Long-term Changes in Spring Across the National Forest System

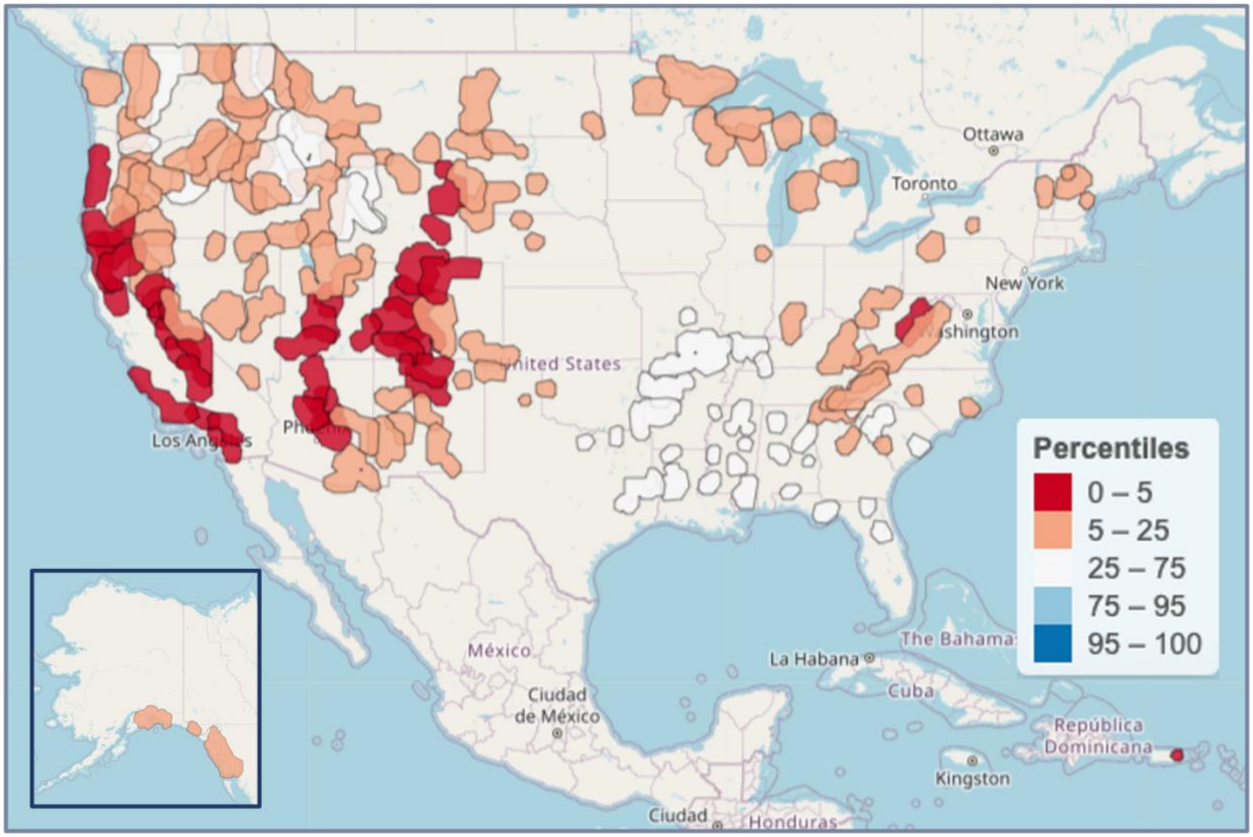
To determine whether the timing in the start of spring has changed within USFS units in recent years, we replicated methods originally developed in collaboration with the National Park Service and used to evaluate changes in timing of spring in NPS units (Monahan et al 2016), and subsequently in USFWS units (Waller et al 2018). These methods are summarized here, see Monahan et al (2016) for additional details.

Data inputs are the gridded Extended Spring Indices, which are maps indicating the day of year conditions associated with the start of biological activity are reached, based on the Berkeley Earth (BEST) daily temperature datasets, and maintained by the USA-NPN (Crimmins et al 2017). These data are available at 1 degree latitude x longitude spatial resolution for the northern hemisphere, 1880-2021. For each year there is one raster layer with estimates of day of leaf out (an early spring event) and one raster for bloom (a mid-spring event). (More information about the Extended Spring Indices)

As trend calculation can be strongly affected by start year and artefacts in climate datasets, we opted to identify the location of recent spring arrival dates in the distribution of prior springs (the historic range of variability). We first buffered the USFS Administrative boundary shapefile by 30 kilometers, to consider forests in the context of the surrounding landscape, and to better match the resolution of the raster data. We then intersected this buffered USFS unit shapefile with the Spring Index leaf and bloom raster layers and calculated a spatially weighted mean for leaf and for bloom for each year, 1900 to 2021. From this dataset we created 10-, 20- and 30-year moving window means for the period, representing common planning horizons and climate summary periods.

We then identified the location of the most recent moving window values in the distribution of all moving window values. This results in 6 percentile values for each forest unit: the location of the most recent 10, 20 and 30 moving window average in its corresponding distribution for leaf and for bloom. For example, at Cleveland National Forest, looking at the leaf index, the most recent decade falls in the 1st percentile relative to all previous 10-year moving window averages at the unit, meaning that the recent period is earlier than 99% of prior springs. At Shoshone National Forest, looking at leaf index, the most recent 20-year period falls in the 51st percentile, meaning that the recent period is typical of prior springs, and is neither earlier or later than in previous decades. (All results available here).

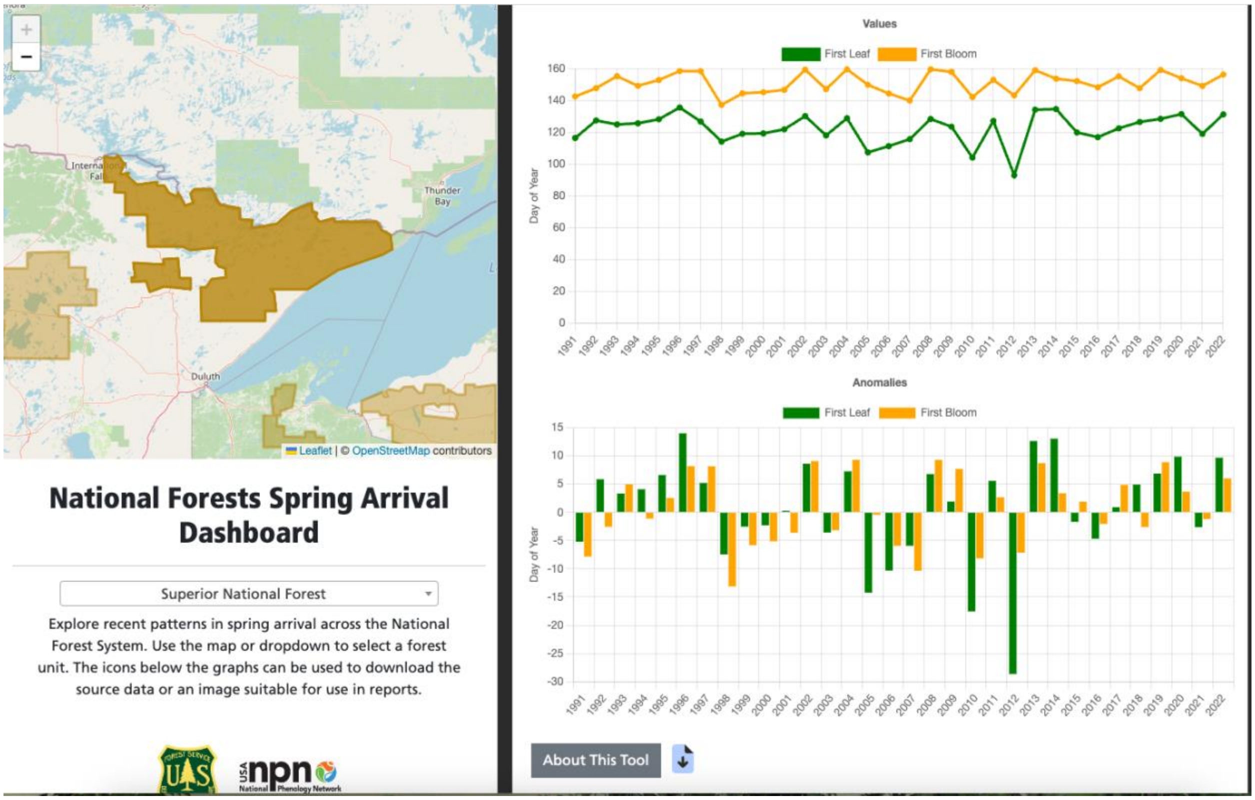
To facilitate mapping, we averaged across the 10-, 20- and 30-year periods for leaf and bloom. The map below shows the average percentile (across moving window periods) for leaf. Red indicates units where the average spring arrival date across the most recent 10-, 20- and 30-year moving windows falls in the earliest 5% of springs in the 120- year period (1900-2021). Pink indicates earlier spring, though less dramatically so, with recent springs falling in the 5th to 25th percentile of historic springs. For units in white, recent springs have been neither earlier nor later (the 25th to 75th percentile) than historic springs.



Recent Trends

While this long-term perspective is powerful and allows us to see changes in the timing of spring due to climate change, it is limited in terms of spatial resolution, and it is difficult to keep up to date, since the Berkeley Earth only releases updates to the underlying data every 3 to 5 years. To ameliorate these issues, we created dashboards where unit-level staff can explore recent patterns in the timing of spring based on the same leaf and bloom indices. These dashboards leverage the higher-resolution and regularly updated PRISM climate data (available 1981-present, and most reliable 1991-present, at 2.5km resolution). To determine the day of year of leaf out or bloom for each unit, an average of all the pixels that fall in the unit polygon is taken, weighted by the percentage of the pixel that falls within the polygon. In addition to providing contextual knowledge, these dashboards can serve to enhance unit-level and regional reports, as a form of biologically-relevant climate summary.

Screencap from the “National Forests Spring Arrival Dashboards” tool for looking at recent trends, available at: https://usanpn.org/partners/usfs/spring.



Code and output for both of these approaches to understanding patterns in changes in spring arrival in the National Forest System is [available in GitHub](#).

References

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