



# A MOMENT TOO SOON

Gardeners and Climate Change  
A Science Backgrounder

Gardening is a beloved hobby for millions of people across the country. Whether motivated by healthy outdoor exercise, the satisfaction of eating delicious home-grown fruits and veggies, or the artistic pleasure of a beautiful flower arrangement, gardeners across the country have one thing in common: they are seeing and feeling the effects of climate change. Whether that means more time spent on weeding, pest control, and watering; choosing different plants as conditions change; or, saying goodbye to garden visitors such as birds and butterflies, gardens are just one of the ways global warming is affecting the things we love to do.

## “Season Creep” and its Impacts

As the planet warms, signs of spring are arriving sooner, while winters are becoming shorter and milder. This phenomenon is informally known as “season creep” in that the onset of spring is creeping earlier.<sup>1 2</sup> The study of the timing of spring events is called phenology.

Season creep manifests in various ways. For example, flowers bloom earlier, including a week earlier on average for Washington’s famous cherry blossoms.<sup>3</sup> Hardwood forests hold their green leaves 10 days longer.<sup>4</sup> Spring snowmelts have shifted so that peak melt flow now arrives one to four weeks earlier.<sup>5</sup> Growing seasons have lengthened by 10-20 days,<sup>6</sup> and bird species are leaving earlier for their migrations.<sup>7</sup>

Although much research is still underway, the signs point to a causal relationship between carbon dioxide, global warming, and the manifestations of season creep. In one study, natural variability explained only one-third the rate of “creep” in the arrival of spring.<sup>8</sup> Likewise, decadal oscillations, or natural cycles of change, could not fully account for early streamflow,<sup>9</sup> and researchers found leaf retention in hardwood forests was “consistent with other studies documenting measurable climate change effects.”<sup>10</sup>

A shorter winter may sound great to those who eagerly await gardening season, but in many ways these changes negatively affect gardeners. Here’s how:

**Frost vulnerability:** High spring temperatures can create earlier flowering schedules. This leaves blooms at risk of a freeze. Although it sounds counter-intuitive given the “global warming” we’re experiencing, cold snaps are still projected to happen even during warmer-than-average springs.<sup>11</sup> This is of greatest concern to commercial fruit farmers, who lose their crop if a frost destroys the flowers.<sup>12 13</sup> Yet hobbyists who grow fruit and flowers will also be affected. For example, mountain-dwelling wildflowers are experiencing frequent frost damage due to early blooming.<sup>14</sup>

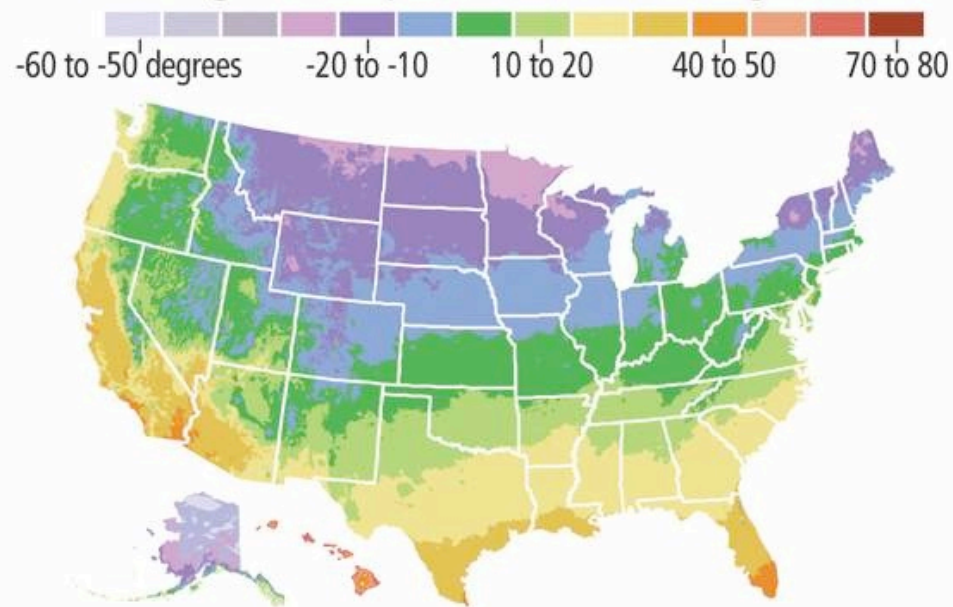
**Species mismatch:** Research shows that species differ in their ability to adjust lifecycles to warming temperatures. If one species adjusts and the other does not, for instance, flowering times can end up out of sync with peak pollinator activity.<sup>15</sup> Mismatches can also occur between predators and their prey, which may affect gardeners interested in attracting birds to their gardens. For example, the pied flycatcher now migrates at the wrong time relative to the availability of its insect prey, and as a result has experienced population declines of 90 percent.<sup>16</sup>

**Pests and invasives:** Season creep provides favorable conditions to many pests and invasive species. In the western U.S., harsh winters normally cull the bark beetle population, but recent mild winters have allowed their population to skyrocket.<sup>17</sup> Gypsy moths, tent caterpillars, beech bark disease, and hemlock woolly adelgid are also expected to expand their ranges thanks to the changing seasons.<sup>18,19</sup> Invasive plant species are by no means uniform in their response to climate change, but research indicates that in many cases they will be able to adapt more effectively to season creep than native species.<sup>20</sup> This was the case at Thoreau's Walden Pond, where invasive species slowly drove out native plants as the climate shifted.<sup>21</sup>

**Hardiness zones:** In 1990, the U.S. Department of Agriculture (USDA) published the Plant Hardiness Zones, a map that divides the country into regions with different climatic conditions. This map aids gardeners in determining which plants will thrive in which regions. However, as conditions warmed and the climate changed, the real conditions in the zones began to differ with what was shown on the map. In 2012, the USDA revised the zones, changing the boundaries and moving most of them northward.<sup>22</sup> For example, Ohio used to be mostly within Zone 5, but now it is almost entirely within the warmer Zone 6.<sup>23</sup> As such, gardeners in these areas may have had to reconsider their planting choices.

## New planting zones

The USDA is changing its planting zone map because the country is warmer and data and map-making technology are better. Average low temperatures for various regions:



SOURCE: USDA

The Associated Press

## Extreme Weather and Gardening

Gardeners are highly attuned to the weather in order to maintain the best care and well-being for their gardens. What a typical season looks like, however, is changing. Climate change can make certain types of extreme weather more intense or frequent, thus creating new challenges for gardeners.

**Heavy Downpours:** Extreme rainfall events have been linked to human-caused global warming. One study found that intensity of extreme precipitation events has increased 6-8 percent for each degree increase in global average temperature.<sup>24</sup> Although it doesn't sound threatening, that can be the difference between a soggy day and one that floods a town's sewer system. Studies using climate models also show extreme precipitation will become more common in a warming world.<sup>25</sup> Flooding and extreme rain can damage gardens by eroding landscaping, physically damaging to plants, and causing root rot in overly wet soil.

**Droughts:** Droughts are a complicated climate impact, in that they do not always have a single cause. Lack of rainfall, early snowmelt, high temperatures, and human overdevelopment and overuse of water can all cause drought. That said, climate change is connected to all of these factors except human overuse, and is predicted to continue to exacerbate them in the future.<sup>26</sup> For gardeners, droughts mean more time and money spent on watering, and even bans on watering in some cases of extreme drought.

It may seem counter-intuitive that both droughts and downpours are increasing, but these are not mutually exclusive. Overall variability in the climate has increased, which means that we are seeing more "feast or famine" swings rather than constant conditions.<sup>27</sup> As such, some regions are experiencing a simple rise in drought or rainfall, while others are experiencing a rise in both through increased variability

## Regional Impacts

In addition to widely generalized effects across the country, gardeners are experiencing more localized climate change impacts from region to region. This list — though by no means exhaustive — shows some site-specific impacts. Many examples focus on agricultural crops and impacts but are still applicable to gardeners and their plants.

**Northeast:** When it comes to phenological changes, the northeastern United States is particularly vulnerable.

- In the Washington, D.C. area, 89 flowering species have advanced their flowering by an average of 4.5 days in the past 30 years, with some flowering as much as 46 days earlier than usual.<sup>28</sup> This leaves them vulnerable to frost damage.
- Woody northeastern perennials such as apple, grape, lilac, and honeysuckle have advanced their spring phenology from two to eight days since 1965.<sup>29</sup>
- Hemlock woolly adelgid, forest tent caterpillar, beech bark disease, and oriental bittersweet are all "problematic" species that are projected to increase in the forests of the northeastern U.S.<sup>30</sup>
- The country's northernmost states are expected to experience the most dramatic change in phenology as climate change continues, with an increase of 38 days by 2100 in Maine and New York, compared to 10 days in the southernmost states.<sup>31</sup>

**Southeast:** In the Southeast, many trees and bushes require a chilling period for normal spring growth. Chilling periods are the amount of time the temperature falls below freezing, with different plants requiring different lengths of chilling to trigger growth.

- Crops including almonds, apples, blueberries, grapes, peaches, pears, plums, raspberries, strawberries and walnuts require chilling periods, and are likely to be affected by the changing climate.<sup>32</sup> Marketable yields of these crops are “highly sensitive to minor environmental stresses related to temperatures outside the optimal range.”<sup>33</sup>

**Midwest:** The Midwest, home to much of the nation’s agriculture, is an important region to examine how climate change is changing phenological patterns.

- A 61-year study at one site in Wisconsin found an advance of more than seven days in spring phenology of many different species, including flowers and birds.<sup>34</sup>
- Many crops respond to the first warmth of the season, causing a premature bud break followed by frost damage. This happened both in 2002 and 2012 to Michigan’s tart cherry crop, a \$60 million industry annually.<sup>35</sup>
- Many of the tree species iconic to the region are projected to move northward, including oaks and pines.<sup>36 37</sup> Others, such as paper birch, quaking aspen, balsam fir, and white spruce are projected to decline as their suitable habitat decreases.<sup>38</sup>
- Michigan and Wisconsin are also expected to experience the onset of spring 38 days earlier by 2100.<sup>39</sup>

**Rocky Mountains:** Due to the variety of climactic conditions along its vertical slopes, climate change affects the Rocky Mountain region in several ways.

- The earlier arrival of warmth has led to increasing mid-June frost kills in sensitive mountain-dwelling wildflower species.<sup>40</sup>
- Because a warmer winter allows them to survive and thrive, the spruce and mountain pine beetles have both been aided by warming temperatures — even breeding twice annually instead of only once.<sup>41 42</sup>
- In a phenomenon known as the “escalator effect,” mountain species are moving to higher elevations in order to maintain a constant temperature.<sup>43</sup> Although this has not been studied in the Rockies specifically, it has been documented around the world and is likely to affect the Rockies as well.<sup>44</sup>
- The Rockies and the surrounding area, including Colorado, California and parts of the Southwest, rely heavily on the gradual melting of winter snows to provide water throughout the hot, dry summer. Winter snows are now melting earlier, leading in some cases to summer water shortages.<sup>45</sup> This problem is projected to increase as global warming intensifies.<sup>46</sup>

**Southwest:** The Southwest’s defining feature is its arid landscape. Changes in water availability will be one of the biggest impacts of climate change in the region.

- A study over the course of 2002-2003 found widespread vegetation die-off in Southwestern woodlands in response to a combination of drought and bark beetle infestations.<sup>47</sup> Researchers reported that climate change exacerbated the die-off and project that such events will get worse.
- More than 60 percent of the climate-related trends in the Southwest since 1950 have been found to be human-induced in that they stem from climate change caused by loading the atmosphere with carbon dioxide. These include higher temperatures, declining snowpack, and decreased river flows, all of which contribute to reduced water availability.<sup>48</sup>
- Models predict that the Sonoran Desert will move northward, changing the vegetation mix of the area.<sup>49</sup> The range of the Joshua tree is projected to shift as well.<sup>50</sup>

**Great Plains:** The Great Plains represents a flat landscape that derives most of its water from underground aquifers. Climate change will affect water availability and species mix.

- In Texas, the range of some rodent pests is expected to increase with climate change.<sup>51</sup>
- The invasive red imported fire ant's suitable habitat in Oklahoma will increase under projected climate change.<sup>52</sup>
- Gypsy moth caterpillars are projected to expand in Utah.<sup>53</sup>
- In the Southern Plains, groundwater depletion is accelerating.<sup>54</sup> Regional changes in the amount and timing of precipitation, as well as increases to the evaporation rate due to higher temperatures, are projected to cause groundwater resources to be depleted even faster.<sup>55</sup>

**Northwest:** Lush forests are one of the most recognizable features of the Northwest, but they face considerable stresses as climate change continues.

- At the same warmer temperatures expand the range of pine beetles, high temperatures stress trees and making them more vulnerable to the beetles.<sup>56</sup>
- Lower availability of summer water will likely cause declining northwestern populations of Douglas firs.<sup>57</sup>
- Measurements in Lake Washington, WA showed a 19-day advance in timing of spring phytoplankton blooms.<sup>58</sup>
- In California, climate change will exacerbate insect pests such as the spruce budworm and Argentine ant.<sup>59</sup>

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