# An Unusual Year for Alaska's Birch Trees

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Birch trees are one of the most widespread and common trees in North America and an integral component of boreal forests. Birch trees, which make up approximately 10% of Alaska's forest, showed thin crowns over much of Interior and Southcentral Alaska. During the 2014 aerial survey season, almost half a million acres of birch trees with thin and discolored crowns were noticeable from the air and mapped by surveyors. From the Yukon River south to the Kenai Peninsula, many birch trees had small and sparsely distributed leaves and heavy catkin production (Figure 59). By August, some trees were completely devoid of leaves. This combination of thin crowns and numerous catkins gave many birch trees and forests a brown hue when viewed at a distance.

Symptomatic areas accessible by road were visited by forest health professionals on the ground over the course of several weeks following the aerial survey. The most severe crown symptoms were observed in the Matanuska-Susitna Valley. Some biotic agents were detected in these stands, including birch leaf roller (*Epinotia solandriana*) and birch leaf rust (*Melampsoridium betulinum*); but in most locations there were no indications that insect or pathogen activity had directly caused significant defoliation or dieback. Portions of tree crowns with few or no leaves usually appeared to be alive, as indicated by catkin production and presence of live bud tissue (Figure 60). Based on ground surveys, it was estimated that approximately 80% of the damage was not caused by birch leaf roller or other biotic agents (95% of observations in the Matanuska-Susitna Valley). However, it is possible that signs of causal agents were less evident by the time ground surveys were conducted in August.

In the following section, we describe how thin birch crowns can be associated with and explained by synchronous, heavy production of seed. During the coming year, we hope to investigate and compare symptomatic and healthy birch stands. This will help us to determine whether these thin-crowned birch forests are expected to fully recover, or whether residual stress and dieback is projected to cause longer-term structural or compositional changes in affected stands.

**Effects of mast seeding on birch physiology**

The most likely cause of the thin birch crowns in 2014 was a synchronized mast seeding event coupled with effects of drought conditions in 2013. A combination of low reserves following a poor growing year in 2013 due to drought and the high input of resources into reproductive tissue may have severely limited the development and productivity of other tree parts or portions of the tree. In stands with the most severe symptoms, insects or pathogens may also benefit from increased tree stress or tree age, and contribute to crown thinning (e.g. defoliation or premature leaf shed).

Birch trees, like many other perennial plants, produce seed crops that can vary widely in abundance from year to year. Synchronized, above-average seed crops are termed mast events or mast years. For wind-pollinated and wind-dispersed plants like birch and spruce, masting is advantageous because heavy flowering improves pollination success, and abundant seed production increases the proportion of seeds that survive predation. Populations of seed predators are limited, in part, by the intervening years of relatively lower seed production.

The heavy investment of a paper birch's resources in catkins and seeds during a mast event often comes at the expense of foliar, branch, and stem growth, with fewer, smaller leaves produced (Gross 1972). Gross described the following typical symptoms associated with paper birch seed masts: (1) missing or dwarf foliage in heavily seeded portions of the tree crown, (2) an average 50% decrease in bud development in terminal portions of branches during and after the event, (3) mean branch dieback affecting the terminal portion of branches, and (4) average decrease of more than 50% in terminal growth. The severity of these symptoms is described as being inversely related to the number of catkins produced in a given portion of the canopy. Our observations of reduced foliage associated with heavy catkin production were consistent with Gross' description.

Masting in birch and other plants often displays a high level of synchrony, with multiple species exhibiting the same behavior over wide geographic area (Koenig and Knops 1998) in response to regional or continental weather patterns (Kelly and Sork 2002, Ranta et al. 2002). In addition to birch in Southcentral and Interior Alaska, 2014 was also a mast year for Sitka spruce and western hemlock in Southeast Alaska, and for white spruce and hemlock in parts of the state (see the Peninsula Clarion article, (http://peninsulaclarion.com/outdoors/2014-08-14/refuge-notebook-spruce-mast-events-feast-or-famine). The exact formula is complex and not entirely understood, but conditions thought to precipitate and follow birch mast events are: (1) One or more good growing seasons (i.e., adequate rainfall and warm, sunny days) to produce the stored energy for substantial reproductive output, (2) warm, dry weather the year before seed mast, stimulating catkin development, and (3) reduction in growth and productivity during and immediately following a mast year due to reproductive investment and stored resource depletion.

This means that trees will need time to recover before another mast event, and mast years will be followed by at least one year of low seed production. The current masting and thinning event was preceded by five years of relatively cool summers from 2008 to 2012, when birch trees were presumably growing and storing resources. In contrast, 2013 was regarded as Alaska's second warmest summer on record (Wendler et al. 2013). These weather trends probably stimulated the heavy catkin production observed in 2014. In general, seed masting does not have long-term negative effects on birch tree health (Gross 1972).

**Figure 59.** A heavy investment in seed production is demonstrated by the numerous catkins. The resources invested into seed production are not available to the tree for growth or the production of leaves. Insects, disease and weather conditions also contribute to the general poor appearance of Alaska's birch trees in 2014.

**Figure 60.** An example of a birch tree displaying branch dieback, a thin crown, and heavy catkin load common throughout Alaska in 2014. The resulting appearance is likely a combination of a variety of physiological, climatic and biotic factors.

## A Complicated Picture

A variety of factors likely play a role in the current state of birch trees in Alaska. Leaf rolling insects were commonly found on birch throughout the state in 2014 and probably contributed to thin crowns in some forests. Other early season defoliators may have also damaged birch crowns before aerial surveys were conducted, leaving little evidence visible in the weeks that ground surveys were conducted. Abiotic factors, such as stress from wind or drought from previous years, also affect crown conditions. It is certain that several of these phenomena occurred together in some of Alaska's birch forests during 2014.

Synchronized dieback may also have been related to aging trees, at least locally. For example, birch trees in eastern North America tend to have dieback cycles of about 22 years (Auclair 2005), corresponding to synchronized maturation of the trees and commensurate increases in susceptibility to various stresses. On the western Kenai Peninsula, few birch seedlings survived from the turn of the 20th century until the 1950s (Gracz et al. 1996) so that most living birches are either over 140 years old, from a surge in recruitment in the 1850s-1870s; or less than 70 years old, having recruited after 1950. Because birch trees rarely live more than 140 years (Safford et al. 1990), many birches on the western Kenai have already exceeded their life expectancy and may be especially vulnerable to drought, defoliation, and disease. In particular, stem decays become more prevalent with increased tree age.

In 2006, forest health specialists with the Alaska Department of Natural Resources and Forest Health Protection investigated Alaska birch stand health following two consecutive years of summer drought. The findings from this Evaluation and Monitoring project were not conclusive, but a greater incidence of dieback and stem decay was detected in older birch stands.

In order to tease apart the effects and extent of the different factors affecting birch, it will be important to continue to monitor the health of birch trees in the coming years. An effective method for evaluation of trends in forest health is the installation of permanent monitoring plots that can be assessed throughout the growing season and over the course of years. When growth decline, mortality, or dieback is observed in any of our major tree species, it is critical that we follow up with focused forest health surveys to identify the biotic causes and attempt to understand interactions with physiological processes such as seed masts and climate stressors such as drought. ☙

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