Phenology and Climate Change

Project Brief

National Park Service
U.S. Department of the Interior

Natural Resource Stewardship & Science

Climate Change is Advancing Spring Onset across the US National Park System

Leaves unfurling and blossoms opening in spring at Shenandoah National Park. NPS photos.

Introduction

Parks across the US National Park System are already experiencing climate change (Monahan and Fisichelli 2014). Changes in phenology – the timing of seasonal biological events (e.g., leaf-out, migration, and reproduction) – constitute one of the most proximate responses to climate change. Information on phenological changes will support managers in adjusting the timing of activities, such as treating invasive species, operating visitor facilities, and scheduling seasonal events.

In collaboration with the USGS, USA National Phenology Network, Cornell University, University of Arizona, Schoodic Institute, and the University of Wisconsin-Milwaukee, we evaluated the recent timing of spring onset (past 10-30 years) in 276 US natural resource parks relative to their historical ranges of variability (1901 – 2012).

In this project brief we report trends across the National Park System; park-specific summaries will be made available on the National Park Service (NPS) Climate Change Response Resources website. See Monahan et al. (2016) for additional results and complete methods.

Results

Of the 276 parks examined, spring is advancing in three-quarters, and half are experiencing an "extreme" early spring exceeding 95% of historical conditions, as measured by first leaf index and/or first bloom index from indicator plant species. (Figure 1, Table 1). No parks are experiencing extreme delays in spring onset. Thus, managers in the "extreme" early parks have for the past 10-30 years already been working under relatively anomalous conditions.

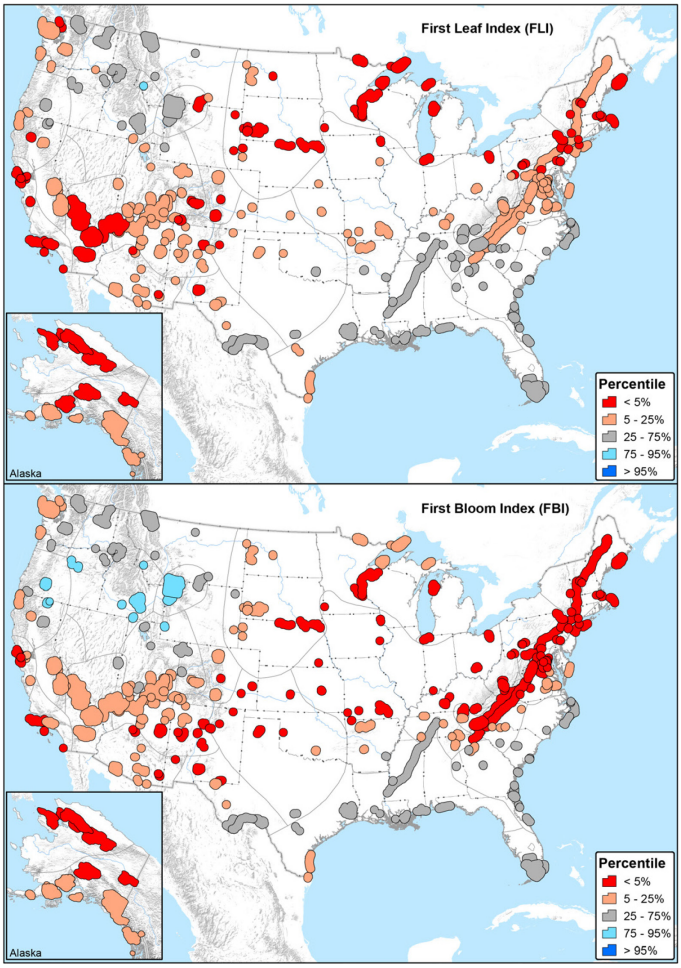

Figure 1. Recent changes in the timing of spring onset relative to the 1901-2012 historical range of variability: First leaf index (top), first bloom index (bottom). Mean values provide an overall measure of recent (past 10, 20, and 30 year windows) change in the indices. For example, a percentile of 5% means that recent spring onset has been earlier than 95% of historical conditions.

Table 1. Number of parks, out of 276, that exhibited extreme early, early, average, late, or extreme late dates for start of spring, according to each of the two spring indices.

Category	First leaf index	First bloom index
Extreme early (< 5th percentile)	82	113
Early (5th–25th percentile)	128	98
Average (25th-75th percentile)	65	54
Late (75th-95th percentile)	1	11
Extreme late (> 95th percentile)	0	0

Implications – Adapting to Change

Our results demonstrate how changes in climate seasonality are important for understanding ecological response, and how spatial variability in effects of climate change necessitates localized adaptation approaches.

Generally, areas that experience extreme early springs are likely more susceptible to ecological mismatches and species invasions. Invasive species tend to have more "flexible" phenologies than their native counterparts, enabling invasives to better track earlier and more variable springs. This and other changes, such as the timing of the fire season and rare species phenology, will help define when monitoring for other natural resources could occur requiring parks to plan earlier and more flexible management schedules. For example, parks may need to hire seasonal staff earlier in the year to coincide with invasive species advancing their phenologies.

Advances in the timing of spring will also impact visitor services. Parks see high levels of visitation in periods of warm (but not hot) weather and visitation across the park system is projected to increase with climate change (Fisichelli et al. 2015). Given the relationship between visitation and air temperature, advancing springs also likely mean longer visitation seasons, with many implications for operations. Changes may be particularly notable at parks where spring events are key attractions (e.g., wildflower blooms).

Parks with high inter-annual variability in the arrival of spring in recent years may need to plan a longer window around cultural events. For example, the Cherry Blossom festival in Washington, DC has evolved from a single day to a multi-week celebration; in 2012 it was broadened to five weeks in order to capture variation in spring onset as measured by peak bloom of cherry trees.

The National Park Service is beginning its second century of preserving America's natural and cultural heritage and providing for visitor enjoyment. The coming decades are likely to see continuing changes in climate and phenology. Parks will need to adapt to both the challenges and opportunities posed by these changes.

Visitors to the Cherry Blossom festival in Washington, DC. The timing of flowering is advancing with warming temperatures. NPS Photo.

More Information

This project is part of ongoing work of the NPS Climate Change Response Program and collaborators to support park adaptation to changing conditions.

Source Publication

Fisichelli N.A., Schuurman G.W., Monahan W.B., and Ziesler P.S. 2015. Protected area tourism in a changing climate: will visitation at US national parks warm up or overheat? PLOS ONE doi: 10.1371/journal.pone.0128226.

Monahan W.B., and Fisichelli N.A. 2014. Climate exposure of US national parks in a new era of change. PLOS ONE 9(7): e101302. doi:10.1371/journal.pone.0101302.

Monahan W.B., Rosemartin A., Gerst, K., Fisichelli N.A., Ault T., Schwartz M.D., Gross J.E., and Weltzin J.F. 2016. Climate change is advancing spring onset across the US national park system. Ecosphere 7(10): e01465 doi: 10.1002/ecs2.1465

Contact

John Gross, Ph.D.
NPS Climate Change Response Program
970-267-2111, john_gross@nps.gov

Alyssa Rosemartin
USA National Phenology Network
520-419-2585, alyssa@usanpn.org

USGS science for a changing world

USA National Phenology Network Taking the Pulse of Our Planet

The University of Arizona

Schoodic Institute at Acadia National Park

University of Wisconsin Milwaukee

Cornell University