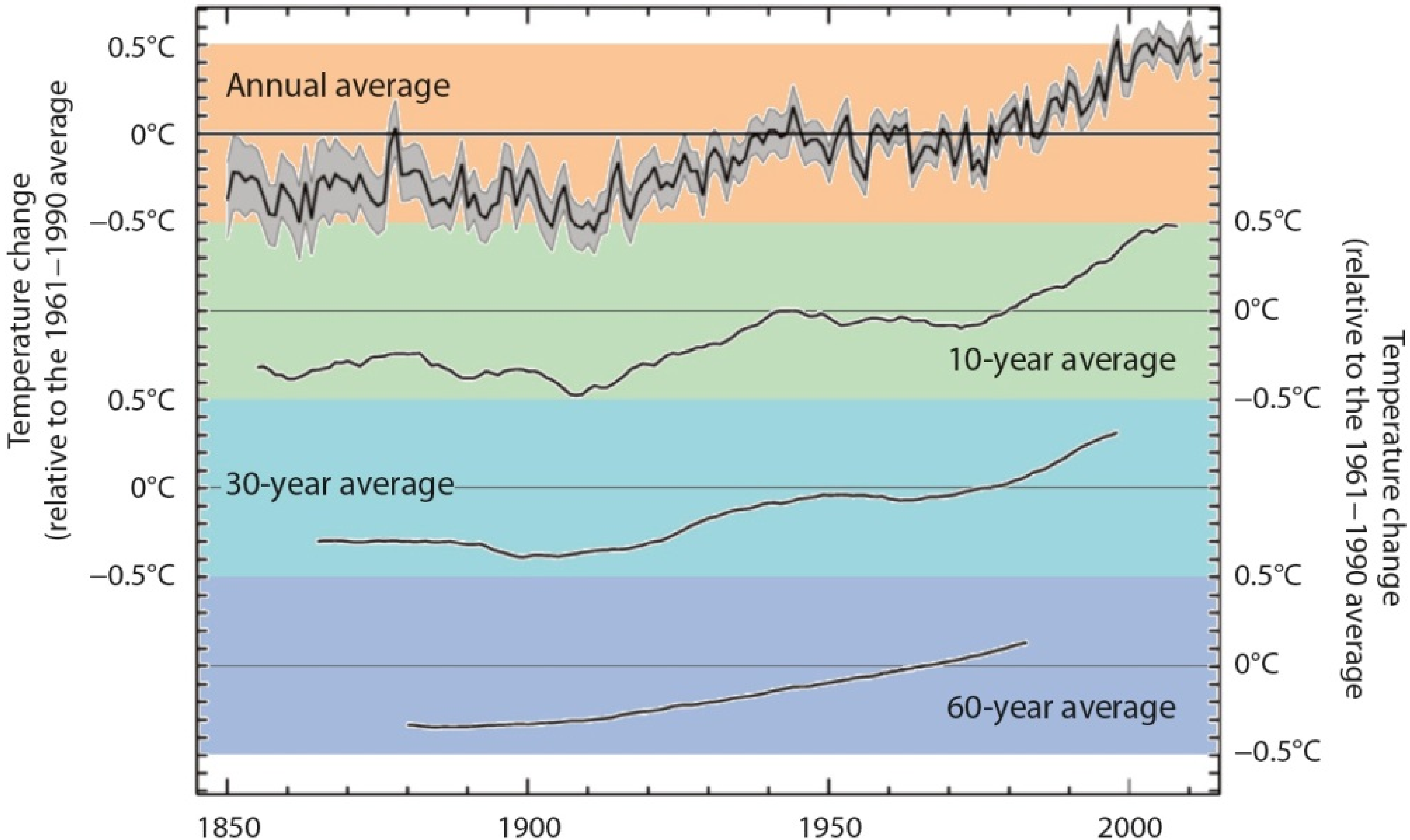


Source: IPCC AR5, data from the HadCRUT4 dataset (black), UK Met Office Hadley Centre, the NCDC MLOST dataset (orange), US National Oceanic and Atmospheric Administration, and the NASA GISS dataset (blue), US National Aeronautics and Space Administration.

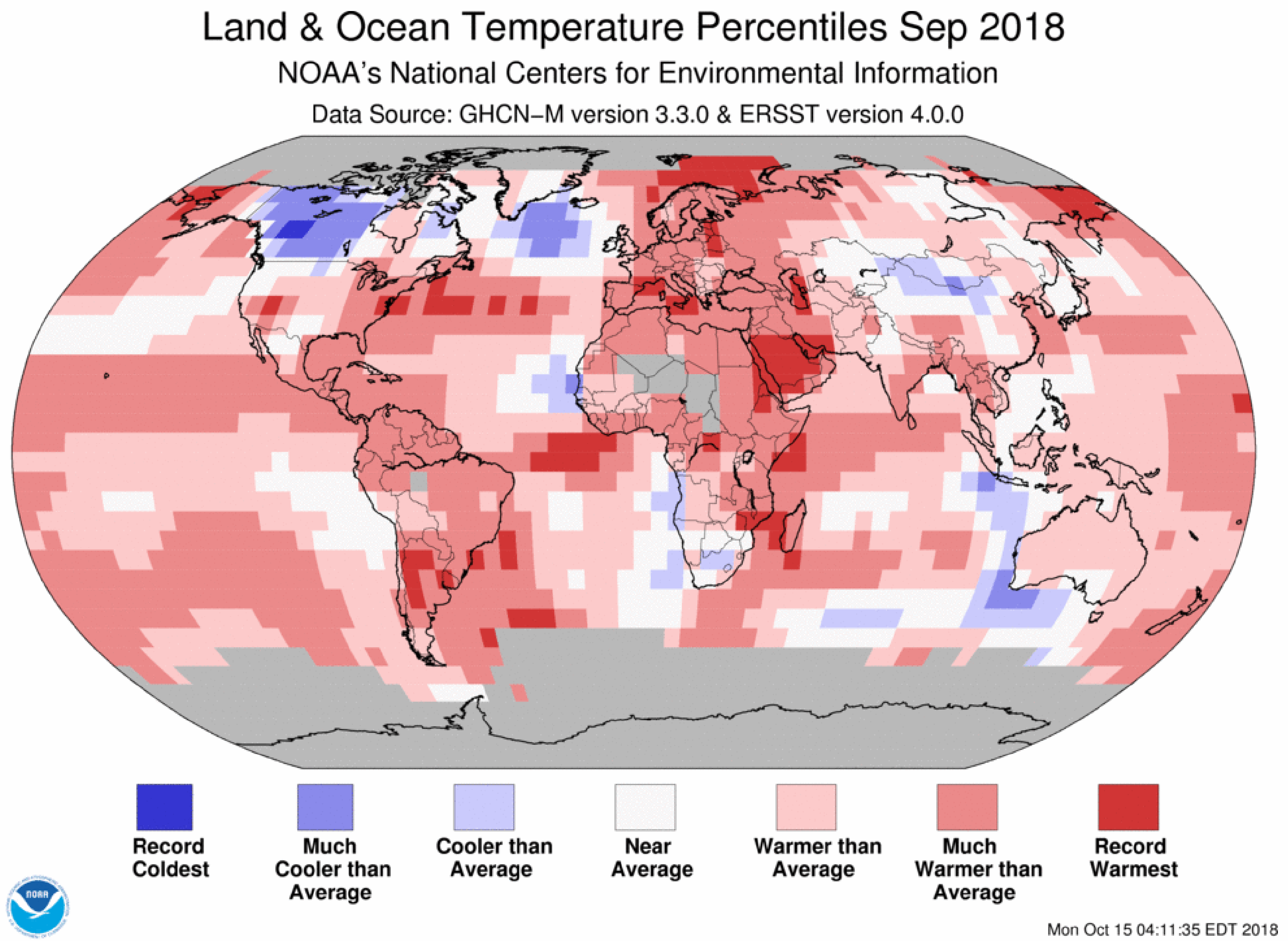
Temperature changes over the past 22 years (1991-2012)



Source: NOAA NCDC / CICS-NC



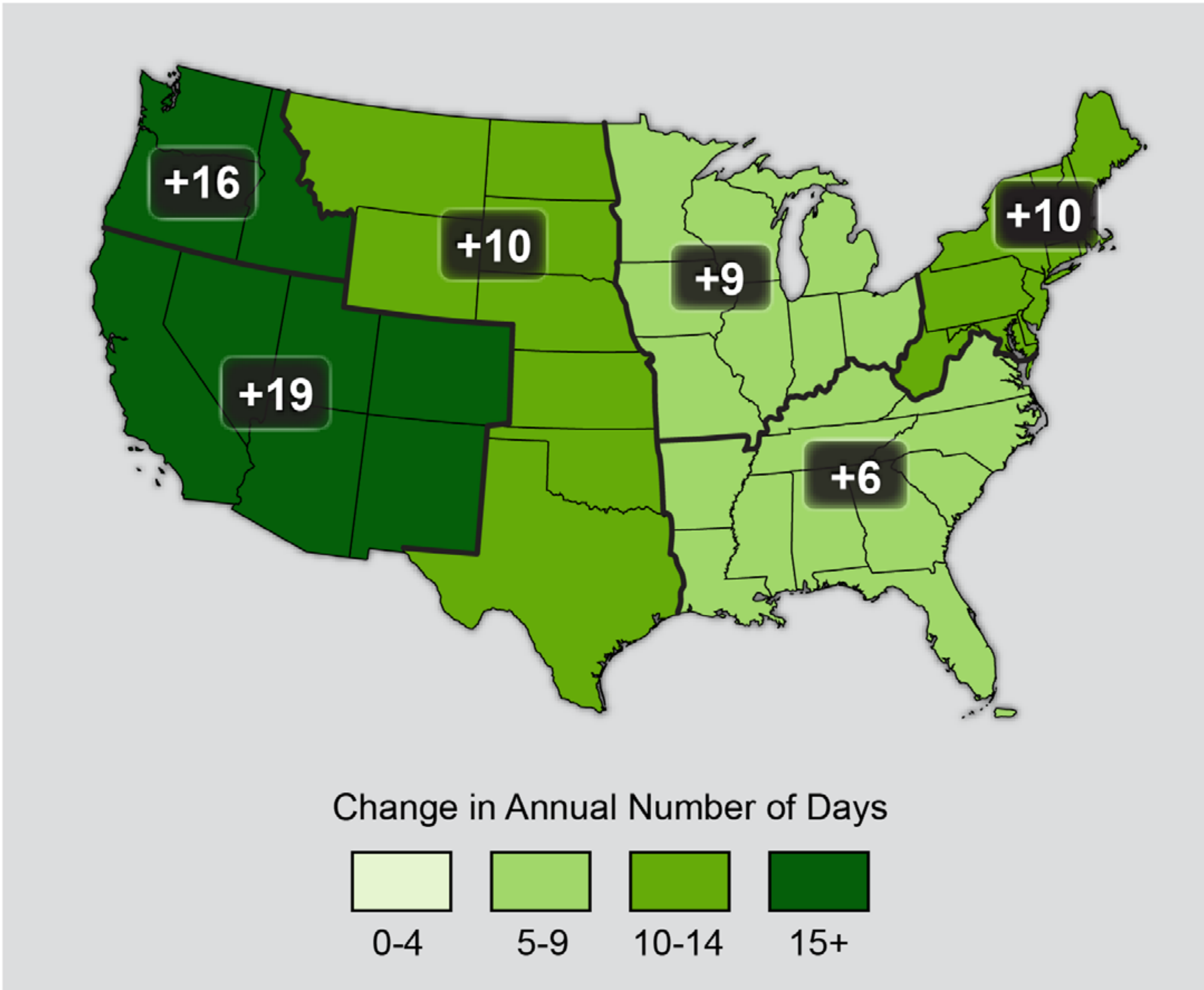
Source: Met Office, based on the HadCRUT4 dataset from the Met Office and Climatic Research Unit (Morice et al., 2012).



September marks the 405th consecutive month with a global temperature above the 20th century average

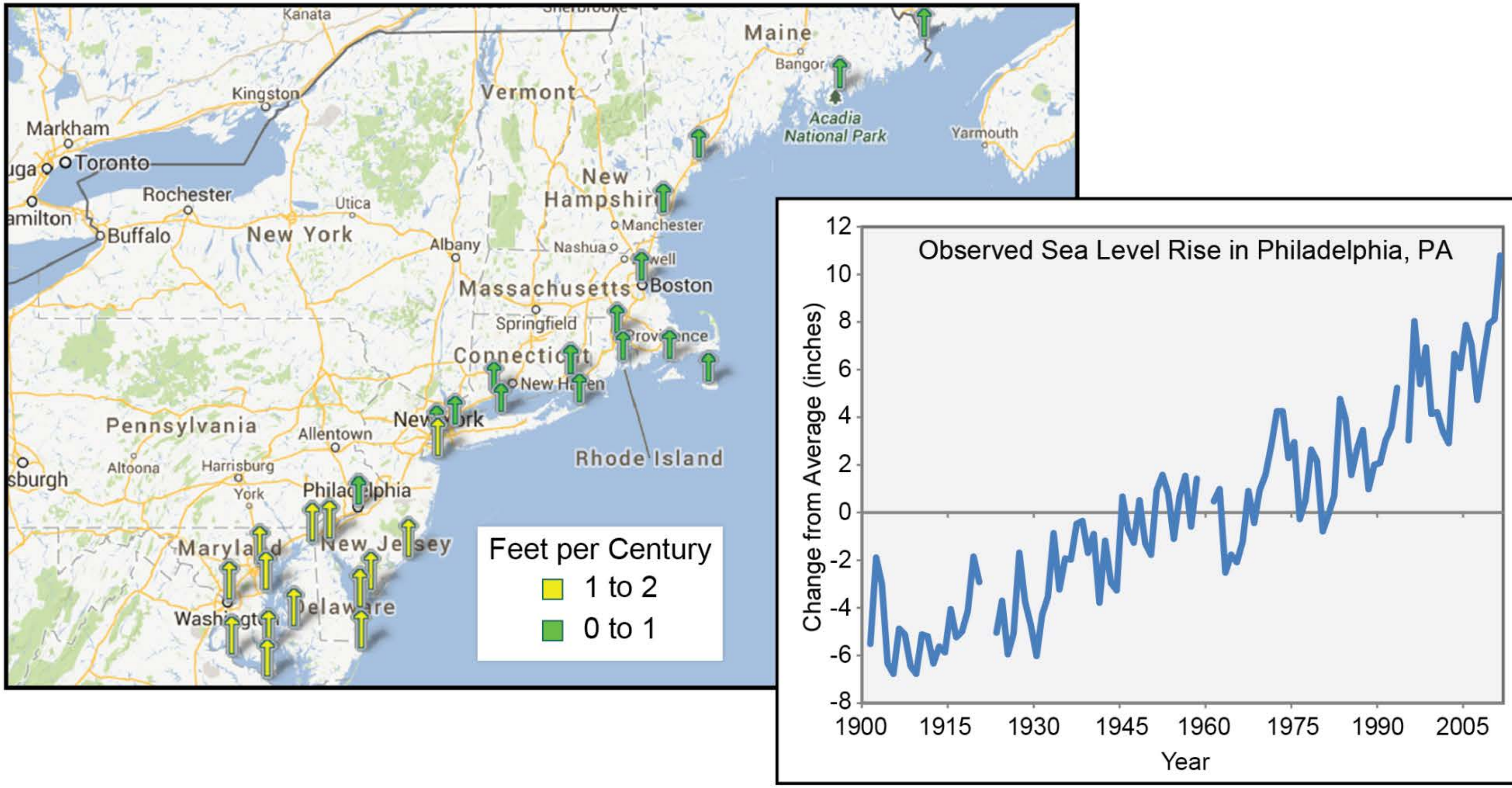
The last five years (2014–2018) rank among the five highest Septembers on record.

Observed Increase in Frost-Free Season Length

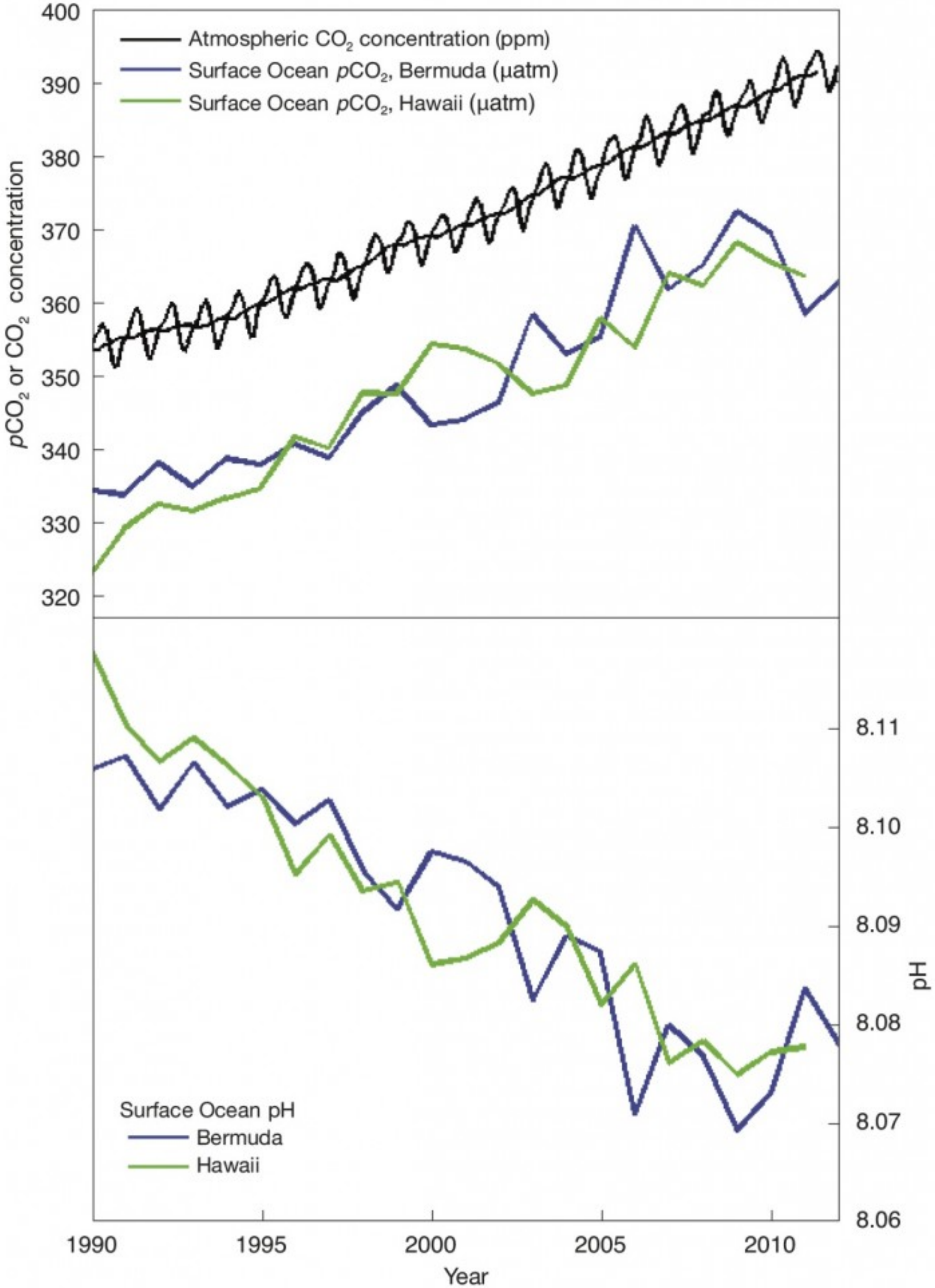


Source: NOAA NCDC / CICS-NC

Sea Level is Rising

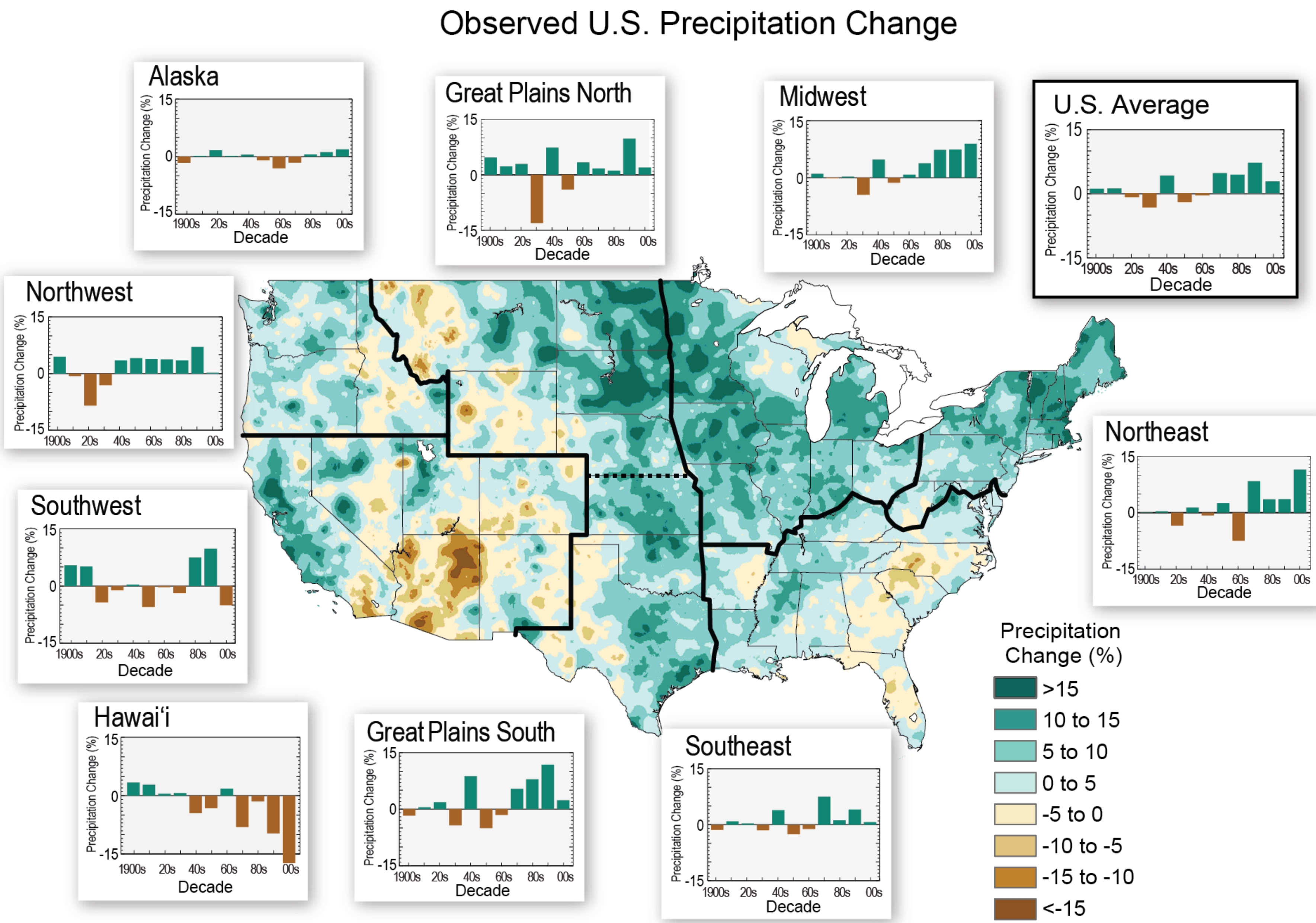


Data from Permanent Service for Mean Sea Level; U.S. National Climate Assessment, 2014



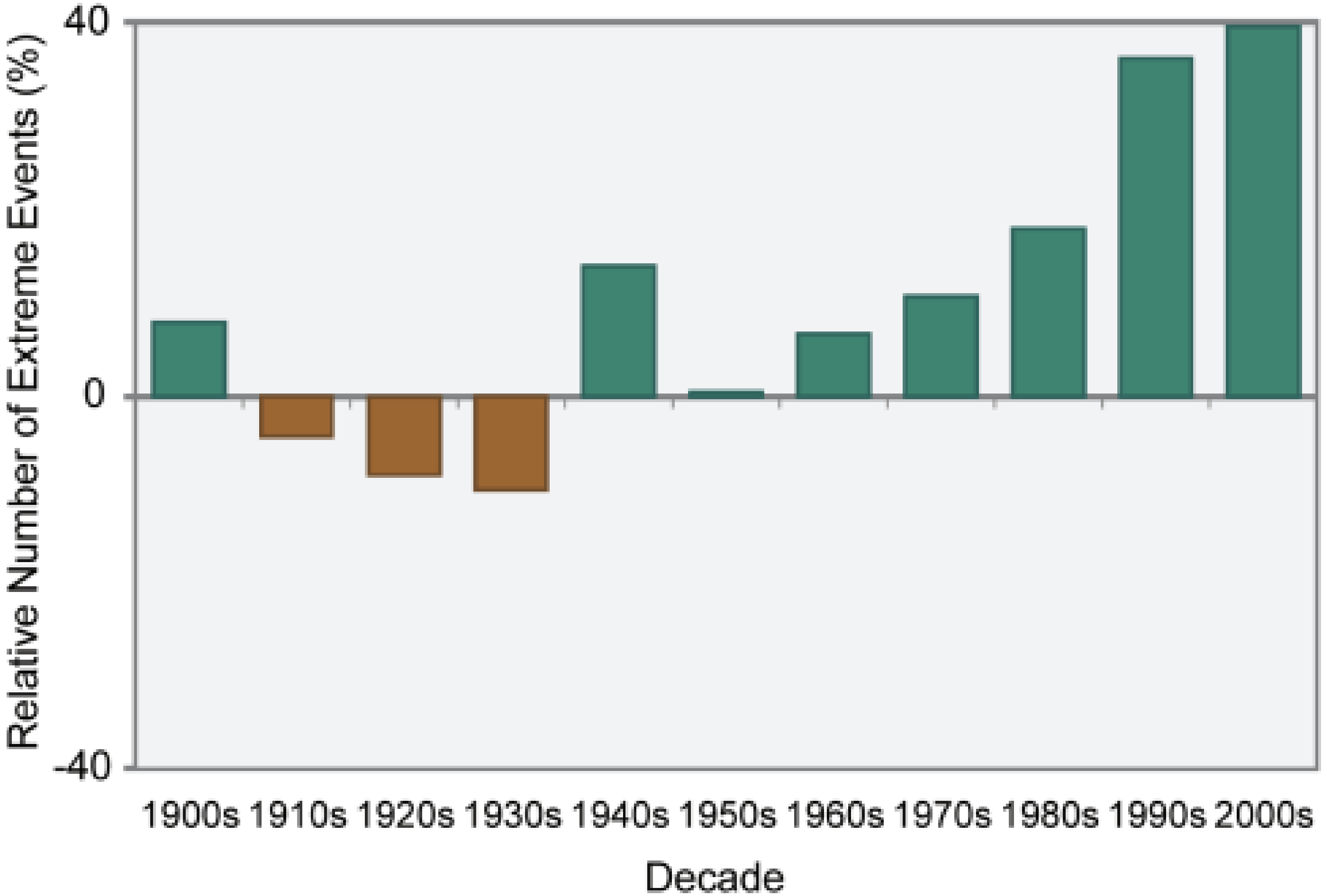
Acidification of the Oceans

Source: adapted from Dore et al. (2009) and Bates et al. (2012)



Source: adapted from Peterson et al. 2013[1]). (U.S. National Climate Assessment, 2014)

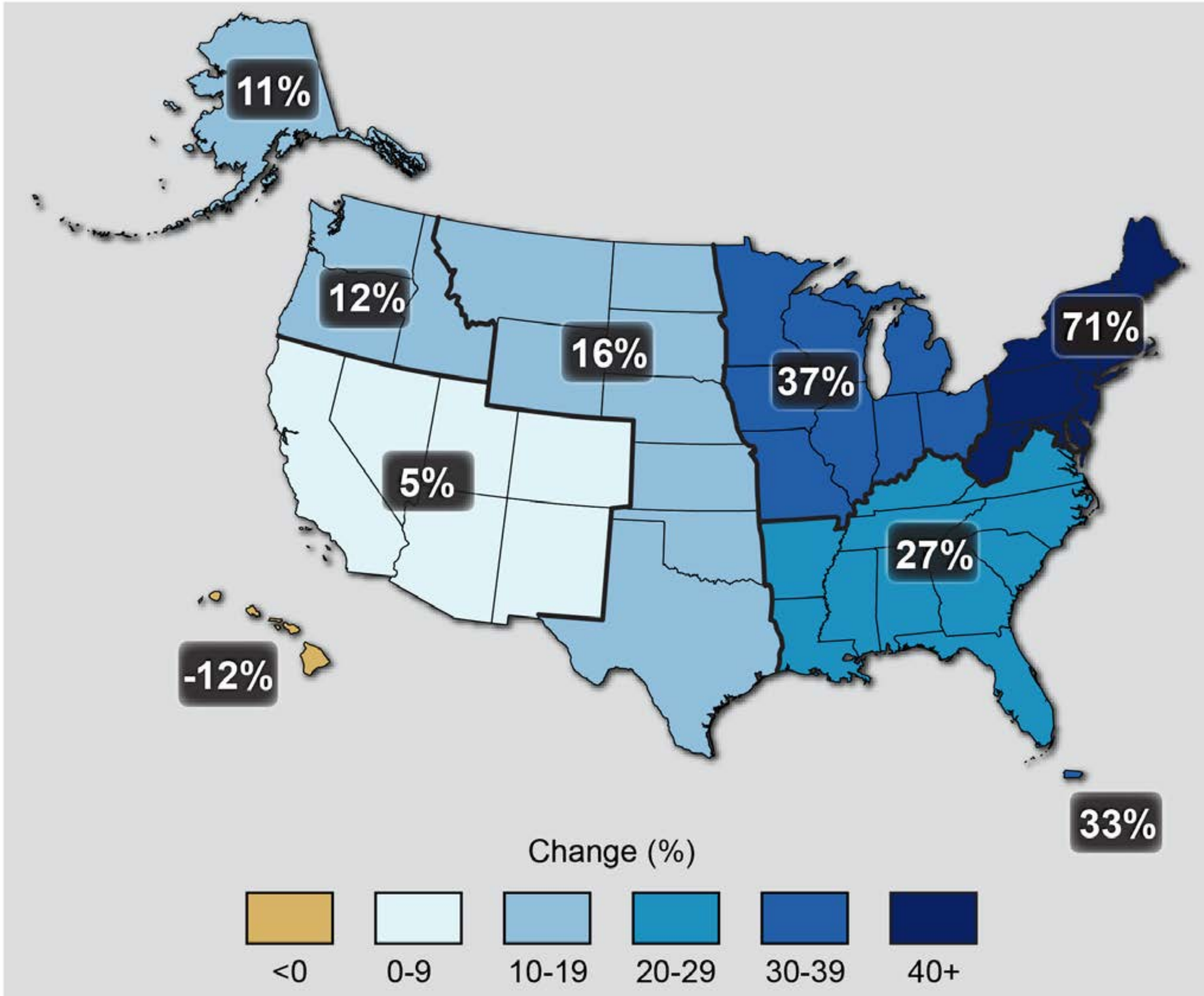
Relative Number of Extreme Events



The measure of a heavy precipitation event is a 2-day precipitation total that is exceeded on average only once in a five-year period, also known as a once-in-five-year event.

Source: adapted from Kunkel et al. 2013

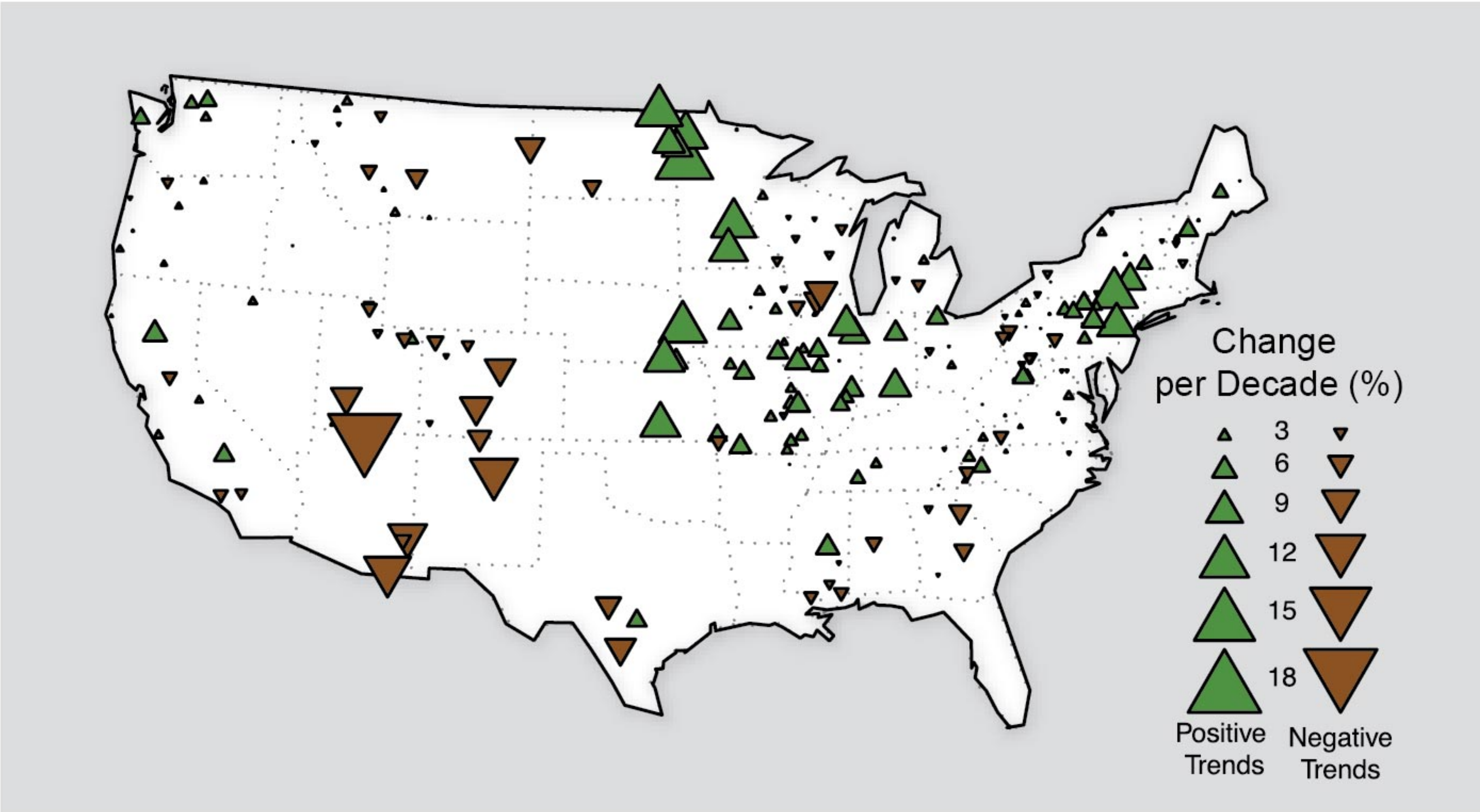
Observed Change in Very Heavy Precipitation



Percent increases in the amount of precipitation falling in very heavy events (defined as the heaviest 1% of all daily events) from 1958 to 2012 for each region of the continental United States

Source: updated from Karl et al. 2009

Trends in Flood Magnitude



Trend magnitude (triangle size) and direction (green = increasing trend, brown = decreasing trend) of annual flood magnitude from the 1920s through 2008

Source: Peterson et al. 2013

What to Expect in New England

- Warmer temperatures (summer & winter)
- Longer growing seasons
- More rain in winter/spring
- Less rain in summer/fall
- Less snow accumulation
- More frequent severe storms
- Storms of greater severity
- Sea level rise of 3-6 feet or more

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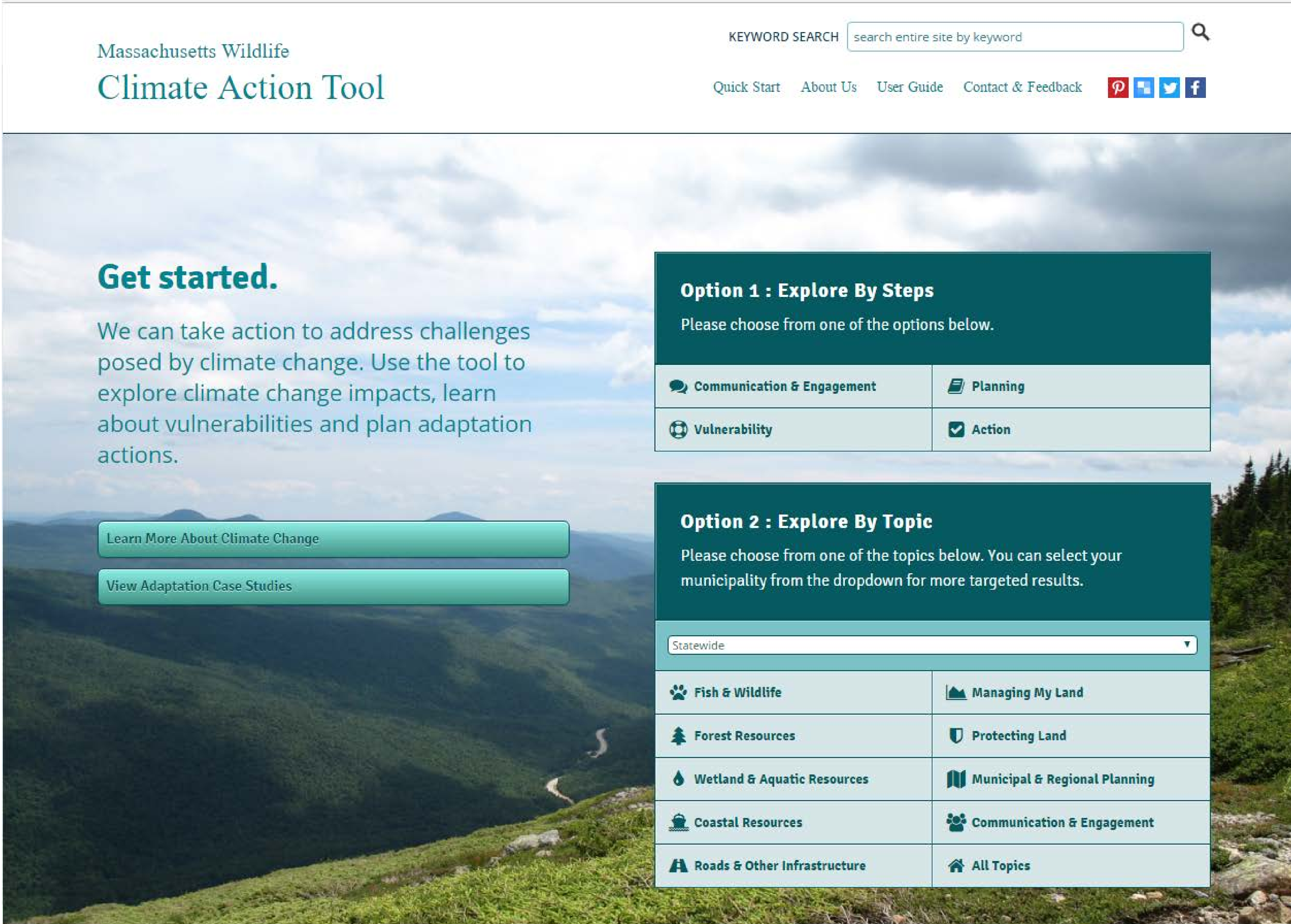


Massachusetts Wildlife Climate Action Tool:

Inspiring local action to protect the Commonwealth's natural resources in a changing climate

Developed by:

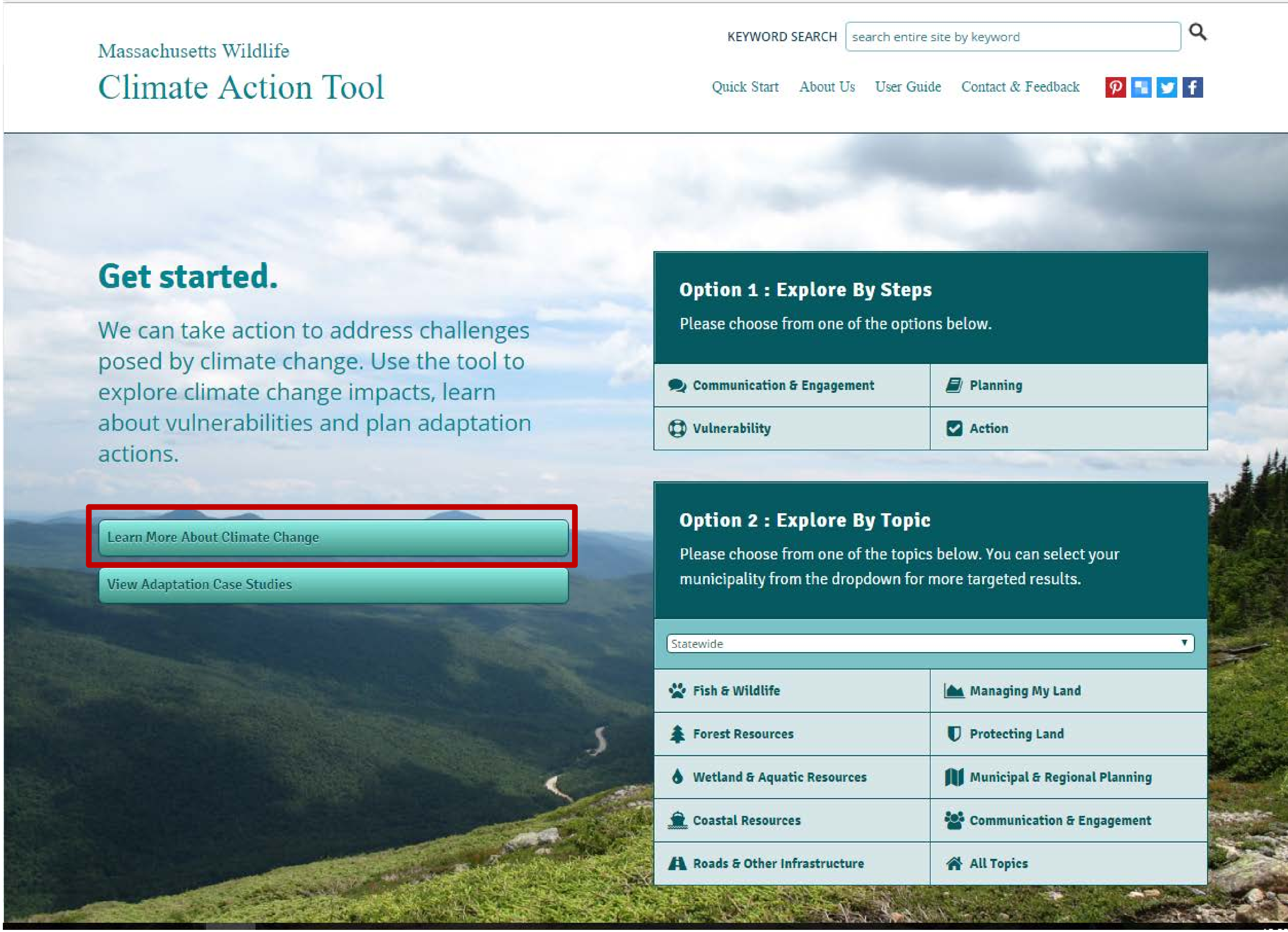
- MA Division of Fisheries and Wildlife
- UMass Amherst Center for Agriculture, Food and the Environment
- MA Cooperative Fish and Wildlife Research Unit
- Dept. of Interior Northeast Climate Science Center

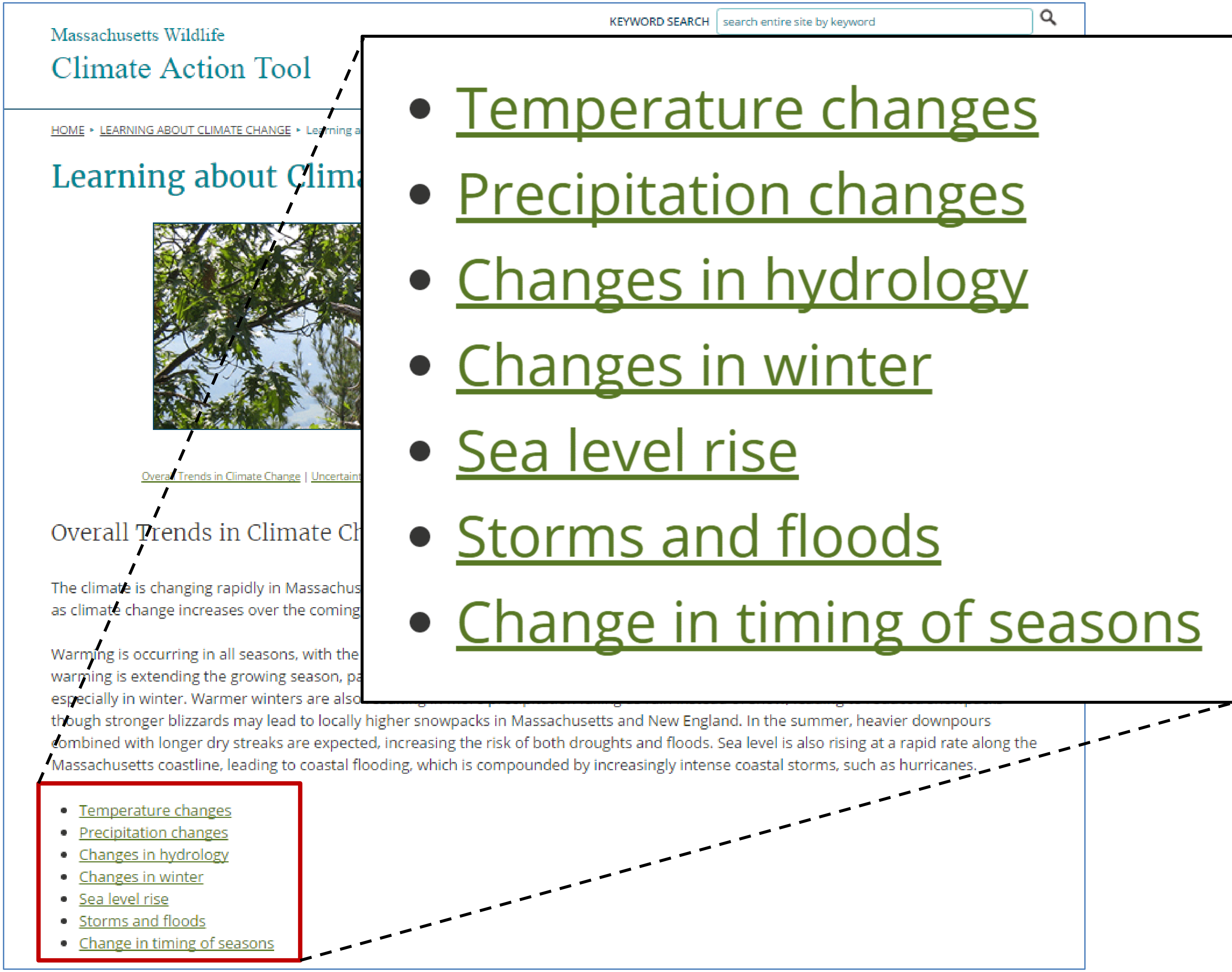
Target Audiences

- Municipal government (conservation commissions, open space committees, departments of public works)
- Local conservation organizations (land trusts, watershed associations)
- Regional planning authorities (RPAs)
- Landowners and individual citizens looking to take action on climate change and protect natural resources

Key Aspects

- Research-based information about climate change impacts and vulnerabilities of various fish, wildlife, and habitats
- Acknowledge uncertainty
- Spatial data viewer
- Promote adaptation actions that can be taken at a local level
- Language suitable for target audiences


Massachusetts Wildlife
Climate Action Tool
KEYWORD SEARCH
search entire site by keyword
Quick Start
About Us
User Guide
Contact & Feedback
Get started.
We can take action to address challenges posed by climate change. Use the tool to explore climate change impacts, learn about vulnerabilities and plan adaptation actions.
Learn More About Climate Change
View Adaptation Case Studies
Option 1 : Explore By Steps
Please choose from one of the options below.
Communication & Engagement
Planning
Vulnerability
Action
Option 2 : Explore By Topic
Please choose from one of the topics below. You can select your municipality from the dropdown for more targeted results.
Statewide
Fish & Wildlife
Managing My Land
Forest Resources
Protecting Land
Wetland & Aquatic Resources
Municipal & Regional Planning
Coastal Resources
Communication & Engagement
Roads & Other Infrastructure
All Topics


KEYWORD SEARCH
search entire site by keyword
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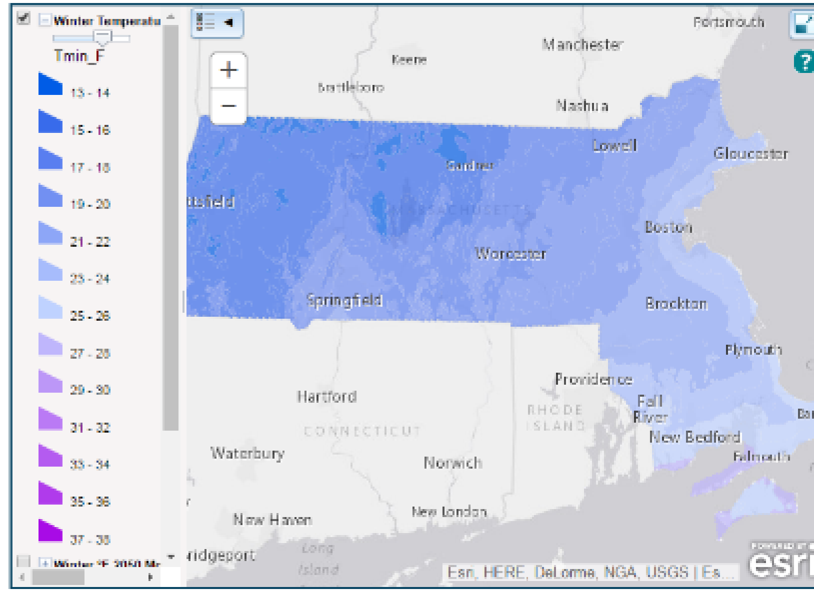
HOME ▸ LEARNING ABOUT CLIMATE CHANGE ▸
Learning about
Overall Trends in Climate Change
though stronger blizzards may lead to locally higher snowpacks in Massachusetts and New England. In the summer, heavier downpours
combined with longer dry streaks are expected, increasing the risk of both droughts and floods. Sea level is also rising at a rapid rate along the
Massachusetts coastline, leading to coastal flooding, which is compounded by increasingly intense coastal storms, such as hurricanes.
Temperature changes
Precipitation changes
Changes in hydrology
Changes in winter
Sea level rise
Storms and floods
Change in timing of seasons

Climate Stressor Pages:

- Summary of historical and future trends
- Maps of current and projected conditions scaled to MA and in low and high emission scenarios
- Additional graphics and resources
- Latest science synthesized by NECSC and partners

Stressors

Changes in winter



Climate projections displayed in this map represent the average of the minimum air temperature (degrees F) for December, January, and February. Colors change from blue to purple as air...
Read More

Recent research has shown that climate changes in winter, such as soil freezing and snow cover, are having strong and often surprising impacts on species and ecosystems in seasonally snow-covered areas such as high-elevation and alpine habitats. Changes in winter are impacting ecosystem structure and function with important consequences for carbon sequestration, decomposition, and export, which influence production in agricultural and forest habitats.

Winter Temperatures

Average air temperatures in New England have shown the greatest increases during the winter season; over the last half-century winter temperatures have risen by more than 3 °F. This trend is projected to continue with winter temperatures in Massachusetts potentially increasing as much as 6 °F under the highest emission scenario by the end-of-century. The winter season has also been getting shorter over past decades, as the timing of fall has shifted later, and spring earlier - each by about a week or more.

Extreme cold winter temperatures in Massachusetts and the Northeast region have been observed in recent years and are thought to be the result of rapid warming in the Arctic, which influences the strength and meandering of the jet stream. These atypical cold temperatures were the exception as the rest of the world experienced some of the highest temperatures on record. Studies of these extreme temperature events are an emerging area of climate science. Recent research suggests it is likely that North America will experience additional extreme winter temperatures though they are expected to vary in intensity and frequency over time. Increases in the amplitude of the jet stream in winter may also explain the observed increases in winter storms affecting the Northeast United States.

Winter Precipitation and Snowpack

Annual winter precipitation has been increasing; however, future projections of precipitation are generally less certain than temperature.

Stressors

Change in timing of seasons

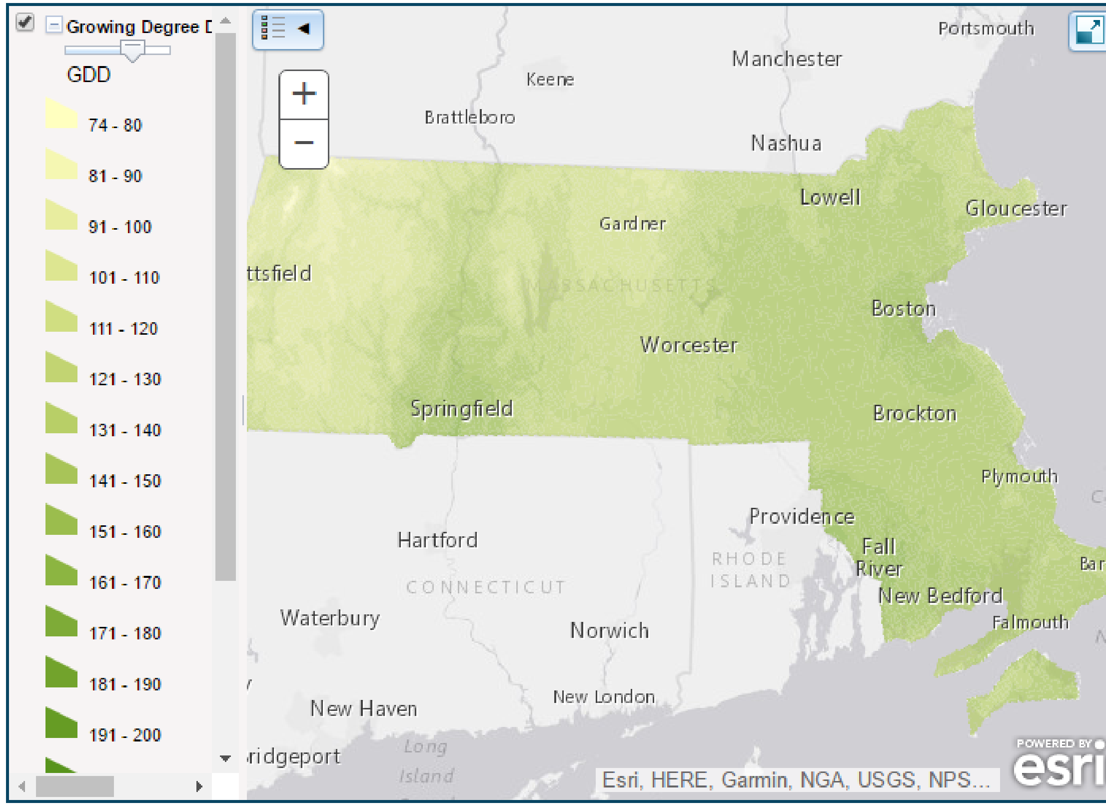
Spring is coming earlier in Massachusetts and fall is shifting later, with longer summers and shorter winters as a result. These changes in the timing of seasons affect fish and wildlife species that use particular environmental conditions, such as temperature, snowpack, and streamflow, as cues for recurring life events or *phenology* including:

- Migration
- Hibernation
- Emergence
- Reproduction
- Development

Because fish, wildlife, and plant species may be shifting the timing of these life cycle events in different ways, shifting seasons and phenologies are resulting in mismatched encounters among dependent species that historically would have overlapped at the same place and time. Mismatches between food and habitat resources can lead to negative impacts on fish and wildlife individual fitness, population success, and overall community structure and

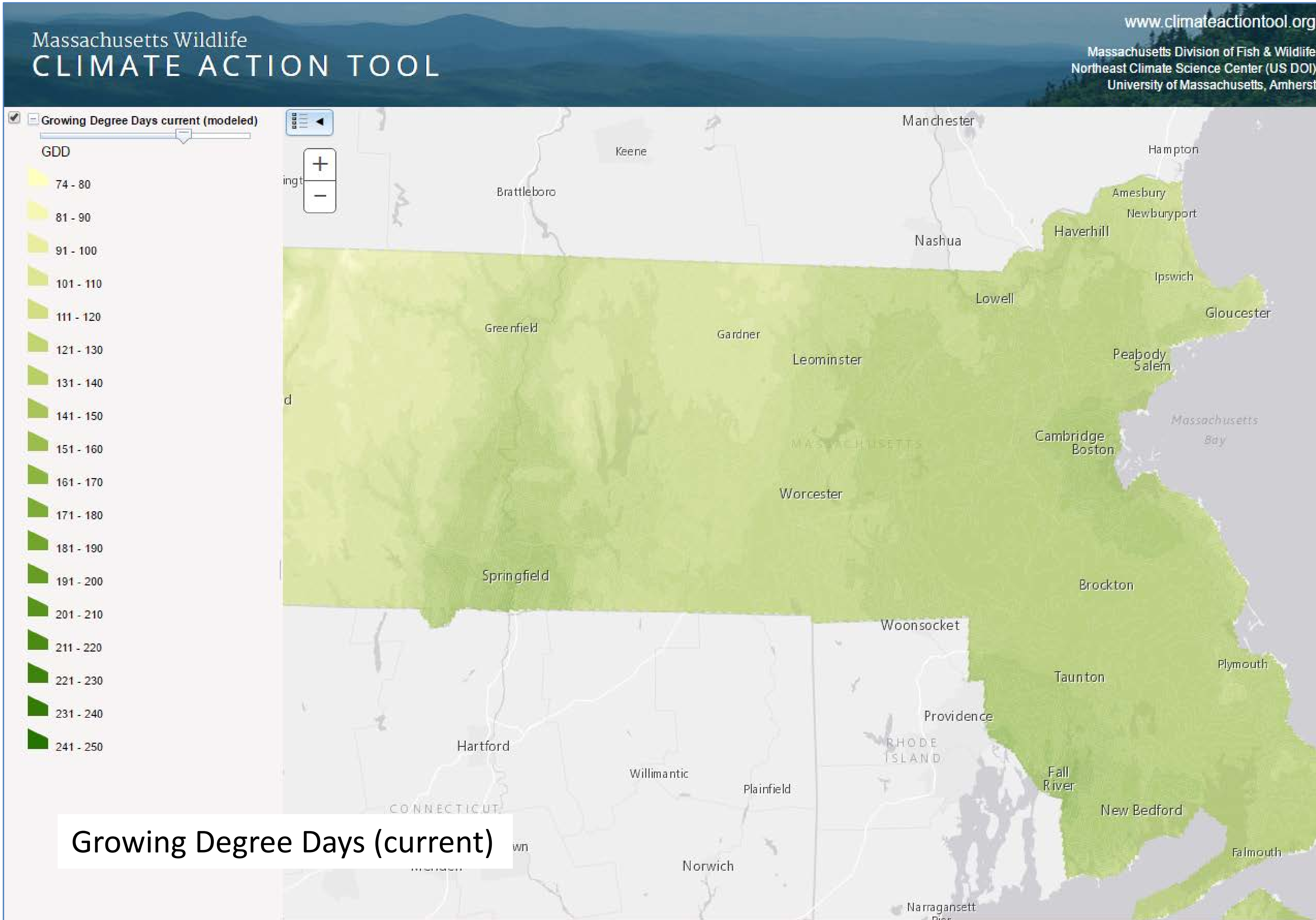
Select layer to show

Growing Degree Days 2050 Moderate Emissions Scenario ▾

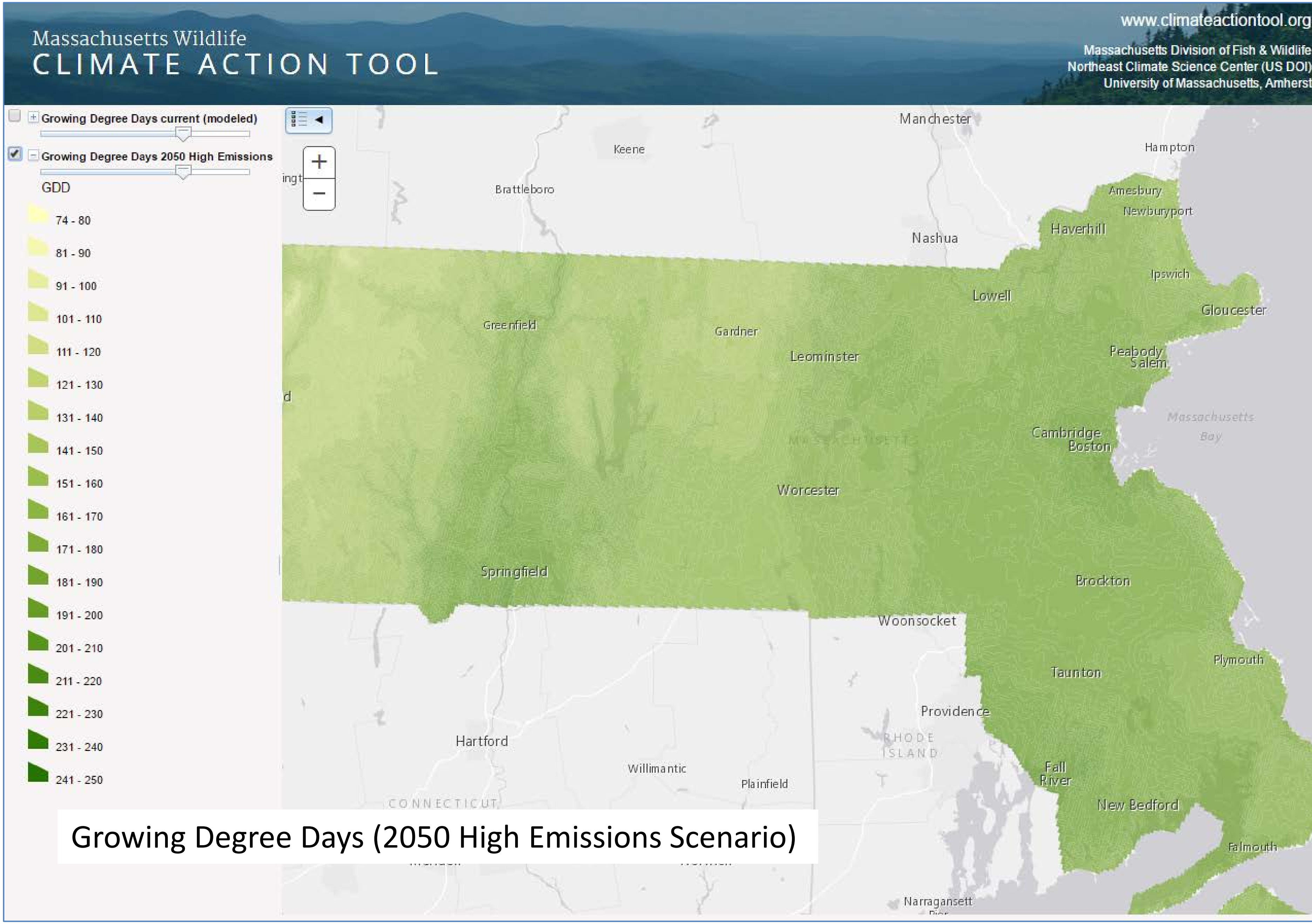


Climate projections displayed in this map represent an index known as Growing Degree Days (GDD: see text below for more information)....

Read More



Growing Degree Days (current)



Growing Degree Days (2050 High Emissions Scenario)

Massachussetts Wildlife
CLIMATE ACTION TOOL

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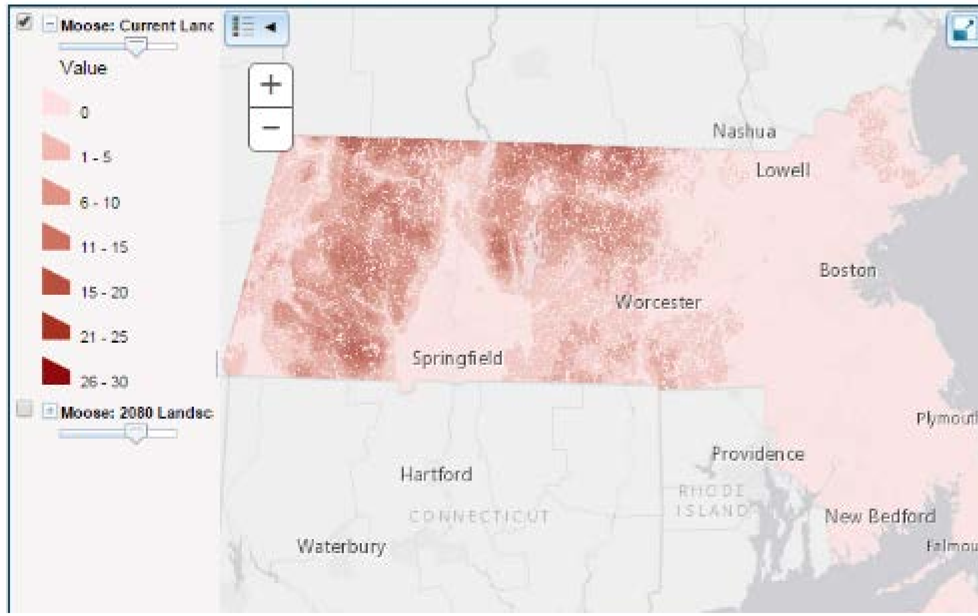
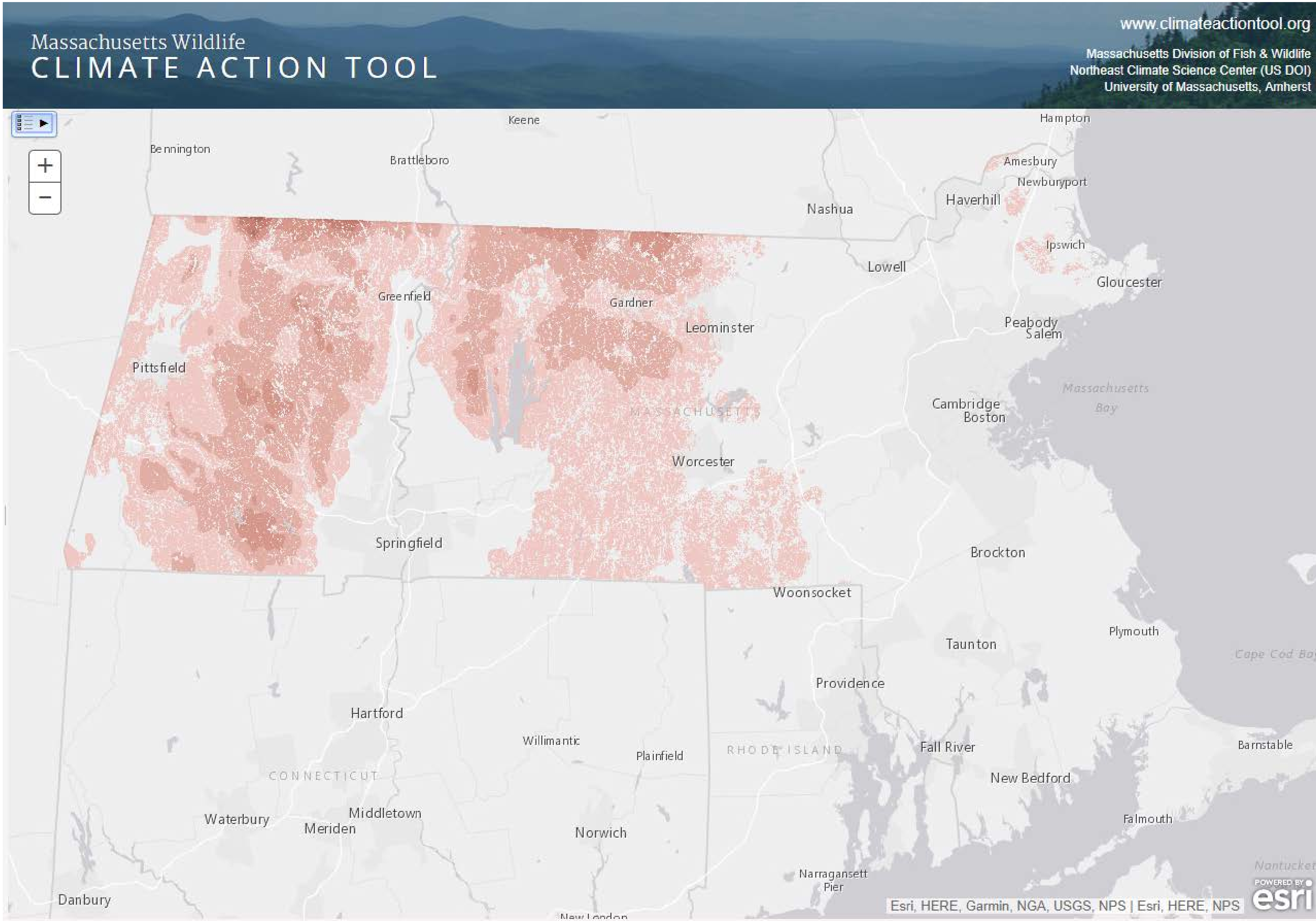
Species Ecology and Vulnerability:

- Background
- Species-specific stressors
- Climate impacts
- Climate Change Vulnerability Assessment results
- Adaptation Strategies
- Related habitats
- Related species groups
    - Large mammals

Moose

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Climate Action Tool Search

Communication & Engagement | Vulnerability | Planning | Action

Narrow your search ?

Clear Search

Towns and Watersheds

SEARCH

- [ ] Check/uncheck all visible
- [ ] Abington
- [ ] Acton
- [ ] Acushnet
- [ ] Adams

Species

SEARCH

- [x] Check/uncheck all visible
- [x] Alewife
- [x] American Beaver
- [x] American Eel
- [ ] American Mink

Species Group

Habitat (Broad)

Habitat (Detailed)

Vulnerability

This intro text for this vulnerability tab is now in an editable block named 'Tool Search Vulnerability Text' which can be found on the blocks admin page.

Stressors

- Aquatic connectivity loss (roads and dams)
- Change in timing of seasons
- Changes in hydrology
- Changes in winter
- Development and habitat loss
- Invasive plants and animals
- Pests and diseases
- Precipitation changes
- Sea level rise
- Storms and floods
- Temperature changes
- Terrestrial connectivity loss (roads and development)

Habitats (broad)

- (Not habitat-specific)
- Coastal
- Freshwater wetlands
- Lakes and ponds
- Rivers and streams

Habitats (detailed)

- Coastal: Beaches and Rocky Shores
- Coastal: Estuaries & embayments
- Coastal: Salt Marsh
- Freshwater wetlands: Bogs and fens
- Freshwater wetlands: Forested wetlands
- Freshwater wetlands: Non-Forested wetlands
- Freshwater wetlands: Vernal pools
- Lakes and ponds: Large lakes and reservoirs
- Lakes and ponds: Small lakes and ponds
- Rivers and streams: Coldwater Fisheries Resources streams
- Rivers and streams: Large and great rivers
- Rivers and streams: Rivers
- Rivers and streams: Streams

Species

- Alewife
- American Beaver
- American Eel
- American Shad
- Blanding's Turtle
- Blueback Herring
- Brook Floater
- Brook Trout
- Long-tailed Duck
- Louisiana Waterthrush
- Marbled Salamander
- Marsh Wren
- Northeastern Beach Tiger Beetle
- Piping Plover
- Spring Salamander
- Wood Duck
- Wood Turtle

Ecology and Vulnerability

Brook Trout

Photo credit: U.S. Forest Service

Scientific name:

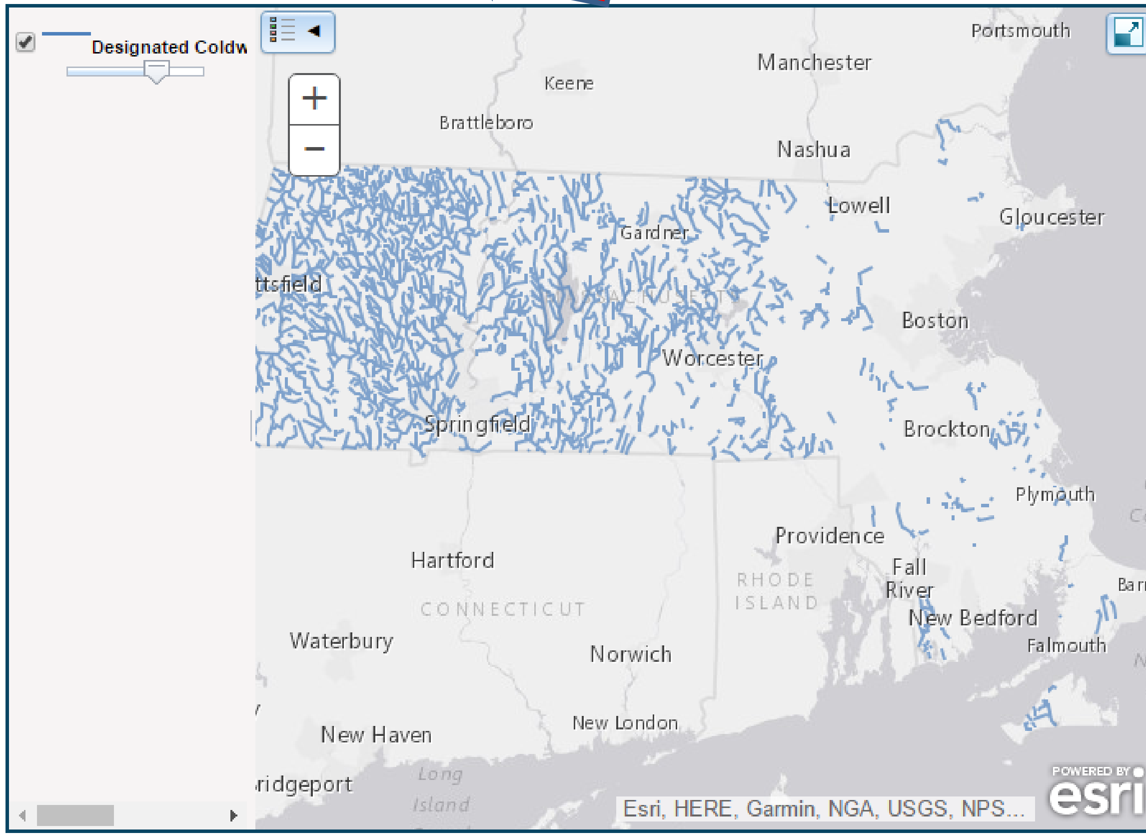
Salvelinus fontinalis

Species stressors:

Aquatic connectivity loss (roads and dams)
Temperature changes
Changes in hydrology
Storms and floods
Change in timing of seasons
Invasive plants and animals
Pests and diseases

Select layer to show

Brook Trout: MassWildlife field survey ▾



Brook trout probability of occurrence: The above map describes the current distribution of brook trout. Streams in blue are more likely to be inhabited by brook trout based on environmental conditions, while streams in yellow are less likely to have brook trout. Stream characteristics that help predict whether brook trout can be found in each stream include stream size, average air temperature, nearby forest cover, and soil characteristics. Estimates are from the USGS Conte Anadromous Fish Research Center, based on field surveys from Massachusetts DFW and agencies of nearby states CT, NH, VT, and NY.

Brook trout observations: Streams in orange indicate that brook trout have been observed by MassDFW field surveys.

Hide

Ecology and Vulnerability

Brook Trout

Photo credit: U.S. Forest Service

Scientific name:

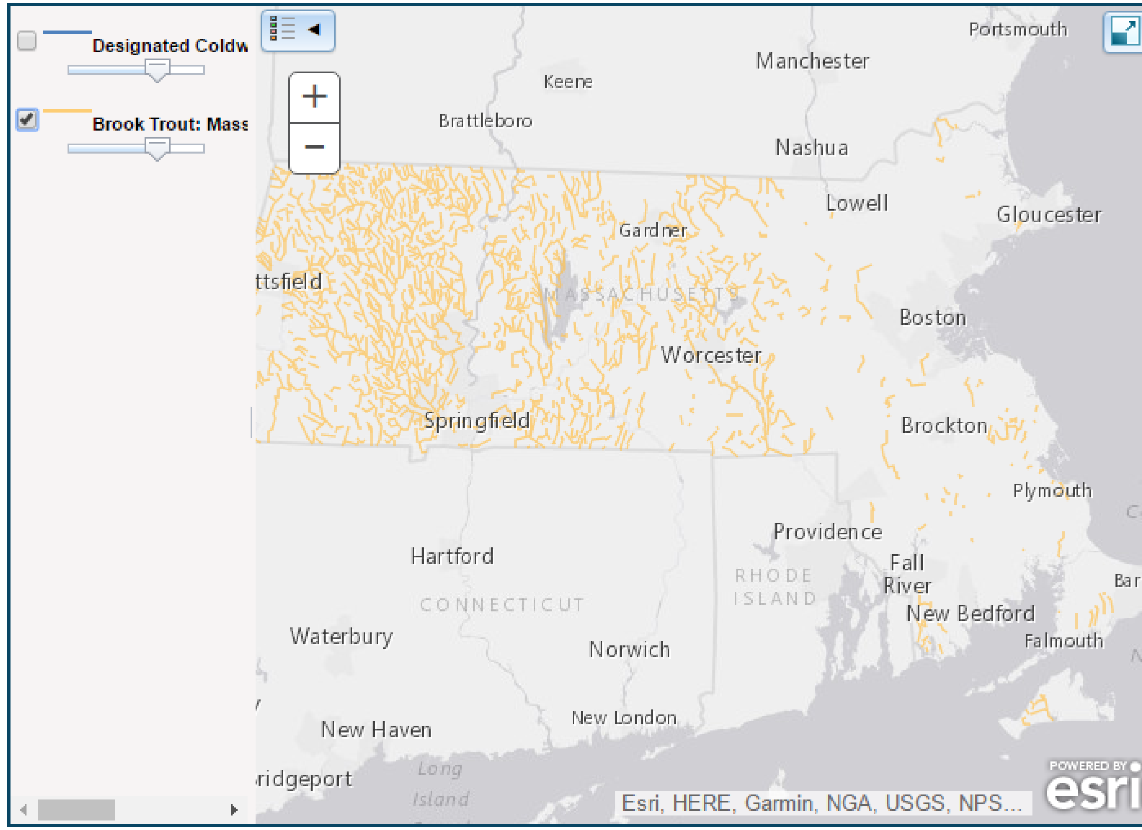
Salvelinus fontinalis

Species stressors:

Aquatic connectivity loss (roads and dams)
Temperature changes
Changes in hydrology
Storms and floods
Change in timing of seasons
Invasive plants and animals
Pests and diseases

Select layer to show

Brook Trout: MassWildlife field survey ▾



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Hide

Ecology and Vulnerability

Brook Trout

Photo credit: U.S. Forest Service

Scientific name:

Salvelinus fontinalis

Species stressors:

[Aquatic connectivity loss (roads and dams)]

[Temperature changes]

[Changes in hydrology]

[Storms and floods]

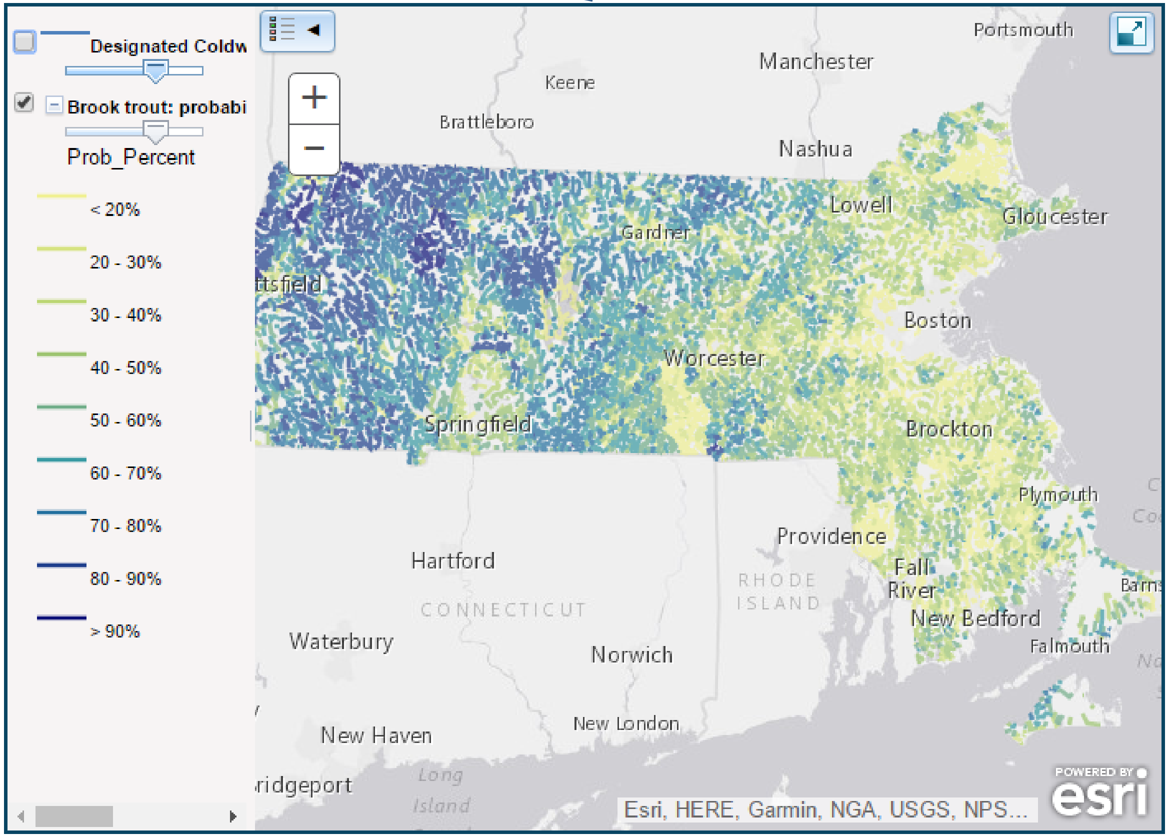
[Change in timing of seasons]

[Invasive plants and animals]

[Pests and diseases]

Select layer to show

Brook trout: probability of occurence



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Brook trout observations: Streams in orange indicate that brook trout have been observed by MassDFW field surveys.

Hide

Profile: Brook Trout ▾

Background

Brook trout are an economically important game species throughout their native range, which extends south in the Appalachians to Georgia[1] and north to the Atlantic drainages of Newfoundland, Labrador, and Quebec[2]. Brook trout in Massachusetts are found primarily in streams that have cold, highly oxygenated water[3]. They generally do not tolerate extended periods of water temperatures above 20°C/68°F[3], and the ideal temperature for growth and activity is between 12-19°C (53.6-66.2°F)[4]. Because of their requirements for clean, cold water, brook trout have experienced extensive reductions in distribution and abundance because of habitat degradation[1]. In Massachusetts, wild, reproducing populations of brook trout have been greatly reduced and the majority that remain are restricted to isolated headwater streams[5].

Climate Impacts

This species' need for cold water implies that there is great potential for climate change to impact brook trout populations. Indeed, modeling studies conducted in various parts of its range, including parts of Canada[6], and in the southern Appalachians[7], suggest large reductions in future distributions for brook trout. Studies commonly have found that in streams where temperatures exceed 20°C/68°F for extended periods, brook trout are either at low abundance, or are absent altogether[8,9,10]. Brook trout begin to experience significant mortality as water temperatures approach 25°C/77°F[11]. However, studies have observed physiological indicators of heat stress in temperatures as low as 21°C/70/68°F[12]. These sublethal temperatures are accompanied by decreased feeding, growth, and reproduction[13,14]. In one Adirondack Lake with marginal temperatures for brook trout, warm temperatures in some years resulted in complete failure to reproduce[13].

Some studies have found that different strains of brook trout have different degrees of thermal tolerance, suggesting some limited capacity to adapt to higher temperatures[15]. Under such conditions, trout seek out thermal refuges such as inflows from cold tributaries or groundwater inputs, where they will aggregate until overall temperatures are more favorable[16]. However, on a broad geographic scale, distribution is largely defined by temperature constraints[16,17], suggesting that adaptive capacity is limited. Additionally, brook trout are able to persist in surprisingly small, isolated populations above barriers in headwater streams[18] so there is potential that these trout could continue to remain in isolated pockets in areas where larger populations decline[19]. While brook trout will likely not disappear from Massachusetts, reductions in suitable habitat are expected.

References:

[1]Hudy, M., T.M. Thieling, N. Gillespie, and E.P. Smith. 2008. Distribution, status, and land use characteristics of subwatersheds within the native range of brook trout in the eastern United States. North American Journal of Fisheries Management **28**:1069-1085.

[2]Ficke, A.D., D.P. Peterson, and W.A. Janowsky. 2009. Brook trout (*Salvelinus fontinalis*): a technical conservation assessment. USDA Forest Service, Rocky Mountain Region. Available: <http://www.fs.fed.us/r2/projects/scp/assessments/brooktrout.pdf>. (Accessed on 20 May 2015).

[3]Hartel, K.E., D.B. Halliwell, and A.E. Launer. 2002. Inland Fishes of Massachusetts. Massachusetts Audubon Society, Lincoln, MA.

[4]Waco, K.E., and W.W. Taylor. 2010. The influence of groundwater withdrawal and land use changes on brook charr (*Salvelinus fontinalis*) thermal

Ecology and Vulnerability ×

climateactiontool.org/species/brook-trout?extents=

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Profile: Brook Trout ▸

Background

Brook trout are an economically important game species throughout their native range, which extends south in the Appalachians to Georgia[1] and north to... **Read More**

Climate Change Vulnerability Assessment: Brook Trout (North Atlantic Coast) ▸

Ranking: Moderately Vulnerable
Confidence: Moderate
Climate scenario: SRES A1B
Location: North Atlantic Coast
Time period: 2050

This species was identified as moderately vulnerable to climate change because of the following factors:

- Anthropogenic and natural barriers prevent dispersal or shifts in species'... **Read More**

Climate Change Vulnerability Assessment: Brook Trout (Connecticut) ▸

Ranking: Highly Vulnerable
Confidence: Not assessed
Climate scenario: SRES B1/A1B/A2
Location: Connecticut
Time period: 2080

This species was identified as highly vulnerable to climate change because of the following factors:

- Suitable habitat expected to decrease (coldwater streams)
  ... **Read More**

Climate Change Vulnerability Assessment: Brook Trout (North Atlantic Coast) ▾
Ranking: Moderately Vulnerable
Confidence: Moderate
Climate scenario: SRES A1B (Mid-range emissions scenario)
Location: North Atlantic Coast
Time period: 2050

This species was identified as moderately vulnerable to climate change because of the following factors:

- Anthropogenic (human-made) and natural barriers prevent dispersal or shifts in species' range
- Sensitive to changes in temperature
- Sensitive to changes in precipitation
- Has already experienced slight variations in annual precipitation (over the last 50 years)
- Slightly impacted by changes due to human response to climate change

The factors below decrease this species' vulnerability to climate change:

- Ability to move across the landscape and/or disperse relatively long distances

What is a Climate Change Vulnerability Assessment?

References

Sneddon, L. A., and G. Hammerson. 2014. Climate Change Vulnerability Assessments of Selected Species in the North Atlantic LCC Region. NatureServe, Arlington, VA. Available from: http://northatlanticlcc.org/projects/completing-northeast-regional-vulne...

Massachusetts Wildlife

Climate Action Tool

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HOME ▸ BACK TO LAST SEARCH ▸ Ecology and Vulnerability Brook Trout

Ecology and Vulnerability

Brook Trout

Photo credit: U.S. Forest Service

Scientific name:

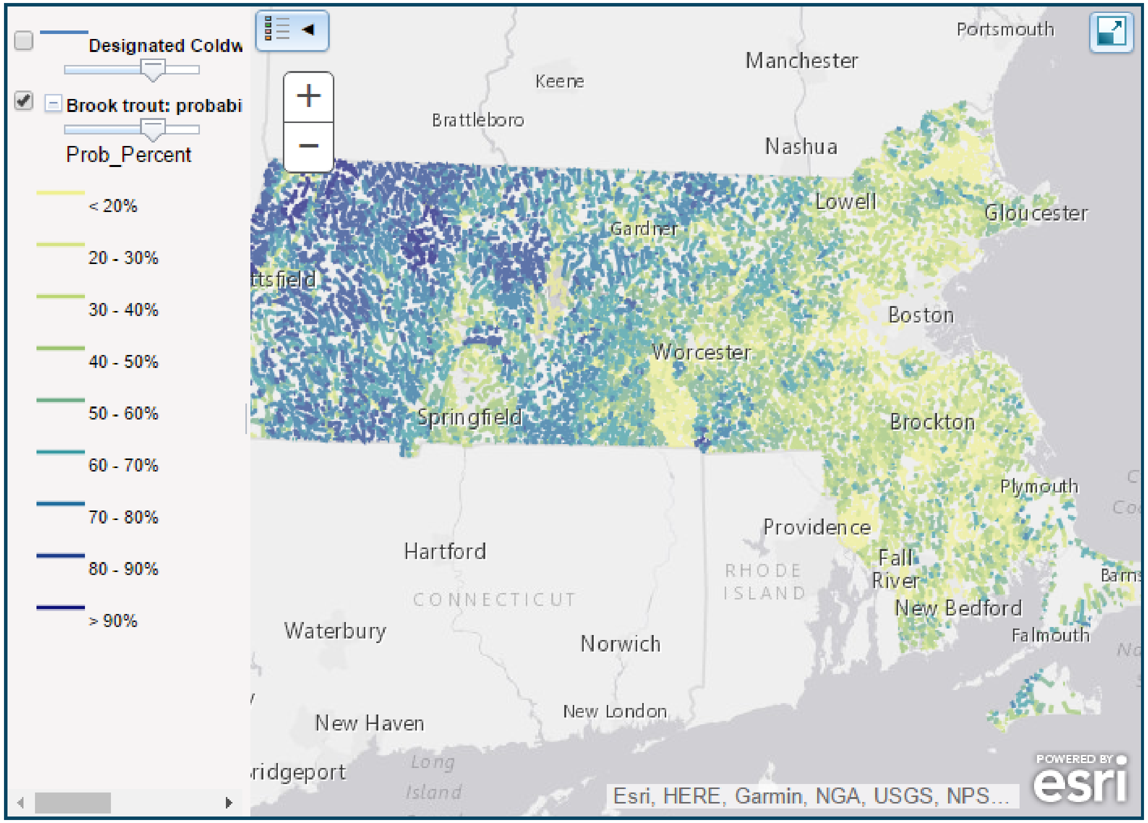
Salvelinus fontinalis

Species stressors:

Aquatic connectivity loss (roads and dams)
Temperature changes
Changes in hydrology
Storms and floods
Change in timing of seasons
Invasive plants and animals
Pests and diseases

Select layer to show

Brook trout: probability of occurence



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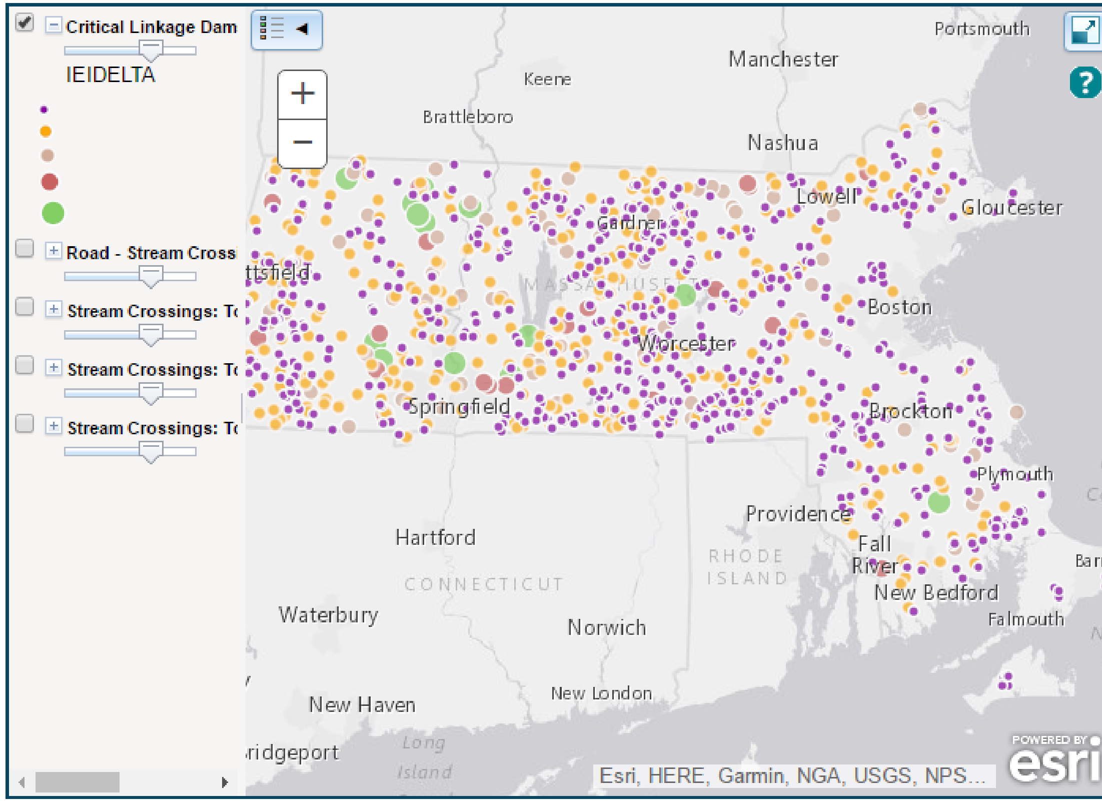
Read More

Stressors

Aquatic connectivity loss (roads and dams)



The first data layer is the results of a Critical Linkages analysis of dams based on the ecological restoration potential of dam removal; larger circles represent greater restoration potential....
Read More

Fish and wildlife need to move in order to feed, reproduce, avoid predators, respond to changing habitat conditions and maintain healthy local and regional populations. Species that inhabit wetlands and aquatic ecosystems often rely on an interconnected network of streams and rivers as pathways for movement. Fully aquatic species (fish, mussels, crayfish) travel through the water while semi-aquatic wildlife (turtles, salamanders, beaver, mink, otter) move along streams utilizing both water and adjacent upland or wetland habitats.

Downstream movements are not generally difficult for these species, unless they have to pass over a dam or through a hydroelectric turbine. In fact, much downstream movement occurs involuntarily during flood events.
Upstream movements are much more difficult as aquatic organisms must make headway against the current and contend with shallow riffles, natural waterfalls and cascades, and a variety of human-created obstacles such as dams and road-stream crossings (bridges and culverts). Yet, without upstream movements that counter the inevitable downward shift in organisms, headwater streams would be depopulated of fish and wildlife.

Most culverts under roads were designed to pass water, not fish or wildlife. Thus, many culverts represent significant barriers to the passage of aquatic organisms as well as some semi-aquatic wildlife, such as turtles. Photo credit: Scott Jackson.

Resources

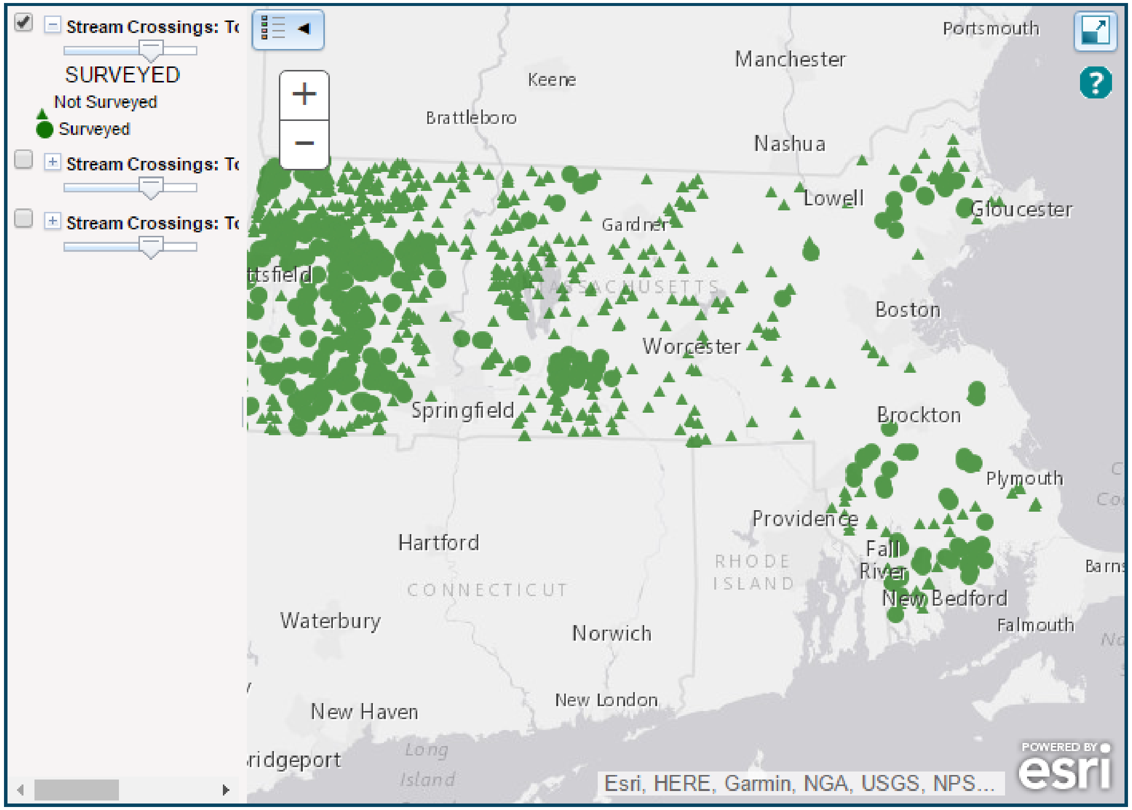
North Atlantic Aquatic Connectivity Collaborative (NAACC)
Critical Linkages Phase I
MA Division of Ecological Restoration - Aquatic Ecosystem Restoration

Related Adaptation Strategies and Actions

Land protection: Strategic land protection
Maintain habitat connectivity: Assessment of road-stream crossings
Maintain habitat connectivity: Modify stream crossings to allow wildlife passage
Maintain habitat connectivity: Retrofit or replace culverts
Restore habitat connectivity: Remove obsolete dams

Adaptation Strategies and Actions

Maintain habitat connectivity: Retrofit or replace culverts



Priority crossings for possible culvert replacement or retrofit are represented by green dots and triangles. If these are not visible, use the plus sign to zoom in. You can layer in locations for... **Read More**

Adaptation type:
Removal of dams and other barriers to aquatic connectivity
Roadway infrastructure, crossings, and dams

Strategy:
Restore and maintain terrestrial and aquatic connectivity sufficient to maintain healthy ecosystems and wildlife populations

Animal movements (of individuals or their offspring) across the landscape are important for maintaining healthy wildlife populations. Climate change is likely to result in changes to habitat conditions (temperature, rainfall, vegetation) that will require adjustments in the areas occupied by many species. Restoring and maintaining landscape connectivity sufficient to allow wildlife populations to adjust their distribution over time is a critically important strategy for adapting to climate change.

Action

Replace or retrofit deficient culverts at strategic locations

It has been recognized that dams are significant barriers to upstream movement of fish and other aquatic organisms. Road-stream crossings, especially culverts, can also constitute barriers to aquatic organism passage. Although the impacts of dams may be more severe, road-stream crossings are more numerous. Some culverts are severe barriers to upstream movement; others represent little or no barrier at all. And there are many in between.

Tools are now available to assess the passability of road-stream crossings and model their effects on aquatic connectivity. Volunteers and technicians working with state agencies and environmental organizations are using protocols from the North Atlantic Aquatic Connectivity Collaborative (NAACC) to assess the passability of bridges and culverts in the field. The University of Massachusetts Amherst uses Critical Linkages software to model crossings where upgrades would result in the largest benefits in terms of aquatic connectivity.

Field assessments and passability scores along with Critical Linkages analyses can be used to target specific culverts for replacement or retrofit. Culvert replacement involves the complete replacement of a sub-standard crossing with another, usually larger, structure. Retrofits are halfway measures such as the use of rock weirs to back up water just below the structure and eliminate outlet drops. In some cases, retrofits can improve aquatic passability at a road-stream crossing until such time that a full replacement is possible.

Culvert replacements are tricky business and replacement structures must be carefully designed, permitted and constructed. Attention must be paid to the potential for downstream flooding (larger structures will pass water more quickly) as well as the potential for stream adjustments such as erosion and head cutting (progressive erosion up the stream channel above the culvert). The stream channel and bed characteristics either need to be retained (bridged) or created within the crossing structure. Appropriate expertise and experience is required to design a stream bed that both simulates characteristics of the natural stream and is able to withstand velocities that are often higher in the structure than in the natural stream during periods of high flow.

Older crossing structures are often single or multiple culvert crossings designed with the sole objective of getting water from one side of the road to the other. Replacement structures that meet the Massachusetts River and Stream Crossing Standards are generally bridges, open bottom arches or large culverts designed according to the principles of Stream Simulation. Stream Simulation design seeks to create crossings that simulate the channel and bottom characteristics and replicate the water depth and velocity conditions found in the natural stream. The U.S. Forest Service has an in-depth manual on Stream Simulation Design that is the best current resource available for culvert replacements.

The Massachusetts Division of Ecological Restoration has a program that assists municipalities with culvert replacement projects. For more information contact Tim Chorey at timothy.chorey@state.ma.us or (617) 626-1541.

Mitchell Brook in Whately, MA, before and after culvert replacement. The PVC piping in the photos are antennae to monitor the passage of fish through the crossing. Researchers report that not only are more brook trout moving from the West Brook up into Mitchell Brook but dace are now being found in the stream for the first time. Photo credits: Scott Jackson.

Resources

USFS Stream Simulation Manual
Design of Bridges and Culverts for Wildlife Passage at Freshwater Streams
Massachusetts Stream Crossings Handbook
Massachusetts Stream Crossings Poster
Massachusetts River and Stream Crossing Standards
Culvert Replacement Examples

Stressors

Aquatic connectivity loss (roads and dams)

Fish and wildlife need to move in order to eat, reproduce, avoid predators, respond to changing habitat conditions, and maintain healthy local and regional populations. Species that inhabit wetlands and aquatic ecosystems often rely on an interconnected network of streams and rivers as pathways for movement. Fully aquatic species (fish, mussels, crayfish) travel through the water while semi-aquatic wildlife (turtles, salamanders, beaver, mink, otter) move along streams, utilizing both water and adjacent upland or wetland habitats.

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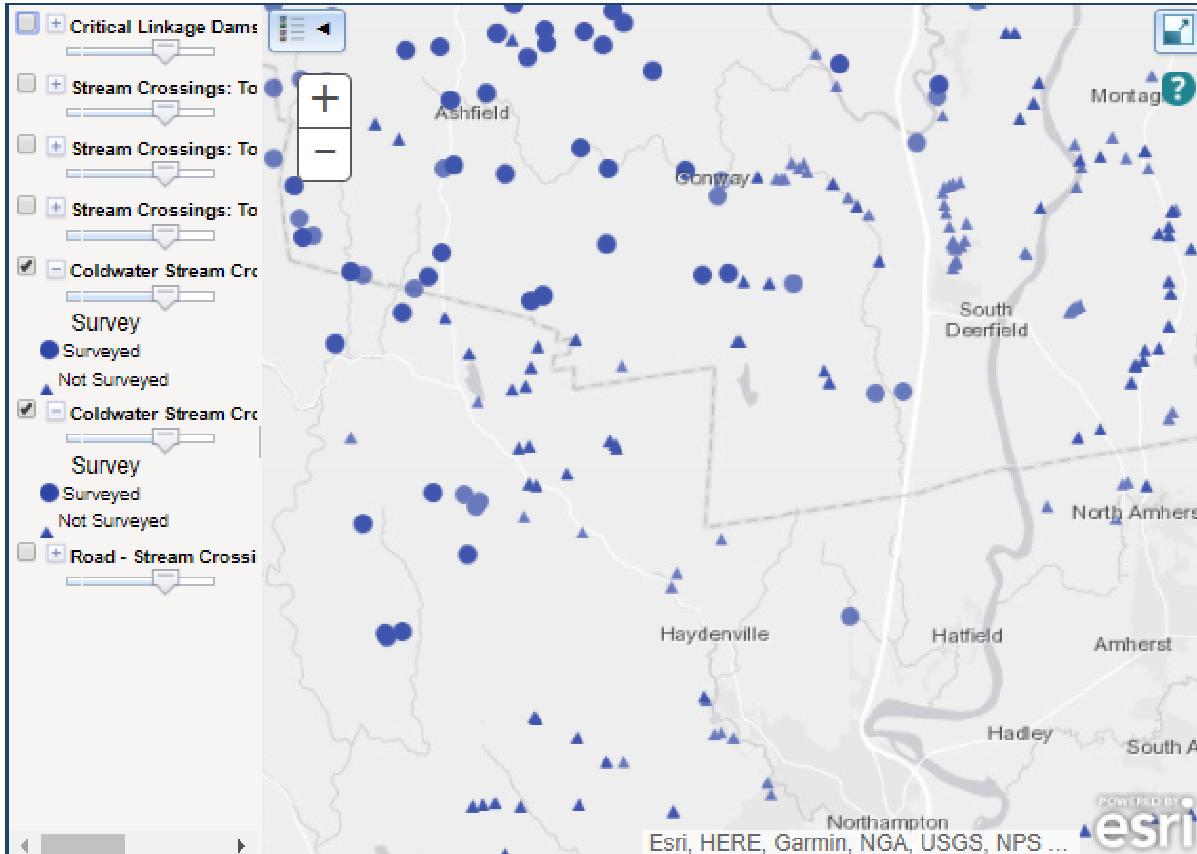


The first data layer is the results of a Critical Linkages analysis of dams based on the ecological restoration potential of dam removal; larger circles represent greater restoration potential....
Read More

Ecology and Vulnerability

Brook Trout

Photo credit: U.S. Forest Service

Scientific name:

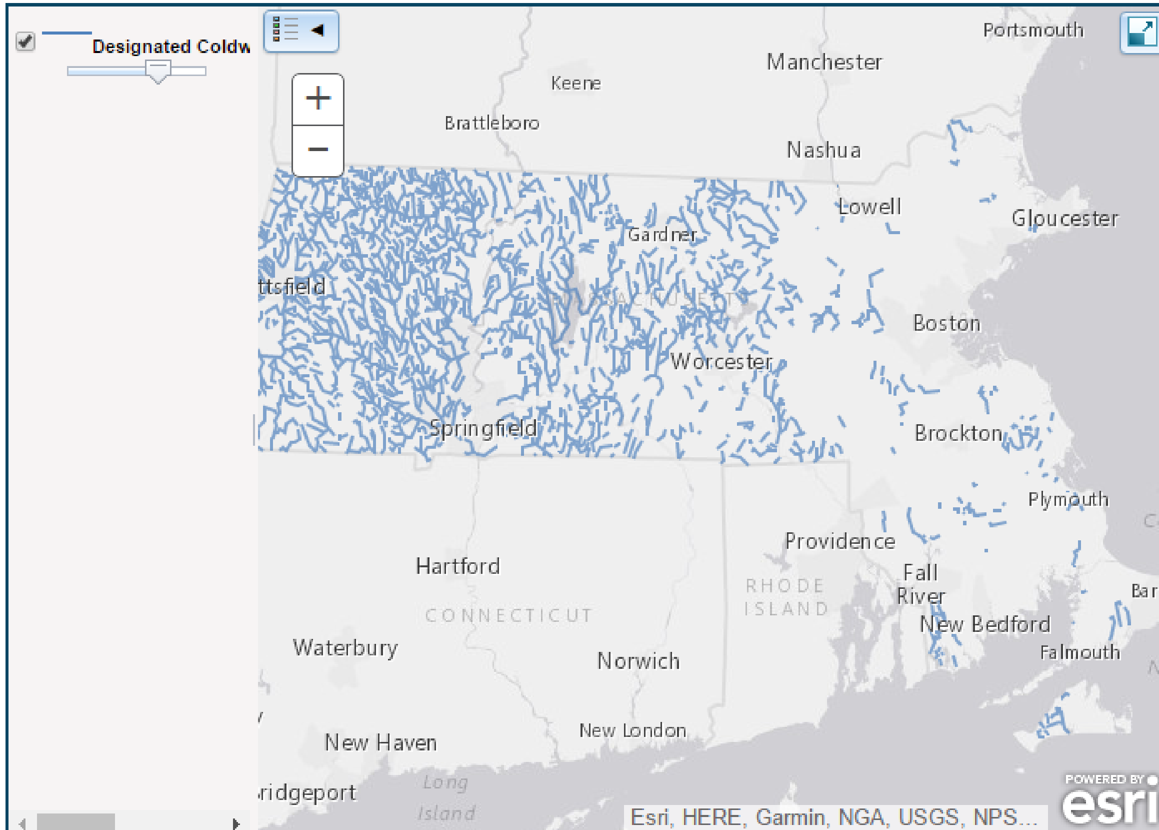
Salvelinus fontinalis

Species stressors:

[Aquatic connectivity loss (roads and dams)]
[Temperature changes]
[Changes in hydrology]
[Storms and floods]
[Change in timing of seasons]
[Invasive plants and animals]
[Pests and diseases]

Select layer to show

Brook Trout: MassWildlife field survey ▼



Brook trout probability of occurrence: The above map describes the current distribution of brook trout. Streams in blue are more likely to be inhabited by brook trout based on environmental...

Read More

Climate Change Vulnerability Assessment: Brook Trout (West Virginia) ▸
Ranking: Highly Vulnerable
Confidence: Very High
Climate scenario: SRES A1B (Mid-range emissions scenario)
Location: West Virginia
Time period: 2050

This species was identified as highly vulnerable to climate change because of the following factors:

- Very sensitive to changes in temperature
- Natural and anthropogenic... **Read More**

Related Habitats (broad)

Rivers and streams

Related Habitats (detailed)

Rivers and streams: Rivers

Rivers and streams: Streams

Related Species Groups

Fish

Fish: Coldwater Fish

Game Species

Wetland and Aquatic Species

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More info

Related Adaptation Strategies and Actions

Adapt or update municipal plans: Hazard Mitigation Plans

Adapt or update municipal plans: Master Plans

Adapt or update municipal plans: Transportation Improvement Plans

Ensure cool water temperatures: Protect and restore riparian areas

Maintain habitat connectivity: Assessment of road-stream crossings

Maintain habitat connectivity: Retrofit or replace culverts

Protect land: Protect land in perpetuity

Protect land: Strategic land protection

Restore habitat connectivity: Remove obsolete dams

Massachusetts Wildlife

Climate Action Tool

KEYWORD SEARCH search entire site by keyword

Quick Start About Us User Guide Contact & Feedback

Adaptation Strategies and Actions

Ensure cool water temperatures: Protect and restore riparian areas

Adaptation type:

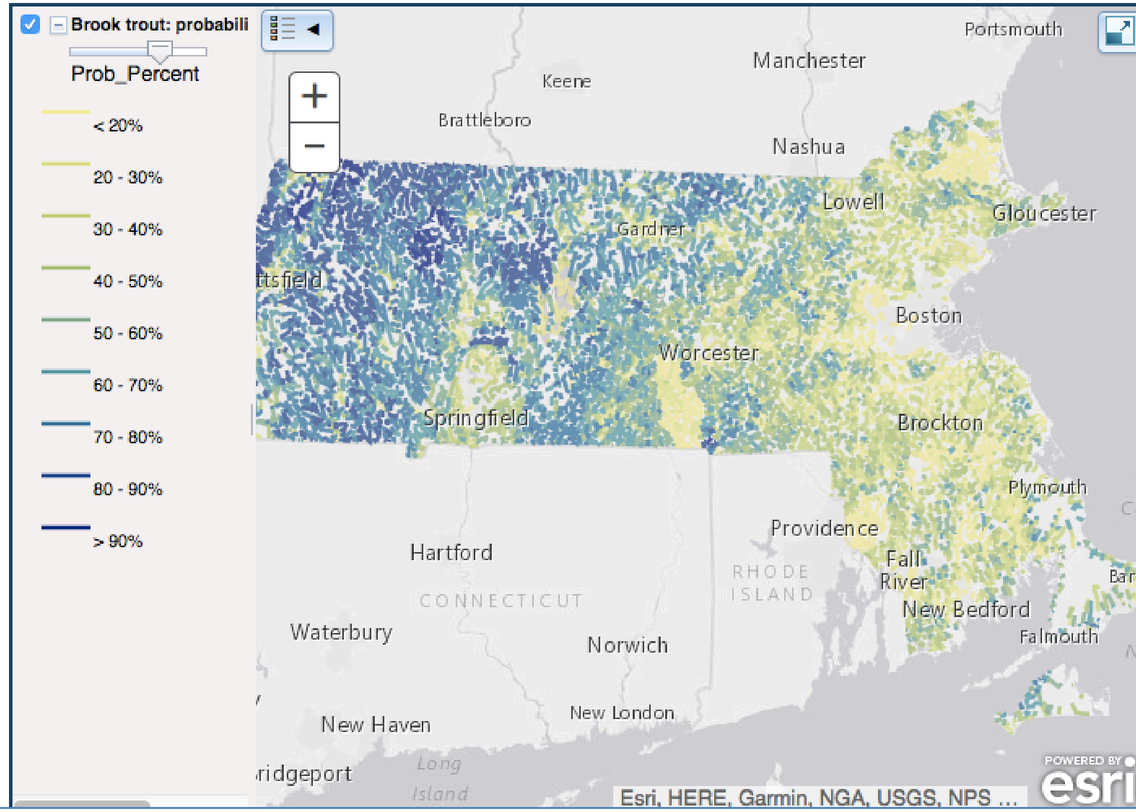
Land and forest stewardship or restoration
Species conservation and management

Strategy:

Maintain cool water temperatures in streams and ponds so that populations of species adapted to cool temperatures are able to survive.

Select layer to show

Brook trout: probability of occurence



https://www.climateactiontool.org/content/ensure-cool-water-temperatures-protect-and-restore-riparian-areas

Apps Bookmarks Imported From Firef...

Action

Protect and restore riparian areas

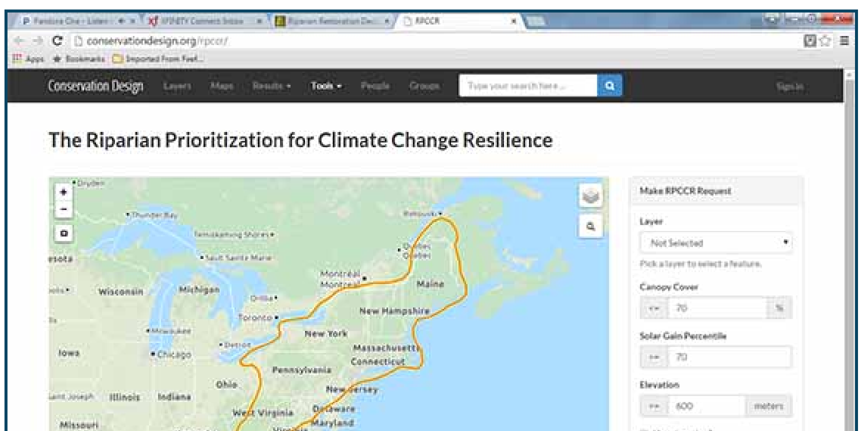
As temperatures continue to rise, as expected due to climate change, it will be important keep seasonal temperatures within the tolerance limits of fish and wildlife that rely on cold-water habitat, such as brook trout. Landowners can help sustain important cold-water habitat by maintaining or restoring climate resilient shade along important stream reaches.

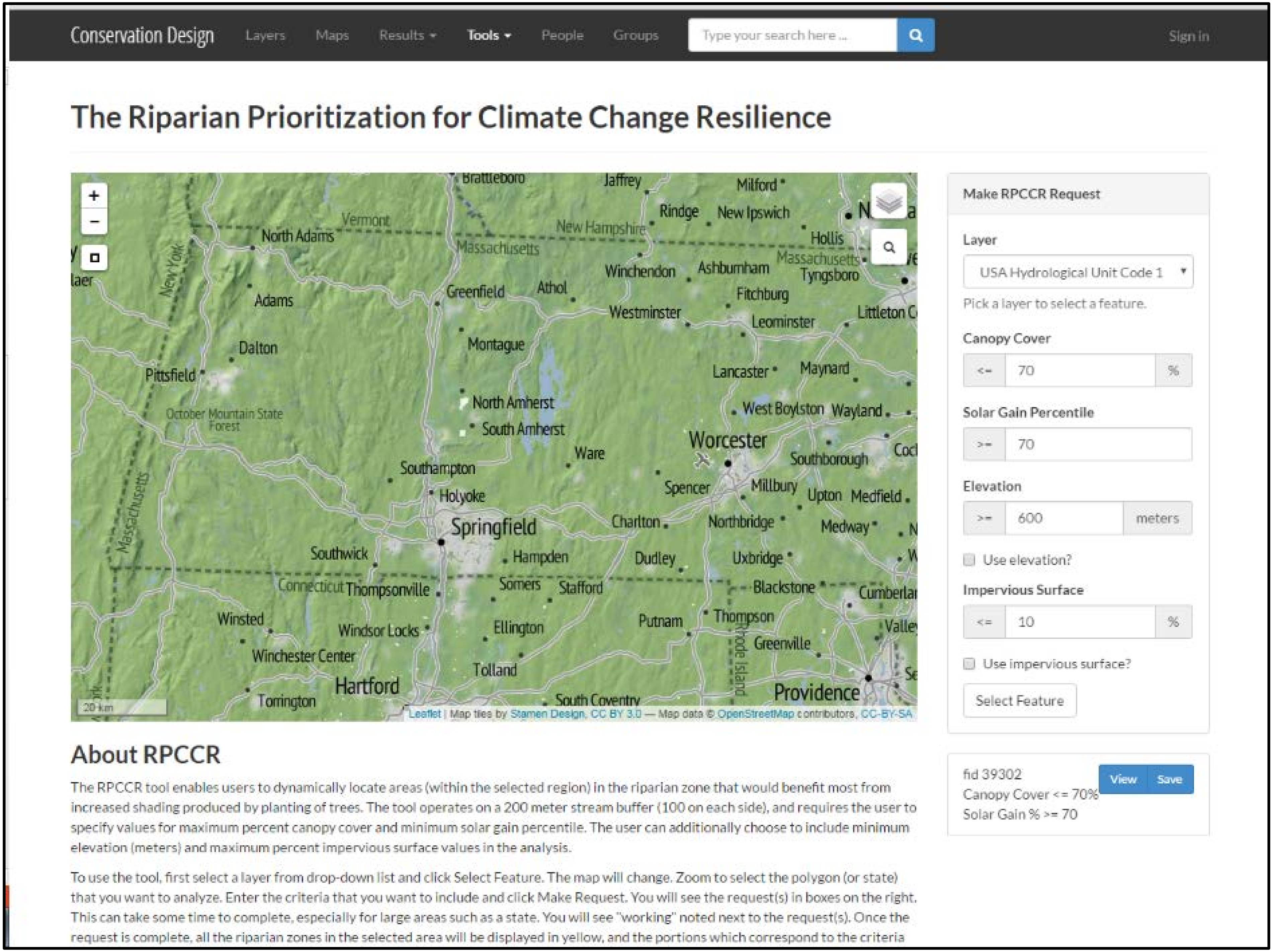
Tree cover in these areas is particularly important for regulating water temperatures. A forested buffer at least 100 feet wide along the stream is ideal. However, even a narrow strip of trees can provide vital shade and other benefits for cold-water streams. If a cold-water stream flows through your property, consider planting trees along open stream banks or allow areas that border the stream to return to forest.

What you can do:

- Stop mowing areas adjacent to cold-water streams and their tributaries and allow these areas to return to forest
- Plant appropriate, native, and resilient tree species along open stream banks
- Expand narrow riparian buffers
- In riparian areas where hemlock is threatened or was lost due to hemlock woolly adelgid, consult a professional forester to see if active management could be used to create a more resilient riparian forest

To help you decide where riparian buffers are most needed, see the Riparian Restoration Decision Support Tool below that identifies vulnerable stream and river banks lacking tree cover and shade in cold-water habitats.




Conservation Design
Layers
Maps
Results
Tools
People
Groups
Type your search here ...
Sign in
The Riparian Prioritization for Climate Change Resilience
Brattleboro
Jaffrey
Milford
Rindge
New Ipswich
Vermont
New Hampshire
North Adams
Massachusetts
Hollis
Winchendon
Ashburnham
Tyngsboro
Greenfield
Athol
Fitchburg
Adams
Westminster
Leominster
Littleton
Montague
Dalton
Lancaster
Maynard
Pittsfield
North Amherst
West Boylston
Wayland
October Mountain State Forest
South Amherst
Worcester
Ware
Southborough
Southampton
Spencer
Millbury
Upton
Medfield
Holyoke
Springfield
Charlton
Northbridge
Medway
Southwick
Hampden
Dudley
Uxbridge
Connecticut
Thompsonville
Somers
Stafford
Blackstone
Winsted
Putnam
Thompson
Windsor Locks
Ellington
Greenville
Winchester Center
Tolland
Rhode Island
Hartford
Torrington
South Coventry
Providence
20 km
Leaflet | Map tiles by Stamen Design, CC BY 3.0 — Map data © OpenStreetMap contributors, CC-BY-SA
Make RPCCR Request
Layer
USA Hydrological Unit Code 1
Pick a layer to select a feature.
Canopy Cover
<= 70 %
Solar Gain Percentile
>= 70
Elevation
>= 600 meters
Use elevation?
Impervious Surface
<= 10 %
Use impervious surface?
Select Feature
fid 39302
Canopy Cover <= 70%
Solar Gain % >= 70
View
Save
About RPCCR
The RPCCR tool enables users to dynamically locate areas (within the selected region) in the riparian zone that would benefit most from increased shading produced by planting of trees. The tool operates on a 200 meter stream buffer (100 on each side), and requires the user to specify values for maximum percent canopy cover and minimum solar gain percentile. The user can additionally choose to include minimum elevation (meters) and maximum percent impervious surface values in the analysis.
To use the tool, first select a layer from drop-down list and click Select Feature. The map will change. Zoom to select the polygon (or state) that you want to analyze. Enter the criteria that you want to include and click Make Request. You will see the request(s) in boxes on the right. This can take some time to complete, especially for large areas such as a state. You will see "working" noted next to the request(s). Once the request is complete, all the riparian zones in the selected area will be displayed in yellow, and the portions which correspond to the criteria

Ecology and Vulnerability

Forest: Beech- Birch- Maple

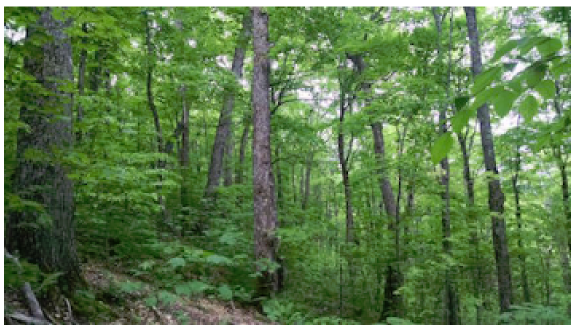
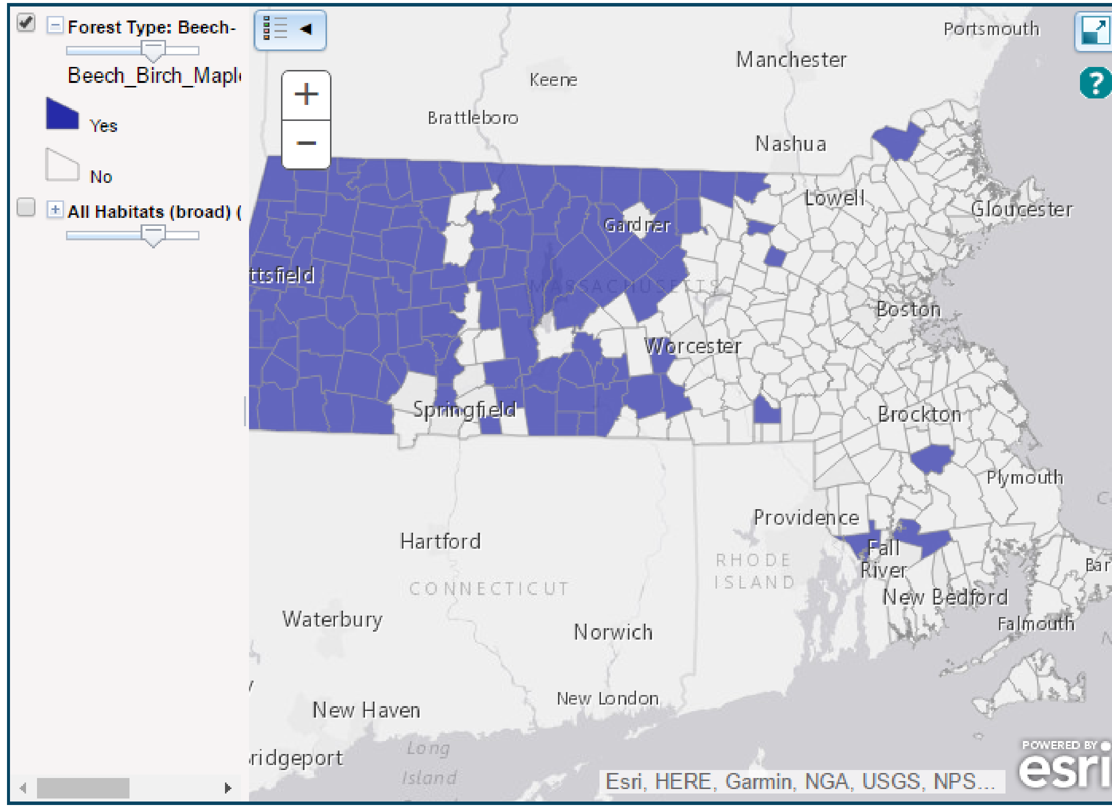


Photo credit: Anthony W. D'Amato

Stressors:

Temperature changes
Precipitation changes
Change in timing of seasons
Invasive plants and animals
Pests and diseases
Development and habitat loss
Terrestrial connectivity loss (roads and development)



These forest types are from The Nature Conservancy's Terrestrial Habitat Classification data.

Climate Change Vulnerability Assessment: Beech-birch-maple ▸

Ranking: 5 - Medium to High Vulnerability

Confidence: Not Specified

Climate scenario: SRES B1 (Lower emissions scenario) and A1FI (Higher emissions scenario)

Related Species

- American Mink
- American Woodcock
- Black Bear
- Blackpoll Warbler
- Canada Warbler
- Coyote
- Louisiana Waterthrush
- Moose
- New England Cottontail
- Northern Long-eared Bat
- Prairie Warbler
- Ruffed Grouse
- Snowshoe Hare
- Spring Salamander
- White-tailed Deer
- Wood Thrush
- Wood Turtle

Related Adaptation Strategies and Actions

- Keep forests as forests
- Maintain diversity of native tree species: Restore native tree species
- Maintain habitat connectivity: Amphibian and reptile tunnels
- Maintain habitat connectivity: Collect road crossing data
- Maintain habitat connectivity: Modify stream crossings to allow wildlife passage
- Maintain or improve the ability of forest to resist pests and pathogens: Increase species and structural diversity
- Maintain or restore soil quality: Increase snags and logs
- Maintain or restore soil quality: Limit recreational impacts
- Maintain or restore soil quality: Protect soils during harvests
- Manage herbivory to promote tree regeneration: Control deer/moose impacts
- Preserve unique habitats: Establish forest patch reserves
- Prevent the introduction of invasive species: Control invasive exotic plants
- Prevent the introduction of invasive species: Monitor for invasive insects
- Prioritize at-risk communities: Protect rare species
- Promote drought and heat tolerant species: Encourage species in northern and middle edge of range
- Promote drought and heat-tolerant species: Promote adapted trees in beech-birch-maple forests
- Promote structural diversity: Diversify tree age classes
- Promote structural diversity: Retain biological legacies
- Protect ecosystem diversity: Establish large connected conserved areas
- Protect forest streams and wetlands: Maintain riparian and wetland buffers
- Reduce wind and ice damage: Increase structural diversity of the forest

Adaptation Strategies and Actions

Promote structural diversity: Diversify tree age classes

Adaptation type:
Land and forest stewardship or restoration

Strategy:
Promote structural diversity

Action

Promote diverse tree age classes
Climate change is predicted to increase the frequency and intensity of storm events. Pests are also predicted to increase. These disturbances often have a disproportionate impact on certain ages of trees. For example, a wind storm is likely to do more damage to an old, large tree than a sapling. Certain pests may prefer young trees. Diversify the tree ages in order to increase resiliency. If one of these disturbances impacts your woods, there will likely be trees of different ages there to take its place.

To diversify tree ages, create gaps in the canopy to let sunlight reach the forest floor. The canopy gap size will depend on which species you are trying to regenerate. For example, sun-loving early successional species will need large gaps (>1/2 acre), while shade-tolerant late successional species, such as maples and balsam fir, need only the gap created by felling a single mature canopy tree. Diversifying tree ages will also provide a diversity of habitat conditions; some wildlife species prefer young, seedling forest while others prefer mature forest with many canopy layers and many prefer a little of both. In addition, promoting diverse age classes can also increase the forest's ability to store carbon by increasing the total number of trees growing in the forest. Carbon storage refers to the amount of carbon contained in tree biomass[?] in a forest. In fact, about 50% of a tree's mass is carbon.

Adaptation Strategies and Actions

Promote structural diversity: Retain biological legacies

Adaptation type:
Land and forest stewardship or restoration

Strategy:
Promote structural diversity

Action

Retain biological legacies
Biological legacies are those elements of a forest that have been around for many years and include snags (standing dead trees), downed logs, and very large trees. The microenvironments created by legacies provide localized areas with more moisture and cooler temperatures. These types of microenvironments will become increasingly important for the survival of many tree and wildlife species as temperatures warm and conditions become drier.

These legacies not only provide crucial habitat for wildlife, but also sequester [?] and store carbon, an essential forest function in the face of climate change. Carbon sequestration is the ability of trees to take carbon from the atmosphere and convert it to solid living material. In fact, about 50% of a tree is carbon. Carbon storage represents the ability of that tree to store the carbon (out of the atmosphere) for extended periods of time. Although carbon is eventually released from dead trees, this process takes a very long time. Consider leaving dead or dying trees in the forest to continue storing carbon and serve as important habitat for plant and wildlife species.

Collaborating on climate adaptation in Massachusetts

massecan.org

What is **Mass ECAN**?

Ecosystem Climate Adaptation Network

- A **community of practice** for climate adaptation practitioners and researchers working on and interested in ecosystem resilience and natural resources conservation in MA
- Launched Oct. 2017

191 Members

- Conservation nonprofits, municipal committees/boards, regional authorities, businesses, universities, federal, state agencies
- Conserving ecosystems and species
- Where ecosystem resilience intersects with other sectors, such as transportation
- Provides co-benefits to our municipalities, such as through nature-based solutions

Mass ECAN Goals

Short-term

- Build community, increase knowledge sharing, and foster collaboration

Long-term

- Advance the field of climate adaptation
- Bring ecosystem resilience & natural resource conservation to the forefront of action
- Weave ecosystem resilience into action across sectors

Mass ECAN Conference

- Nov. 2017: Foundational conference - 85 attendees
- Communications workshop
- Project Examples Panel
- State Hazard Mitigation & Adaptation Plan

Expert Work Groups

- Ad-hoc – focused on specific ecosystems or adaptation initiatives
- Made up of experts (researchers and practitioners)
- Led by expert from organization/agency actively working on the topic in Massachusetts
- Identify gaps in research, data, practical knowledge, or policy, and coordinate efforts to fill these gaps and create a comprehensive strategy for ecosystem conservation


Cold-water Streams


Forests

Slow the Flow

Salt Marshes

Expert Work Groups

- Climate change communications
- Main-streaming Nature-based solutions
- Cold-water streams
- Salt marsh
- Slow the flow
- Forests