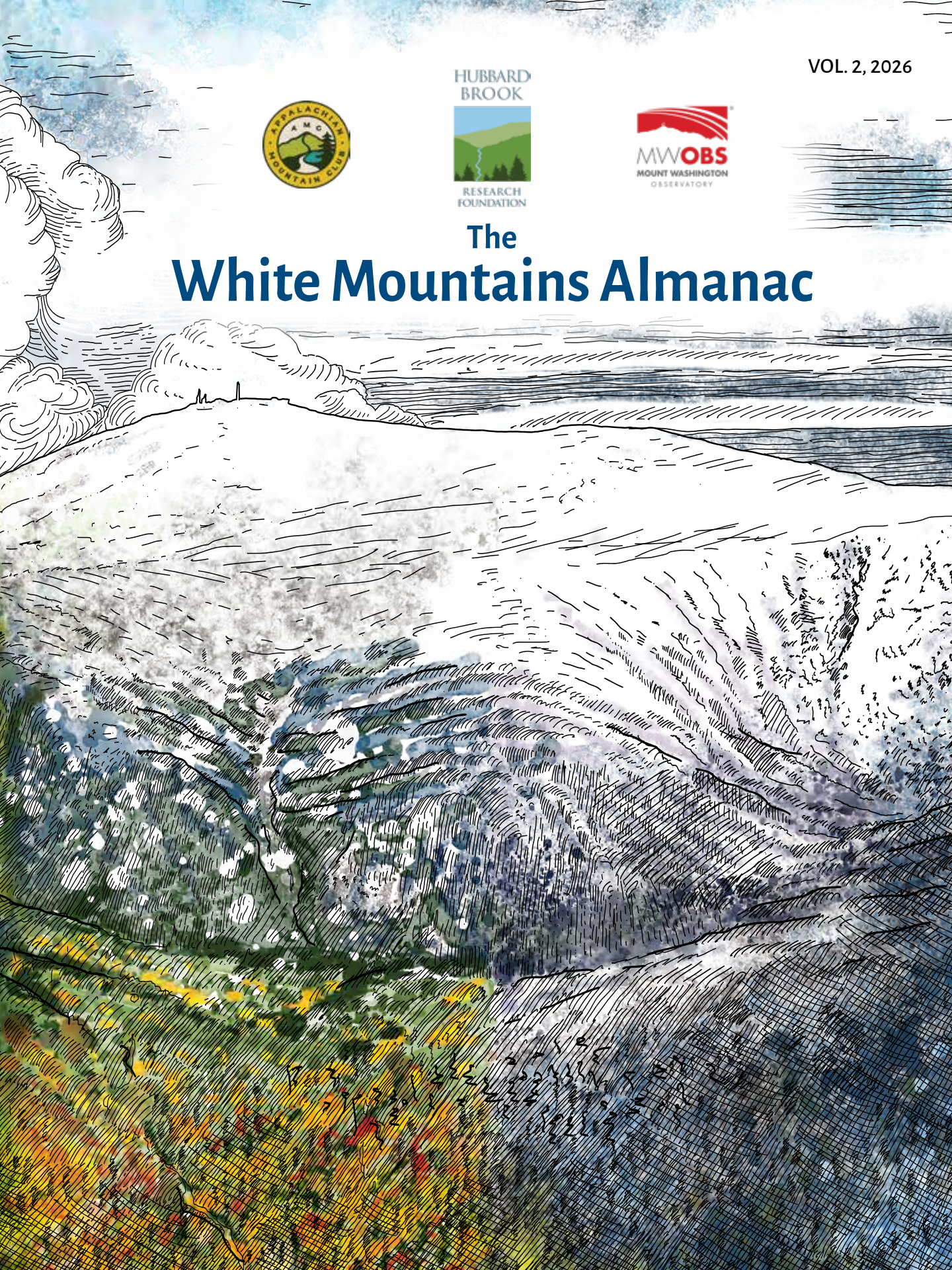
VOL. 2, 2026

HUBBARD BROOK RESEARCH FOUNDATION

MWOBS MOUNT WASHINGTON OBSERVATORY

The White Mountains Almanac





Lakes of the Clouds at sunset.
Photo by MWOBS.

About the publication

The White Mountains Almanac is a publication produced in collaboration by the Mount Washington Observatory, Appalachian Mountain Club, and Hubbard Brook Research Foundation, offering a comprehensive year-in-review exploration of ecological and climatological changes observed in the White Mountains region. Merging scientific findings with visual storytelling, the publication serves as both a resource for researchers and a guide for outdoor and nature enthusiasts, educators, policymakers, and the general public.

The Hubbard Brook Experimental Forest is one of the longest running and most comprehensive ecosystem study sites in the world. Operated and maintained by the U.S. Department of Agriculture, Forest Service since 1955, this 7,800-acre research site is located just north of Plymouth, NH, in the White Mountains. Long-term ecological research at Hubbard Brook is supported by the National Science Foundation along with other agencies and partners. The Hubbard Brook Research Foundation leads outreach and education programs to strengthen connections between science and society. Learn more and donate at *hubbardbrook.org*

Hubbard Brook Research Foundation
Administrative Offices
234 Mirror Lake Road
North Woodstock, NH 03262

The Appalachian Mountain Club is the nation's oldest conservation and recreation organization, committed to fostering the protection, enjoyment, and understanding of the outdoors. Since 1876, AMC has encouraged generations to deepen their passions for the outdoors and helped protect some of the most critical natural environments in the Northeast and Mid-Atlantic regions. Learn more and join at *outdoors.org*.

Appalachian Mountain Club
10 City Square
Boston, MA 02129

Mount Washington Observatory is a private, non-profit, member-supported institution dating back to 1932 with a mission to advance understanding of the natural systems that create earth's weather and climate. It serves this mission by maintaining a weather station on the summit of Mount Washington, performing weather and climate research, conducting innovative science education programs, and interpreting the heritage of the Mount Washington region. Learn more and donate at *mountwashington.org*.

Mount Washington Observatory
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No generative artificial intelligence (AI) was used in the writing of this publication.

Please email us at info@mountwashington.org with your feedback, suggestions for topics, and any other questions/comments.

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Land Acknowledgment

The land where this almanac lies within Ndakinna, the ancestral homeland of the Abenaki (Wôbanakiak), an Algonquin-speaking people. Their name derives from wôban (light) and aki (earth), meaning "people of the dawn land." The Abenaki are part of the greater Wabanaki Confederacy, which includes the Mi'kmaq, Maliseet, Passamaquoddy, and Penobscot nations, all of whom have held deep and enduring relationships with these mountains, rivers, and forests for centuries.

We recognize that these lands include places known today by colonial names, including Mount Washington, which has long carried Indigenous names and meanings such as Agiocochook ("Home of the Great Spirit" or "Mother Goddess of the Storm"), Waumbik ("White Rocks"), and G8dagwjo/K8daakwaj ("Hidden Mountain Always in the Clouds"). The White Mountains are not empty or untouched wilderness; they are living homelands with rich histories that predate Euro-American settlements.

We acknowledge the violence of colonization perpetuated against the Abenaki peoples, and the systems that continue to cause harm today, including the erasure of Indigenous presence through systems of environmental protection and conservation. Much of the Abenaki territory remains in the hands of non-native people and organizations. We recognize that environmental stewardship of these lands is inseparable from the stewardship the Abenaki have practiced for generations, and that this work carries a responsibility to honor that legacy. We support the continued presence, sovereignty, and stewardship of the Abenaki peoples. To learn more about the Abenaki communities or how you can contribute, please visit: caodanak.com, dawnlandreturn.org, wabanakialliance.com and fourdirectionsmaine.org.

Preface

Mountains are dynamic. Unique. Challenging. Alluring. They stand apart from the landscapes at their feet: cooler, steeper, snowier, and with specialized plant and animal communities. Perhaps nowhere in New England is the contrast between high and low elevation as pronounced as in the White Mountains of New Hampshire and Maine. *The White Mountains Almanac* is an annual publication with monthly topics that have science and data underpinnings largely generated from organizational partners and colleagues. Our goal of presenting this as an Almanac is to ground the monthly topics in the context of seasonal change and the interests of our readers as the year unfolds. In 2026, we focus on exploring elevational gradients across the region: how they drive processes and reveal patterns. We purposefully coalesce science, art, and storytelling to communicate what our science-based monitoring and studies are presenting. Key to this project is the collaboration across organizations that have ongoing long-term monitoring efforts in the region. The people involved are living, observing, measuring, and playing in the White Mountains and are therefore invested in its health, beauty, and sustainability. The ultimate goal is to enthrall our audience as nature does, generate curiosity and passion for this place we work and love. Join us in our journey and enjoy the seasons.

Co-written by scientific leaders Georgia Murray, Sarah Nelson, and Jay Broccolo.

About the Creators

Athena Hendrick (they/she) - Lead Author

Athena is a naturalist with specialization in place-based education and climate change communication. While their work has taken them to a myriad of landscapes, Athena's home will always be the Northeast Kingdom of Vermont. The wisdom passed on by their family and community instilled the invaluable importance of local ways of knowing. Paired with a degree in Environmental Studies, Athena values the interdisciplinary storytelling crafted when combining scientific research with lived experience.

Athena will always be grateful for their 6th-grade science teacher, Mr. Wurzburg, for his dedication to environmental education and facilitation of annual trips to the Appalachian Mountain Club (AMC) High Mountain Huts, the St. Johnsbury Academy Outing Club for leading trips to the White Mountains and beyond, and their time working as a naturalist on AMC hut croos. As an artist and activist, Athena knows the value of inspiring wonder, conversation, and structural change.

Kathryn Hawkes - Lead Researcher

Kathryn is the lead climate science data analyst and co-author of the second edition of the *White Mountains Almanac*. Growing up in North Conway, New Hampshire, she has the privilege of calling the White Mountains home. It was here she developed an early and enduring fascination with the way the weather and climate shape the natural world.

Kathryn graduated from Colorado College in 2025, where she studied Environmental Science and Statistics. Her studies took her across the Rocky Mountains and the globe, where she conducted field research amid some of the most dramatic and rapidly changing landscapes on earth. These experiences broadened her understanding of climate science and reinforced her appreciation for the places, like the Whites, where weather is not just a backdrop, but a defining force.

Her internship brought her full circle back to the mountains she grew up exploring, this time from the summit of Mount Washington. She spent the first part of 2026 living and working at the Observatory, researching and analyzing long-term climate and ecological datasets from all three partner organizations and examining how decades of change are written into the landscapes below. In her free time, Kathryn enjoys skiing, hiking, mountain biking, traveling, and spending as much time outside as the weather will allow.

Mark Lesh - Artist

Mark is a Vermont-based illustrator, information designer, and art director with more than 20 years of experience working in print and digital media. He is an avid cyclist, skier, and hiker who loves spending time with his family traveling the forests and mountains of northern New England and beyond. His creative work is rooted in his experience as a geologist and science educator, and shaped by a lifelong love of maps, information graphics, and scientific illustration.

Mark began drawing pen-and-ink house portraits and landscapes in high school, captivated by the challenge of conveying form and depth through the simplicity of line and minimal color. Working with maps and geographic information systems during undergraduate and graduate studies in Earth Sciences ignited Mark's interest in cartography and map illustration which eventually led him to the publishing industry where he has worked as an art director and graphic designer for numerous outdoors and travel-related publications. Mark has recently renewed his focus on illustration, developing a growing body of work for the National Academies of Science, Engineering, and Medicine as well as creating fine art prints available in local gift shops, online, and by commission.

Welcome to the White Mountains Almanac

The White Mountains are a subset of the Appalachian Mountain range. Home to the world's worst weather and the largest expanse of the lowest alpine zone, the White Mountains have been a site of long-term climate and ecological research. From acid rain to mountain flowers, it has an expansive science history.

Throughout the Almanac, when discussing climate and weather phenomena we used the **meteorological seasons** as a framework. These differ from **astronomical seasons**, which are defined by the tilt and orbit of the Earth signified with solstice and equinox events. When discussing ecological processes there is a focus on **phenology**, the study of the timing of annual patterns of the life cycles. This allows us to investigate how living organisms respond to environmental cues and how climate change may be influencing these seasonal events.

The White Mountains have been getting warmer and wetter. There has been an increase in extreme weather, including droughts, rainfall, and snow events. The timing of many phenological events has changed. How has this impacted you? Think of the recent summers of 2023 and 2025, which were the wettest and driest in New Hampshire record, respectively. Only two years apart, they had extremely different effects on day to day routines, recreation, public health, infrastructure, and the economy. Bring to mind some memories from each summer and consider how they shaped your life.

Living in the era of climate change creates an undeniable emphasis on the importance of local community and resilience. As humans, we need a sense of place and belonging. What do we do when this is being impacted directly and indirectly? While we often hear about global trends, it is important to see the tangible improvements and solutions already being implemented in the region, from hiking trails to snowmaking technology and beyond. Throughout this publication there are resources to learn more and get involved. These are invitations to craft personal agency and join established collective action. Science and climate change communication can be informative, relevant, and hopeful. Beyond these pages the journey of this work is up to you. What stories will you write in your lifetime?

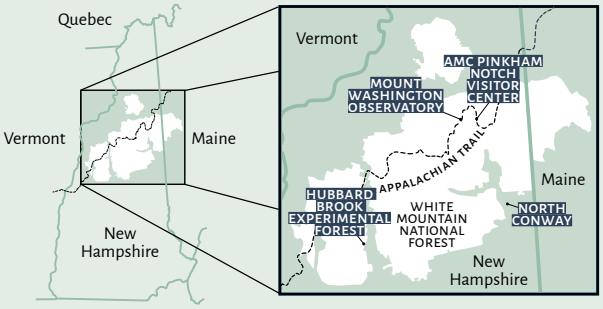
Type:		Meteorological	Astronomical
Season in the Northern Hemisphere:	Winter	December, January, February	Solstice - March 20th
	Spring	March, April, May	Equinox - June 21st
	Summer	June, July, August	Solstice - September 21st
	Autumn/Fall	September, October, November	Equinox - December 21st



First rime and snow of the season looking at the summit sign at sunrise. Photo by MWOBS.

Year-Long Trends

The long-term data collections of the Mount Washington Observatory, AMC Pinkham Notch Visitor Center, and Hubbard Brook Experimental Forest reveal seasonal and climate trends.



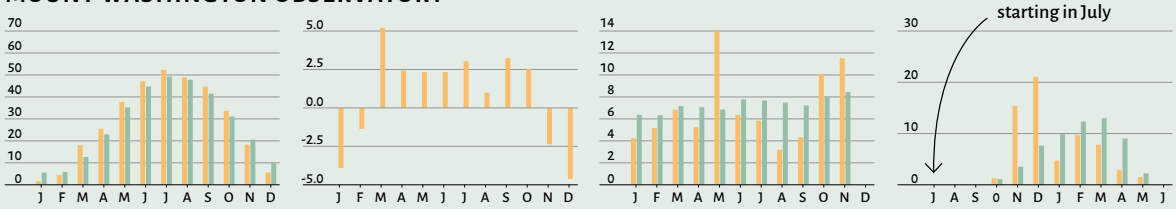
AVERAGE TEMPERATURE (°F)
2025
Full Record

TEMPERATURE ANOMALY (°F)
2025

AVERAGE PRECIPITATION (INCHES)
2025
Full Record

AVERAGE SNOW DEPTH (INCHES)
2025
Full Record

MOUNT WASHINGTON OBSERVATORY



APPALACHIAN MOUNTAIN CLUB PINKHAM NOTCH VISITOR CENTER



HUBBARD BROOK EXPERIMENTAL FOREST

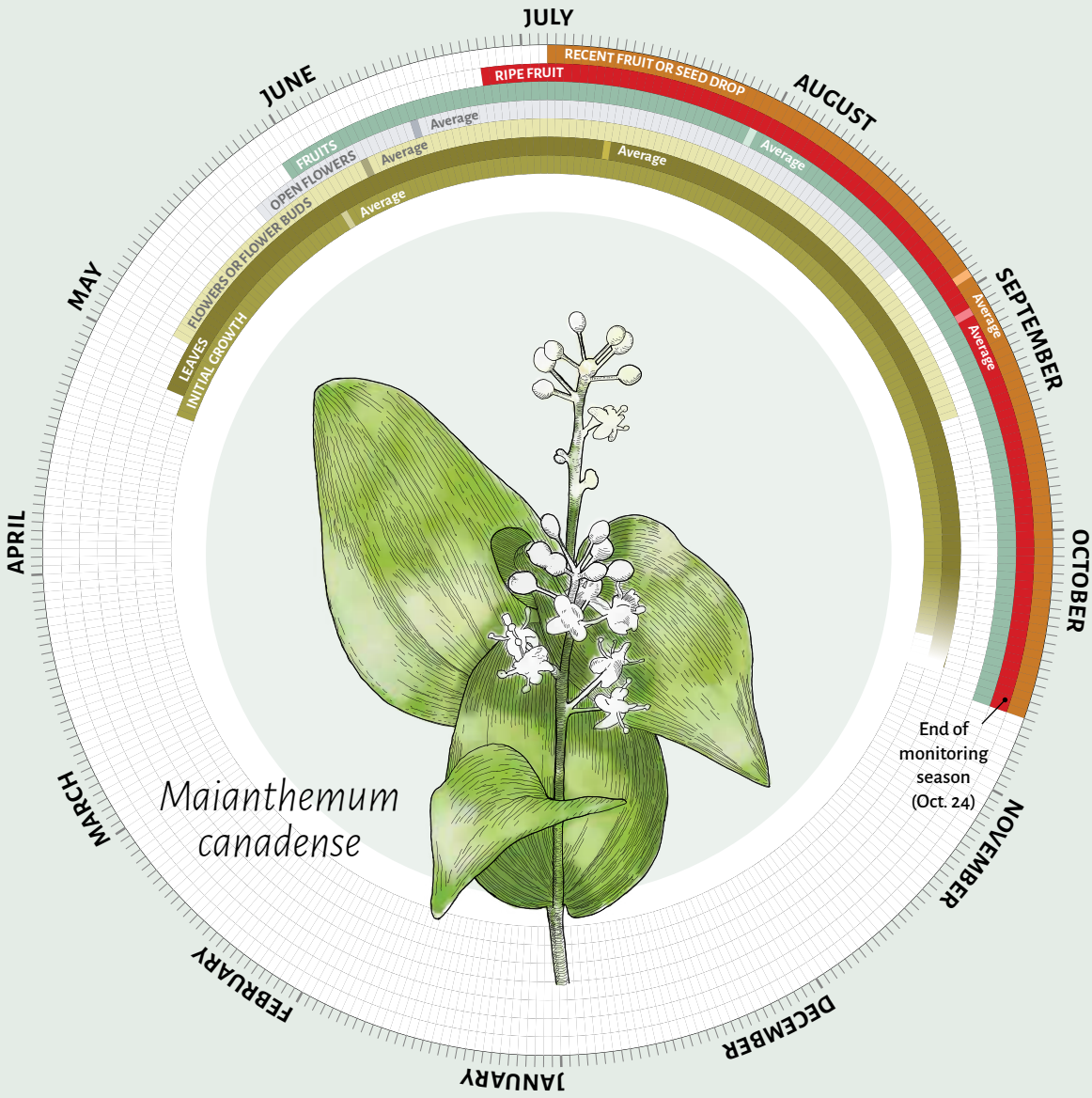


NORTH CONWAY, NEW HAMPSHIRE



Canada Mayflower Phenology Wheel

By visualizing the timing of annual patterns, phenology wheels provide insight into life cycles and how they may be impacted by climate change.



JANUARY

Mount Washington Valley Snowfall

"In the heart of the Granite State's winter, the world seems to pause, allowing us to marvel at the intricate lacework of snowflakes and the crystalline beauty of a frozen moment."

— Rachel Carson

A quiet morning with the White Mountains covered in freshly fallen snow is both peaceful and buzzing with excitement. Snow clings to spruce branches, swallowing sound except for the hoots and hollers of pure joy from folks celebrating the magic of winter. Snowstorms range from light, airy powder of skiers' dreams to heavier, wetter snow that bends tree branches. Some even end in rain, leaving behind a thick crust on the "ice coast."

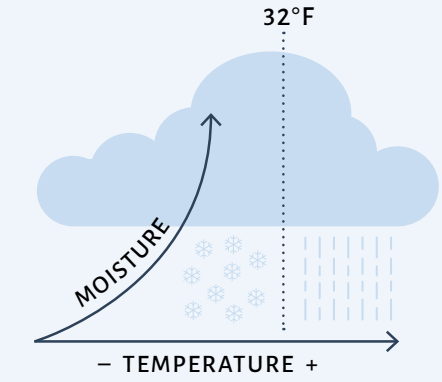
This variability is a natural part of winter in the Whites, adding to the dynamic feeling of the region. Yet, snowfall and the very character of winter itself is changing (Bergeron, 2022; Lemcke-Stampone et al., 2022; Outdoor Recreation Industry Development, 2023). The Northeast has experienced an increase in the proportion of winter precipitation falling as rain rather than snow, and this trend is projected to continue over the 21st century (Burakowski et al., 2022; Climate Central, 2024; Huntington et al, 2004). The New Hampshire Climate Assessment (2021) projects that as winters continue to warm, regional snowfall will likely decrease by 20-50% by 2099. Yet, the most extreme snowfall amounts are projected to have a much slower decline than the average, so while the frequency may lessen, there will still be extreme snow storms (McCray, 2023).

Why It Matters:

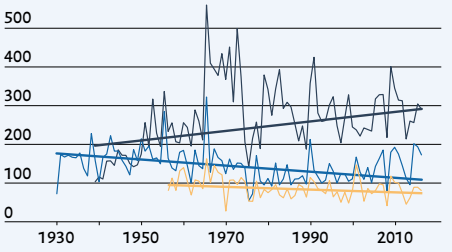
- Studies have demonstrated a decrease in snowpack (depth and duration of seasonal accumulation of slow-melting packed snow) and snowfall (total annual and seasonal range), as air temperatures warm and winter rainfall increases in the Mount Washington Valley (Burakowski et al., 2022; Climate Central, 2024; Huntington et al, 2004; Lemcke-Stampone et al., 2022; Murray et al., 2021).
- New Hampshire is one of the top ten states where winter recreation is a key economic driver. In the 2018 season, in-bounds skiing, snowboarding, and nordic skiing contributed a total of $508 million, while snowmobiling contributed $298 million (NH Department of Business and Economic Affairs, 2025; Outdoor Recreation Industry Development, 2023).
- Future emissions scenarios suggest that the winter recreation season is likely to become increasingly shorter throughout much of the Northeast as winters continue to warm (Burakowski et al., 2022; Climate Central, 2024).
- Snow sports are deeply embedded in local culture and identity. Many activities rely on a deep snowpack and some are not able to use advancements in snowmaking technology, such as snowmobiling and nordic skiing (Outdoor Recreation Industry Development, 2023).

Figure 1.1 (page 11 - top). Annual snowfall totals across the period of record at Mount Washington Observatory (1940-2025), Pinkham Notch (1930-2025), and North Conway (1957-2025). A snow year begins July 1st and ends June 30th. The concluding year represents said snow year (i.e. 2024-2025 snow year = 2025). Linear trend analysis revealed a loss of 7.9 inches per decade and 5.4 inches per decade at Pinkham Notch and North Conway, respectively, that is statistically very significant ($p<0.01$). Mount Washington Observatory has seen an increase by 11.4 inches per decade that is statistically significant.

Snowfall in the Mount Washington Valley



ANNUAL SNOWFALL TOTALS (IN.)

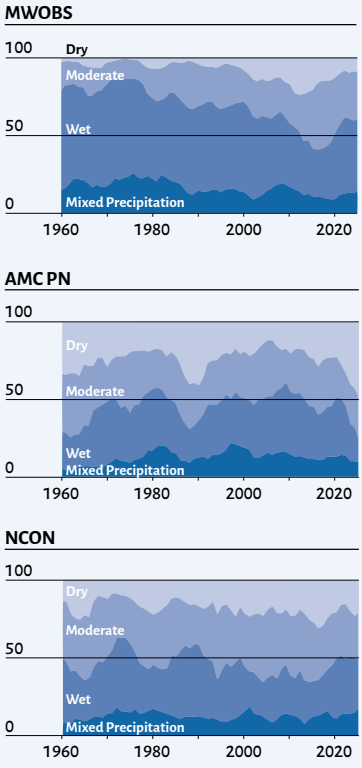


Mount Washington Observatory

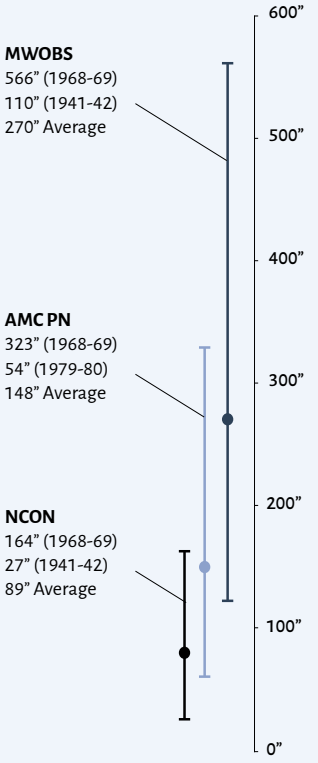
Appalachian Mountain Club Pinkham Notch

North Conway, New Hampshire

PERCENTAGE OF TOTAL SNOWFALL BY TYPE



ANNUAL SNOWFALL RECORDS & AVERAGES



SNOWFALL SNOW-TO-LIQUID RATIO THRESHOLD VALUES AND SNOW CHARACTERISTICS

SNOWFALL TYPE	MIXED PRECIPITATION	WET	MODERATE	DRY
Snow-to-Liquid Ratio (SLR)	1:1 < SLR ≤ 5:1	5:1 < SLR ≤ 10:1	10:1 < SLR ≤ 15:1	15:1 < SLR
Inches of Snowfall per Inch of Water	1 - 5 in	5.1 - 10 in	10.1 - 15	15.1 or more
Pounds per Shovel	16 - 35 lbs	8 - 15 lbs	7 - 10 lbs	6 lbs & under
Best Activity	Fat Biking	Snow Sculpture	Snow-shoeing	Powder Skiing
Hazards	Instant Freezing & Slick Roads	Structural Collapse & Power Outages	Slick Roads & Tree Wells	Whiteouts & Wind Drifts
Snowflake Structure	Rimed crystals & graupel	Thin hexagonal plates & simple prisms	Sector plates & smaller stellar plates	Stellar dendrites

Figure 1.2 (middle). Yearly percentage of total snowfall contributed by each snowfall type, categorized using snow-to-liquid ratio, from 1960 to 2025. For this analysis, dates are limited to November 1st to April 30th.
Figure 1.3 (right). Annual snowfall records and averages across the period of record at Mount Washington Observatory (1940-2025), Pinkham Notch (1930-2025), and North Conway (1957-2025).

Changes in Snowfall

Pinkham Notch (2,032') and North Conway (525') have had a decrease in annual snowfall of 7.9 inches and 5.4 inches per decade, respectively, which is statistically very significant (p<0. 01) (Figure 1.1). In contrast, the Mount Washington Observatory (6,288') has seen an increase in annual snowfall that is statistically very significant: 11.4 inches per decade since 1940. This aligns with the findings in previous studies looking at snowfall in the Mount Washington Valley and Northeast (Burakowski et al., 2022; Climate Central, 2024; Lemcke-Stampone et al., 2022; Murray et al., 2021). As the atmosphere warms it is able to hold more moisture, so some places are receiving an increase in snowfall, as seen on the summit of Mount Washington (Figure 1.1; Climate Central, 2024). Yet, once we lose freezing winter temperatures, we stand to lose more snow, even at high elevations.

Snow-to-liquid Ratio Trends

To better understand the changes in snowfall type, the snow-to-liquid ratios (SLR) of snowfall were analyzed for winters 1960 to 2025 at Mount Washington Observatory (Mount Washington Observatory, 2026), Pinkham Notch, and North Conway (Cornell University, 2026). **Snow-to-liquid** ratio (SLR) represents how many inches of snowfall are equivalent to one inch of melted water (See Equation E.2.1) and is the inverse of snow density. Higher SLR values indicate drier/lighter snow- less dense, while lower values show wetter/heavier snow- more dense. Snow density is impacted by a variety of factors, including temperature, humidity, elevation, and wind - typically decreasing with colder temperatures and lower humidity (Peachey, 2024).

In this analysis, SLR ranges were divided into four categories of snow: dry, moderate, wet, and mixed precipitation (See page 11) (Peachey, 2024; Baxter et al., 2005). The snow year was defined as November to April to reflect the winter snow season. Snowfall measurements were collected in a precipitation can (an open-topped cylindrical device that collects solid and liquid precipitation) at a frequency of every six hours (Mount Washington Observatory) or once a day (Pinkham Notch and North Conway). This snow was melted and measured again to determine the liquid equivalent. These measurements were then used to calculate SLR proportions by dividing the total snowfall by its liquid equivalent. The percentage of snowfall by type was determined by the total snowfall in each SLR category per snow year for the temporal analysis and per day across the 1960 to 2025 period for the seasonal analysis. This analysis did not look at the frequency of events or relative snowpack.

What the Data Tell Us:

From 1960 to 2025,

- *At Mount Washington Observatory, the proportion of*
  - dry snowfall increased by an average of 6.5%
  - moderate snowfall increased by an average of 16.9%,
  - wet snowfall decreased by an average 14.3%
  - mixed precipitation decreased by an average of 7.8%
- *At Pinkham Notch, the proportion of*
  - dry snowfall did not have a statistically significant trend
  - moderate snowfall decreased by an average of 9.1%
  - wet snowfall increased by an average of 5.6%
  - mixed precipitation increased by 5.2%
- *At North Conway, the proportion of*
  - dry snowfall increased by an average of 10.4%
  - moderate snowfall did not have a statistically significant trend
  - wet snowfall did not have a statistically significant trend
  - wet snowfall decreased by an average of 9.8%.

In the Northeast, the climatological average SLR is 13:1, whereas Mount Washington Observatory experiences a slightly denser average of 10:1 (Baxter et al., 2005; Hutton, 2023). This difference reflects the summit's extreme environment and the impact local conditions have on SLR,

such as high winds fracturing snowflakes and causing surface compaction (Roebber et al., 2002). Overall, lower elevations are seeing declines in the middle ground, emphasizing growing variability.

Snowpack Development & Yearlong Effects

Since 1971 in the Lake Winnipesaukee Watershed and Central New Hampshire, there has been a decline in the annual maximum snow water equivalent, showing a reduction in the amount of water stored in the snowpack (Lemcke-Stampone et al., 2022). As the water stored in snowpack declines and winter rainfall increases, there will be an increased flooding risk, shift in the magnitude and timing of spring runoff, and reduced groundwater storage (Demaria et al., 2016; Huntington, 2003; Huntington et al., 2004).

While it is common knowledge that snow and the experience of winter in the White Mountains is changing, understanding how snowfall and snowpack are shifting allows for adaptation. For example, local ski resorts are applying new snowmaking technology to become more resilient to winter rainfall and reduced snowfall (The New Hampshire Climate Assessment, 2021).

Get Involved

Join local citizen-science programs monitoring snowfall and precipitation! Individuals who make observations for citizen science projects directly support conservation efforts and deepen their connection to natural communities (Bonney et al., 2016; McKinley et al., 2017; Tourville et al., 2024).

Community Snow Observations. Join at *communitysnowobs.org*

Community Collaborative Rain, Hail & Snow Network (CoCoRaHS). Join at *cocorahs.org*

Mountain Rain or Snow. Join at *rainorsnow.org*

Learn More

Protect Our Winters (POW).
Visit *protectourwinters*

Key Takeaways:

- Over the period of record, the average annual snowfall at North Conway and Pinkham Notch has decreased by an average of 36.7 inches and 75.1 inches respectively, statistically very significant (Figure 1.1). Mount Washington Observatory, however, has increased by 96.9 inches.
- In the past 65 years, there have been statistically significant changes to the proportions of snow-to-liquid ratio at Mount Washington Observatory, Pinkham Notch, and North Conway (Table 1.6). The proportion of:
  - dry snow has increased at Mount Washington Observatory and North Conway,
  - moderate snow has increased at Mount Washington Observatory while decreasing at Pinkham Notch,
  - wet snow has decreased at Mount Washington Observatory and North Conway while increasing at Pinkham Notch,
  - mixed precipitation has declined at Mount Washington Observatory while decreasing at Pinkham Notch.
- As the density of snow shifts to the extremes and snowfall declines, there are implications for local recreation, public safety, and the economy.

In snow,

two of us keep watch
over the lip of the
ravine,
turning our faces to sun
and the mountain side—
he with his eight-point
rack,
me with my glasses,
ballpoint pen,
each of us chewing over
our day—
it's warm for winter,
and I remember
his father or
grandfather
just there, years back,
forty-below, studying
mountains
as I was studying him.

— *Robin Chapman*

FEBRUARY

Earlier Lake Ice-Out

Frozen lakes are a foundational element of the culture of the White Mountains. Winter enthusiasts take the opportunity to walk on water. People can be found playing pond hockey, ice skating, cross-country skiing, snowshoeing, snowmobiling, and ice fishing. With over 800 lakes and ponds throughout the state, ice coverage is deeply intertwined with local identities and livelihood (State of New Hampshire, 2026).

Life of a Lake

Each winter as the air temperature drops, the cold water begins to rise. At 32°F, ice begins to form across the surface. This is an annual reset for seasonal ice-covered lakes. Throughout the winter, surface ice acts as an insulating blanket to regulate temperatures and sunlight below the surface (Hampton et al., 2024). The ice functions as a barrier from winter storms and prevents lakes from freezing solid (Anderson et al., 2024; Hampton et al., 2024). The presence of ice on the surface is vital for aquatic life to survive over the winter (Hampton et al., 2024; Sharma et al., 2024).

In the spring, as the ice melts, the lake experiences **turnover** when the entire column of water equalizes in temperature, allowing surface water and bottom water to mix. This brings nutrients to the surface and revitalizes oxygen in deep waters.

When the surface of a lake is covered in ice, it is marked as **ice-in**, and the timing of break-up is described as **ice-out**. Both are being impacted by climate change: long-term lake ice records reveal that globally lakes are freezing later, thawing earlier, or both (Benson et al., 2012; Hampton et al., 2024; Sharma et al., 2024). Many lakes are transitioning from annual to intermittent ice cover, with winter open-water periods and some ice-free winters (Hampton et al., 2024).

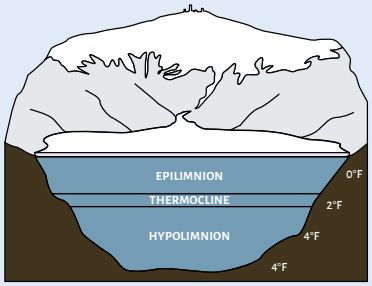
Throughout the Northern Hemisphere, lake ice formation has arrived 11 days later per century, and ice melt has arrived 6.8 days earlier on average (Sharma et al., 2022; Hampton et al., 2024). In New England between 1850 and 2000, ice-out occurred 9 days earlier in the northern mountainous regions and 16 days earlier in the southern regions (Hodgkins, 2002). This aligns with research suggesting ice-out timing is influenced by the local climate, elevation, and amount of snow on the lake's surface in late winter (Dykema et al., 2025).

An earlier ice-out has been shown to impact lake ecosystems (Hampton et al., 2024; Sharma et al., 2024). Aquatic species are threatened by warming, as it disrupts food webs, lifecycle timing, and stability within the ecosystem (Hampton et al., 2024; Sharma et al., 2024). Since waterfowl use lake ice as a migration cue and signal to begin establishing breeding habitat, delayed freezing is impacting their fall departure and the timing of spring breeding (Anderson et al., 2024; Bianchini et. al, 2021). There has been a mixed impact on loons, with an increase in iced-in loons with erratic freezing and an increase in breeding success with earlier ice-off (Bianchini et al., 2021; Schoch et al., 2024). This shows climate change's influence on lake ice has nuanced impacts on loon populations.

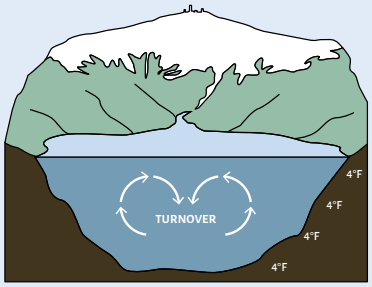
Seasonal ice cover and quality has varying socioeconomic and public safety impacts. Even when lakes do freeze over completely, ice is destabilized by warming temperatures, and rain-on-snow freeze-thaw events. The impact on the structural integrity of the ice can be difficult to determine (McCoy et al., 2026). Even if it maintains thickness after refreezing, the lake's surface may develop ice shelves, where water is situated between solid ice (McCoy et al., 2026). This reduces the weight ice can hold even if it maintains its thickness, correlating with an increased risk of people falling through the ice and drowning (Hampton et al., 2024). This poses concerns for safety, especially since there were more incidents during ice-in and ice-out than any other timeframe (Hampton et al., 2024).

Changes in Seasonal Ice Cover on Lakes

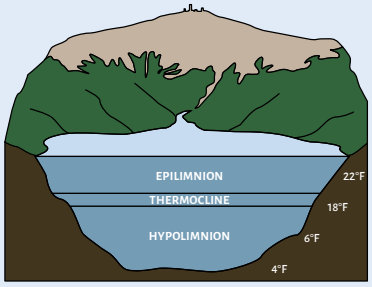
SEASONAL LAKE TURNOVER



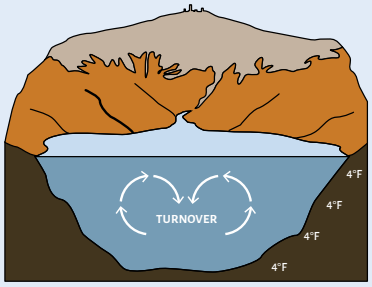
Winter



Spring



Summer



Fall

ICE-OUT TIMING — BY THE NUMBERS

Throughout the Northern Hemisphere:

11 days ----→ lake ice formation has arrived later per centuy

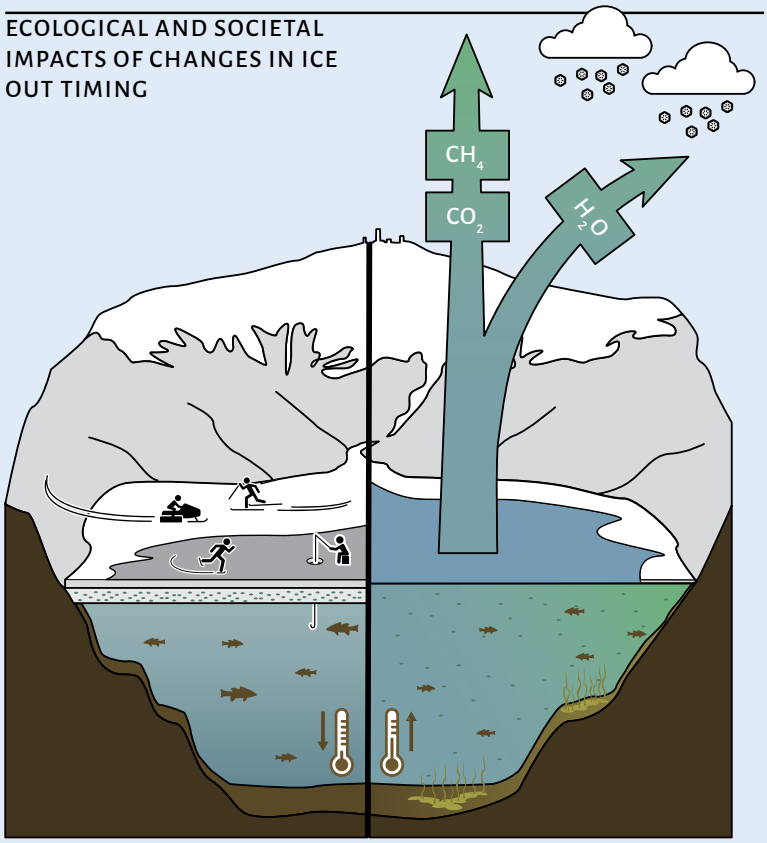
6.8 days ----→ ice-out has arrived earlier on average

In New England between 1850 and 2000:

9 days ----→ ice-out occurred earlier in the northern mountains

16 days ----→ and earlier in the souther regions

ECOLOGICAL AND SOCIETAL IMPACTS OF CHANGES IN ICE OUT TIMING



Why It Matters:

- Globally, seasonal ice-covered lakes have been freezing over for shorter periods, including lakes in New England.
- Lake ecosystems and water quality depend on seasonal ice coverage and melt timing.
- Warmer winter temperatures decrease ice stability, which poses safety risks.
- Ice-based recreation is an important part of local culture — tied to both individuals' sense of place and the tourism-based economy.

A Closer Look at Local Lake Ice-out

How have lake ice-out dates changed in and around the White Mountains? In 2024, lake ice-in on Lake Winnipesaukee wasn't declared until Feb. 9, the latest date since at least 1887, when it started being recorded (NHDES, 2025). This was followed by the earliest ice-out on March 17 (NHDES, 2025). That's less than six weeks frozen. To learn more about the regional trend, lake ice-out dates were examined at 6 lakes in and around the White Mountains. Throughout this investigation, lake ice-out was defined as the earliest date when a boat could travel across the lake. Some ice may remain in the lake for this definition to be applicable.

Ice-out dates were collected from a lake monitoring study conducted by the New Hampshire Department of Environmental Services for Lake Winnipesaukee, Stinson Lake, and Squam Lake (NHDES, 2025) (Figure 1.1). Additional ice-out data for Lake Umbagog, Lake Sunapee, and Kezar Lake were gathered from a United States Geological Survey study and Maine Department of Agriculture, Conservation and Forestry monitoring study (Hodgkins, 2010; MDACF, 2025). These data were analyzed for trends in ice-out



Figure 2.2. Lakes examined for ice-out dates.

dates over each lake's respective period of record (Figure 2.3) and aggregated together (Figure 2.4).

What the Data Tell Us:

- The regional lake ice-out trends indicate that five out of six lakes (Winnipesaukee, Sunapee, Stinson, Umbagog, and Kezar) have experienced statistically significantly earlier ice-out since 1869 (Figure 1.2), and the remaining one with the shortest record (Squam) showed no change.
- On average, lake ice-out dates in this region are shifting earlier by 0.6 days per decade, a statistically significant trend (Figure 2.3).
- Over this period of data collection (approximately 150 years), ice-out dates shifted an average of 9 days earlier (Figure 2.4).

Overall, these results show that lakes in and around the White Mountains have been experiencing an earlier average ice-out date. The trends align with other studies in New England and the Northern Hemisphere (Dykema et al., 2025; Hodgkins et al., 2002; Magnuson et al., 2000; Mitchell, 2022).

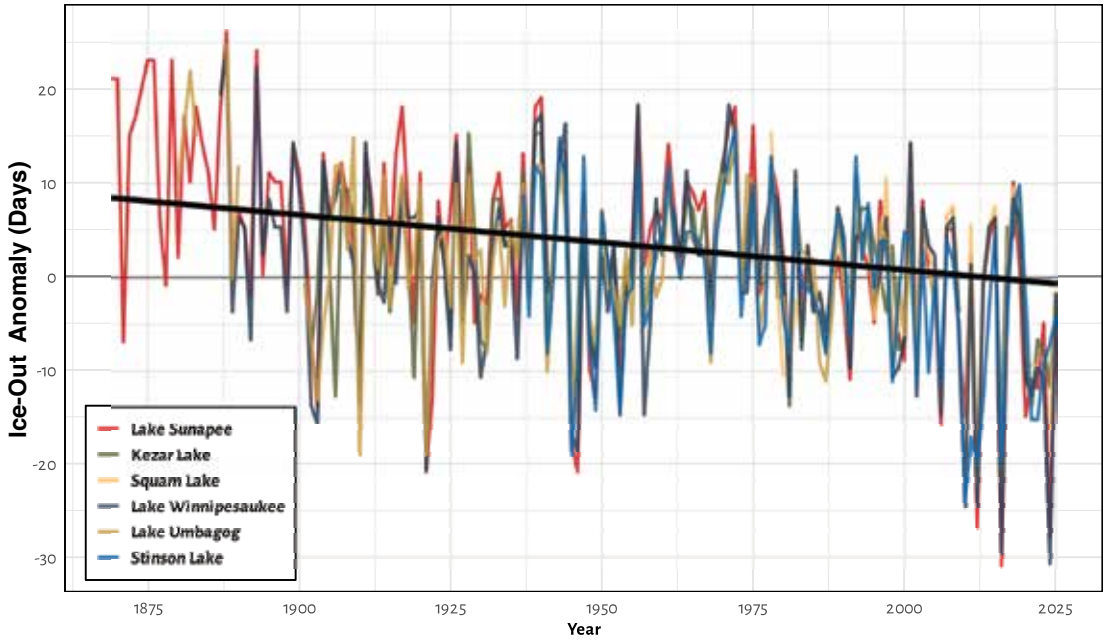


Figure 2.3. Lake ice-out anomaly shows how much a given year differs from the average conditions during a specific reference period, here using a period of 1978 – 2007 (See Equations E.1.1 and E.1.2. The data revealed an average of 0.6 days of ice lost per decade. This equates to a total of 9 days lost over the approximately 150-year record. The linear trend line fit over the average of the data reveals a statistically very significant negative relationship (p<0. 01).

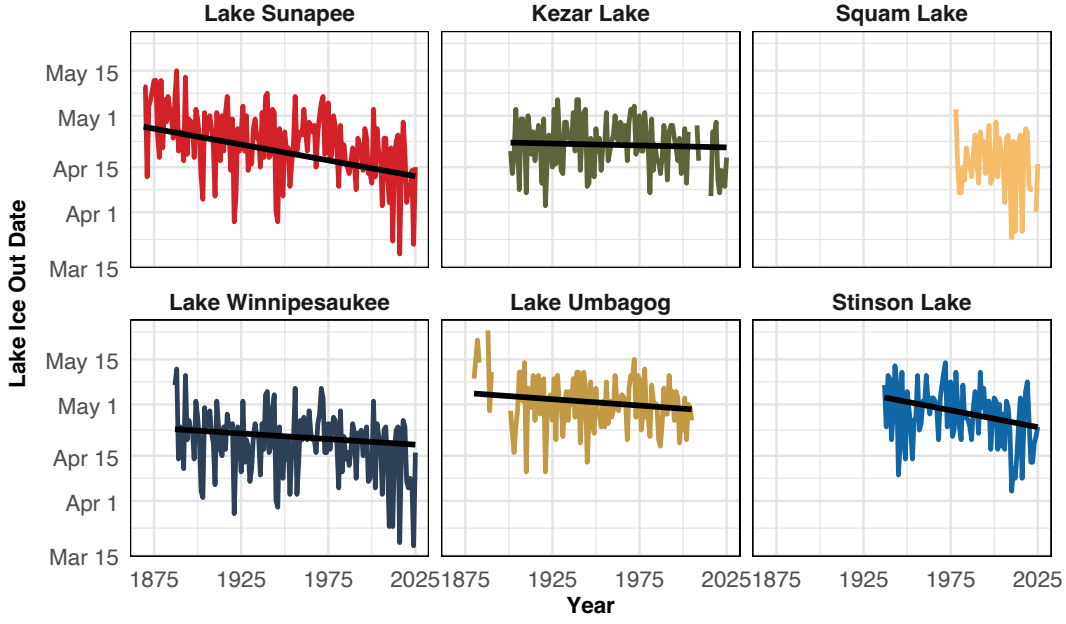


Figure 2.4. Linear trend analysis reveals statistically very significant (p<0.01) trends towards earlier lake ice-out for all of the above lakes with the exception of Squam. Sunapee (period of record (POR): 1869-2025) and Stinson (POR: 1937-2025) are losing 1.0 days per decade, while Lake Winnipesaukee (POR: 1887-2025), Umbagog (POR: 1880-2005), and Kezar (POR: 1901-2025) are losing 0.3, 0.4, and 0.1 days per decade, respectively. Squam Lake (POR: 1978-2025) has no statistically significant trend.

There are clear potential impacts on the health of New Hampshire's lakes. Winter ice influences oxygen availability and moderates summer water temperatures, and thus, changes affect water quality (Sharma et al., 2024; Figure 2.1). Changes to the timing of lake ice formation holds potential impacts for local wildlife, including increased stressors to cold water fish species and delayed signaling to migratory birds (Anderson et al., 2024; Magnuson, 2010; McCoy et al., 2026). Since lake size, elevation, and latitude affect the presence and duration of lake ice. Future research could help understand the influence of these varied characteristics.

How does a shortening ice cover season impact local culture? As the ice shrinks, the season of safe ice-based recreation also shortens. Unexpected timing and intermittent freezing and thawing lead to increased difficulty in assessing risks of lake ice and increase public safety concerns. Combined with the impacts on cold-water fish species, there is a risk to local ice fishing. The future of ice-based recreation in the White Mountains will rely on adapting traditions and updating safety protocols.

Key Takeaways:

- Lakes in and around the White Mountains have been seeing ice-out 9 days earlier on average over the last 150 years.
- Shorter periods of ice cover have negative implications for winter recreation.
- Warming winter weather destabilizes the lake ice and increases the risk of falling through the ice and drowning.
- While the ramifications of earlier ice-out are nuanced and varied, there is a clear increase in ecological stressors in New Hampshire's lakes.

Get Involved

Join your state's citizen-science program and monitor the timing of ice-out in local lakes!

New Hampshire Department of Environmental Services' Volunteer Lake Assessment Program.

Volunteer Lake Monitoring Program with Lake Stewards of Maine. Visit ***https://www.lakestewardsofmaine.org/***

Learn More

Local resources discussing lake ice, ice safety, ice-based recreation, lake ecology, and more!

New Hampshire Department of Environmental Services. Visit ***des.nh.gov.***

New Hampshire Fish and Wildlife. Visit ***wildlife.nh.gov.***

NH Lakes. Visit *nhlakes.org*.

THE FROZEN LAKES

Edwina Reizer

The lakes are frozen again.
They look like silver glass.
The cold winds from the north do blow
and another winter must pass.
The life that's under this wintry scene
conserves its energy.
It awaits the warmer approach of spring
to lift this canopy.
And when it feels the crackling ice
and the warmth of the sun
it will rise to the surface in its annual search
for food to overcome
the stillness it's known in the deepest water
that now seems to be done.
Life returns to the lakes again
as the ice does disappear.
The water comes alive again
and once again we hear
its life



Alpenglow on the summit observation tower.
Photo by MWOBS.

Maple Sugaring Season Shifts Earlier

"Drinking maple syrup gives you quite a sugar rush. This too is what it means to be a citizen of Maple Nation, having maple in your bloodstream, maple in your bones. You are what we eat, and with every golden spoonful maple carbon becomes human carbon. Our traditional thinking had it right: maples are people, people are maples." (Kimmerer, 2013).

Maple sugaring is a seasonal ritual and one of the oldest agricultural practices in North America with roots tracing back to Indigenous communities who first discovered how to collect sap and turn it into sugar (Ahmed et al., 2023; Kimmerer, 2013; University of Vermont, 2024). Today, maple sugar is still deeply woven into the cultural and economic fabric of the Northeast, which produces approximately 80% of the maple syrup in the United States, equating to an annual value of $160 million (NASS, 2025).

Sap flow follows the rhythm of spring, with freezing nights and warm, sunny days with snowmelt increasing the soil water content (Ahmed, 2023; Milideo, 2024; Rapp et al., 2019; University of New Hampshire Extension, 2026). These freeze-thaw cycles are essential to sap runs, which build pressure within the trees, causing the sap to flow from winter storage in the roots to the branches (Vermont Maple Sugar Makers' Association, 2026). Sap does not have a continuous or even flow throughout the season and a few ideal days can yield 20% of a season's crop (Milideo, 2024). The season concludes after temperatures remain high enough to end the freeze and thaw cycle for more than a few days, when soil temperatures increase, and when buds begin to break (Kurokawa, 2025; Vermont Maple Sugar Makers' Association, 2026).

Maple Sugaring in a Changing Climate

In the Northeast, the maple sugaring season is shifting earlier, and the total length is shortening (Milideo, 2024; Kurokawa et al., 2005; Rapp et al., 2019). Short-term threats to maple producers include high wind events, late frost, or sudden, extreme warming episodes (Ahmed et al., 2023; Kurokawa et al., 2005; Milideo, 2024). For instance, in 2012 and 2021, the sap run ended prematurely after a series of unseasonably warm days when temperatures surpassed 70° (Milideo, 2024).

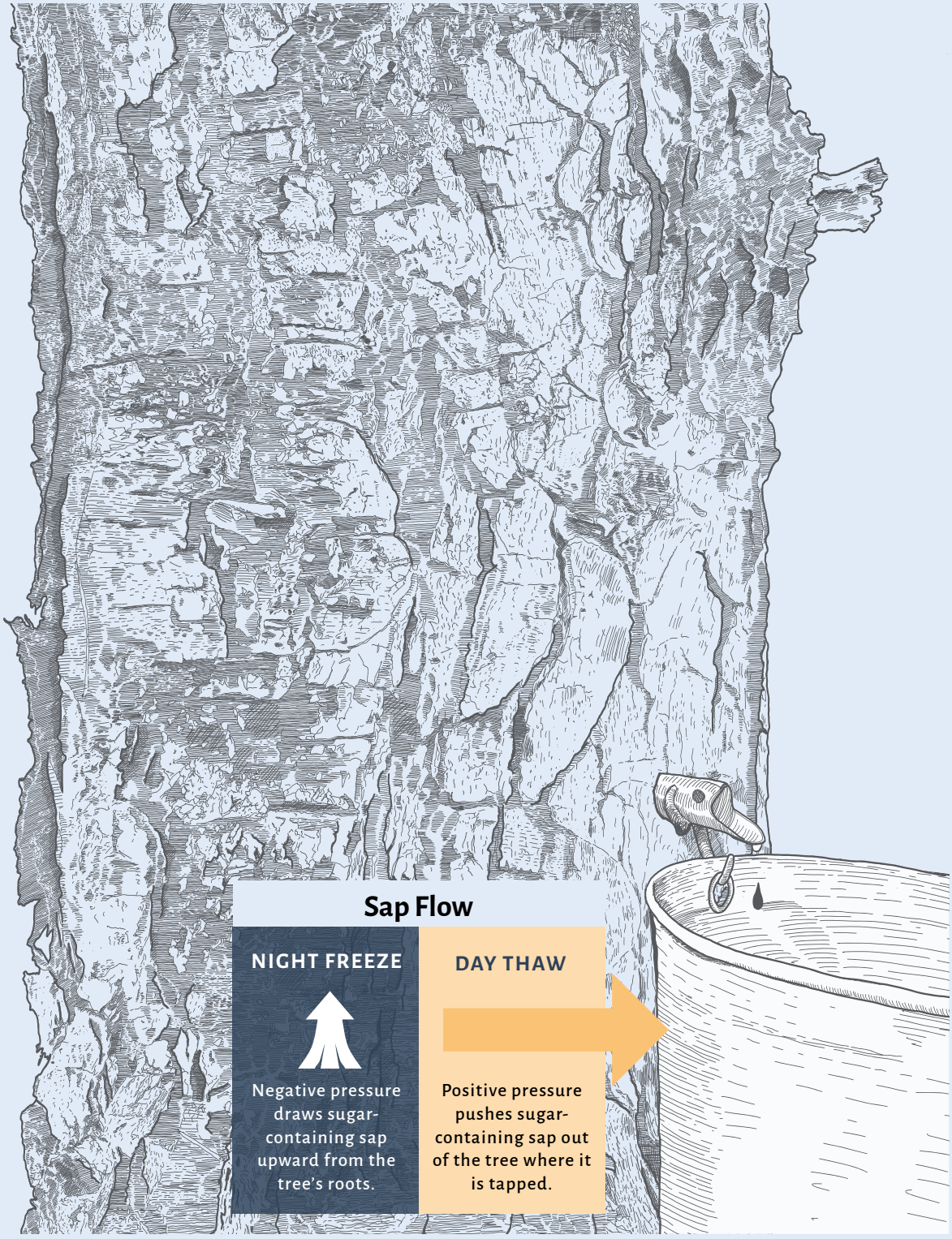
Long-term outlooks aren't so sweet either. An increase in stressors include increased temperatures, forest pests, damaged root systems, and changes in rainfall (Helmer, 2018; Moran, 2018; Reinmann, 2018; Reinmann, 2023). The loss of ideal conditions may impact the regeneration and growth of maple crop trees, ultimately being a major factor in determining whether sugaring remains sustainable long-term (Milideo, 2024).

"'Of course sugaring is a gamble every year. It's not like you can control the sap flow. Some years are good and some aren't. You take what you get and be grateful for it. It all depends on the temperature, and that's out of our hands.' But that's not entirely true anymore. Our addiction to fossil fuel and current energy policies accelerate carbon dioxide inputs every year, unequivocally causing a global rise in temperatures. Spring comes nearly a week earlier than it did just twenty years ago." (Kimmerer, 2023, ibid).

A Local Look

This analysis looks at more than a century of temperature data from four long-term weather stations: Berlin, Concord, and Keene NH, and

Optimal Conditions for Sap Flow



St. Johnsbury, VT. Using daily minimum (T_{min}) and maximum temperatures (T_{max}) from the Global Historical Climatology Network (NOAA, 2025), a "potential sugaring day" was defined as one in which T_{max} rose above 40°F during the day and T_{min} dropped to (or below) 32°F (Kurokawa et al., 2005). These are the general conditions that support the freeze-thaw cycles needed for sap flow. Once these freeze-thaw cycles stop for several days or bud burst occurs, sap flow decreases and eventually ends for the season (Kurokawa et al., 2005). To account for this in the analysis, the sugaring season ends when T_{min} remains above 32°F for at least 7 consecutive days to ensure a sustained cessation of freeze-thaw cycles and not a brief warm period that may not have as severe an influence on the sugaring season. We recognize that sap flow is impacted by snow cover, regional climate, temperature changes, sun exposure, wind, atmospheric pressure, and the physical characteristics of individual trees, therefore our use of the minimum and maximums temperatures is a simplified proxy for change over time. From these data, each sugaring season was examined to determine when these temperature swings occur. The median potential day with sap flow was determined for each season (See Equation E.3.1).

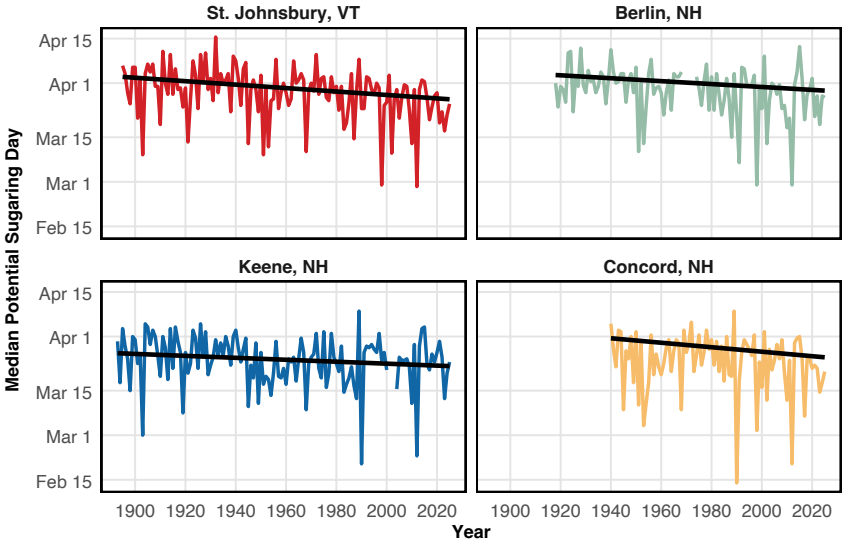


Figure 3.1. Median potential sugaring day during the sugaring season (February - April) in Berlin (1918-2025), Keene (1893-2025), Concord (1939-2025), and St. Johnsbury (1894-2025). Linear analysis revealed statistically very significant trends ($p<0.01$) for all sites, with St. Johnsbury shifted earlier by 0.5 days per decade, Concord by 0.7 days per decade, Berlin by 0.5 days per decade, and Keene by 0.3 days per decade.

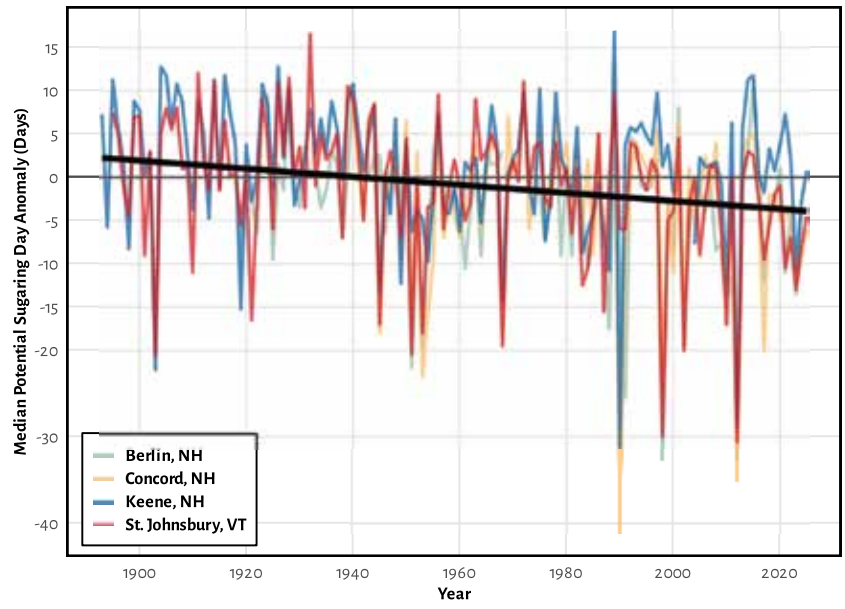


Figure 3.2. Median potential sugaring day anomaly from 1893 to 2025, with a baseline of 1940-1969 (Equations E.3.2 and E.3.3; See Appendix B for more information on anomalies). Across the data, the median potential sugaring day is shifting 0.6 days per decade earlier, and this shift is very statistically significant ($p<0.01$) in the season by 0.6 days per decade. This is an earlier shift of up to 7.5 days across the record.

What the Data Tell Us:

- Across all four locations, there is an earlier shift in median potential sugaring days that is statistically very significant (Figure 3.1).
- Comparing modern seasons to a mid-20th century baseline (1940-1969), the median timing of freeze-thaws has shifted earlier by about 0.6 days per decade on average (Figure 3.2).
- This totals to nearly 8 days over the 132-year period.

Maple Producers are Adapting Practices

Sugar-makers remain concerned about the threats posed by climate change, but are committed to incorporating strategies and technology to adapt as best they can (Milideo, 2024). Responses include short-term technology to increase volume and long-term management to consider a future with increased stressors. A survey found that the majority of producers have adapted their harvesting practices to climate effects (Ahmed et al., 2023).

Short-term strategies include harvesting practices such as changing the type and number of taps, and sap processing practices focused on the integration of technology, such as the use of an evaporator and reverse osmosis (Ahmed et al., 2023). By collecting sap via a combination of tubing and pumps instead of metal buckets, the operator can continue gathering sap even in less-than-optimal temperatures while also allowing a syrup operation to take full advantage of a good sap run (Milideo, 2024). This can double the sap volume collected over the course of a season, assuming the tubing system is well-maintained, and the pumps are managed in a way to harvest sap during each run. Longer-term management practices include stand management practices such as diversification of sap species tapped, and marketing practices, such as innovation of products and different maple syrup characteristics (Ahmed et al., 2023).

In the White Mountains, where seasonal change shapes both landscape and culture, maple sugaring continues to connect people to place. As the climate evolves, so too will this tradition. As long as winter gives way to spring and if there are sugar maples to tap, the story of maple sugaring will continue, adapting with the rhythm of the changing world.

Key Takeaways:

- The median potential sugaring day has shifted nearly 8 days earlier over 132 years, shifting potential sugaring days from late-March to early- to mid-March.
- Maple producers are implementing strategies to adapt to both short-term and long-term stressors in an effort to keep sugaring viable.

Get Involved

Become a community scientist volunteer and support your local sugar house!

Sugar Maple Regeneration Project: a partnership between the Hubbard Brook Ecosystem Study and the Society for the Protection of New Hampshire Forests. Join at ***hubbardbrook.org/community-partnerships-citizen-science/***.

New Hampshire Sugar Houses via ***www.nhmaplemap.com***

Learn More

Local resources on maple syrup production!

New Hampshire Maple Producers Association. Visit nhmapleproducers.com/

NH Maple Museum. Visit ***nhmapleexperience.com/about-nh-maple-syrup/***

Cornell Maple Program & the Maple Climate Network Dashboard. Visit ***cornellsaprun.com***

Proctor Maple Research Center. Visit ***uvm.edu/cals/proctor***

APRIL

Increasing Spring Mud Days

April is often a slow, soggy slide into spring with mornings that begin with frozen soil turning to mud by midday. Tuckerman's Ravine is flooded with backcountry skiers earning some of their last turns of the season. While winter enthusiasts stretch their final snow activities, the snowpack retreats and the meltwater replenishes groundwater and increases streamflow.

As soils thaw and become saturated, they function as both a reservoir and a point of vulnerability. Snowmelt replenishes groundwater and streamflow, while the soil is more susceptible to erosion, sediment transport, and compaction from vehicles and recreators (USDA, 2025). Disturbances during this period can weaken soil porosity and infiltration capacity (how much water can run through the soil), affecting runoff patterns and aquatic ecosystems downstream. Saturated soils are vulnerable to compression and rutting from vehicles and hiker activity. This can reduce infiltration, degrade water quality, and expand overland flow. This aftermath is why land management teams restrict seasonal road weight limits, timber harvests, and trail access to prevent long-term damage.

Investigating Increasing Spring Mud Days

As springs warm, it remains vital for towns, agencies, and landowners to understand mud days, and adapt regulations to conserve infrastructure and ecosystems. A mud day is defined as a day where the maximum daily temperature (T_{max}) is above the freezing threshold of 32°F (T_{freeze}) and the snow depth is zero inches (Contosta et al., 2019; Murray et al., 2021).

While there has been an increase of winter thaws throughout the Northeast, the analysis was restricted to meteorological spring (March-May), since the definition of mud day is relatively simplistic, and mud formation depends on other factors (soil moisture and rate of snow melt) (Burakowski, 2022; Harrison, 2020). This framework aligns with mud season, the time period when the frozen ground thaws and soil becomes saturated from snowmelt and spring rain (Harrison, 2020). Historical temperature and snow depth measurements in spring at Pinkham Notch, Hubbard Brook (USDA Forest Service, 2026), and North Conway (Cornell University, 2026) were used for this analysis. Snow

Why It Matters:

- From the 1930s to the 2010s, mud days occurring from November to May increased on the summit of Mount Washington by 1.4 days per decade, a statistically significant trend (Murray et al., 2021).
- The management and use of recreational trails, forest, and road infrastructure are impacted by the increase of mud days, since there is an increase in erosion, landslide risk, and soil compaction (Casson et al., 2019).
- Erratic freeze-thaw cycles impact water availability, forest health, and soil chemistry (Casson et al., 2019; USDA, 2025). More erratic freeze-thaws can impact when trees emerge from dormancy, their water storage and access capacities, and nutrient release and uptake during thawing (Contosta et al., 2019).



During mud season, every footprint can have a lasting impact. When hikers walk through soft, saturated trails, the soil becomes more vulnerable to erosion from rain and snowmelt, and damage can extend beyond the trail itself as people step off the path to avoid muddy sections. These impacts can contribute to trail widening and disturb sensitive forest ecosystems. If you're not prepared to embrace the mud, it's often best to postpone your trip or choose a destination with more durable trail conditions.

— Alex DeLucia
AMC's Director of Trails

depth measurements at Pinkham Notch and North Conway were recorded daily, whereas snow depths at Hubbard Brook were recorded weekly and interpolated to the rest of the days in each week. To see how the characteristics of mud days are changing, the thaw intensity of each mud day was also calculated. Thaw intensity (ΔT) is simply the T_{max} minus T_{freeze} (See Equation E.4.1). By calculating the cumulative thaw intensity, the magnitude of warmth across each spring can be examined. Higher cumulative thaw intensity reflects a combination of an increase in the number of mud days and how warm each day became.

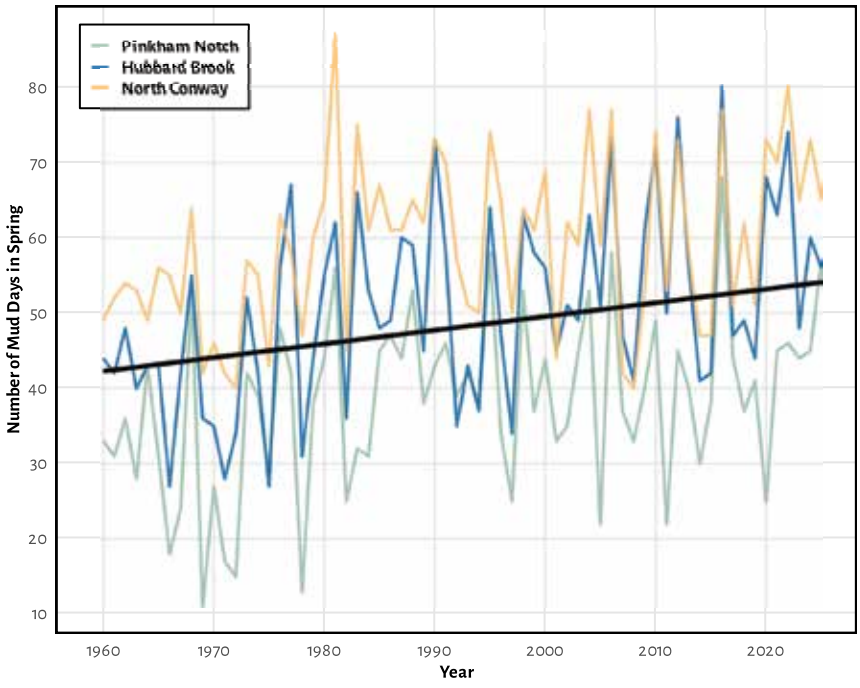


Figure 4.1. Spring (March - May) mud days at Pinkham Notch, Hubbard Brook, and North Conway from 1960 to 2025. Across the sites, an average increase of 1.8 mud days per decade, with linear analysis fit across the average of the data revealing a statistically very significant relationship ($p<0.01$).

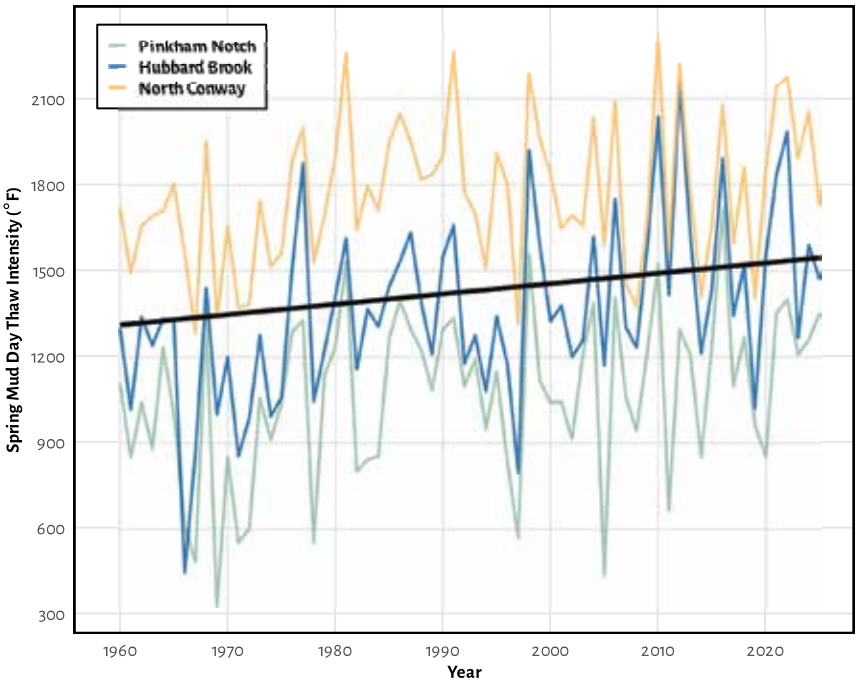


Figure 4.2. Cumulative spring (March - May) thaw intensity of mud days at Pinkham Notch, Hubbard Brook, and North Conway from 1960 to 2025. Across the sites, there is an average of +36.0°F per decade gain in thaw intensity, with linear analysis fit across the average of the data revealing a statistically very significant relationship ($p<0.01$).

Site:	Pinkham Notch	Hubbard Brook	North Conway
Spring Mud Days per Decade	+1.4	+2.4	+2.5
Cumulative Spring Thaw Intensity of Mud Days	+35.6°F	+49.3°F	+33.4°F

Table 4.1. Spring (March - May) mud days at Pinkham Notch, Hubbard Brook, and North Conway from 1960 to 2025.

What the Data Tell Us:

- All three sites are seeing an increase in the number of mud days and thaw intensity during spring: +1.8 mud days per decade and +36.0°F of thaw intensity per decade (Figure 4.1; Figure 4.2).
- When comparing springs in the 1960s to the 2010s,
  - Pinkham Notch averaged 8 more mud days and thaw intensity increased by +214°F,
  - Hubbard Brook averaged 14 more mud days and the intensity increased by +296°F,
  - North Conway averaged 15 more mud days and thaw intensity increased by +200°F.
- As a cumulative metric, thaw intensity values occasionally exceed 1,200°F, reflecting the combined warmth accumulated across all mud days during meteorological spring rather than individual daily events.

Management Strategies

While you may want to dive into summer activities, respecting restrictions and following leave-no-trace principles during periods of increased fragility will help conserve trails for decades to come. What can you do to help? The Appalachian Mountain Club and State of NH Division of Travel and Tourism Development recommend respecting trail closures, shifting hiking and wheel activities to durable surfaces, waiting until trails have dried, and walking through the mud or over ice if you find yourself on thawing trails (AMC Staff, 2026; Gurney, 2026; NH Division of Travel and Tourism Development, 2026). Low-impact activities include exploring the Presidential Rail Trail, birding on boardwalks, long walks on sandy beaches, and visiting a sugar house [1] (Gurney, 2026; NH Division of Travel and Tourism Development, 2026). There are many ways to enjoy the spring, while respecting public lands!

Key Takeaways:

- Since 1960, the number of mud days in spring has increased by an average of 11.7 days at Pinkham Notch, Hubbard Brook, and North Conway — a +26.7% increase over the past 65 years (Figure 4.1).
- The intensity of mud days, how much the temperature surpasses freezing, has increased as springs become warmer (+27.5%) (Figure 4.2).
- Land management practices and recreational variation can help mitigate the ecological and economic effects of increasing mud days.

Learn More

Practice recognized standards of recreational use and stewardship.

Leave No Trace Principles. See ***lnt.org***

Get Involved

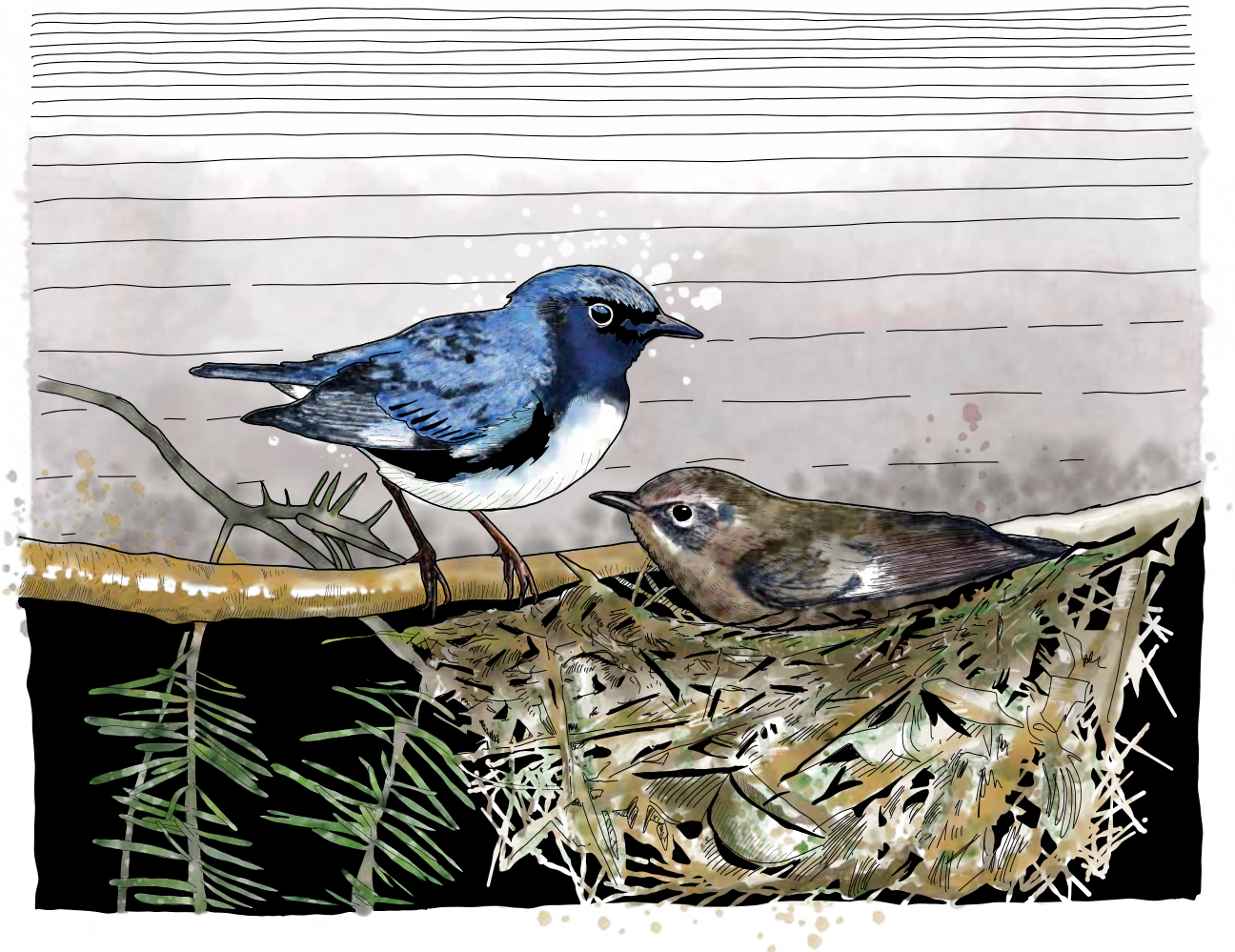
Be a steward of your trail systems with the Appalachian Mountain Club!

Trail Volunteers include: Chapter-Led Trail Work, Volunteer Vacations & Work Days, Adopt-A-Trail, Customize a Trail Crew. Join at ***www.outdoors.org/get-involved***

[1] *See New Hampshire Sugar Houses in Chapter 3: March Maple Sugaring Season Shifts Earlier.*

A Songbird's Spring Sync

Imagine wintering in the Caribbean in dense tropical forests, then taking flight under the cover of night to fly along the East Coast and Appalachian Mountains until you return to where your life began (National Audubon Society, 2026). This is the spring migration path for the Black-throated Blue Warblers as they return to their breeding range in the White Mountains, where there are large tracts of hardwood and mixed hardwood-evergreen forests with a shrubby understory (Cornell Lab, 2026; National Audubon Society, 2026). Upon arrival, male Black-throated Blue Warblers sing to establish equitable breeding territories and attract mates, filling the hardwood forest with buzzy songs that sound like "please, please, please squeeeeze" and calls that have a flat smack (Cornell Lab, 2026). Since they eat the insects on the undersides of leaves and thick vegetation provide coverage from nest predation, Black-throated



Blue Warblers have historically timed their spring rituals with canopy closure, the day when leaves were fully expanded and there was minimal light visibility through the canopy (Cornell Lab, 2026; Lany et al., 2015; National Audubon Society, 2026).

Warming temperatures and earlier spring phenology can affect migratory birds. To see how the Black-throated Blue Warblers are being impacted, Hubbard Brook scientists investigated food availability, canopy closure, and clutch initiation, the day when the first egg was laid in a nest (Lany et al., 2015). They found the timing of clutch initiation was strongly linked with canopy closure, signifying mating adjustments made to maximize reproductive success (Lany et al., 2015).

Why It Matters:

- Black-throated Blue Warblers are common and their populations increased by 163% between 1970 and 2014 to an estimated 2.4 million (Cornell Lab, 2026; Partners in Flight Databases, 2026). Their populations are likely still recovering from declines in the 18th and 19th centuries as a result of widespread clear cutting (Cornell Lab, 2026; Partners in Flight Databases, 2026).
- Bird population has been influenced by changes in migration, local land use, and the varying abilities species have to adjust the timing of laying their eggs to local climate, plant phenologies, and food availability (Johnston et al., 2025).
- Climate-specific threats to nesting in the White Mountains include fire weather, heat, heavy rain, and development (National Audubon Society, 2026).

Clutch-Initiation Timing

This analysis sought to expand on the understanding of the connection between Black-throated Blue Warblers clutch initiation and canopy closure. At Hubbard Brook, a long-term study has tracked the date of tree leaf canopy closure since 1989 and clutch initiation since 1986. Canopy closure data were sourced from 1989 to 2025 with both a model of growing degree days of sugar maple trees (Lany et al., 2015) and of observations of three dominant, northern hardwood tree species: sugar maple (*Acer saccharum*), yellow birch (*Betula alleghaniensis*), and American beech (*Fagus grandifolia*) (USDA Forest Service, 2025). Observed data were collected weekly and therefore were only used in the temporal analysis (Figure 5.3). The Black-throated Blue Warblers monitoring captured the median date of first clutch initiation from 1986 to 2010 (Rodenhouse et al., 2019).

What the Data Tell Us:

- Over the 36 year period, canopy closure dates have shifted earlier by 3.0 days per decade, amounting to over 11 days change from 1989 to 2025 (Figure 5.3).
- For every day earlier the canopy closure date shifted, the median clutch initiation moved 0.50 days earlier, as well (Figure 5.4). This figure shows that Black-throated Blue Warblers adjust the timing of breeding according to inter-annual variation in the timing of canopy closure. Both data sets span similar seasonal ranges.

Although the Black-throated Blue Warblers' population status is currently categorized as least concerned, their population is projected to decline with an increase of global temperatures and climate change stressors (National Audubon Society, 2026). Yet, the Black-throated Blue Warblers have been recorded expanding their traditional diets to adapt to changes during their spring arrival and fall departure (Kaiser, 2014).

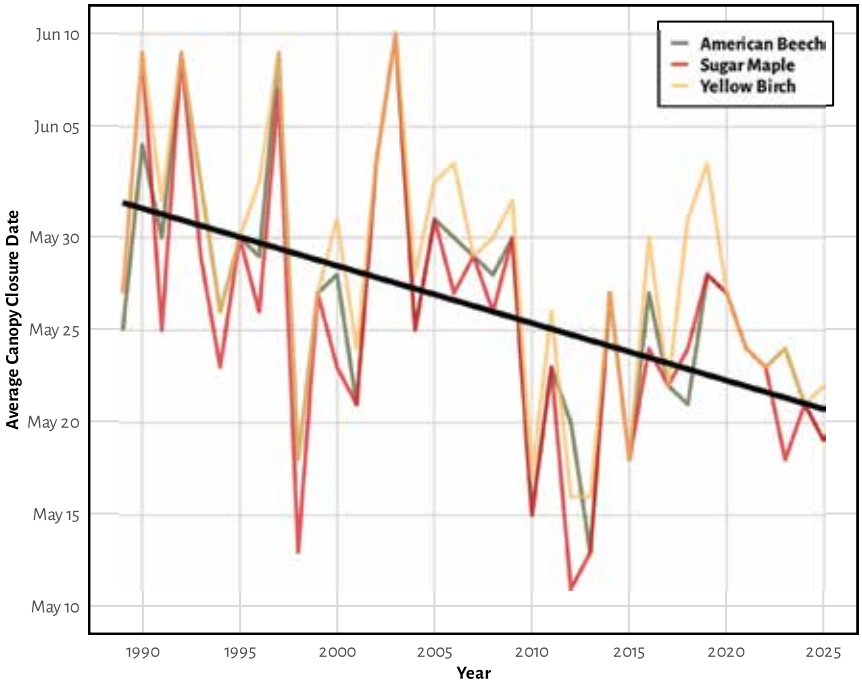


Figure 5.3. Annual average canopy closure dates in sugar maple (*Acer saccharum*), yellow birch (*Betula alleghaniensis*), American beech (*Fagus grandifolia*) from 1989 to 2025 at Hubbard Brook. Linear analysis of average canopy closure date across the three species revealed a statistically very significant trend ($p<0.01$), with closure date shifting earlier by 3.1 days per decade on average.

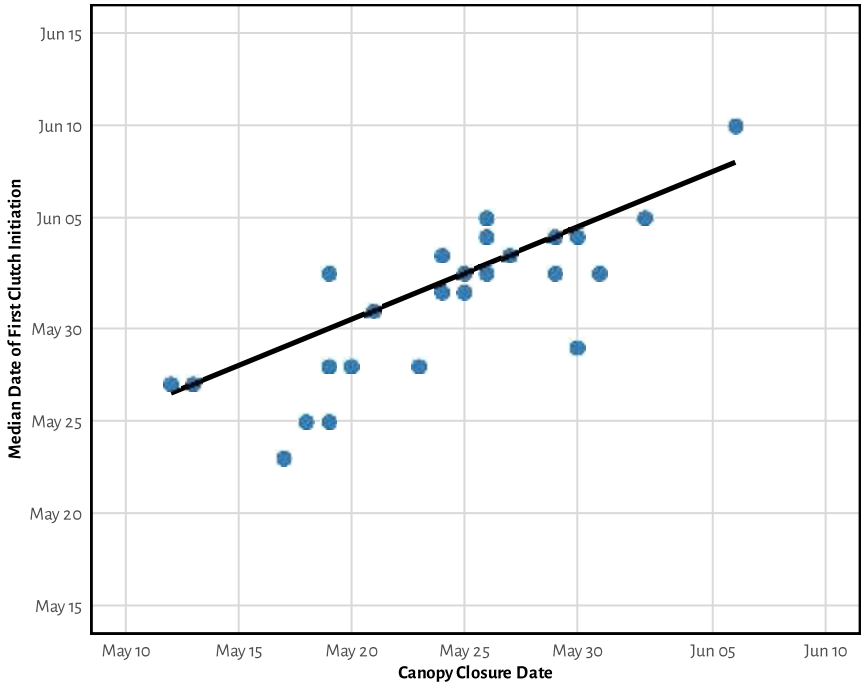


Figure 5.4. Relationship between canopy closure timing of sugar maples and median date of first clutch initiation of black-throated blue warblers from 1986 to 2010. As the canopy closure date shifts earlier by 1 day, clutch initiation follows by shifting 0.50 days earlier. Linear analysis revealed a statistically very significant trend ($p<0.01$).

Tree Species:	American Beech *(Fagus grandifolia)*	Sugar Maple *(Acer saccharum)*	Yellow Birch *(Betula alleghaniensis)*
Average Canopy Closure Date Shift Per Decade	-3.1	-2.8	-3.0

By supporting long-term studies and areas of protected woodlands, you can help support this small songbird and its summer home.

Key Takeaways:

- Clutch initiation of the Black-throated Blue Warbler (BTBW) is closely aligned with canopy closure and both have been shifting earlier as spring temperatures warm.
- While the populations of BTBWs are still recovering from loss of habitat and facing local stressuring linked with climate change, the value of protecting mating grounds becomes increasingly important for this woodland songbird.

Get Involved

Turn birding into a citizen-science effort!

NH Audubon Participatory Science & Volunteering ***nhaudubon.org***

eBird Science ***ebird.org***

Learn More

Birding and conservation resources.

Merlin Bird ***ID merlin.allaboutbirds.org***

Hubbard Brook Ecosystem Study. Visit ***hubbardbrook.org.***

NIGHT MIGRATIONS

by Hannah Fries

We sleep,
stumbling
through doorless dreams,
while over our rooftops
sky shivers with wings —
warblers, cuckoos,
herons and sparrows —
waves rising
on night's cool breath.

We sleep
as they follow the stars
(hummingbird and wren)
high over shadowed earth,
trees clinging to rock,
cities curled in grief.
We close our windows,
bury our faces —

we sleep
and they speak:
buzz and whistle,
secret names
through air
tying each to each.

We sleep as they fly
(imagine being lifted)
by moon and magnet,
over undulating sea
toward a place
(remember)
that echoes
in hallowed clearings,
in hollowed bones,
the song that pulls them
home.

Blooming — No Limit but the Sky

As the ground thaws, plants bring color back into the landscape with blooming flowers and unfurling leaves. Spring ephemerals, woodland wildflowers that develop early each spring, quickly bloom before the canopy refills with leaves. Meanwhile, alpine flowers wait for the retreat of the winter snowpack. With these variances, flowering timing is staggered throughout the mountains' biomes.

The White Mountain region consists of three biomes, each defined by its climate and plant communities. The northern hardwood forest tends to be below 3,000 feet, montane spruce-fir is predominantly between 3,000 and 4,400 feet, and the alpine biome largely resides above 4,400 feet (Ballard, 2024; Marchand, 2010; McNab & Avers, 1994). The transition between northern hardwood and montane spruce-fir biomes occurs when trees switch from predominantly deciduous to predominantly coniferous. The montane spruce-fir to alpine biome occurs where the forest becomes discontinuous and less than 2 meters in height, transitioning to krummholz, lower-growing plants and cushions. As elevation increases, the accompanying changes in temperature, precipitation, soil moisture, and snow cover influence when flowering occurs.

There are different scales for discussing ecosystems: ***ecozone*** *(continental),* ***bioregion*** *or* ***biome*** *(global/regional),* ***ecoregion*** *(regional), and* ***plant community*** *(local).*

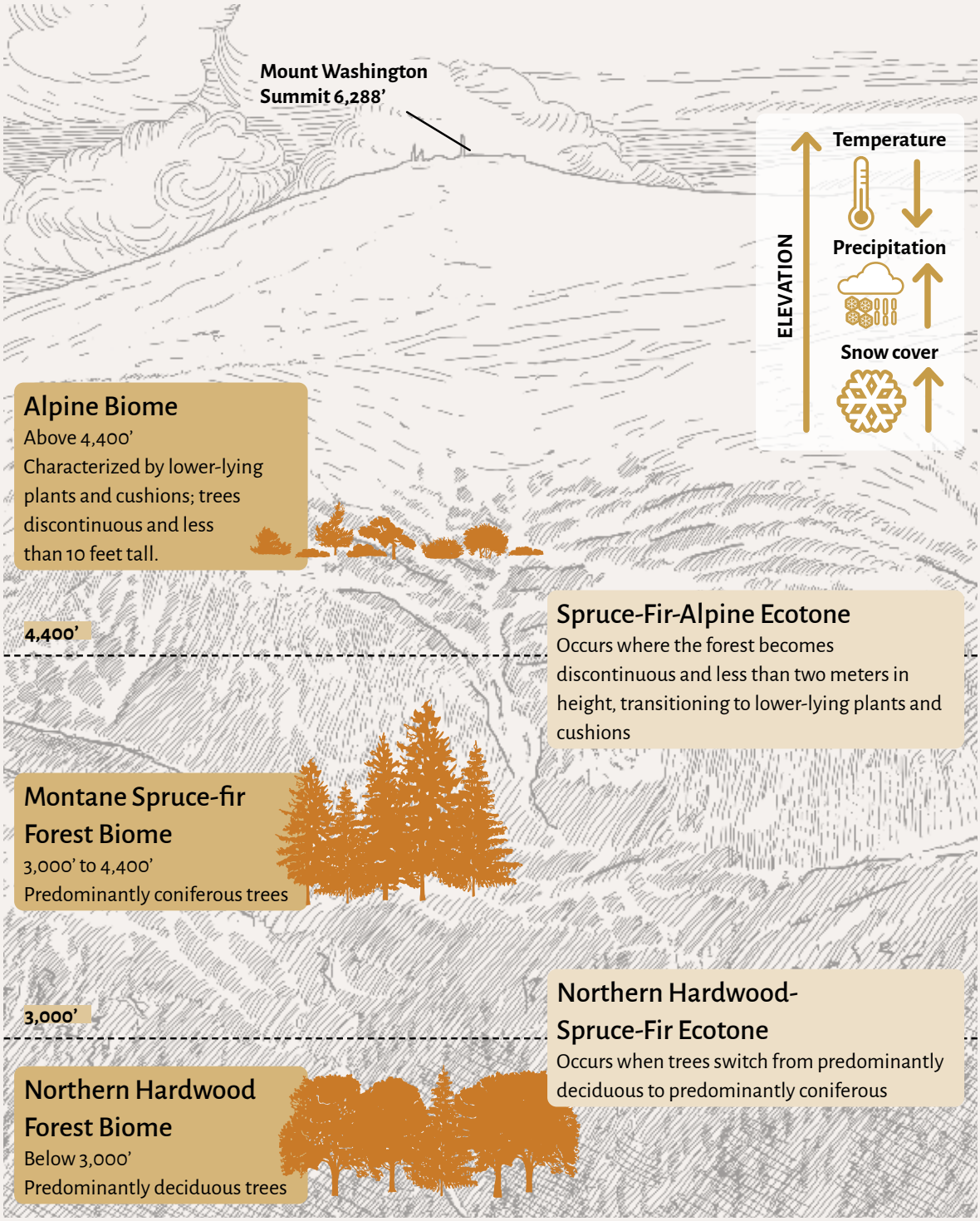
Why It Matters:

- Understanding the timing of blooming across elevations can offer insight into the current patterns and future of these ecosystems.
- Spring phenologies for both understory plants and canopy trees have been found to advance with warming temperatures along the Appalachian Trail, and the spring phenological window has expanded in the north (Tourville et al., 2024).

Bloom Timing

Since flowering is a **phenophase**, an observable stage or phase in the annual life cycle of a plant or animal that can be defined by a start and end point, its timing can be monitored and studied. To understand elevational influence on species flowering time, this study examined fifteen flowering plant species in the White Mountains: bigelow's sedge (*Carex bigelowii*), bluebead lily (*Clintonia borealis*), Canadian bunchberry (*Cornus canadensis*), diapensia (*Diapensia lapponica*), yellow trout lily (*Erythronium americanum*), Mountain avens (*Geum peckii*), Canada mayflower (*Maianthemum canadense*), labrador tea (*Rhododendron groenlandicum*), three-toothed cinquefoil (*Sibbaldiopsis tridentata*), red trillium (*Trillium erectum*), painted trillium (*Trillium undulatum*), sessile bellwort (*Uvularia sessilifolia*), bog bilberry (*Vaccinium uliginosum*), mountain cranberry (*Vaccinium vitis-idaea*) or lingonberry, and hobblebush (*Viburnum lantanoides*). In this analysis, plant species were categorized into three biomes to evaluate flowering timing: northern hardwood forest, montane spruce-fir forest, and alpine. These categories were chosen based on informed recommendations from

Biomes of the White Mountains Region



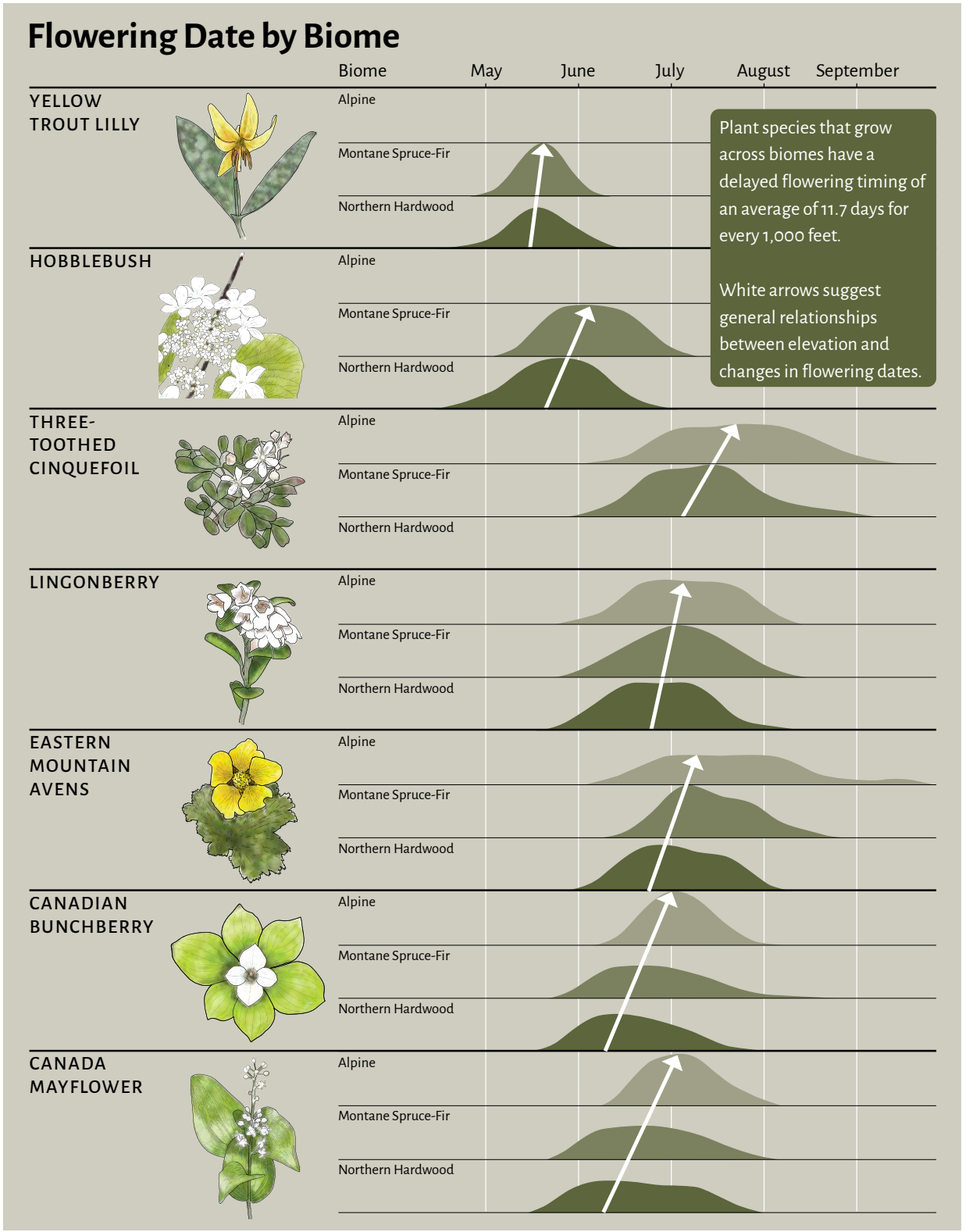


Figure 6.3. Distribution of observed flowering dates for seven plant species across the alpine, montane spruce-fir, and northern hardwood biomes from 2015 to 2025. The peak of each curve indicates when the largest number of plants were in flower. Species selected had > 20 observations in each plant community.

Appalachian Mountain Club ecologists. Data were sourced from iNaturalist (iNat) and the USA National Phenology Network (NPN), two large community science datasets (iNaturalist Network, 2018a & 2018b; USA National Phenology Network, 2007). Each dataset contains thousands of observations of plant phenophases taken from 2015 to 2025. For this analysis, over 7,000 observations were gathered from the HUC10 watersheds within 5 miles of the Appalachian National Scenic Trail section passing through the White Mountain National Forest (National Park Service, 2026). Since these datasets do not always capture the exact start or end of the flowering period, because there was not continuous monitoring of the same individual plants, the data were analyzed using quartiles to estimate timing (Equations E.5.1 and E.5.2). Additionally, comparisons were made between flowering timing and elevation across species and biomes, since elevation drives ambient temperature, with cooler temperatures found at higher elevations.

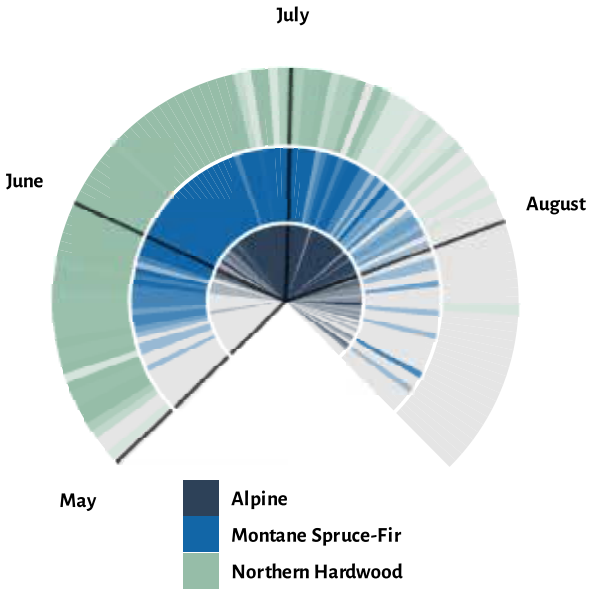


Figure 6.2. Bloom wheel revealing flowering timing of fifteen plant species across the northern hardwood, montane spruce-fir, and alpine biomes in the White Mountains from 2015 to 2025. Darker colors show higher concentrations of flowering at those times.

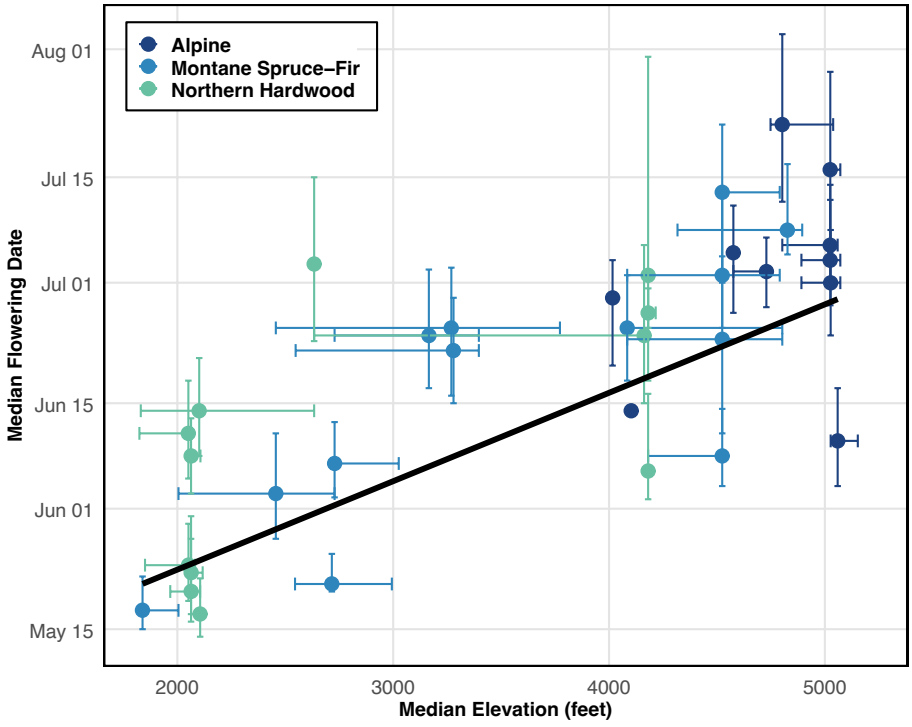


Figure 6.3. Relationship between median flowering date and median elevation across the alpine, montane spruce-fir, and northern hardwood biomes from 2015 to 2025 (See Equation E.5.2). Plant species selected had > 30 observations total, and may inhabit different biomes; therefore, each data point represents a different species-biome combination. Horizontal bars (elevation) and vertical bars (flowering date) indicate interquartile range of the collected observations for each species (See Equation E.5.1; The linear analysis revealed a statistically very significant relationship ($p<0.01$), with an average flowering time of 11.7 days later for every 1,000 feet gained.

What the Data Tell Us:

- For seven species investigated, flowering is delayed by an average of 11.7 days for every 1,000 feet gained in elevation (Figure 6.1). This reflects the underlying weather gradient in the White Mountains, with cooling as elevation increases and the varying amount it impacts the species evaluated.

Within the individual species investigated, flowering timing varies across biomes (Figure 6.3). Each species has a bloom window with some beginning to flower mid-May, and others maintaining a longer or more staggered bloom across the summer.

Flowers' Future

These phenological patterns are changing. Increasing temperature is shifting spring phenology earlier, causing uncertainty in flowering patterns across the greater region (Tourville et al., 2024). Warmer spring temperatures have led to plants blooming earlier along the Appalachian Trail corridor. However, not all species respond the same way; some are more sensitive to temperature, while others are aligned with day length or snowmelt (Tourville et al., 2024). This means that the timing of flowering is not just shifting — it's becoming less predictable. The unfolding petals interweave connections necessary for a functioning ecosystem, since flowering facilitates interactions among species. Changes in the timing of flowering can create a phenological mismatch with potential pollinators, meaning seasonal life-cycle events become out of sync between interacting species (Tourville et al, 2024). As the climate warms and spring weather becomes more erratic, the rhythm of flowering and other plant phenophases will likely continue to shift in the White Mountains.

At the same time, environmental thresholds that define where species can live are also changing, with some plants advancing to higher elevations (Tourville et al., 2023). This may lead to shifts in plant community boundaries in the White Mountains: forests gradually expanding upslope and alpine habitats becoming more limited (Tourville et al., 2023). The progression of flowering reflects how climate, elevation, and ecology interact to shape when plant activity emerges each year, from ephemerals in the northern hardwood forest to alpine flowers in the highest reaches of New England.

Key Takeaways:

- The White Mountains consist of three major biomes: hardwood forest, montane spruce-fir, and alpine. Plant species that grow across all three biomes have a delayed flowering timing of an average of 11.7 days for every 1,000 feet upslope.
- As springs warm in the Appalachian Mountains, the timing of flowering has shifted earlier but not consistently across species.
- Continuing long-term monitoring of plants' phenophases will assist understanding how these changes are occurring for individual species and their interactions with pollinators and frugivores.

Get Involved

Participate in citizen science & help protect the fragile alpine ecosystem.

Join at ***https://www.outdoors.org/resources/amc-outdoors/conservation-and-climate/inaturalist/***.

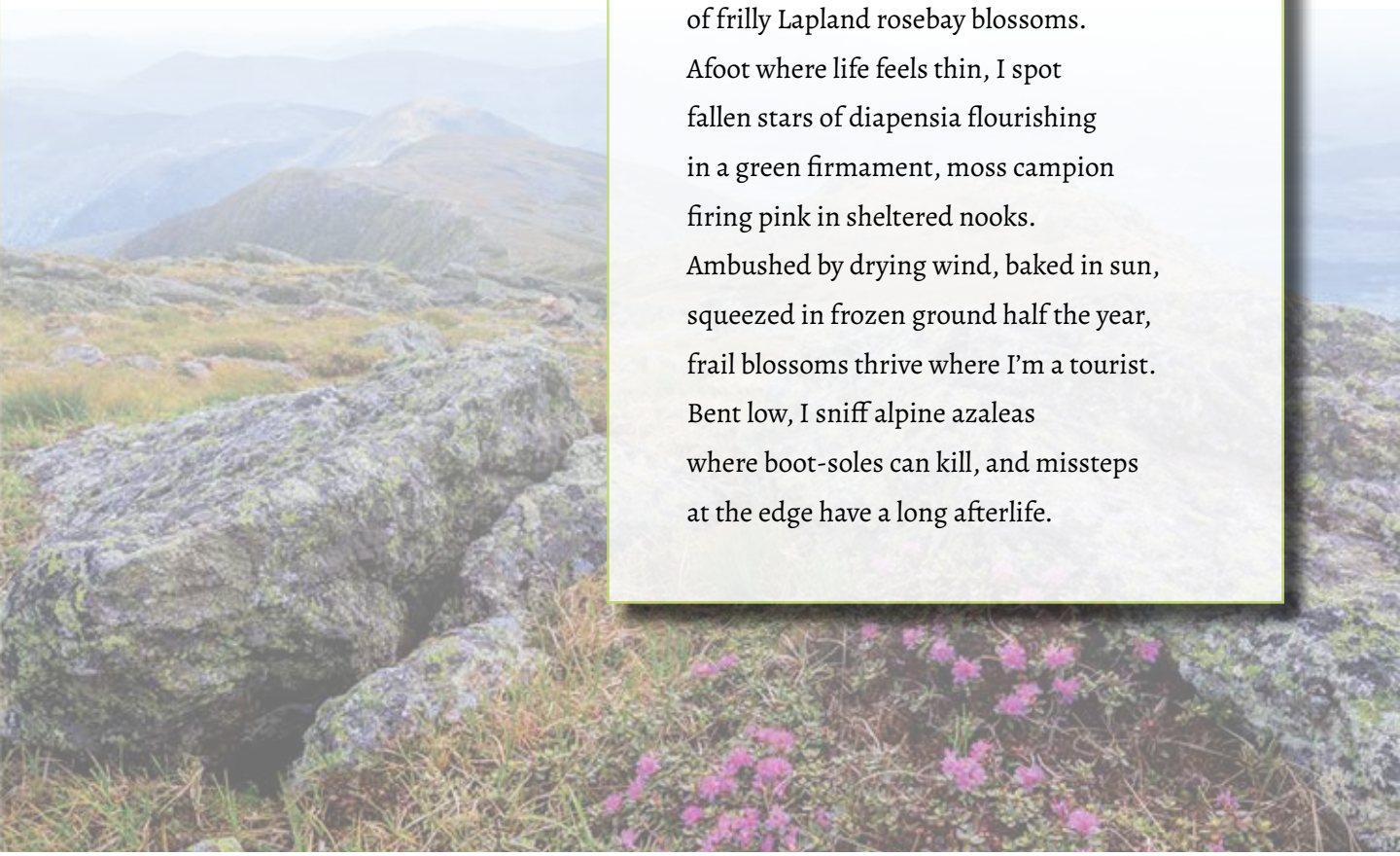
Become an Alpine Steward. Learn more by emailing ***amcvolservices@outdoors.org***.

Learn More

Resources discussing flower phenology and White Mountain ecology!

Nature Guide to the Northern Forest by Peter J. Marchand.

Field Guide to the New England Alpine Summits by Nancy G. Slack & Alison W. Bell.



ALPINE GARDEN

David K. Lef

a plateau on Mount Washington
Wind ripples through rock
studded grasses, tousles my hair, drives
dirigible cumulous across a blue sea.
The massive summit cone of broken talus
looms on one side; craggy, muscular ravines,
a horizon of peaks and ridges on the other.
Exposed in a gray, bouldery vastness,
breathless from climbing, chilled by sweat,
I brave sunlight that stings my eyes, sears
my neck as I hopscotch rocks, pockets
of frilly Lapland rosebay blossoms.
Afoot where life feels thin, I spot
fallen stars of diapensia flourishing
in a green firmament, moss campion
firing pink in sheltered nooks.
Ambushed by drying wind, baked in sun,
squeezed in frozen ground half the year,
frail blossoms thrive where I'm a tourist.
Bent low, I sniff alpine azaleas
where boot-soles can kill, and missteps
at the edge have a long afterlife.

JULY

Climbing through Climate Zones

"Those planning on venturing to the higher terrain should prepare and dress accordingly, as it will feel much colder than in the nearby valleys and lower elevations" (Smith, 2026).

In the summer, it is not uncommon for it to be 70° and sunny in the valley, while simultaneously 40° and raining sideways with gusts reaching hurricane force on the summit. How can there be both ice-cream-eating weather and hypothermia conditions within just a few miles? The answer lies in the combination of atmospheric properties, mountain weather conditions, and a difference in climate zones!

As you hike up a mountain the **atmospheric pressure** of the air around you will decrease (NOAA, 2026). As air expands as it moves up, both its pressure and temperature decrease. So, the same phenomenon that causes shortness of breath while hiking at higher elevations also leads to lower temperatures.

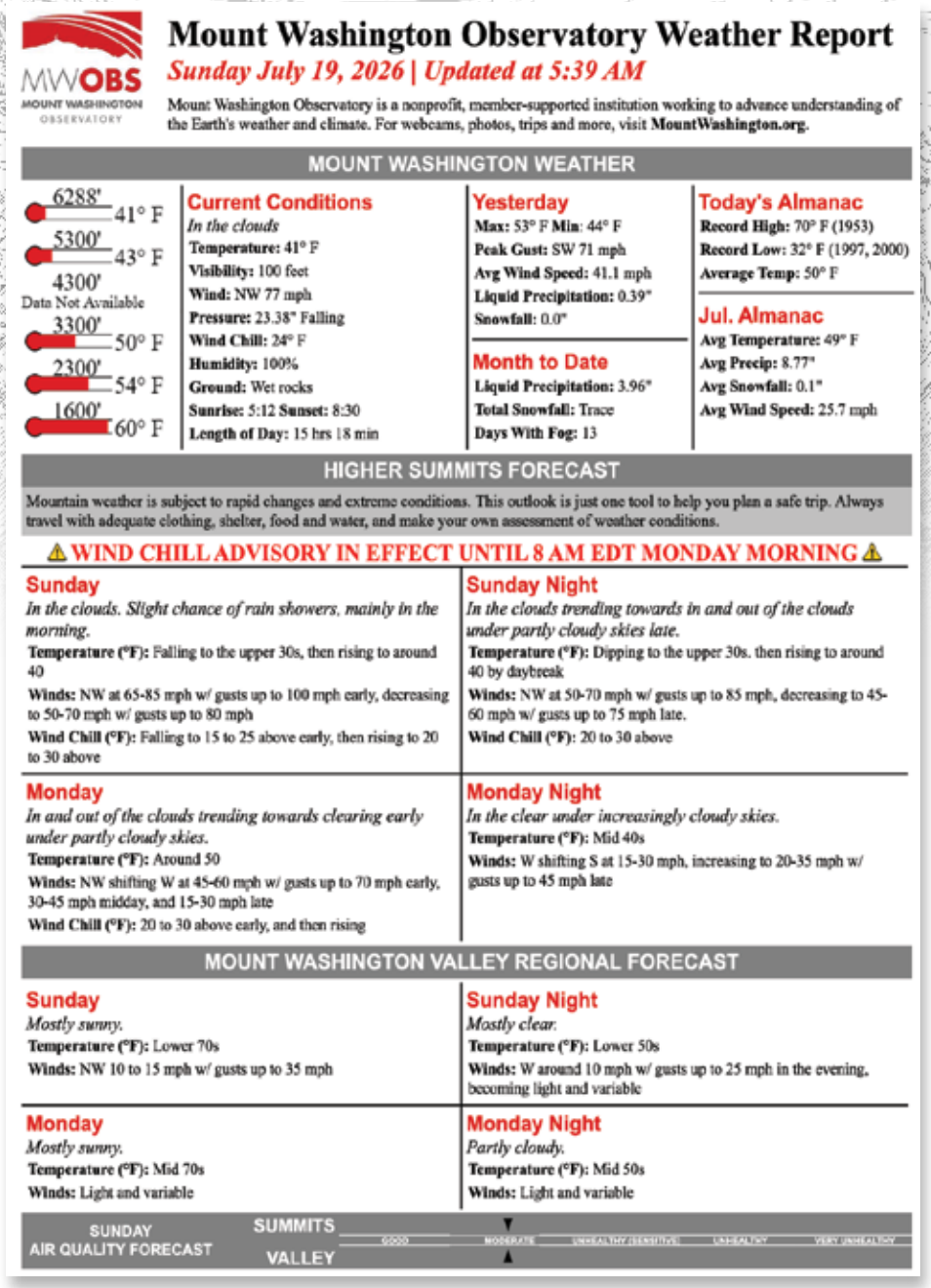
It's usually cooler at the top, but a temperature inversion and cold-air pooling can occur when temperatures increase with elevation with cold air settling into the lowest topographical areas, such as notches and valleys. This can be caused by radiational cooling - common when the mountains are under clear skies with low wind (Kimball, 2012; Zukswert et al., 2024).

Weather is the state of the atmosphere at a given time and place, with respect to variables such as temperature, moisture, wind speed and direction, and barometric pressure. As you gain elevation in the White Mountains, not only does the temperature cool, but the moisture and wind speed increase. The summit of Mount Washington spends 60% of the year in the fog. Imagine spending 220 days annually in a cloud! To read more about wind speed, see Chapter 12: December Winds of Mount Washington.

Climate is the recurring average weather found in any particular place, measured over a period of 30 years or longer. **Climate zones** are distinct regions characterized by specific weather patterns and ecological communities, primarily determined by temperature and precipitation over extended periods (Beck et al., 2023; NOAA, 2023; Price, 2023). Climate is what you expect, weather is what you get.

The classification of climate zones is commonly based on the Köppen Climate Classification System, developed by climatologist Wladimir Köppen, which identifies five major climate types: tropical moist climates, dry climates, humid middle latitude climates, continental climates, and cold climates (NOAA, 2023; Price, 2023).

In the White Mountains, there is one major climate type, moist continental mid-latitude with two climate zones, Humid Continental and Subarctic (NOAA, 2023). Moist continental mid-latitude climates have warm to cool summers and cold winters, which are severe, with snowstorms, strong winds, and bitter cold from



Mount Washington Observatory Weather Report

Sunday July 19, 2026 | Updated at 5:39 AM

MWOBS MOUNT WASHINGTON OBSERVATORY

Mount Washington Observatory is a nonprofit, member-supported institution working to advance understanding of the Earth's weather and climate. For webcams, photos, trips and more, visit **MountWashington.org**.

MOUNT WASHINGTON WEATHER

6288' 41° F
5300' 43° F
4300' Data Not Available
3300' 50° F
2300' 54° F
1600' 60° F

Current Conditions

In the clouds
Temperature: 41° F
Visibility: 100 feet
Wind: NW 77 mph
Pressure: 23.38" Falling
Wind Chill: 24° F
Humidity: 100%
Ground: Wet rocks
Sunrise: 5:12 **Sunset:** 8:30
Length of Day: 15 hrs 18 min

Yesterday

Max: 53° F **Min:** 44° F
Peak Gust: SW 71 mph
Avg Wind Speed: 41.1 mph
Liquid Precipitation: 0.39"
Snowfall: 0.0"

Month to Date

Liquid Precipitation: 3.96"
Total Snowfall: Trace
Days With Fog: 13

Today's Almanac

Record High: 70° F (1953)
Record Low: 32° F (1997, 2000)
Average Temp: 50° F

Jul. Almanac

Avg Temperature: 49° F
Avg Precip: 8.77"
Avg Snowfall: 0.1"
Avg Wind Speed: 25.7 mph

HIGHER SUMMITS FORECAST

Mountain weather is subject to rapid changes and extreme conditions. This outlook is just one tool to help you plan a safe trip. Always travel with adequate clothing, shelter, food and water, and make your own assessment of weather conditions.

⚠ WIND CHILL ADVISORY IN EFFECT UNTIL 8 AM EDT MONDAY MORNING ⚠

Sunday

In the clouds. Slight chance of rain showers, mainly in the morning.
Temperature (°F): Falling to the upper 30s, then rising to around 40
Winds: NW at 65-85 mph w/ gusts up to 100 mph early, decreasing to 50-70 mph w/ gusts up to 80 mph
Wind Chill (°F): Falling to 15 to 25 above early, then rising to 20 to 30 above

Sunday Night

In the clouds trending towards in and out of the clouds under partly cloudy skies late.
Temperature (°F): Dipping to the upper 30s, then rising to around 40 by daybreak
Winds: NW at 50-70 mph w/ gusts up to 85 mph, decreasing to 45-60 mph w/ gusts up to 75 mph late.
Wind Chill (°F): 20 to 30 above

Monday

In and out of the clouds trending towards clearing early under partly cloudy skies.
Temperature (°F): Around 50
Winds: NW shifting W at 45-60 mph w/ gusts up to 70 mph early, 30-45 mph midday, and 15-30 mph late
Wind Chill (°F): 20 to 30 above early, and then rising

Monday Night

In the clear under increasingly cloudy skies.
Temperature (°F): Mid 40s
Winds: W shifting S at 15-30 mph, increasing to 20-35 mph w/ gusts up to 45 mph late

MOUNT WASHINGTON VALLEY REGIONAL FORECAST

Sunday

Mostly sunny.
Temperature (°F): Lower 70s
Winds: NW 10 to 15 mph w/ gusts up to 35 mph

Sunday Night

Mostly clear.
Temperature (°F): Lower 50s
Winds: W around 10 mph w/ gusts up to 25 mph in the evening, becoming light and variable

Monday

Mostly sunny.
Temperature (°F): Mid 70s
Winds: Light and variable

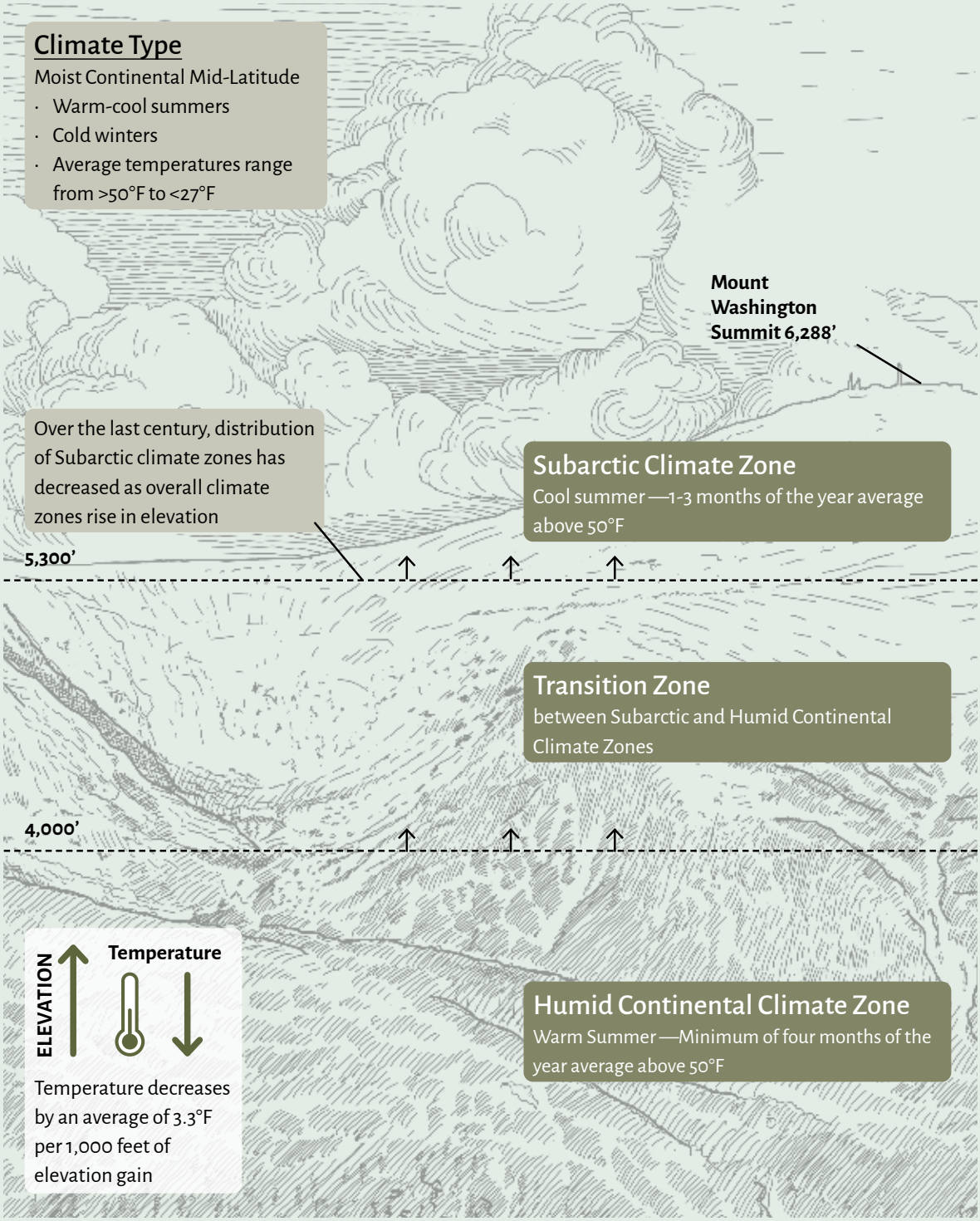
Monday Night

Partly cloudy.
Temperature (°F): Mid 50s
Winds: Light and variable

SUNDAY AIR QUALITY FORECAST
SUMMITS
VALLEY
GOOD MODERATE UNHEALTHY (SENSITIVE) UNHEALTHY VERY UNHEALTHY

Figure 7.1. Mount Washington Observatory morning Weather Report for July 19th, 2026.

Climate Zones of the White Mountains



Continental Polar or Arctic air masses (NOAA, 2023). Average temperatures in both of these humid continental and subarctic zones must average above 50°F and below 27°F for at least one month. The distinction between them has to do with how warm they are during the summer. Each of the four warmest months in humid continental zones must average >50°F, while subarctic zones only have 1 to 3 months that average >50®F (Beck et al., 2023; NOAA, 2023).

Why It Matters:

- Understanding elevational characteristics helps recreators be more prepared and make thoughtful decisions.
- Climate zones articulate the mountain's characteristics, specifically temperature and precipitation trends.

Investigating Mount Washington's Summer Temperature Profile and Climate Zones

We evaluated Mount Washington daily temperature data from 2016 to 2025 during the meteorological summer (June – August) at the summit, 5 mesonet stations along the Mount Washington Auto Road (Mount Washington Observatory, 2026a and 2026b), and North Conway (Cornell

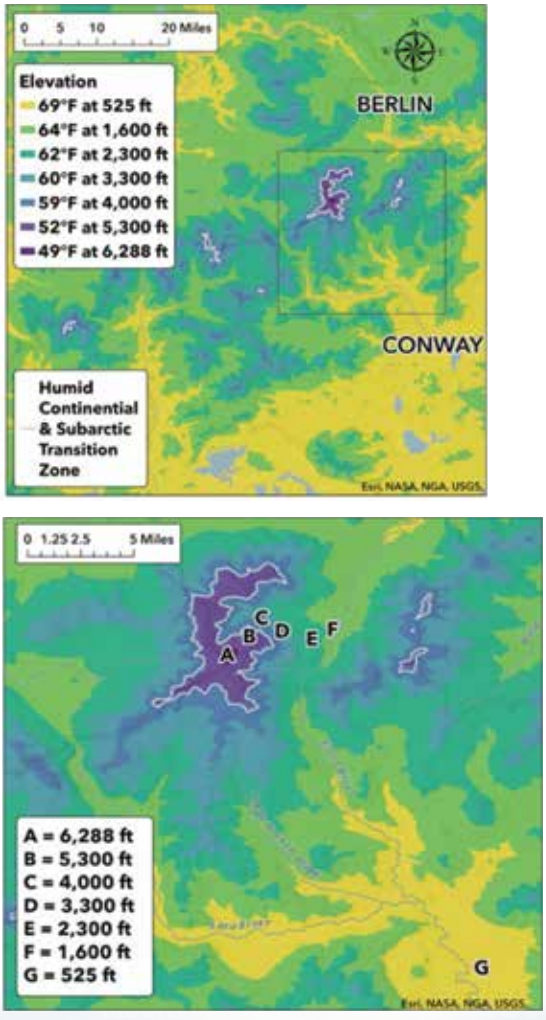


Figure 7.2. Average temperature by elevation on Mount Washington and in North Conway during meteorological summer (June – August) from 2016 to 2025 in the White Mountain region (top) and the sites examined (bottom).



University, 2026). We then calculated the average and **summer daily temperature** and average summer daily temperature range (the difference between daily highs and lows) for each station (Figure 7.4; See Equations E.7.2 and E.7.3). Using the daily average temperatures, we calculated atmospheric lapse rate for the summer, which is the rate at which air temperature decreases with an increase in elevation.

What the Data Tell Us:

- The temperature decreases by an average of 3.3°F per 1,000 feet of elevation gained with an average decline of 20°F between the North Conway and summit locations Figure 7.3).
- Higher elevations experience narrower daily temperature fluctuations in summer (Figure 7.4).
- On Mount Washington, the transition zone between the humid continental and subarctic climate zones occurs at around 4500' (Figure 7.2).

Public Safety

While recreators may know that temperature decreases as elevation increases, it is important to understand that a hike into the higher summits is comparable to a trip to the subarctic, truly! Above treeline, the compounding impacts of cooler tempera-

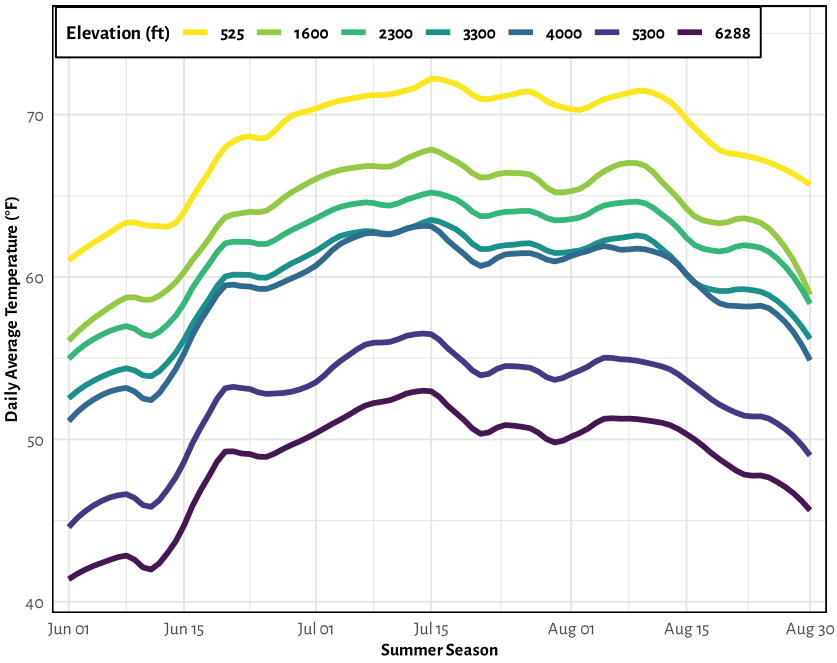


Figure 7.3. Daily average temperature during meteorological summer (June - August) at the Observatory office in North Conway (525 ft), along the Mount Washington Auto Road (1,600 - 5,300 ft), and at Mount Washington Observatory (6,288 ft) from 2016 to 2025. A LOESS curve is fit across the data to smooth the variability in the data.

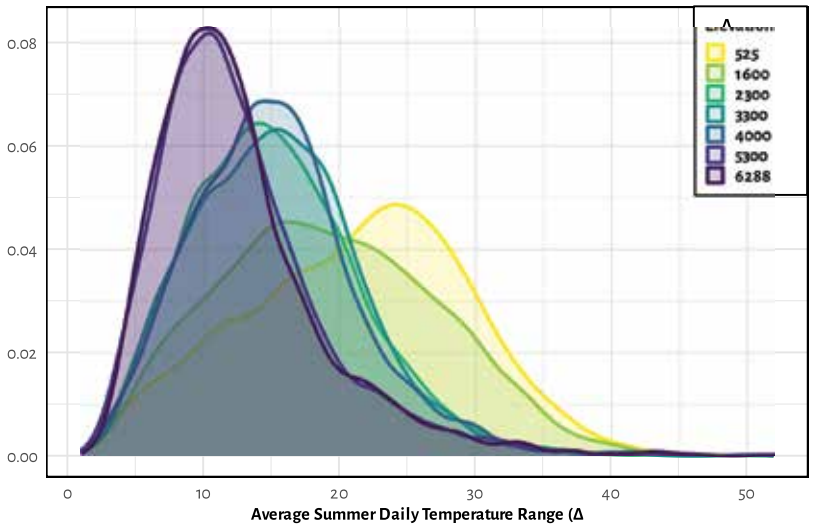


Figure 7.4. Distribution of average summer (June - August) daily temperature range (the difference between daily lows and highs) across elevational profiles in the Mount Washington Valley. Peaks in the curves show the temperature ranges that are most common at each elevation.

tures, higher winds, and increased precipitation result in frequent extreme weather conditions year-round. Checking the Higher Summits Forecast (see below), being prepared, and willing to turn around are key for safety in the mountains. In addition to getting to hike another day, if you decide to turn around before the summit due to conditions, you can typically receive a gold star from the Pinkham Notch Visitor Center front desk.

The Ten Essentials:

1. *Navigation (map, compass, GPS device)*
2. *Headlamp & extra batteries*
3. *Sun protection (sunglasses & protective clothing)*
4. *First aid (including foot care)*
5. *Knife & gear repair kit*
6. *Fire matches, lighter, and/or stove*
7. *Shelter (can be a light emergency bivvy)*
8. *Extra food (Beyond the minimum expectation)*
9. *Extra water (Beyond the minimum expectation)*
10. *Extra clothes (Beyond the minimum expectation)*



Changing Climate Zones

These climate zones are changing. The subarctic climate zone in the Koppen Climate model was reduced in 1991-2020 compared to 1961-1990 (Beck et al., 2023). Future projections indicate the continuation of warmer temperatures and changes to precipitation patterns will have cascading effects on ecosystem distributions. The way water moves through landscape is also changing, with multi-peaking spring floods, prolonged thaw periods, and intensified rainfall (Blåfield, 2025). This has implications for mountain communities, as well as rivers across the region (Blåfield, 2025).

Key Takeaways:

- There are two climate zones represented in the White Mountains: humid continental and subarctic, with the transitions occurring above 4,000 feet and below 5,300 feet on Mount Washington.
- Between recent climatologies, the distribution of the Subarctic climate zone has reduced (Beck et al., 2023). Understanding how climate zones are changing helps conservation efforts in the region.
- The average summer atmospheric lapse rate is 3.3°F per 1,000 feet of elevation gained.
- The daily temperature range is typically larger at the base of Mount Washington and smaller at higher elevations.

Get Involved

Seek the Peak Annual Fundraiser at *mountwashington.org*.

Learn More

Mount Washington Observatory Higher Summits Forecast at *mountwashington.org/weather/*

White Mountain Search and Rescue at *pemisar.org/sar-in-nh/*.

AUGUST

The Driest Summer on Record

After the long darkness of winter and slow unfolding of spring, it's not unusual to daydream of a cloudless summer when the sunshine fills all hours of the day. But what if it did? After one of the wettest springs on record, 2025 weather shifted to another extreme. Weeks with little rain became months. Lakes' water lines lowered by feet. The streams became a trickle. The soil became so dry that when it did rain the water ran off. The mud of the spring felt far away. The groundwater levels dropped. Phones rang requesting assistance as wells went dry. Hiking was mud-free, but backcountry water sources became less reliable. Summer water sports struggled. It became the driest summer in New Hampshire's 131 year-long record. By September 30th, all regions of New Hampshire were officially experiencing drought conditions. Burn bans became statewide. Throughout the fall, precipitation levels continued to be below normal. By December, the White Mountains' precipitation deficit from June 1st ranged from ten to twelve inches. The groundwater remained low after the hard freeze. The drought persisted throughout the winter, only easing slightly with meltwater and spring rain.

This record drought came on the heels of a severe drought in the fall of 2024 (Figure 8.1; NEIWPCC, 2026; NOAA National Centers for Environmental Information, 2026; Rains, 2025).

So, how did these extreme shifts take place so quickly? Even though New Hampshire, overall, is getting wetter with climate change, it is also seeing warmer temperatures and an increase in drought conditions, specifically flash droughts (National Integrated Drought Information System, 2026; New Hampshire Department of Environmental Services, 2026). A **drought** occurs when a region experiences below-average precipitation over an extended period of time, resulting in low stream flows and low surface water and groundwater levels. The 2025 event was a **flash drought,** which occurs when there is a rapid onset or intensification of drought when there are lower-than-normal rates of precipitation paired with abnormally high temperatures, winds, and radiation; combined, these changes in weather rapidly alter the local climate (National Integrated Drought Information System, 2026; New Hampshire Department

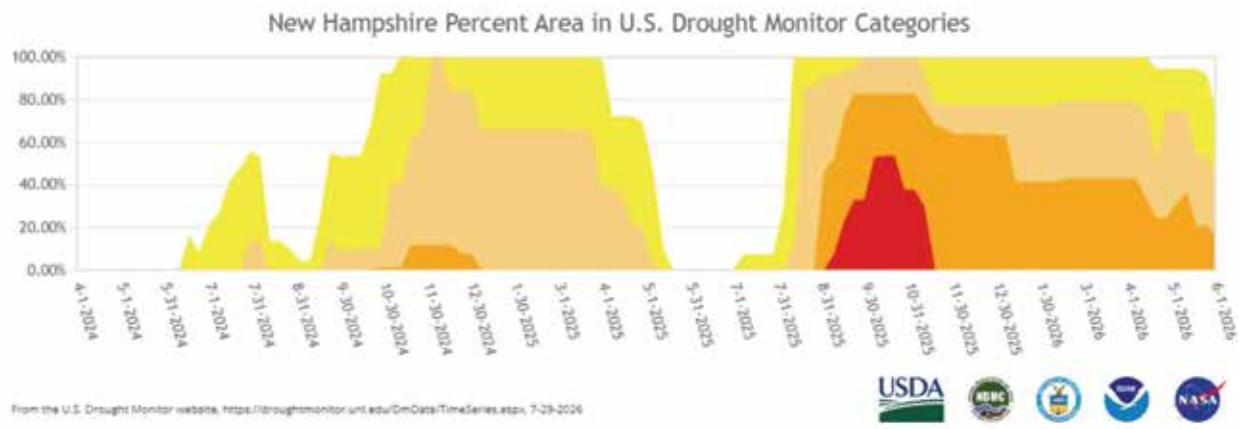


Figure 8.1. Time series of percentage of drought intensity across New Hampshire from April 2024 to May 2026 (National Drought Mitigation Center, 2026).



of Environmental Services, 2026). This increases the rate of evaporation, causing plant, soil, and surface water to lose moisture at a much faster rate and intensifies the initial effects of a drought (National Integrated Drought Information System, 2026). Since there has been an increase in extreme events, it is important to understand how this shift impacts the White Mountains.

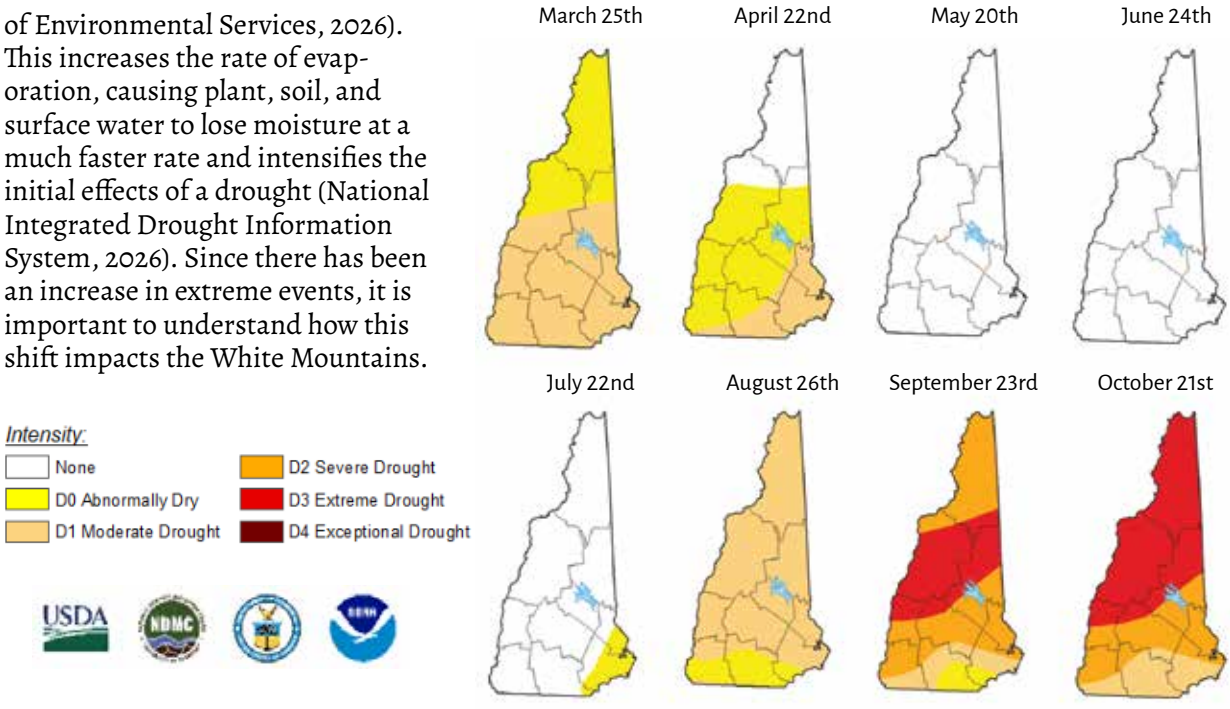


Figure 8.2. Drought intensity across New Hampshire from March 25th until October 21st, 2025. Adapted from the National Drought Mitigation Center (2026).

Why It Matters:

- With only 7.5" of rainfall from June to August, the summer of 2025 was the driest in New Hampshire's 131-year record (NOAA, 2026; Rains, 2025).
- A statewide burn ban was put in place by the New Hampshire Governor on September 22, 2025 (NEIWPCC, 2026; Rains, 2025).
- Over 1,000 dry wells were reported and more than 90 water usage restrictions were implemented throughout the state of New Hampshire (NEIWPCC, 2026). Regional farmers, ecosystems, and water-based recreation saw the strain (New Hampshire Department of Environmental Services, 2026).
- Management plans were updated for protected rivers, including three in the White Mountains, which were evaluated in this analysis (New Hampshire Department of Environmental Services, 2026).

Drought Investigation

To get a deeper understanding of the drought that began in August 2025, two metrics were evaluated: precipitation and river discharge. Precipitation data were pulled from Mount Washington Observatory (Mount Washington Observatory, 2026), Pinkham Notch, Hubbard Brook (USDA Forest Service, 2026), and North Conway (Cornell University, 2026). Cumulative precipitation data were analyzed from May through November 2025 and compared to the average since 1960. This 7-month period was

examined to include the transition from above average precipitation and streamflow conditions in spring to severe drought in late summer. Streamflow data were obtained from the U.S. Geological Survey (USGS) gauge stations on four rivers with headwaters in the White Mountains: the Saco, Pemigewasset, Ammonoosuc, and Wild (Figure 8.2; USGS, 2026). Each river gauge records water level and streamflow each second. To evaluate the changes in water volume throughout the year, the daily average streamflow rates were calculated for each river using the historical record (1960-2025).

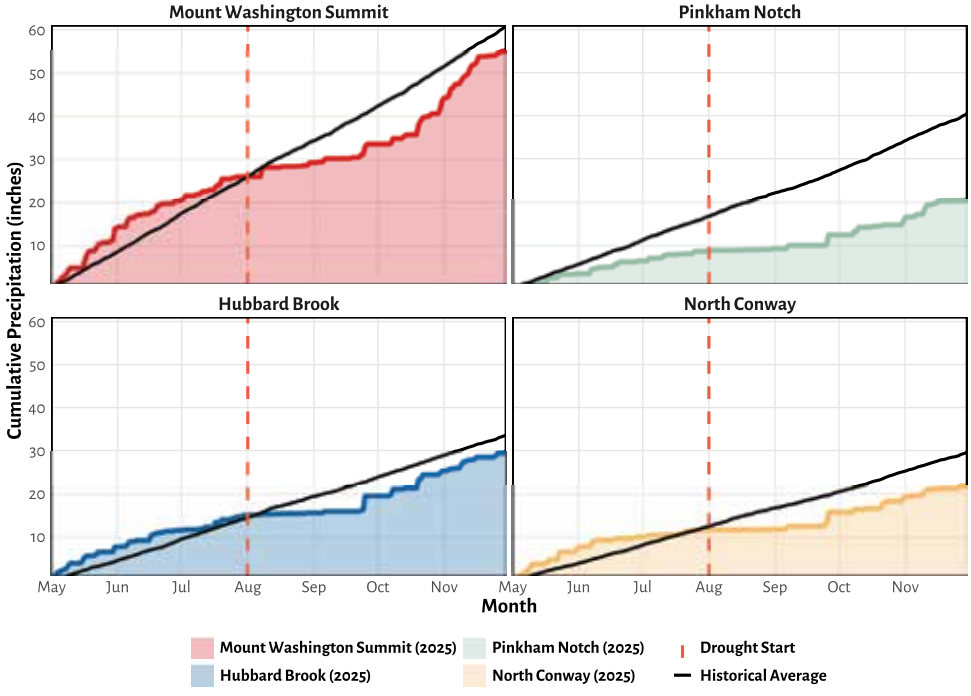


Figure 8.3. Cumulative precipitation (in inches) from May 1st to November 30th. The black line represents the average since 1960, and shaded regions show the cumulative precipitation measured over the same time period in 2025. The white space under the black line indicates less than average. The red dashed line signifies the start of the drought in August 2025.



Figure 8.4. Four rivers evaluated for analysis: the Ammonoosuc, Pemigewasset, Saco, and Wild Rivers, with the location of the USGS streamflow gauges.

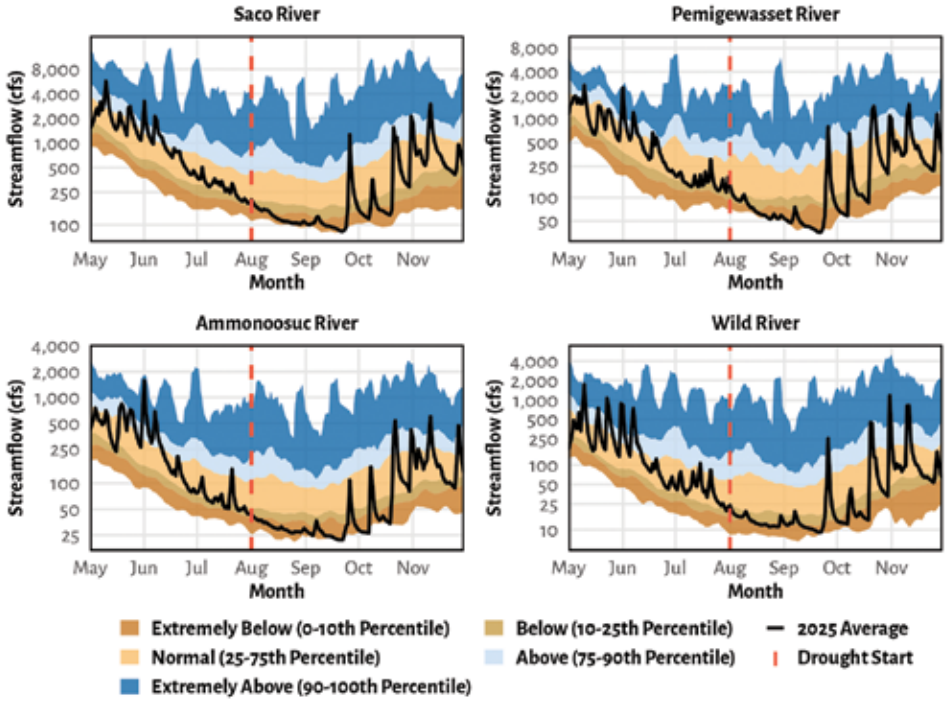


Figure 8.5. Daily streamflow rates (in cubic feet per second (cfs) at the four main rivers in the White Mountains (May-November) from long-term USGS gauge records since 1960. The black line represents daily average streamflow in 2025. The beginning of drought conditions is highlighted by the red dashed line. Shading (blue to brown = higher to lower flow) indicates historic flow in each stream, for comparison with 2025 streamflow.

What the Data Tell Us:

- In 2025, precipitation was above average in the spring then below average dipping into drought conditions by late-summer (Figure 8.3).
- Total precipitation from May to November 2025 compared to the historical average (Figure 8.3):
  - Mount Washington Observatory: 2.0 inches less (55.2 inches total)
  - Pinkham Notch: 16.5 inches less (20.4 inches total)
  - Hubbard Brook: 3.9 inches less (29.7 inches total)
  - North Conway: 7.7 inches less (21.7 inches total)
- All four rivers transitioned from above to extremely below normal levels (Figure 8.5).
- Days in the lowest 10% of historical flows from August to the end of November (total of 122 days):
  - Ammonoosuc River: 72 (59%)
  - Pemigewasset: 52 (43%)
  - Saco: 62 (51%)
  - Wild River: 47 (39%)

Navigating Low Water

Since New Hampshire appears water-rich in comparison to many other regions, there is a common misconception that droughts in the state are rare. This can lead to folks being caught off-guard when regulations and conditions call for change in behavior. In reality, New Hampshire now experiences droughts relatively frequently, with drought conditions occurring 11 of the 20 years between 2000 and 2020 (New Hampshire Department of Environmental Services, 2026). Looking for guidance? The River Management and Protection Program (RMPP) stewards protected rivers and makes efforts to educate recreationists on how they can care for the waters they love. Meanwhile, the State of

New Hampshire provides drought guidance and tips for water conservation.

With extreme climate swings, individuals can practice making the most of the situation by becoming involved in river conservation or pivoting their recreational activities to match the current climate. From the wettest to the driest summers, there are many ways to be a steward of the landscape and enjoy life in the White Mountains.

Key Takeaways:

- The Northeast is simultaneously getting wetter, warmer, and experiencing more flash droughts. This emphasizes the increase in extreme weather and climate patterns New Hampshire has experienced and will continue to navigate in the era of climate change.
- Flash droughts impact human health, local food systems, recreation, ecosystems, and the conomy.
- New Hampshire residents and visitors can learn more about water conservation strategies to mitigate their impact during drought conditions.

Get Involved

Join a Local River Management Advisory Committee. Learn more at *lac.des.nh.gov.*

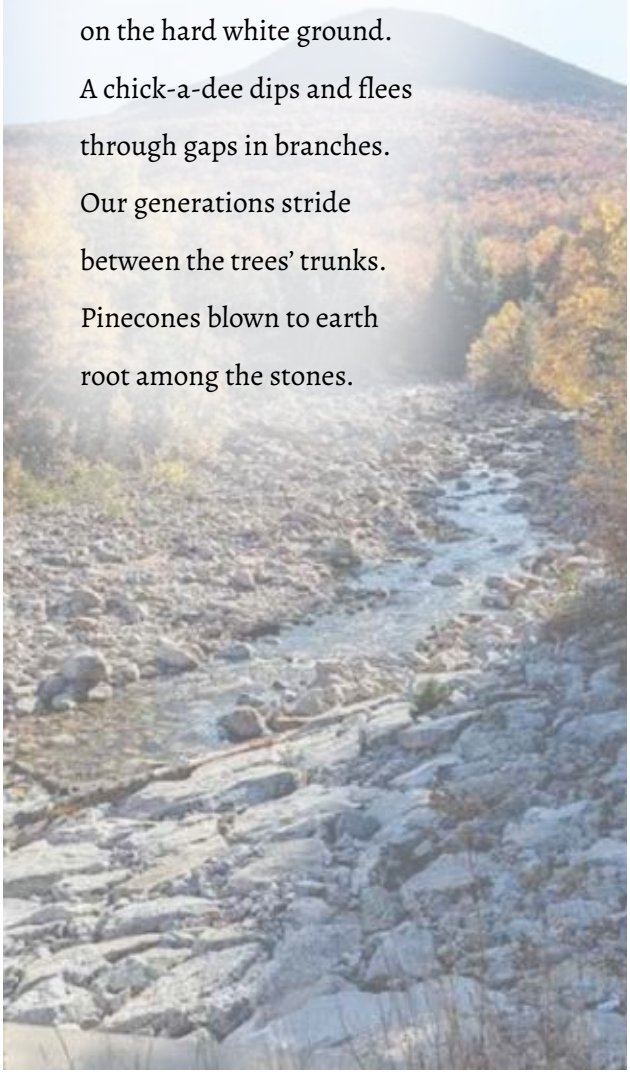
Learn More

River Management and Protection Program (RMPP) by the NH Department of Environmental Services (NHDES) *des.nh.gov/water/rivers-and-lakes/rivers-management-and-protection*

AUTUMN BESIDE THE SACO RIVER

Parker Towle

Leaves spin down like lures, flop
on the shore like fish. The hillside
deepens to kaleidoscopic sleep. No
cold can stay the rubble stream.
Wind lifts me like a treble note,
riffs the treetops, empties limbs
on the hard white ground.
A chick-a-dee dips and flees
through gaps in branches.
Our generations stride
between the trees' trunks.
Pinecones blown to earth
root among the stones.



Hurricane History

What do you remember about Hurricane Irene? Hundreds of trees washed down surging rivers. Water leaked through the edges of windows because of extreme pressure differences inside and outside homes. People navigated washed-out roads for weeks afterward. Even though Irene was categorized as a tropical storm when it crossed into New Hampshire, it still dropped 10 inches of rain on the White Mountain National Forest, which led to major flooding and bridge failure (Downey, 2023). On the summit of Mount Washington, the hourly average wind speed was 93 mph and the peak gust reached 120 mph! The death and damage impacts cannot be overstated.

Although hurricanes infrequently pass through the White Mountains, locals and annual visitors know they have had long-lasting influences on the region. Even the damage from the great hurricane of 1938 can still be seen in the structure of forests of New Hampshire today, since it caused drastic changes to tree species distribution and canopy (D'Amato et al., 2017; Nash, 2022; Oswald et al., 2024; Peart et al., 1992).

Difficult to Forget: On October 29 and 30, 2012, Hurricane Sandy tracked 325 nautical miles from Mount Washington. Yet the summit still received sustained winds over 100 mph, a peak gust of 140 mph, and 4.8 inches of rain over the two day period.

Hurricanes that have Tracked Near the White Mountains

To deepen the understanding of the history of hurricanes in the White Mountains, we investigated the frequency and intensity of hurricanes within 100 nautical miles (nm) of the Mount Washington Observatory. The National Oceanic and Atmospheric Administration's (NOAA) historical hurricane track records were examined between 1851 and 2025 for tropical cyclones that passed within 100 nm of Mount Washington Observatory and grouped by decade (NOAA, 2026). A storm map was pulled from NOAA's Historical Hurricane Tracks to evaluate the storm paths (Figure 9.2).

What the Data Tell Us:

- Some of the most notable storms in the record include Carol, Donna, Gloria, and Bob (Table 9.1).
- Since so few hurricanes pass through the White Mountains, there is not enough data to evaluate local trends.

Key Takeaways:

- Although infrequent, hurricanes in the Northeast can cause large-scale damage with long-lasting effects to the landscape and communities.
- When hurricanes hit the White Mountains, they can cause significant forest canopy damage and alter hydrologic and biogeochemical cycles (Vidon et al., 2018; Yellen et al., 2014).

Learn More

NOAA Hurricane Historical Tacks. Visit ***coast.noaa.gov/hurricanes.***

Hurricane Hall of Fame

	1938 - UNNAMED	1954 - CAROL	1960 - DONNA	1985 - GLORIA	1991 - BOB
Category	3	3	1	1	2
Peak Gust	160 mph	142 mph	112 mph	127 mph	115 mph
Hourly Average Wind Speed	118 mph	93 mph	82 mph	78 mph	77 mph
Total Rainfall	2.60 in (2 days)	3.88 in (2 days)	4.94 in (2 days)	6.03 in (4 days)	6.63 in (2 days)

Table 9.1. (top) Records of hurricanes (category 1 - 5) within 100 nautical miles of Mount Washington Observatory from 1935 to 2025. Category refers to the peak strength refers to the highest Saffir-Simpson category of the storm 100 nautical miles (nm) of the Mount Washington Observatory. Peak gust refers to the top wind speed recorded, the hourly average wind speed shows the average wind speed recorded continuiously, total rainfall shows the total precipetation collected during the duration of the storm on the summit by the Mount Washington Observatory.

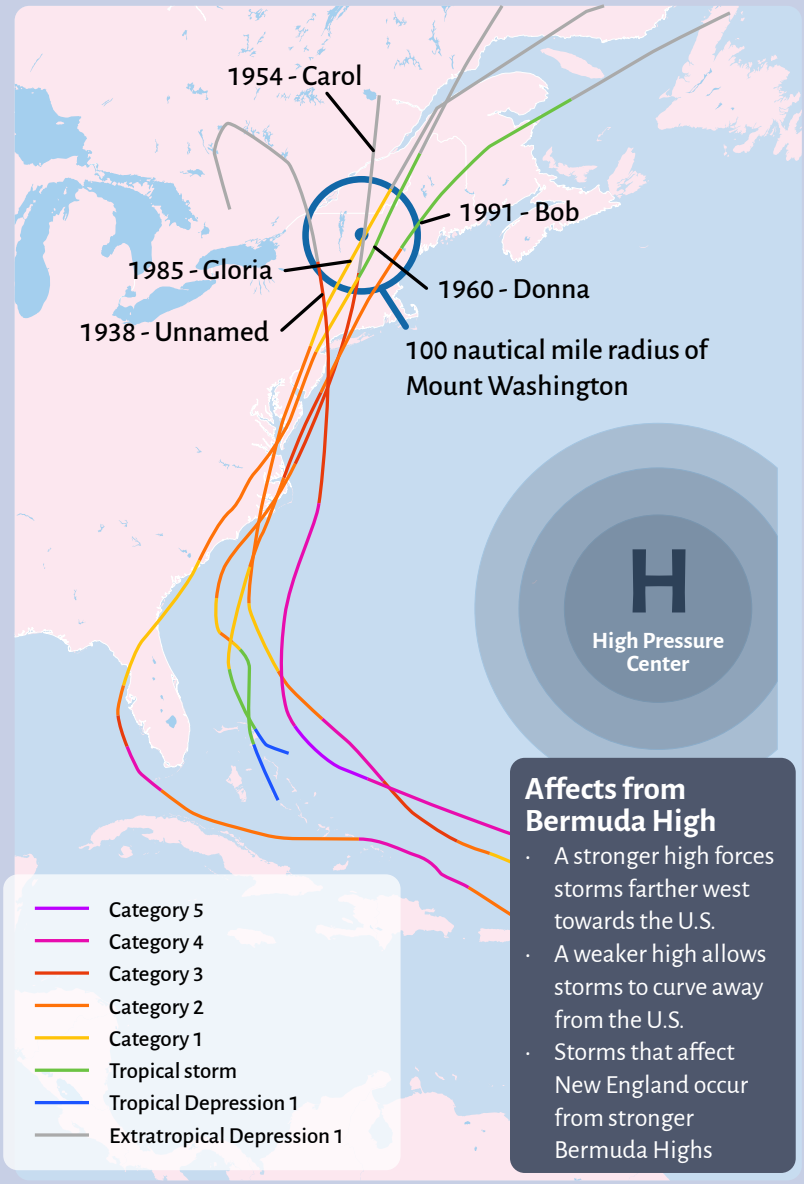


Figure 9.1. (left) Hurricane tracks of record storms within 100 nautical miles of the Mount Washington Observatory.

Nimbus the Cat



Nimbus is the resident cat at the Mount Washington Observatory, living atop one of Earth's windiest peaks. He keeps weather observers company, charms visitors, and has become a beloved mascot. Between snowstorms, summit selfies, and cozy naps, Nimbus enjoys a life unlike almost any other cat in the world.

Saffir-Simpson Hurricane Scale

Max. Avg. Wind Speed (mph, 1 min sustained)

< 38		Tropical Depression
39-73		Tropical Storm
74-95	Hurricane	Category 1
96-110	Hurricane	Category 2
111-129	Hurricane	Category 3
130-156	Hurricane	Category 4
≥157	Hurricane	Category 5

Extratropical Storm

Large-scale, low-pressure weather system that develops outside the tropics and derives its primary energy from the temperature contrasts between warm and cold air masses.



DECADAL FREQUENCY OF TROPICAL CYCLONES WITHIN 100 NAUTICAL MILES OF MOUNT WASHINGTON

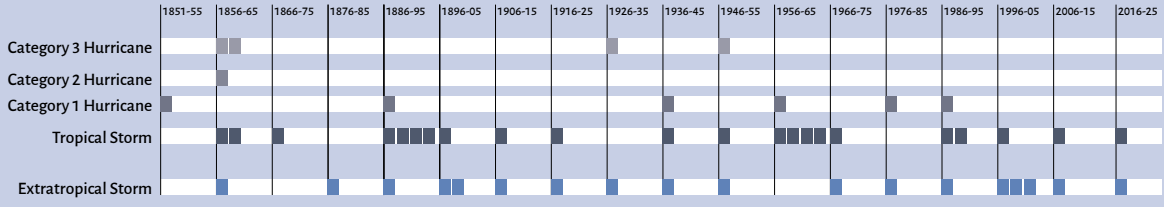


Figure 9.2. Decadal frequency of tropical cyclones within 100 nautical miles of the Mount Washington Observatory from 1851 to 2025. While these all originated as hurricanes, each was categorized by its maximum strength within this 100 nm range from the Mount Washington Observatory.



View of Summit under partly cloudy skies.
Photo by MWOBS.

OCTOBER

Fall Foliage Timing

"October is the month of painted leaves"

— Henry David Thoreau (1862).

Shorter days and cooler temperatures are signals to people and trees alike: fall has arrived. As we pull out our sweaters and plan autumn festivities, broad-leaf deciduous trees prepare for winter dormancy. Trees form a seal between the stem and leaves before releasing them. This, combined with reduced solar energy, leads to the breakdown of chlorophyll, the chemical that absorbs light energy for photosynthesis. During the spring and summer green-pigmented chlorophyll covers other chemicals in the leaf: flavonoids are yellow and carotenoids are yellow, orange and red. As chlorophyll breaks down, the green pigment disappears, the other chemicals become visible and the creation of anthocyanins form a red pigment, revealing their beautiful fall colors. These seasonal plant processes and chemical reactions give us a spectacular annual show of colors across the landscape. Enthusiasm for fall foliage can be seen in the abundance of art inspirations and leaf peepers, tourists who visit the region to view the change in leaf coloration.

Complex Changes

How is climate change impacting fall foliage? There is no simple answer, since fall foliage is affected by a variety of factors: air temperature, latitude, precipitation, and day length (Dio et al., 2008; Spera et al., 2023). At higher latitudes with cold autumns, like the White Mountains, fall foliage is mainly induced by cooler temperature, compared to lower latitudes with warm autumns where it is triggered by shortening day length (Lang et al., 2024). The warming of fall temperatures has been linked to later peak fall foliage in New England, across North America, and globally (Doi et al., 2008; Spera et al., 2023). In Acadia National Park, peak fall foliage is now occurring two weeks later than in 1950, which has also delayed the final wave of tourists (Spera et al., 2023). With the projected increase in temperatures, the cues for leaf coloration could shift from temperature to length of day (Lang et al., 2024).

Drought can lead to multiple responses by fall foliage, since water stress has varied outcomes. These changes to foliage include premature leaf fall, a less pronounced peak, and earlier timing (Estiarte et al., 2015). This is a more varied response than warming temperatures, since one, two, or all three can occur during a fall season with drought conditions (Estiarte et al., 2015). For more information on droughts in the White Mountains, see Chapter 8 August: The Driest Summer on Record.

Why It Matters:

- Approximately 3.7 million people visit New Hampshire to view fall foliage, adding $1.8 billion dollars to the state's economy (NH Department of Business and Economic Affairs, 2026).
- Warming temperatures have been linked to the delay of foliage timing.
- Understanding how climate is affecting fall foliage will provide crucial information to the tourism industry when planning for a resilient, sustainable future (Doi et al., 2008; Spera et al., 2023).



Peak Foliage Timing at Hubbard Brook

To better understand the timing of peak fall foliage in the White Mountains, phenology observations collected between 1989 and 2025 at Hubbard Brook Experimental Forest were analyzed (USDA Forest Service, 2025). The observations used in this analysis focused on three tree species: sugar maple (*Acer saccharum*), yellow birch (*Betula alleghaniensis*), and American beech (*Fagus grandifolia*). Observations from Hubbard Brook were collected from three sites within the south-facing watershed to determine the timing of phenophases for each species each year. This analysis focused on the peak foliage phenophase, defined as: most leaves yellow, red, or colored; few leaves have fallen, and leaves still obscure the

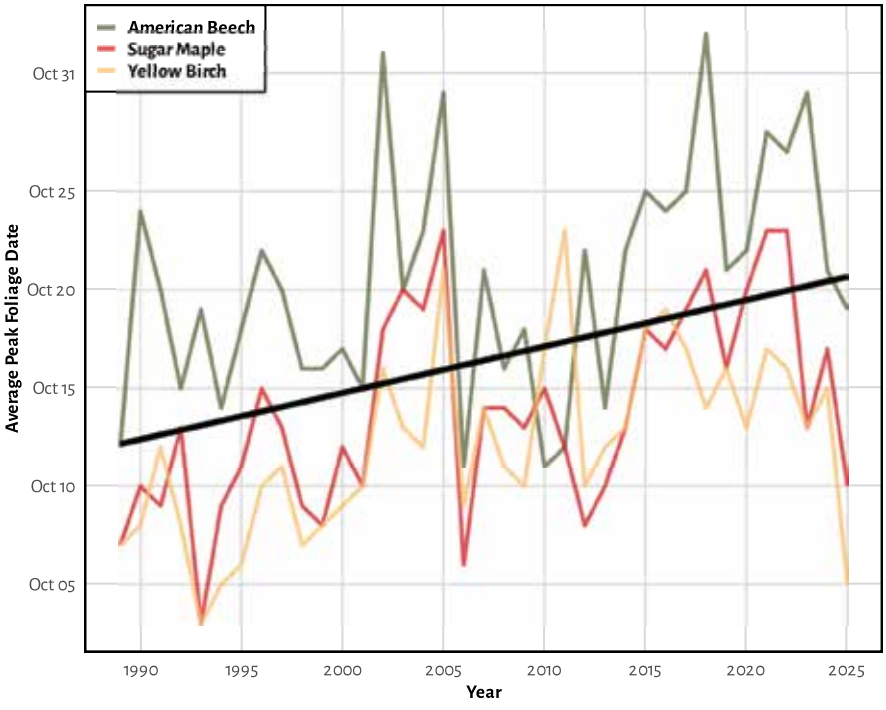


Figure 10.1. A linear analysis reveals statistacally significant trends of peak foliage date occuring later by 2.3 days per decade for all three tree species, 2.49 days per decade for sugar maple (*Acer saccharum*), 2.31 days per decade for yellow birch (*Betula alleghaniensis*), 2.11 days per decade for American beech (*Fagus grandifolia*) ($p<0.01$).

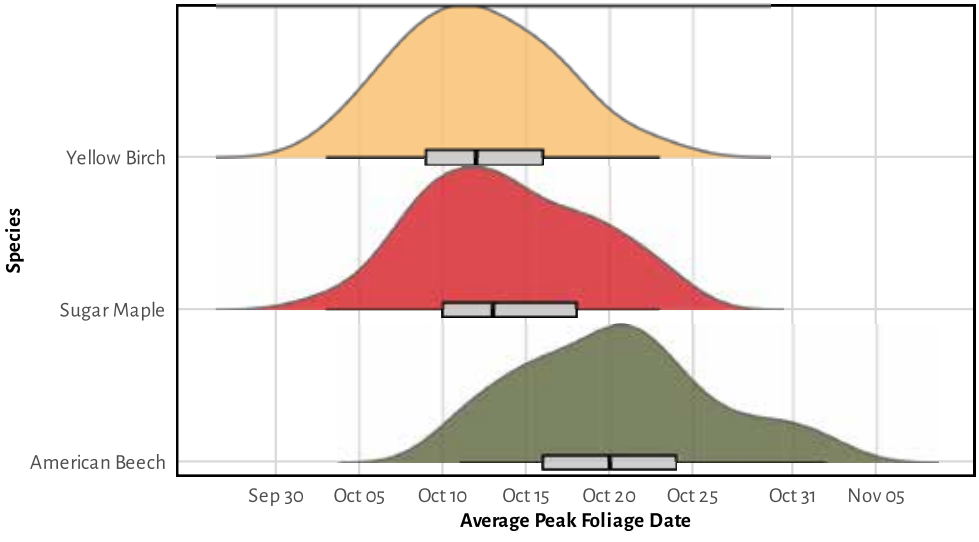


Figure 10.2. Distribution of average peak foliage date of three tree species at Hubbard Brook from 1989 to 2025.

sky as seen through the crown. The peak date across the record was analyzed to evaluate the shift in foliage timing (Figure 10.1).

What the Data Tell Us:

- At Hubbard Brook, the average peak foliage date has shifted later by approximately 2.3 days per decade for all three species, approximately 8 days later than in 1989 (Figure 10.2).
- Further research is needed to understand the possible influence of air temperature, drought conditions, and precipitation patterns on the variability of the peak foliage date.

The Future of Fall:

Part of the wonder of fall foliage is the anticipation. Even with changes to peak foliage timing and the impacts of drought, the culture of leaf peeping remains strong and will continue. From watching the daily changes of your neighborhood trees to road trips winding through the notches of the White Mountains, there is so much to celebrate for years to come.

Key Takeaways:

- Peak foliage at Hubbard Brook has occurred later an average of 8 days between 1989 to 2025, (Figure 10.1).
- Warming temperatures led to a delay in peak foliage, while drought induces varied responses, such as premature leaf fall, reduced peak, and earlier timing.

Learn More

Foliage Tracker - *visitnh.gov/plan-your-trip/fall/foliage-tracker-app*

Fall Foliage Report - *visitnh.gov/plan-your-trip*



NOVEMBER

Hard Freeze Timing

As daylight shortens and nights grow colder, the arrival of the season's first hard freeze signals an important ecological transition. A **hard freeze** occurs when temperatures fall to 28°F (-2°C) or below for at least an hour. The period between the last hard freeze in the spring and first in the fall marks the general growing season, since many cold-sensitive plants are damaged or go into dormancy below this temperature. The length of the growing season influences seasonal rhythms and the overall function of the ecosystem.

Methods

To investigate how hard freeze timing has changed across the White Mountains, long-term temperature records were analyzed from Mount Washington Observatory (Mount Washington Observatory, 2026), Pinkham Notch, Hubbard Brook (USDA Forest Service, 2026), and North Conway (Cornell University, 2026). For each year from 1960 to 2025, the last hard freeze in spring and the first hard freeze in fall were identified.

Why It Matters:

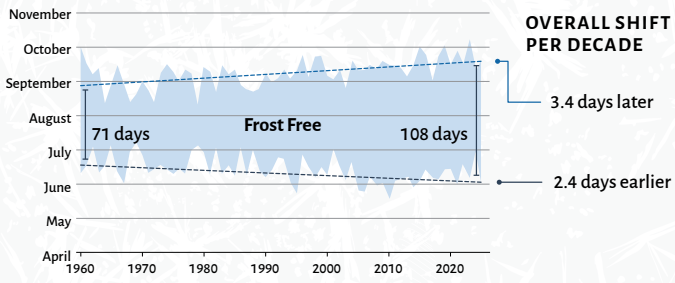
- Changes to hard freeze timing has cascading consequences, such increased stress on groundwater, delayed signaling to migrational birds, and a longer time period for ticks to latch onto moose (Hamburg et al., 2013; Holmes et al., 2018; Van Tatenhove et al., 2019).
- An extended growing season may be seen as positive for agriculture, yet it has nuanced impacts for the industry (Vega et al., 2020).

Figure 11.1. (Opposite page): Length of period from last hard freeze in spring to first hard freeze in fall from 1960 to 2025. Linear analyses for the last hard freeze revealed statistically very significant trends ($p<0.01$) for all sites.

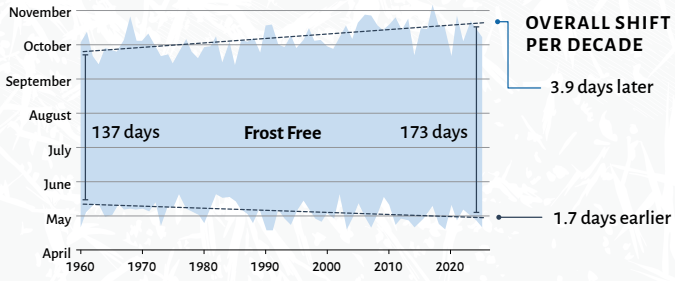


Later Winters, Earlier Summers

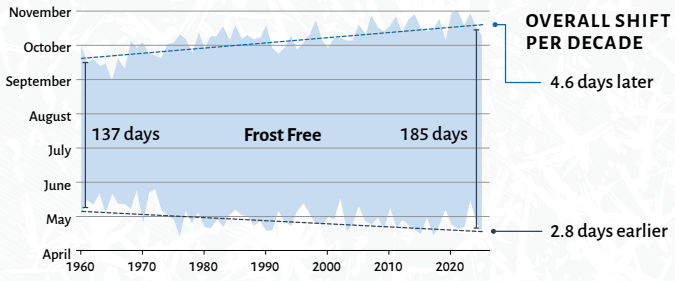
MOUNT WASHINGTON OBSERVATORY



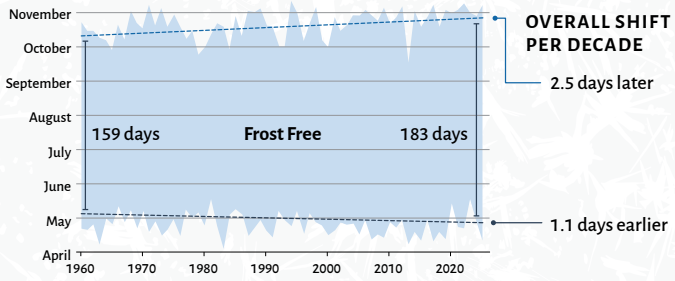
APPALACHIAN MOUNTAIN CLUB, PINKHAM NOTCH



NORTH CONWAY, NEW HAMPSHIRE



HUBBARD BROOK EXPERIMENTAL FOREST



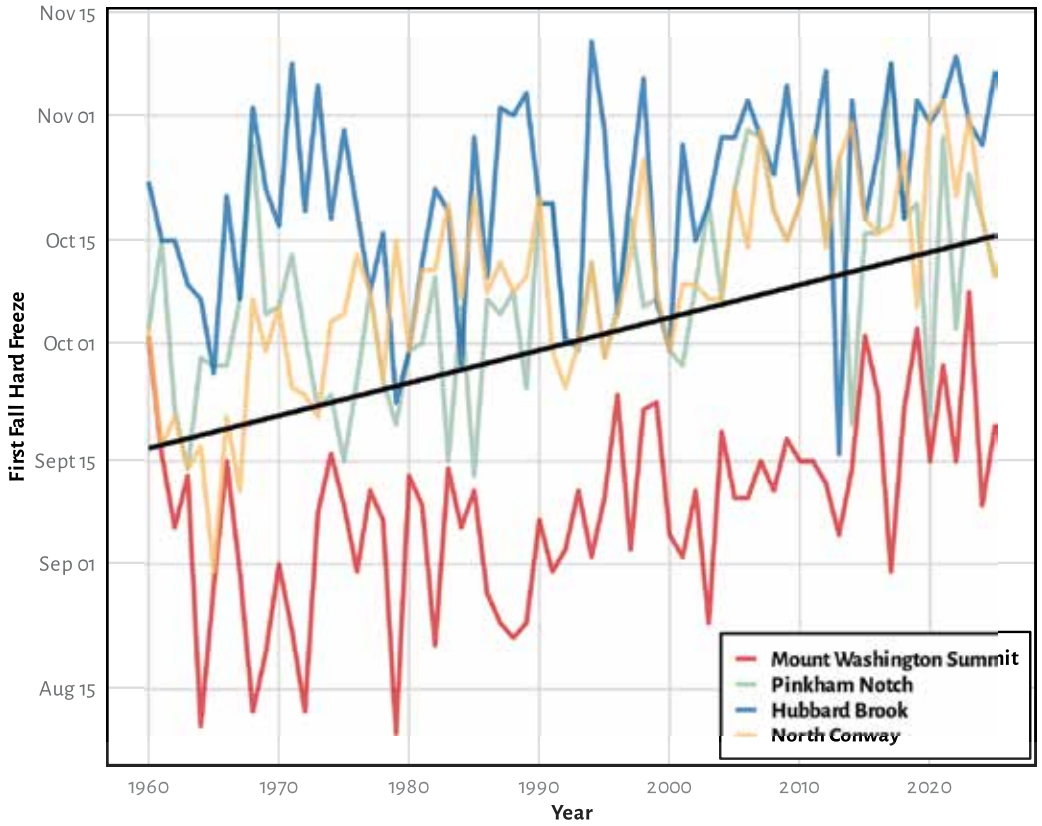


Figure 11.2. First hard freeze date in fall from 1960 to 2025 at the Mount Washington Observatory, Pinkham Notch, Hubbard Brook, and North Conway. Linear analysis fit over the average of the data shows the last hard freeze date shifting later in the year by 4.4 days per decade, with a statistically very significant trend ($p<0.01$).

What the Data Tell Us:

- At all four sites, the first hard freeze is arriving later, while the last hard freeze is happening earlier than it did during the mid-20th century, both statistically significant trends. On average across the sites, the first hard freeze occurs later by approximately 4.4 days per decade and the last is 2.0 days per decade earlier.
- Over the past 65 years, this amounts to an extension of the general growing season about a month in the fall and just under two weeks in the pring.

Longer frost-free periods can extend the general growing season for some plant species. Delayed freezes may also affect the timing of fall foliage seasons, as observed in other White Mountains phenology records, see the October Chapter. At the same time, longer growing seasons can create ecological mismatches. Insects, pathogens, and invasive species that were once limited by colder fall conditions may survive longer into the sea-son or expand farther north and upslope. The timing of the first and last hard freeze aren't just weather statistics, but an indicator of environmental change.

Learn More

USDA Hardiness Zones *planthardiness.ars.usda.gov/.*

DECEMBER

Winds of Mount Washington

"If you don't like the weather, wait a moment"
— Mark Twain

Why does wind happen? Wind is simply the movement of air across the Earth's surface due to changes in pressure. Major storm tracks and air mass routes pass through the White Mountains, so there are frequent fluctuations between high and low pressure. This is the foundation for why the weather changes often and Mark Twain's quote is a common saying. How does the weather become extreme? As air approaches Mount Washington it is funneled by the topography and accelerates, similar to a stream flowing faster when it narrows. What makes it different from the notches? As the air is compressed on the sides, it is also being squeezed vertically over the summit while expanding with the increase in elevation. So, breezy weather at the base can be occurring at the same time as gusts up to 100 mph at the summit. This is the difference between swaying flowers and people struggling to stand.

Investigating Wind Across Elevation

Wind dynamics on Mount Washington were evaluated by elevation and season. Hourly wind speeds were analyzed from remote weather stations along the Mount Washington Auto Road from 2015 to 2025, then daily average wind speeds were calculated and analyzed to determine how winds at three elevations change through the year (Figure 12.1; See Equation E.12.1; Mount Washington Observatory, 2026a and 2026b). To characterize the seasons and dynamics on the summit, we examined the distribution of daily average wind speeds between meteorological seasons from 1981 to 2025 (Figure 12.2) and how winds at the summit have changed since 1981 (Figure 12.3; See Equation E.12.2). The 1981-2025 period is used because of the location change of the anemometer (wind sensor) on the summit in 1980.

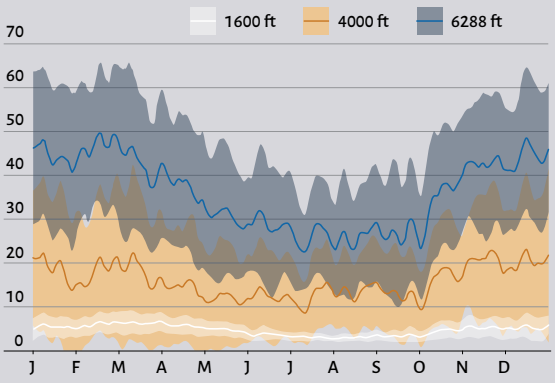
What the Data Tell Us:

- Variability increases with elevation, with the summit showing the widest spread of daily conditions (standard deviation = ±14.3), indicating that higher elevations experience not only stronger winds but also greater day-to-day variations than lower elevations (1,600 ft standard deviation = ±1.84; 4,000 ft = ±12.8).
- Seasonal frequency distributions at the summit from 1981 to 2025 reveal the following patterns (Figure 12.2; Table 12.1):
  - Winter has the broadest range and highest wind speeds overall, consistent with frequent low-pressure systems moving over the Northeast.
  - Spring and fall remain relatively windy but begin to shift toward lower and more moderate values.
  - Summer has a tighter distribution centered on lower wind speeds, reflecting more stable atmospheric conditions, with the least exposure to the higher winds of the free troposphere. Even in summer, extremes can occur, with daily average winds of >70 mph possible.
- Long-term winter trends from 1981 to 2025 show no statistically significant change in average wind speeds (Figure 12.3).

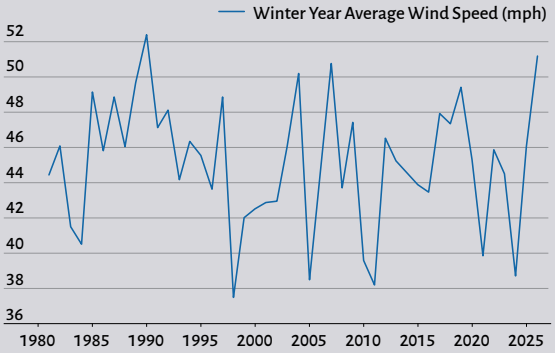
Winds of Mount Washington



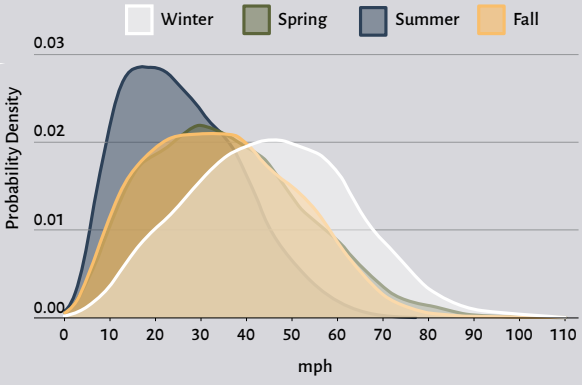
DAILY AVERAGE WIND SPEED (MPH)



WIND SPEEDS AT MOUNT WASHINGTON OBSERVATORY



SEASONAL PROBABILITY OF VARIOUS WIND SPEEDS



Overall, these results show that Mount Washington's wind regime is primarily controlled by elevation and season. The mountain experiences a persistent and well-defined seasonal cycle, strong vertical gradients in wind speeds, and high variability at the summit. Long-term winter winds remain relatively stable over the recent observation record. Hold on tight to your kites!

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Figure 12.1. (opposite page, top right) Daily average wind speed at 1,600, 4,000 and 6,288 feet on Mount Washington from 2015 to 2025. Fit with a LOESS curve, shaded regions represent 1 standard deviation of wind speed variability.

Figure 12.2. (middle) Winter (December-February) average wind speeds at the Mount Washington Observatory from 1981 to 2025. The winter year begins on December 1st of one year and ends on February 28th/29th of the next to capture the entirety of each winter season. The concluding year represents said winter year (i.e. 2024-2025 winter year = 2025). There were no statistically significant trends in winter average wind speeds ($p>0.05$).

Figure 12.3. (bottom) Distribution of daily average wind speeds at Mount Washington Observatory from 1981 to 2025 for each season, with the highest daily average wind speed at 110 mph. Peaks in the curves show the wind speeds that are most common during each season.

POLAR VORTEX

Laurie D. Morrissey

Far to the north, a whirling mass
of arctic air sheds sheets of itself southward.
I pull my fingers out of their wool sheaths,
curl them into my palms for warmth,
and follow your signature in the snow
through the field, through a break
in the stone wall, where last summer
a garter snake and her heaped-up hatchlings
lay on sunbaked leaves.
Now they lie below, slow but awake.
I trudge onto the frozen lake,
Thoreau's quiet parlor of fishes,
and stand as far as I can from any shore—
while down below, the spotted turtle rests
beneath a blanket of mud, his heart
beating once every eight frozen minutes.



Record Board

Location:	Mount Washington Observatory	Pinkham Notch	Hubbard Brook	North Conway
Temperature ℉ (rounded to the nearest integer)				
Record High	72°F (Aug 2nd, 1975 & June 26th, 2003)	93°F (July 20th, 1982)	95°F (July 7th, 2010)	103°F (Aug 3rd, 1975)
Record Low	-47°F (Jan 29th, 1934 & Feb 4th, 2023)	-33°F (Feb 16th, 1943)	-27°F (Dec 25th, 1980, Jan 4th, 1981, & Feb 4th, 2023)	-34°F (Feb 2nd, 1962 & Jan 20th, 1971)
Highest Year-long Average	31°F (2024)	44°F (1998)	47°F (2012)	49°F (1973)
Lowest Year-long Average	25°F (1943)	38°F (1972)	40°F (1965)	42°F (1962)
Precipitation Inches (rounded to the nearest hundredths place)				
Highest Day	10.82 (Oct 21st, 1996)	8.98 (Oct 4th, 1959)	5.44 (Oct 24th, 1959)	5.51 (Sept 12th, 1960)
Highest Month	28.70 (Oct 2005)	23.86 (Mar 1936)	13.90 (Jun 1973)	12.53 (Nov 1963)
Highest Year	130.15 (1969)	87.70 (2005)	69.70 (1973)	65.90 (2005)
Lowest Year	54.33 (1941)	36.02 (2001)	36.20 (1961)	31.80 (2001)

Location:	Mount Washington Observatory	Pinkham Notch	North Conway
Snowfall Inches (rounded to the nearest tenth)			
Highest Day	49.3 (Feb 25th, 1969)	33.5 (Feb 18th, 1952)	21.0 (Feb 19th, 1960 & Feb 25th, 1969)
Highest Month	172.8 (Feb 1969)	130.0 (Feb 1969)	67.5 (Feb 1960)
Highest Year	566.4 (1968-69)	323.0 (1968-69)	164.0 (1968-69)
Lowest Year	141.8 (1949-50)	53.7 (1979-80)	27.0 (1973-74)

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	Snow Depth Inches (rounded to the nearest integer)		
Highest Recorded	50 (Apr 5th, 1947)	164 (Feb 27th, 1969)	65 (Feb 27th,1969)
Lowest Year-long Maximum	7 (1967-68 and 1990-91)	15 (2006-07)	7 (2006-07)

Monthly Trends

Temperature

All temperature values are rounded to the nearest integer. Hubbard Brook temperature data is from Station 1 "STA1."

Location	Mount Washington Observatory			Pinkham Notch			Hubbard Brook			North Conway		
Recorded Temperature	1935 - 2025	1991 - 2020	2025	1935 - 2025	1991 - 2020	2025	1959 - 2025	1991 - 2020	2025	1957 - 2025	1991 - 2020	2025
January												
Highest	48°F	48°F	29°F	64°F	63°F	43°F	57°F	57°F	36°F	61°F	61°F	49°F
Average	**5°F**	**6°F**	**2°F**	**16°F**	**17°F**	**15°F**	**18°F**	**19°F**	**16°F**	**19°F**	**20°F**	**20°F**
Lowest	-46°F	-45°F	-22°F	-31°F	-23°F	-10°F	-27° F	-22°F	-17° F	-34°F	-29°F	-11°F
February												
Highest	48°F	48°F	28°F	72°F	72°F	45°F	63°F	63°F	41°F	71°F	71°F	50°F
Average	**6°F**	**6°F**	**5°F**	**17°F**	**18°F**	**17°F**	**20°F**	**21°F**	**19°F**	**21°F**	**22°F**	**21°F**
Lowest	-47°F	-40° F	-18°F	-33°F	-24°F	-11°F	-27° F	-21°F	-3°F	-34°F	-21°F	-9°F
March												
Highest	54°F	54°F	44°F	78°F	78°F	58°F	81°F	81°F	55°F	85°F	85°F	63°F
Average	**13°F**	**13°F**	**18°F**	**26°F**	**26°F**	**29°F**	**29°F**	**29°F**	**32°F**	**31°F**	**31°F**	**34°F**
Lowest	-38°F	-37°F	-20°F	-21°F	-19°F	-2°F	-13°F	-9°F	0°F	-22°F	-10°F	-3°F
April												
Highest	60°F	59°F	54°F	86°F	86°F	69°F	88°F	88°F	82°F	92°F	92°F	86°F
Average	**23°F**	**24°F**	**26°F**	**38°F**	**38°F**	**39°F**	**41°F**	**41°F**	**43°F**	**43°F**	**43°F**	**38°F**
Lowest	-20°F	-20°F	-3°F	-4°F	2°F	14°F	1°F	7°F	17°F	0°F	9°F	-4°F

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May												
Highest	66°F	66°F	58°F	90°F	90°F	77°F	93°F	92°F	81°F	98°F	98°F	83°F
Average	**35°F**	**36°F**	**38°F**	**50°F**	**50°F**	**51°F**	**53°F**	**54°F**	**54°F**	**55°F**	**55°F**	**56°F**
Lowest	-2°F	4°F	20°F	10°F	21°F	31°F	23°F	25°F	34°F	18°F	24°F	34°F
June												
Highest	72°F	72°F	65°F	91°F	91°F	90°F	93°F	93°F	90°F	102°F	102°F	97°F
Average	**45°F**	**45°F**	**47°F**	**59°F**	**59°F**	**60°F**	**62°F**	**62°F**	**63°F**	**64°F**	**64°F**	**66°F**
Lowest	8°F	16°F	26°F	29°F	30°F	38°F	34°F	35°F	42°F	29°F	34°F	42°F
July												
Highest	71°F	71°F	66°F	93°F	92°F	88°F	95°F	95°F	87°F	100°F	100°F	94°F
Average	**49°F**	**50°F**	**52°F**	**64°F**	**64°F**	**67°F**	**66°F**	**67°F**	**68°F**	**69°F**	**69°F**	**73°F**
Lowest	24°F	24°F	34°F	32°F	33°F	43°F	39°F	39°F	47°F	33°F	41°F	46°F
August												
Highest	72°F	69°F	69°F	92°F	91°F	90°F	91°F	91°F	89°F	103°F	100°F	96°F
Average	**48°F**	**49°F**	**49°F**	**62°F**	**63°F**	**63°F**	**64°F**	**65°F**	**65°F**	**67°F**	**68°F**	**69°F**
Lowest	20°F	24°F	34°F	31°F	31°F	42°F	34°F	43°F	45°F	26°F	42°F	42°F
September												
Highest	69°F	69°F	57°F	92°F	92°F	79°F	91°F	91°F	81°F	98°F	98°F	86°F
Average	**42°F**	**43°F**	**45°F**	**55°F**	**56°F**	**58°F**	**57°F**	**58°F**	**61°F**	**59°F**	**60°F**	**63°F**
Lowest	9°F	9°F	27°F	21°F	26°F	34°F	25°F	25°F	43°F	20°F	25°F	36°F
October												
Highest	62°F	62°F	59°F	86°F	80°F	84°F	83°F	82°F	83°F	88°F	85°F	86°F
Average	**31°F**	**31°F**	**34°F**	**44°F**	**45°F**	**47°F**	**46°F**	**46°F**	**50°F**	**47°F**	**48°F**	**63°F**
Lowest	-5°F	3°F	15°F	8°F	15°F	27°F	14°F	19°F	31°F	10°F	19°F	36°F
November												
Highest	52°F	52°F	37°F	75°F	75°F	55°F	74°F	74°F	55°F	78°F	77°F	59°F
Average	**21°F**	**21°F**	**18°F**	**33°F**	**33°F**	**32°F**	**34°F**	**35°F**	**33°F**	**36°F**	**37°F**	**37°F**
Lowest	-26°F	-26°F	2°F	-7°F	-4°F	15°F	-8°F	-8°F	19°F	-4°F	3°F	20°F

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December												
Highest	47°F	47°F	38°F	67°F	67°F	49°F	63°F	61°F	49°F	71°F	71°F	49°F
Average	**10°F**	**12°F**	**6°F**	**21°F**	**23°F**	**16°F**	**23°F**	**25°F**	**19°F**	**25°F**	**26°F**	**21°F**
Lowest	-45°F	-36°F	-21°F	-31°F	-20°F	-8°F	-31°F	-17°F	-5°F	-24°F	-16°F	-5°F

Precipitation

All precipitation values are reported to the nearest hundredths place. Hubbard Brook precipitation data is from Rain Gauge 1 "RG1." In the tables below, a dash (-) indicates that monthly high and low records cannot be calculated because the 2025 dataset contains only a single year of observation.

Location:	Mount Washington Observatory			Pinkham Notch			Hubbard Brook			North Conway		
Recorded Precipitation (Inches)	1935 – 2025	1991 – 2020	2025	1935 – 2025	1991 – 2020	2025	1959 – 2025	1991 – 2020	2025	1957 – 2025	1991 – 2020	2025
January												
Highest	18.23	10.94	-	12.80	12.80	-	9.17	9.17	-	8.58	8.11	-
Average	**6.37**	**5.85**	**4.20**	**4.48**	**5.01**	**2.01**	**4.05**	**4.30**	**4.54**	**3.56**	**3.66**	**1.03**
Lowest	1.29	1.81	-	0.41	1.60	-	0.85	1.41	-	0.55	0.75	-
February												
Highest	25.56	8.95	-	13.52	10.24	-	10.39	7.91	-	9.64	8.16	-
Average	**6.35**	**5.42**	**5.15**	**4.03**	**4.68**	**5.32**	**3.48**	**3.49**	**4.54**	**3.32**	**3.13**	**3.52**
Lowest	0.98	3.04	-	1.02	1.38	-	0.48	1.18	-	0.30	0.30	-
March												
Highest	15.98	13.43	-	23.86	10.24	-	8.81	6.17	-	9.07	8.46	-
Average	**7.16**	**6.69**	**6.82**	**4.91**	**4.68**	**1.96**	**4.11**	**4.03**	**5.96**	**3.74**	**3.61**	**4.48**
Lowest	2.07	3.35	-	0.71	1.38	-	0.99	1.85	-	0.81	0.93	-
April												
Highest	15.21	12.82	-	11.60	11.60	-	9.41	9.41	-	8.68	8.68	-
Average	**7.05**	**7.24**	**5.23**	**4.98**	**5.61**	**1.58**	**4.25**	**4.60**	**3.91**	**4.20**	**4.38**	**2.70**
Lowest	2.13	2.13	-	0.59	0.59	-	0.81	0.81	-	0.20	0.20	-

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May												
Highest	19.28	19.28	-	13.68	13.68	-	11.82	9.41	-	9.02	7.68	-
Average	**7.14**	**7.7**	**13.97**	**5.02**	**5.64**	**3.56**	**4.50**	**4.60**	**7.83**	**3.89**	**3.73**	**7.12**
Lowest	1.87	2.61	-	0.87	0.87	-	0.87	1.93	-	0.45	0.55	-
June												
Highest	19.96	19.96	-	17.70	17.70	-	13.94	11.99	-	12.45	12.45	-
Average	**7.76**	**8.6**	**6.34**	**5.10**	**5.44**	**2.94**	**4.82**	**5.27**	**3.81**	**4.20**	**4.49**	**3.01**
Lowest	2.43	3.03	-	0.99	0.99	-	1.21	1.76	-	0.57	1.4	-
July												
Highest	17.08	16.85	-	13.83	10.75	-	9.87	9.87	-	9.43	9.20	-
Average	**7.66**	**8.84**	**5.80**	**4.93**	**5.31**	**2.28**	**4.92**	**5.35**	**3.53**	**4.21**	**4.45**	**1.54**
Lowest	2.69	3.63	-	1.12	1.53	-	1.94	2.11	-	1.18	1.18	-
August												
Highest	20.69	18.82	-	14.64	14.64	-	12.36	12.36	-	10.31	10.31	-
Average	**7.48**	**7.62**	**3.19**	**4.76**	**5.23**	**0.55**	**4.81**	**5.47**	**0.46**	**4.22**	**4.62**	**0.19**
Lowest	2.46	3.28	-	0.55	1.15	-	0.46	0.86	-	0.19	1.30	-
September												
Highest	18.82	18.82	-	14.25	14.25	-	12.57	12.57	-	10.58	10.58	-
Average	**7.24**	**7.62**	**4.30**	**4.79**	**4.87**	**3.17**	**4.43**	**4.64**	**3.90**	**3.70**	**3.63**	**3.92**
Lowest	1.91	3.28	-	1.35	1.59	-	1.31	1.79	-	0.64	0.82	-
October												
Highest	28.77	28.77	-	17.92	17.92	-	12.72	12.72	-	12.70	12.70	-
Average	**7.94**	**10.12**	**10.07**	**5.81**	**7.64**	**3.26**	**5.06**	**5.77**	**5.79**	**4.73**	**5.55**	**3.45**
Lowest	0.44	2.17	-	0.48	1.07	-	1.17	1.17	-	0.79	0.79	-

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November												
Highest	19.56	15.75	-	14.16	12.06	-	8.51	8.31	-	12.90	7.45	-
Average	**8.42**	**8.16**	**11.49**	**5.63**	**5.69**	**4.67**	**4.90**	**4.97**	**4.33**	**4.58**	**4.43**	**2.51**
Lowest	2.04	2.55	-	1.61	2.85	-	0.86	0.86	-	0.32	0.32	-
December												
Highest	17.95	13.10	-	16.20	13.02	-	11.24	8.69	-	9.57	8.09	-
Average	**7.86**	**7.57**	**5.59**	**5.14**	**5.75**	**2.30**	**5.04**	**5.15**	**5.30**	**4.50**	**4.62**	**4.07**

Snowfall

All snowfall values are reported to the nearest tenth. The snow year begins on July 1st of one year and ends on June 30th of the next to capture the entirety of winter's snowfall. The concluding year represents said snow year (i.e. 2024-2025 snow year = 2025).

Location:	**Mount Washington Observatory**			**Pinkham Notch**			**North Conway**		
Recorded Snowfall (Inches)	1935 - 2025	1991 - 2020	2025	1935 - 2025	1991 - 2020	2025	1957 - 2025	1991 - 2020	2025
January									
Highest	94.6	71.4	-	83.0	57.0	-	43.7	43.7	-
Average	**41.1**	**39.9**	**46.6**	**29.7**	**25.8**	**44.1**	**21.1**	**19.6**	**8.8**
Lowest	12.2	18.2	-	2.5	4.1	-	2.8	2.8	-
February									
Highest	172.8	76.2	-	130.0	48.1	-	67.5	54.2	-
Average	**41.5**	**42.9**	**57.4**	**29.5**	**28.4**	**55.3**	**21.3**	**21.8**	**37.8**
Lowest	13.4	24.2	-	4.5	14.0	-	2.8	5.1	-
March									
Highest	98.0	81.4	-	81.0	64.0	-	40.9	**40.9**	-
Average	**43.8**	**45.8**	**38**	**28.5**	**24.5**	**18.1**	**16.1**	**15.0**	**11.1**
Lowest	7.2	16.8	-	1.1	4.3	-	0.2	1.4	-
April									
Highest	110.9	73.3	-	57.1	38.5	-	29.3	29.3	-
Average	**32.7**	**32.6**	**21.5**	**14.3**	**10.3**	**5.2**	**5.4**	**4.4**	**0.9**
Lowest	2.1	5.9	-	0.2	0.2	-	0.1	0.2	-

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May									
Highest	95.8	95.8	-	26.5	8.7	-	3.5	0.5	-
Average	**11.5**	**12.9**	**13.9**	**1.3**	**0.5**	**0.0**	**0.1**	**0.0**	**0.0**
Lowest	0.0	T	-	0.1	0.1	-	0.5	0.5	-
June									
Highest	8.4	6.9	-	0.0	0.0	-	0.5	0.5	-
Average	**1.2**	**1.2**	**0.8**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Lowest	0.0	0.0	-	0.0	0.0	-	0.0	0.0	-
July									
Highest	1.1	0.4	-	0.0	0.0	-	0.0	0.0	-
Average	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Lowest	0.0	0.0	-	0.0	0.0	-	0.0	0.0	-
August									
Highest	2.5	0.8	-	0.0	0.0	-	0.0	0.0	-
Average	**0.1**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Lowest	0.0	0.0	-	0.0	0.0	-	0.0	0.0	-
September									
Highest	7.8	5.5	-	0.8	0.0	-	0.0	0.0	-
Average	**1.6**	**1.3**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Lowest	0.0	0.0	-	0.0	0.0	-	0.0	0.0	-
October									
Highest	79.1	79.1	-	12.0	12.0	-	9.5	7.0	-
Average	**14.1**	**18.9**	**29.3**	**1.8**	**2.4**	**2.1**	**0.5**	**0.3**	**0.0**
Lowest	0.4	3.5	-	0.1	0.5	-	0.5	0.5	-
November									
Highest	86.6	62.7	-	60.0	43.1	-	25.0	21.6	-
Average	**33.6**	**35.4**	**39.8**	**13.1**	**11.1**	**12.3**	**5.6**	**4.4**	**5.4**
Lowest	6.1	7.4	-	0.1	0.1	-	0.1	0.1	-
December									
Highest	97.7	93.6	-	72.3	70.5	-	60.5	40.8	-
Average	**45.1**	**48.0**	**42.5**	**29.0**	**28.0**	**35.6**	**20.0**	**17.0**	**16.1**
Lowest	7.2	19.5	-	4.5	8.3	-	2.4	2.4	-

Snowpack Depth

All snowpack depth values are rounded to the nearest integer. The snow year begins on July 1st and ends on June 30th. The concluding calendar year represents a snow year (i.e. 2024-2025 snow year = 2025).

Location:	Mount Washington Observatory			Pinkham Notch			Hubbard Brook			NCNorth ConwayON		
Recorded Snowpack Depth (Inches)	1935 – 2025	1991 – 2020	2025	1935 – 2025	1991 – 2020	2025	1959 – 2025	1991 – 2020	2025	1957 – 2025	1991 – 2020	2025
January												
Highest	37	29	9	73	33	15	37	32	10	38	34	9
Average	**10**	**9**	**5**	**20**	**14**	**10**	**14**	**11**	**7**	**12**	**10**	**5**
Lowest	1	1	2	1	1	6	1	1	3	1	1	3
February												
Highest	38	38	14	164	48	32	43	34	24	65	50	21
Average	**12**	**11**	**10**	**28**	**22**	**24**	**19**	**16**	**22**	**18**	**16**	**16**
Lowest	1	1	6	1	2	16	3	6	14	1	1	11
March												
Highest	48	36	13	145	61	26	54	39	25	61	54	21
Average	**13**	**11**	**8**	**30**	**22**	**12**	**18**	**14**	**14**	**14**	**12**	**7**
Lowest	1	1	3	1	1	1	1	1	3	1	1	3
April												
Highest	50	33	7	78	56	3	44	32	3	44	36	1
Average	**9**	**7**	**3**	**13**	**8**	**0**	**5**	**4**	**2**	**2**	**2**	**0**
Lowest	1	1	1	1	1	1	1	1	1	1	1	1
May												
Highest	41	20	8	30	7	0	4	0	0	1	0	0
Average	**2**	**2**	**1**	**1**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Lowest	1	1	1	1	1	0	1	0	0	1	0	0
June												
Highest	6	3	1	0	0	0	0	0	0	0	0	0
Average	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Lowest	1	1	1	0	0	0	0	0	0	0	0	0

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July												
Highest	4	0	0	0	0	0	0	0	0	0	0	0
Average	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Lowest	1	0	0	0	0	0	0	0	0	0	0	0
August												
Highest	1	0	0	0	0	0	0	0	0	0	0	0
Average	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Lowest	1	0	0	0	0	0	0	0	0	0	0	0
September												
Highest	5	2	0	0	0	0	0	0	0	0	0	0
Average	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Lowest	1	1	0	0	0	0	0	0	0	0	0	0
October												
Highest	32	32	6	15	11	1	0	0	0	10	4	0
Average	**1**	**1**	**2**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Lowest	1	1	1	1	1	1	0	0	0	1	1	0
November												
Highest	28	25	16	48	22	11	8	8	0	18	13	5
Average	**4**	**3**	**3**	**2**	**2**	**1**	**3**	**6**	**0**	**1**	**0**	**0**
Lowest	1	1	1	1	1	1	2	2	0	1	1	4
December												
Highest	31	27	25	55	47	14	26	22	12	33	23	10
Average	**8**	**7**	**14**	**10**	**9**	**10**	**9**	**8**	**9**	**5**	**4**	**6**
Lowest	1	1	2	1	1	5	1	2	3	1	1	3

Wind

All wind speed values are rounded to the nearest integer, but averages round the nearest tenths place.

Mount Washington Observatory			
Values (mph)	1935–2025	1991–2020	2025
January			
Peak Gust	172	148	142
Average Peak Gust	**129.2**	**126.2**	**–**
Average Wind Speed	**45.4**	**45.8**	**50.3**

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February			
Peak Gust	171	171	161
Average Peak Gust	**126.9**	**127.4**	–
Average Wind Speed	**44.0**	**44.9**	**50.1**
March			
Peak Gust	180	145	138
Average Peak Gust	**124.6**	**122.8**	–
Average Wind Speed	**41.0**	**40.0**	**46.0**
April			
Peak Gust	231	164	122
Average Peak Gust	**118.6**	**118.8**	–
Average Wind Speed	**35.7**	**35.7**	**42.4**
May			
Peak Gust	164	141	98
Average Peak Gust	**100.9**	**104.9**	–
Average Wind Speed	**29.4**	**29.5**	**29.4**
June			
Peak Gust	136	127	124
Average Peak Gust	**91.7**	**92.4**	–
Average Wind Speed	**27.1**	**26.7**	**31.0**
July			
Peak Gust	154	154	97
Average Peak Gust	**85.0**	**88.0**	–
Average Wind Speed	**25.3**	**25.5**	**27.0**
August			
Peak Gust	147	147	65
Average Peak Gust	**88.1**	**89.4**	–
Average Wind Speed	**24.7**	**24.3**	**17.7**
September			
Peak Gust	174	128	85
Average Peak Gust	**96.2**	**94.1**	–
Average Wind Speed	**28.1**	**27.6**	**23.2**
October			
Peak Gust	161	158	126
Average Peak Gust	**107.5**	**114.2**	–
Average Wind Speed	**33.9**	**35.6**	**31.9**
November			
Peak Gust	163	161	124
Average Peak Gust	**116.1**	**118.5**	–
Average Wind Speed	**39.3**	**39.8**	**45.0**

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December			
Peak Gust	182	141	125
Average Peak Gust	**123.5**	**120.4**	**–**
Average Wind Speed	**43.7**	**44.1**	**51.8**

Glossary

Astronomical seasons: based on the position of the Earth in relation to the sun.

Canopy closure: the day when leaves are fully expanded and there is minimal light visibility through the canopy.

Chlorophyll: the chemical that absorbs light energy for photosynthesis.

Clutch initiation: the first day an egg is laid in a nest.

Deciduous trees: trees that shed their leaves annually before winter dormancy.

Drought: when a region experiences below-average precipitation over an extended period of time, resulting in low stream flows and low surface water and groundwater levels.

Flash droughts: rapid onset or intensification of drought when there are lower-than-normal rates of precipitation paired with abnormally high temperatures, winds, and radiation.

Hard freeze: when air temperature reaches 28°F or -2°C or lower for at least an hour.

High peaks: summits in the White Mountains with elevations surpassing 4,000 feet.

Ice-in: when the surface of a lake freezes in the fall.

Ice-out: the timing of lake ice break-up in the spring.

Meteorological seasons: groupings of three months based on the annual temperature cycle.

Mud day: a day where the maximum daily temperature (T_{max}) is above the freezing threshold of 32°F (T_{freeze}) and the snow depth is 0 inches.

Phenological mismatch: when seasonal life-cycle events become out of sync between interacting species.

Phenology: the study of the timing and cyclical patterns of events in the natural world, particularly those related to the annual life cycles of plants, animals, and other living things.

Phenophase: an observable stage or phase in the annual life cycle of a plant or animal that can be defined by a start and end point.

Snow-to-liquid ratio (SLR): inches of snowfall are equivalent to one inch of melted water.

Thaw intensity (ΔT): the difference between the day's maximum temperature and 32°F.

Turnover: a process of mixing as the cold water sinks to the bottom and the warm water rises to the top.

Appendix

January

Snow-to-Liquid Ratio
$SLR_t = \frac{\Sigma S_i}{\Sigma P_i}$
SLR_t = snow-to-liquid ratio across a specific time period (week or decade) S_i = snowfall (inches) on day i P_i = liquid precipitation (inches) on day i This equation calculates total snowfall in a period divided by total liquid precipitation in that same period. These were used to calculate SLR in each quartile of the data.

Equation E.1.2

February

30-Year Average
$30\text{-Year Average} = \frac{\Sigma\ Ice\ Out\ Dates\ in\ 30\text{–}Year\ Period}{30}$

Equation E.2.1

Lake Ice Out Anomaly
$Anomaly = Observed\ Date_{Ice\ Out} - 30\text{-Year Average}$

Equation E.2.1

March

Median Sugaring Days	
n = number of data points	
If n is odd:	If n is even:
$Sugaring\ Days_{median} = \left(\frac{n+1}{2}\right)^{th}\ term$	$Sugaring\ Days_{median} = \frac{\left(\frac{n}{2}\right)^{th}\ term + \left(\frac{n}{2}+1\right)^{th}\ term}{2}$

Equation E.3.1

30-Year Average
$30\text{-Year Average} = \frac{\Sigma\ Sugaring\ Dates\ in\ 30\text{–}Year\ Period}{30}$

Equation E.3.2

Median Sugaring Day Anomaly
$Anomaly = Observed\ Date_{Median\ Sugaring\ Day} - 30\text{-Year Median}$

Equation E.3.3

April

Mud Day Thaw Intensity
$\Delta T = T_{max} - T_{freeze}$
If $T_{freeze} \geq T_{max}$, then $\Delta T = 0$

Equation E.4.1

June

Quartiles for Flowering Dates and Elevation Individually	
n = number of data points	
First Quartile (Q1)	Third Quartile (Q3)
$Q1 = \left(\frac{n+1}{4}\right)^{th}$ term	$Q3 = \left(\frac{3(n+1)}{4}\right)^{th}$ term
If the formula produces a decimal (such as 6.5 for example), interpolate: Example: term = 6.5 $Q\# = \frac{value\ at\ 6th\ position + value\ at\ 7th\ position}{2}$	
Interquartile Range	
IQR = Q3 − Q1	

Equation E.6.1

Median Flowering Date and Elevation Individually	
n = number of data points	
If n is odd:	If n is even:
$Median = \left(\frac{n+1}{2}\right)^{th}$ term	$Median = \frac{\left(\frac{n}{2}\right)^{th}\ term + \left(\frac{n}{2}+1\right)^{th}\ term}{2}$

Equation E.6.2

July

Average Diurnal Temperature
For each day: $T_{daily\ average} = \frac{T_{max} + T_{min}}{2}$
Individual days across years: $T_{average\ across\ years} = \frac{\Sigma\ T_{daily\ average}}{Total\ number\ of\ years}$

Equation E.7.1

Diurnal Temperature Range
$DTR\ (\Delta°F) = T_{max} - T_{min}$

Equation E.7.2

Atmospheric Lapse Rate
$Lapse\ Rate\ \left(\frac{\Delta°F}{ft}\right) = \frac{T\ average\ (highest) - T\ average\ (lowest)}{Elevation\ Highest - Elevation\ Lowest}$
This calculates the rate at which air temperature decreases with an increase in elevation. For this scenario in the July chapter, the highest elevation was 6,288 feet and the lowest was 525 feet.

Equation E.7.3

October

Average Peak Foliage Day-of-Year
$\text{Peak Foliage DOY}_{\text{average}} = \frac{\Sigma\ Peak\ DOY\ from\ each\ tree}{3}$
This was calculated for each species each year.

Equation E.10.1

December

Daily Average Wind Speed
$\text{Daily Wind Speed}_{\text{average}} = \frac{\Sigma\ Hourly\ Average\ Wind\ Speeds}{24}$

Equation E.12.1

Seasonal Average Wind Speed
$\text{Seasonal Wind Speed}_{\text{average}} = \frac{\Sigma\ Daily\ Average\ Wind\ Speeds\ per\ Season}{Total\ number\ of\ days\ in\ selected\ season}$

Equation E.12.2

Climatology Averages

Average Diurnal Temperature
For each day: $T_{\text{daily average}} = \frac{T_{max} + T_{min}}{2}$
Individual days across years: $T_{\text{average across years}} = \frac{\Sigma\ T_{daily\ average}}{Total\ number\ of\ years}$

Equation E.13.1

Average Monthly Temperature
For each month: $T_{sum} = \Sigma\ T_{daily}$
For individual months across years: $T_{average} = \frac{\Sigma\ T_{sum}}{Total\ number\ of\ years}$

Equation E.13.2

Average Monthly Precipitation
For each month: $P_{sum} = \Sigma\ P_{daily}$
For individual months across years: $P_{average} = \frac{\Sigma\ P_{sum}}{Total\ number\ of\ years}$

Equation E.13.3

Average Monthly Snowfall
For each month: $SF_{sum} = \Sigma\ SF_{daily}$
For individual months across years: $SF_{average} = \frac{\Sigma\ SF_{sum}}{Total\ number\ of\ years}$

Equation E.13.4

Average Monthly Snow Depth
For each month: $SD_{\text{monthly average}} = \frac{\Sigma\ SD_{daily}}{Number\ of\ days\ in\ said\ month}$
For individual months across years: $SD_{average} = \frac{\Sigma\ SD_{monthly\ average}}{Total\ number\ of\ years}$

Equation E.13.5

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The Mount Washington Observatory instrument tower at sunset.
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