

Observed Changes in Phenology Across the United States - Southeast

Virginia, Kentucky, Tennessee, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Louisiana, Arkansas

Background

Phenology — the seasonal timing of life cycle events in plants and animals such as flowering, hibernation, and migration — has been linked to shifts in the timing of allergy seasons, public visitation to National Parks, and cultural festivals. Change in phenology, recognized as a bio-indicator of climate change impacts, has also been linked to increased wildfire activity and pest outbreak, shifts in species distributions, spread of invasive species, and changes in carbon cycling in forests. Phenological information can and already is being used to identify species vulnerable to climate change, to generate computer models of carbon sequestration, to manage invasive species, to forecast seasonal allergens, and to track disease vectors, such as mosquitoes and ticks, in human population centers.



“Plants of economic importance may become increasingly vulnerable to early springs followed by false springs.”

This is one in a series of eight, geographic region-focused information sheets that summarizes documented changes in plant and animal phenology over the past century across the United States. This summary is based on long-term studies (10 years or more) published in the primary scientific literature since 2001. A forthcoming manuscript synthesizes the findings of the eight regional information sheets.

This information was developed in support of the U.S. Global Change Research Program’s **National Climate Assessment** and can be used to facilitate preparation for the cascading effects of ongoing climate change.

The Southeast

Land cover of the Southeast is characterized by productive forests, mountains, and extensive wetlands and shorelines [1, 2]. Climate is humid and subtropical, with the tip of Florida classified as tropical with wet and dry seasons. The large wetlands in the Southeast are especially vulnerable to predicted shifts in water levels, which could inundate critical regions such as the Everglades. This region is also susceptible to hurricanes: these storms are expected to become more intense with increasing ocean water temperatures [3]. Since 1970, the annual mean temperature of the region has increased by nearly 1.1°C (2.0°F), with most of this warming in the winter [1, 2].

Over the past century, the Southeast has experienced significant growth in urban areas, increased evaporation and cloudiness from increased temperatures, and a general cooling trend until 1980 when temperatures began to increase. The last hard freeze dates have become significantly later from 1901-present, on the order of more than 1 day/decade [4]. The so-called “warming hole” (an area centered across the southeastern U.S. where warming is happening at a slower rate than elsewhere in the U.S.) has recently been linked to decadal variability [5] in the Pacific Ocean.

Changes in Phenology - Highlights

Delays in plant leafing and flowering

In contrast to many parts of the U.S., plants of the Southeast on average are experiencing, and likely will continue to experience, delays in leafing and flowering. This may be due to a lack of sufficient chilling days due to increasing temperatures. This may result in a delay in spring budburst for plants that require this chilling period [6]. Herbarium specimens collected in Florida from 1819 to 2008 showed a delay in blooming (with a range of four to 19 days later than the beginning of the dataset) for both native and non-native species. Research has linked this delay to within-year variability in minimum temperatures, suggesting that the physiology of the examined species may be connected to

changes in minimum temperatures [7].

Timing of bird migrations in flux

According to 40 years of data on birds migrating between the northeastern U.S. and Louisiana, the interval between capture dates across the migration route has become shorter in warm years and longer in cold years. This suggests that the long-distance migrants may have the capacity to adjust their migration times relative to changing temperatures [8].

Loggerhead turtles nesting in terrestrial sites

Along Florida's Atlantic Coast, the median date of egg laying for loggerhead turtles (*Caretta caretta*) shifted 12 days earlier over a 15-year period at what is considered to be the most important nesting beach in the western hemisphere. Researchers related this date to increased sea surface temperatures during the study period. [9].

Plants of economic importance are vulnerable to increased frequency of 'false springs'

The pattern of an early spring followed by a hard freeze (a 'false spring') has occurred more frequently between 1901-2007 relative to the 1961-1990 average [4, 10]. Invasive plant species sustained significantly less damage to early leaf growth than native counterparts in false spring events [11]. Damage to plants during frosts following more frequent false springs has both economic (i.e., damaged apple and peach crops) and ecological ramifications. Cascading effects can result – such as higher primary production and evaporation in streams as a consequence of increased light at the water surface from tree canopy damage sustained during the late frost. Increased primary production led to an increase in the snail population and higher rates of nitrate uptake by plants [12].

Case Study: Salamander Arrives to Breed 76 Days Later Than 30 Years Ago

Over a 30-year time span (1978 to 2008) in South Carolina, researchers observed that two species of autumn-breeding amphibians arrived at breeding sites increasingly later, while two winter-breeding species arrived increasingly earlier. The autumn-breeding dwarf salamander (*Eurycea quadridigitata*) arrived as much as 76 days later. Rates of change overall ranged from 5.9 to 37.2 days per decade, and are some of the fastest rates of phenological change observed to date. Increasing overnight temperatures during

the breeding season and amount of cumulative rainfall were related to the changes in arrival times. The authors noted that changes in breeding phenology may affect the outcome of competitive interactions and predator-prey dynamics [13].

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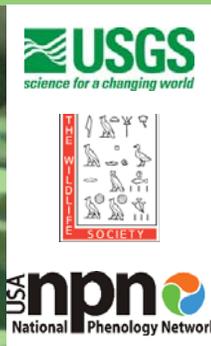
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