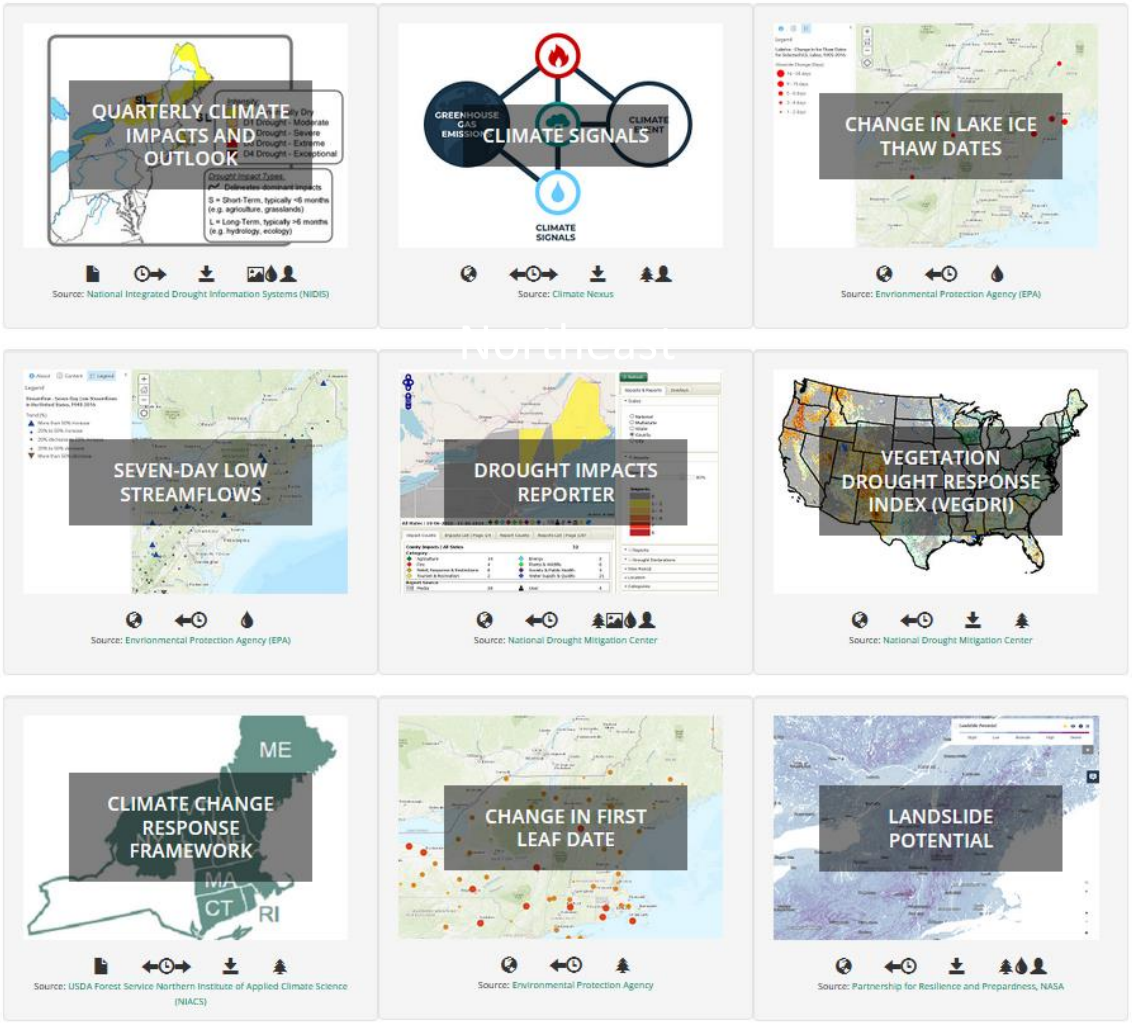
CLIMATE CONNECTION:

TOOLS FOR UNDERSTANDING CLIMATE CHANGE AND HOW IT IMPACTS FOREST ECOSYSTEMS IN THE NORTHEAST

Technical Report



FEMC

Forest Ecosystem Monitoring Cooperative

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Climate Connection: Tools for understanding climate change and how it impacts forest ecosystems in the Northeast

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Table of Contents

Executive Summary

The Forest Ecosystem Monitoring Cooperative (FEMC) Climate Connection (https://www.uvm.edu/femc/climate-connection) is an online resource for policy makers, researchers, students, natural resource professionals, and the general public to quickly find the tools they need to explore climate change and how it will impact forested ecosystems in the northeastern United States (US).

The FEMC Climate Connection is a point of access for key resources that include:

1. Tools for exploring how climate change will affect weather, temperature, and precipitation patterns in our region in ecologically meaningful ways;
2. Tools for exploring or quantifying the impacts of climate change on forest ecosystems, from driving pest outbreaks to reducing streamflow to changing the timing of key seasonal events;
3. A collection of research and monitoring studies investigating climate change in the Northeast and archived on the FEMC data archive,
4. A list of other climate change related portals and clearinghouses, and
5. A list of trusted, high-quality climate data sources.

With easier access to these resources, the FEMC Climate Connection provides users tools they need to understand the implications of climate change and incorporate them into the management of the region's forested ecosystems.

Introduction

As we learn more about climate change and its impacts, there is an ever increasing amount of information available, but finding the right resource for that information can be a daunting task. Forest managers, policy makers, educators, and the general public who may not have a deep understanding of the nuances of climate models and potential outcomes have voiced frustration in not knowing where to look for information related to climate change and determining how this information is relevant to forests. While climatologists are not certain of the precise changes that will manifest into the future, we are already seeing changes to the climate in the Northeast US. Increasingly, people working with forest resources need information on how climate change will impact forests to better incorporate climate change science in their current and future work.

In light of these information gaps, the FEMC governing committees selected "climate change and impacts to forest ecosystems in the Northeast" as an area for needed information synthesis and aggregation. In 2018, the FEMC took on this project as one of its Regional Priority Projects (https://www.uvm.edu/femc/attachments/project/999/FEMC_RegionalWorkPlan_2017-2018.pdf). FEMC staff inventoried existing climate change websites and information portals to determine what resources were available and garnered input from experts in the field. We sought to provide access to two main types of resources: those that display information on the impacts of climate change on forested ecosystems and those that help the user understand how the climate has changed and may continue to change. As a result of this assessment, the FEMC compiled a curated information clearinghouse specifically related to climate change impacts to forest ecosystems in the Northeast: the Climate Connection (https://www.uvm.edu/femc/climate-connection). The goal of this website is to provide an easy to use and interpret source of climate change

information that is not overwhelming to a user, and helps them visualize and understand changes in the regional climate as well as impacts to our forests.

Methodology

FEMC staff inventoried existing climate change resources and informational clearinghouses housed on the internet as of October 31, 2018 using a variety of keyword searches. From this list (Table 1), we assessed whether there was a current clearinghouse or information portal that met the needs of regional forest planners and managers.

Table 1: Inventory of existing clearinghouses and information sources related to climate change in the Northeast

Resource Name	URL
Adaptation Clearinghouse	https://www.adaptationclearinghouse.org/
Center for Climate and Energy Solutions	https://www.c2es.org/
Climate Adaptation Knowledge Exchange	https://www.cakex.org/
Climate Change Information Resources	https://www.dec.ny.gov/energy/50399.html
Climate Change Knowledge Portal	http://sdwebx.worldbank.org/climateportal/
Climate Data and Tools	https://www.fs.fed.us/managing-land/sc/data-dashboard
Climate Impacts on Forests	https://epa.gov/climate-impacts/climate-impacts-forests
Extreme Precipitation for New York and New England	http://precip.eas.cornell.edu/
ICARP Adaptation Clearinghouse	http://opr.ca.gov/clearinghouse/adaptation/
Massachusetts Climate Action Tool	https://climateactiontool.org/
NASA: Climate Change and Global Warming	https://climate.nasa.gov/
National Centers for Environmental Information NOAA	https://www.ncei.noaa.gov/
New York Climate Change Science Clearinghouse	https://nyclimatescience.org/
NExUS	http://neclimateus.org/index.php
Northeast Climate Adaptation Science Center	https://necsc.umass.edu/
Northeast Regional Climate Center	http://www.nrcc.cornell.edu/
Northern Institute of Applied Climate Science	https://www.nrs.fs.fed.us/niacs/
Real-time data	https://www.climatesignals.org/data
Resilient MA	http://resilientma.org/
State of Vermont: Climate Change in Vermont	http://climatechange.vermont.gov/
The Climate Explorer	https://crt-climate-explorer.nemac.org/
US Climate Alliance Clearinghouse	http://usclimateallianceclearinghouse.org/
US Climate Resilience Toolkit	https://toolkit.climate.gov/
US Global Change Research Program	https://www.globalchange.gov/browse/datasets
USFS Climate Change Resource Center	https://www.fs.usda.gov/ccrc/
Yale program on climate change communication	http://climatecommunication.yale.edu/

From this inventory, we determined that there was not a resource that addressed both climate change and its potential impacts on forest ecosystems in the Northeast. Thus, we created a clearinghouse that does address these needs. To compile a forest ecosystem specific information portal, we selected resources that fell under two main categories:

(1) Resources that display or present Northeast climate data and show how these trends are changing over time, and

(2) Resources that display or analyze impacts of climate change on forest ecosystems.

We selected a subset of the best tools, maps, or reports we could find on the internet for inclusion on the Climate Connection portal using the following criteria:

- Includes the Northeastern US in the spatial extent
- Has a direct connection to forest ecosystems
- Relatively easy to use and understand
- Available electronically (web application or document download)
- Has a graphical interface or information display component
- Created by a known, reliable entity to ensure continued upkeep
- If possible, the resource is dynamic or periodically updated
- If possible, includes comparisons of the past to recent conditions, or some other indication of change

In general, we sought to identify a focused set of resources, and not to create a complete clearinghouse of all available resources. For each resource we selected for inclusion, we provided detailed descriptive and structured information, including a description of use and interpretation. On the main landing page, we display some of this information as icons that quickly provide key details to the user the (Table 2). Further details on each resource are visible when the user clicks on the resource (Table 3).

Additionally, we included other resources that we identified during this process. These other resources include,

(1) Climate change related research and monitoring projects currently archived on the FEMC data archive,

(2) Sources of high-quality climate data, and

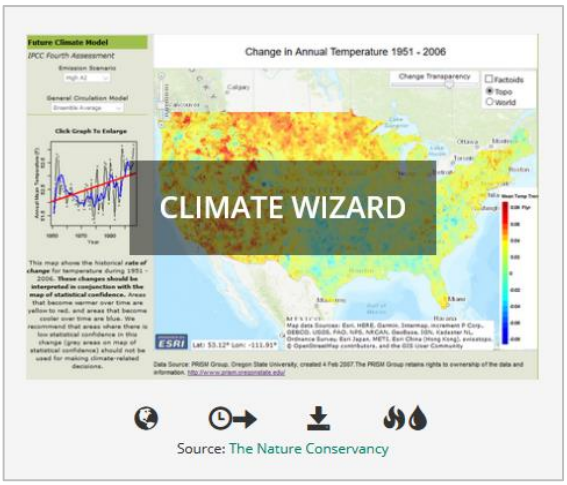
(3) Relevant climate change portals and clearinghouses.

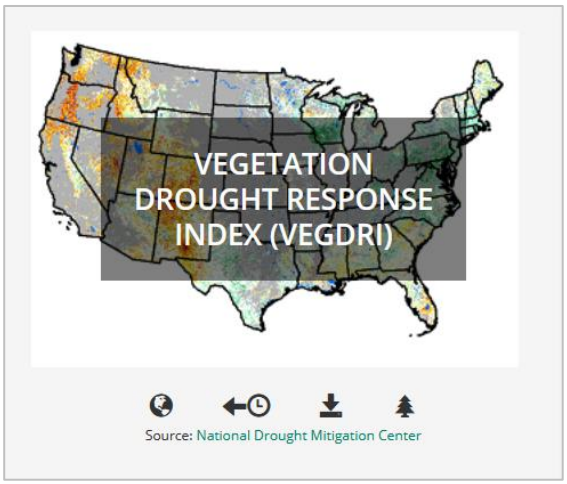
Table 2: List of the informational icons included for each selected resource on the Climate Connection landing page.

Information Category	Icon
The type of resource	Web Map Summary
If the resource covers historical (includes current) climate or impacts, projected (future) climate or impacts, or both	Historical Projected Both
The thematic focus of the resource; resources can have multiple foci	Forests Water Wildlife People
If the resource has downloadable data	

Table 3: List of metadata attributes populated for each resource.

Attribute	Description
Available at	URL of the resource
Description	An easy to understand overview of the resource
Source	The organization name and link to the source of the resource
Tags	A list of tags related to the resource for queries
Type	The type of resource (web map or summary report)
Downloadable	Indication if the data is available for download
Download format	Format of the data, if it is downloadable (e.g., comma-separated value, PDF, image)
Temporal coverage	The timeframe that the resource covers
Spatial coverage	The geographic area that the resource covers
Climate layers	List of climate data included in the resource
How to use	Step-by-step guide on using the resource and how to interpret it





CLIMATE CONNECTION RESOURCE INFORMATION

Climate Wizard

Available at	http://www.climatewizard.org/
Description	The ClimateWizard is an interactive map targeting users with a moderate understanding of climate data for the exploration and access to past and projected climate data under a range of emissions scenarios.
Source	The Nature Conservancy
Tags	emission scenarios, general circulation models, precipitation, temperature
Type	Webmap
Timeframe	Projected
Downloadable	Data Downloadable
Download Formats	ASC, PNG
Temporal Coverage	1951-2090
Spatial Coverage	Contiguous US
Climate Layers	Annual average temperature, annual total precipitation, seasonal average temperature, seasonal total precipitation, monthly average temperature, monthly total precipitation
How to Use	The map has many different options to select and explore depending on the user's goals. To use this map, select an area, a time period (includes both observed and projected), display options, a climate variable, and emissions scenario from the options provided. Climate variables can be displayed as annual, seasonal, or monthly. Various resources are also provided, including links to data downloads and map images.

CLIMATE CONNECTION RESOURCE INFORMATION

Vegetation Drought Response Index (VegDRI)

Available at	https://vegdri.unl.edu/Home.aspx
Description	The Vegetation Drought Response Index, or VegDRI, is a weekly depiction of vegetation stress due to water availibility across the contiguous United States.
Source	National Drought Mitigation Center
Tags	drought, forest stressors, vegetation, water availability
Type	Webmap
Timeframe	Historical
Downloadable	Data Downloadable
Download Formats	PNG, PDF, JPG
Temporal Coverage	2010-present
Spatial Coverage	Contiguous US
Climate Layers	Palmer Drought Severity Index (PDSI), Standard Precipitation Index (SPI) (36-week)
Supplemental Layers	Percent Average Seasonal Greenness (PASG), Start of Season Anomaly (SOSA)
How to Use	The current condition of vegetation due to either drought or deluge (excess precipitation) is displayed in a map. As depicted in the legend, areas in darker red show locations of extreme drought. Select a state to explore in more detail to visualize the vegetation condition. Regions within a state can be also be selected (if applicable). At the bottom of the site, view the current vegetation condition compared to the historical past, or view a time lapse of drought data in a year. In both of these other maps, individual states cannot be selected.

Figure 1: Examples of two resources and the information provided on the Climate Connection. The example on the left is a climate data resource and the one displayed on the right is a climate change impacts resource. On the Climate Connection landing page (top images), resources are displayed with an image, title, and graphical metadata (see Table 2 for descriptions). When a resource is selected by the user, a resource information box (bottom images) display additional information, including a link to the resource (see Table 3 for descriptions of each attribute).

Results & Discussion

The Climate Connection

We selected nine resources to be included under the heading “Explore Climate Change” (

Table 4). We selected 15 resources to be included under “Explore Impacts of Climate Change” (

Table 5). Additionally, we linked 43 research and monitoring projects that were archived in the FEMC data archive and related to climate change (https://www.uvm.edu/femc/data/archive/project/themes#climate-change; Appendix A), nine sources of high-quality climate data (Appendix B), and 12 additional portals and clearinghouses that may be of interest to a user (Appendix C). The Climate Connection can be accessed at https://www.uvm.edu/femc/climate-connection.

The FEMC staff plans to continue to update The Climate Connection if there are novel, relevant, and suitable resources that would enhance the portal. We also provide a mechanism for website users to suggest additional resources for inclusion.

Table 4: Resources selected under the heading “Explore Climate Change”. These resources provide access to typical climate change metrics and data that explain the mechanics of how climate change is impacting key abiotic factors.

Name	Source	Type
Average Daily Maximum Summer Temperature	NOAA National Centers for Environmental Information	Web map
Average Daily Minimum Winter Temperature	NOAA National Centers for Environmental Information	Web map
Change in Total Snowfall	Environmental Protection Agency (EPA)	Web map
Changes in Temperature and Precipitation	USDA Forest Service - Office of Sustainability and Climate	Report
Climate Data Primer	NOAA	Report
Climate Wizard	The Nature Conservancy	Web map
Growing Degree Days	NOAA National Centers for Environmental Information	Web map
Northeast Climate Assessment	US Global Change Research Project	Report
Number of Dry Days	NOAA National Centers for Environmental Information	Web map

Table 5: Resources selected under the heading "Explore Impacts of Climate Change". These resources provide ways for users to explore different types of impacts that climate change will have on natural and human systems related to forests.

Name	Source	Type
Climate Change Effects on Forests of New England and Northern New York	USDA Forest Service Office of Sustainability and Climate, Northern Institute of Applied Climate Science	Report
Growing Degree Day Accumulations to support Emerald Ash Borer tracking	Northeast Regional Climate Center	Web map
Growing Degree Day Accumulations to support Gypsy Moth tracking	Northeast Regional Climate Center	Web map
Drought Impacts Reporter	National Drought Mitigation Center	Web map
Vegetation Drought Response Index	National Drought Mitigation Center	Web map
Climate Change Response Framework	USDA Forest Service Northern Institute of Applied Climate Science	Report
Change in First Leaf Date	Environmental Protection Agency	Web map
Landslide potential	Partnership for Resilience and Preparedness, NASA	Web map
Erosion risk	Partnership for Resilience and Preparedness, World Resources Institute	Web map
Extreme Weather Map	Environment America	Web map
Change in Ice Thaw Dates	Environmental Protection Agency	Web map
Seven-Day Low Streamflows	Environmental Protection Agency	Web map
Climate Signals	Climate Nexus	Web map
Quarterly Climate Impacts and Outlook	National Integrated Drought Information Systems	Report
i-Tree Landscape	i-Tree	Web map

Information Gaps

In our inventory of what climate change information and tools currently exist that visualize or explain related impacts to forest ecosystems, we found a number of gaps and areas for improvement.

First, we found that climate metrics presented online are often difficult to understand and interpret. For example, temperature and precipitation data may be displayed in metric units -- the international scientific standard -- but this scale is not intuitive for most US residents. Another common format is to display data as an index, however indices are often not explained in sufficient detail for a lay person to understand and interpret. The timeframe of the information presented can be a challenge, too. Current data can be helpful to understand the recent conditions, but does not provide information on how the climate is changing over time. Climate models that forecast potential conditions in the distant future can seem irrelevant in current planning. In general, clear directions on use and interpretation of the information or tool would improve many resources. What do these data show and what does that mean? Overall, we found that it can be difficult to sort through the many datasets, tools, and websites and know what is relevant.

Second, we found that some climate change information is not provided in the most ecologically relevant format. The most commonly presented climate information is monthly or annual (mean, min, or max) temperature and total precipitation. However, there are other metrics of climate change that may have a greater influence on forests. For example, the length of summer heat waves greater than 95°F may be more impactful to tree growth and water uptake compared to the maximum July temperature. Anomalous events (e.g., climate events that differ considerably from the historical norm) are also not commonly included but are important to both human and forest health.

Lastly, we found that there is not a lot of climate change information at the sub-state level (e.g., county, town, geophysical region, forest district level) which makes it difficult to understand how climate change will impact areas at the scale at which they are managed.

We did not find a wealth of information on the specific impacts of climate change on forests in the Northeast; this is a much needed area of improvement. While there may be many information sources to view historical and projected temperature ranges, it can be difficult to understand how to incorporate these data into forest planning and management. For example, where might winter logging be problematic as snowpack declines? Where are bottomland forests most at risk of more frequent flooding? The forest science community could do more to provide more assessments of the potential impacts, thresholds, and key indicators of climate change in the Northeast. The Climate Connection provides a framework for easier discovery and use of these types of resources, and will be updated as new resources become available.

Appendix

A. Climate Change Related Research and Monitoring Projects

Table 6. List of climate change related research and monitoring projects archived on the FEMC data archive (https://www.uvm.edu/femc/data/archive/project/themes#climate-change) and included on the Climate Connection.

Project Name	People	Dates

Surprising Growth Resurgence of Red Spruce in the Northern Forest	Shelly Rayback, Gary Hawley, Paul Schaberg, Alexandra Kosiba	2013-01-01 to 2016-08-01
Climate Adaptations of Different Red Spruce Populations Across its Range	Stephen Keller, John Butnor	2015-08-15 (Ongoing)
Continuous Forest Inventory on the state forests in the Northeast Kingdom of Vermont	Emily Meacham	2015-06-01 (Ongoing)
Controls on Forest Soil Carbon Storage	Adam Noel	2017-07-24 (Ongoing)
Effects of Climate Change on Growth, Productivity, and Wood Properties of White Pine in Northern Forest Ecosystems	Ronald Zalesny, John Brissette, Sophan Chin, Steve Colombo, Pengxin Lu, Bill Parker, Les Groom	2010-01-01 (Ongoing)
EMMA Weather Station Data - Cary Institute of Ecosystem Studies	Vicky Kelly, Kerri Scrivanos, Lindsay Charlop	1988-01-01 (Ongoing)
EMMA Weather Station Data - Louis Calder Center	Vicky Kelly, Kerri Scrivanos, Lindsay Charlop, Alissa Perrone	2014-07-30 (Ongoing)
EMMA Weather Station Data - Mohonk Preserve	Vicky Kelly, Kerri Scrivanos, Lindsay Charlop, Megan Napoli, Natalie Feldsine, Elizabeth Long	1896-01-01 (Ongoing)
EMMA Weather Station Data - New York Botanical Garden	Vicky Kelly, Kerri Scrivanos, Lindsay Charlop, Jessica Schuler	2013-05-28 (Ongoing)
EMMA Weather Station Data - Teatown Lake Reservation	Vicky Kelly, Kerri Scrivanos, Lindsay Charlop	
EMMA Weather Station Data - Vassar Farm and Ecological Preserve at Collins Field Station	Vicky Kelly, Keri VanCamp, Kerri Scrivanos, Lindsay Charlop	
EMMA Weather Station Data - Ward Pound Ridge Reservation	Vicky Kelly, Kerri Scrivanos, Lindsay Charlop, Dan Aitchison, Glenn Horton	2003-02-01 (Ongoing)
Experimental Ice Glazing in a Northern Hardwood Forest to Understand Ecological Impacts of Ice Storms	John Campbell, Wally Shortle, Paul Schaberg, Lindsay Rustad	2009-01-01 to 2013-12-01
Forest Environmental Monitoring (Canopy Tower)	Tim Scherbatskoy, Carl Waite, Eric Miller, Gerry Livingston, Miriam Pendleton, James Duncan	1992-07-07 (Ongoing)
FPR Fire weather Remote Automated Weather Stations (RAWS)	Tess Greaves	1999-05-01 (Ongoing)

Genomic Analysis of Climate Change Responses in Northeastern Red Spruce Forests	Stephen Keller, Brittany Verrico	2015-09-01 (Ongoing)
Integrating Effects of Climate Change, Acidic Deposition and Insect Defoliation on Sugar Maple (*Acer saccharum*) Growth and Yield in the Northern Forest	Greg Lawrence, Colin Beier, Daniel Bishop, Neil Pederson, John Stella	2013-01-01 (Ongoing)
Mapping forest species mixes across the Northeast from Landsat imagery	Jennifer Pontius, David Gudex-Cross, Alison Adams	2014-10-01 to 2018-09-30
Mount Mansfield Summit Meteorology	Tim Scherbatskoy, Carl Waite, Wesley Alan Wright, James Duncan, WCAX Engineers	1954-01-01 (Ongoing)
Mt. Mansfield West Slope Mid-Elevation Forest Meteorological Monitoring	Tim Scherbatskoy, Carl Waite, Joanne Cummings, Dick Furbush, Gerry Livingston, Miriam Pendleton, James Duncan	1996-09-01 (Ongoing)
National Oceanic and Atmospheric Administration (NOAA) Weather Stations	Jamie Deppen	1924-06-01 (Ongoing)
Northeastern Forest Health Trend Index Derived from Landsat Imagery	Jennifer Pontius, Mary Martin	2011-01-01 to 2012-12-31
Northeastern Regional Aerial Detection Surveys and Insect and Disease Surveys	Barbara Schultz, Dave Struble, Jennifer Pontius, Alexandra Kosiba, James Duncan, Emma Tait, Jerry Carlson, Garrett Meigs, Ken Gooch, Kyle Lombard	2016-06-02 (Ongoing)
NYCDEP Catskills Meteorological Data	Jamie Deppen, Glenn Horton	1996-01-01 (Ongoing)
Processes Affecting Climatic Disequilibrium in the Green Mountains: A Seedling Pilot Study	Carrie Pucko	2007-01-01 to 2007-12-31
Snow Cover in Vermont		1888-09-01 (Ongoing)
Soil Climate Analysis Network (SCAN)	Thomas Villars, Garry Schaefer, Tony Tolsdorf	2000-09-13 (Ongoing)
Spatial Variability of Precipitation and Snow Accumulation on Mount Mansfield	Beverley Wemple, Paul Bierman, Keith Musselman, Colin Howard	2002-10-10 to 2003-04-30

Standardized Precipitation-Evapotranspiration Index of Drought		1951-01-01 (Ongoing)
Susceptibility of Montane Spruce-Fir Forests of the Northeastern United States to Climate Change	Greg Lawrence, Jay W. Wason, Martin Dovciak, Colin Beier, John Battles	2011-01-01 to 2015-09-30
Tree Phenology Monitoring: Bud development	Joshua Halman, Michael Johnson, Tom Simmons, Sandra Wilmot, Sean Lawson, Dan Dillner	1991-04-01 (Ongoing)
Tree Phenology Monitoring: Fall Color and Leaf Drop	Joshua Halman, Michael Johnson, Tom Simmons, Sandra Wilmot, Barbara Schultz, Sean Lawson, Dan Dillner	1991-07-15 (Ongoing)
Tree Phenology Monitoring: Understory plant phenology	Michael Johnson, Tom Simmons, Sandra Wilmot, Sean Lawson	1991-04-01 (Ongoing)
Tree species growing at their elevational limits: bioindicator of climate or atmospheric change	Jeffrey Hughes, Walter Poleman	1992-06-01 to 1997-01-14
Understanding Impacts of Precipitation Change and Drought on the Northern Forest	Pamela Templer, Lindsay Rustad, Heidi Asbjornsen	2014-01-01 (Ongoing)
Updating Red Spruce Growth Trends	Barry Sims, John Donnelly	1996-08-01 to 1996-10-01
Weather-Related Causes of Red Spruce Winter Injury and Impacts on Carbon Storage	Joshua Halman, Barbara Schultz, Gary Hawley, Paul Schaberg	2006-01-01
Webcams Monitor Changing Climate Effects on Leaf Phenology and Forest Productivity	Andrew Richardson	2009-01-01 (Ongoing)
Winter Injury, Carbon Loss, but Surprising Growth Resurgence in Red Spruce	Christopher Hansen, Gary Hawley, Paul Schaberg, Alexandra Kosiba	2010-01-01 to 2013-03-04

B. Other Sources of Climate Change Data

Table 7. Other resources of climate change data included on the Climate Connection.

Source Name	Description

PRISM Climate Data	The PRISM (Parameter-elevation Regressions on Independent Slopes Model) Climate Group uses a range of climate observations to develop spatial climate datasets (precipitation, temperature, vapor pressure deficit). The resulting datasets incorporate a variety of modeling techniques and are available at multiple spatial/temporal resolutions, covering the period from 1895 to the present.
IPCC Data	The Data Distribution Centre of the Intergovernmental Panel on Climate Change (IPCC) allows users to browse and access climate, socio-economic, and environmental data, both from the past and future projections. The site also provides technical guidelines on the selection and use of different types of data and scenarios.
NCEI Climate Data Online	The National Centers for Environmental Information (NCEI) provide daily climate summaries, marine data, along with global climatic summaries and local data. Data can be explored with a web map or search tool.
Climate - Data Catalog	A clearinghouse of publicly available data, with a focus on climate, which is hosted by U.S. General Services Administration, Technology Transformation Service. Other criteria can be designated to refine the search.
NCAR Climate Data Guide	National Center for Atmospheric Research (NCAR) provides a comprehensive list of climate maps and datasets, mostly spatial. Products can be searched by location, time frame, and keyword.
Climatic Research Unit - High-resolution Gridded Datasets	The Climatic Research Unit (CRU) provides spatial models of historical climate, including cloud cover, sunshine duration, and wind speed, to name a few.
National Forest Climate Change Maps	The National Forest Climate Change Maps project was developed to meet the need of National Forest managers and are available for every National Forest in the contiguous United States with relevant data coverage, and include variables related to precipitation, air temperature, snow, and stream flow.
Climate Change Atlas	The Climate Change Atlas, produced by the USDA Forest Service, documents the current and possible future distribution of 134 tree species and 147 bird species in the Eastern US and gives detailed information on environmental characteristics defining these distributions.
NCEI Quick Links	Follow links to gain quick access to many climate and weather datasets, products, and various web pages and resources provided by NCEI (National Centers for Environmental Information).

C. List of Climate Change Related Portals and Clearinghouses

Table 8. List of other climate change related portals and clearinghouses available on the Climate Connection.

Resource Name	Description
New York Climate Change Science Clearinghouse	The New York Climate Change Science Clearinghouse (NYCCSC) is a gateway for policymakers, local planners, and the public to identify and access documents, data, websites, tools, and maps relevant to climate change adaptation and mitigation across New York State.
State of Vermont: Climate Change in Vermont	Vermont's Climate Dashboard provides information about specific changes in Vermont's climate during the last fifty years. The Dashboard also presents information about how these changes in temperature, precipitation, and the timing of seasons may effect Vermont's quality of life and economy.
Resilient MA	The Massachusetts Climate Change Clearinghouse (Resilient MA) is a gateway to data and information relevant to climate change adaptation and mitigation across the state.
Northeast Climate Adaptation Science Center	The Department of Interior's Northeast Climate Adaptation Science Center (NE CASC) is part of a federal network of eight Climate Adaptation Science Centers created to work with natural and cultural resource managers to gather the scientific information and build the tools needed to help fish, wildlife, and ecosystems adapt to the impacts of climate change.
NASA: Climate Change and Global Warming	NASA's (National Aeronautics and Space Administration) climate site provides resources collected by NASA related to climate change.
Climate Change Knowledge Portal	The Climate Change Knowledge Portal (CCKP) is a central hub of information, data and reports about climate change around the world. Query, map, compare, chart and summarize key climate and climate-related information.
Adaptation Clearinghouse	The Adaptation Clearinghouse, powered by Georgetown Climate Center, is an online database and networking site that serves policymakers and others who are working to help communities adapt to climate change.
The Climate Explorer	Explore graphs and maps of historical and projected climate variables for any county in the contiguous US

	using this NOAA (National Oceanic and Atmospheric Administration) site.
Climate Change Resource Center	The Climate Change Resource Center (CCRC) provides access to information and tools concerning ecosystem management and climate change.
Climate Data and Tools	A gallery of climate maps, tools, and resources pertaining to the climate, with an emphasis on forests ecosystems, provided by the USDA Forest Service.
Real-Time Data	A gallery of real-time climate maps, tools, and resources, with a focus on climate-related events hosted by Climate Nexus.
Massachusetts Climate Action Tool	Use this tool to explore climate change impacts, learn about vulnerabilities and plan adaptation actions.

FEMC

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Providing the information needed to understand, manage, and protect the region's forested ecosystems in a changing global environment

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