

HOW DOES A TREE KNOW IT IS AUTUMN?



How does a tree know it is autumn? How is climate change affecting when the leaves of Swedish deciduous trees turn colour in the autumn? Are there variations in autumn leaf development between different tree species and in different locations in Sweden? Is it possible to study autumn using satellite images? These are the questions that the mass 'Autumn Experiment' is helping scientists to answer.

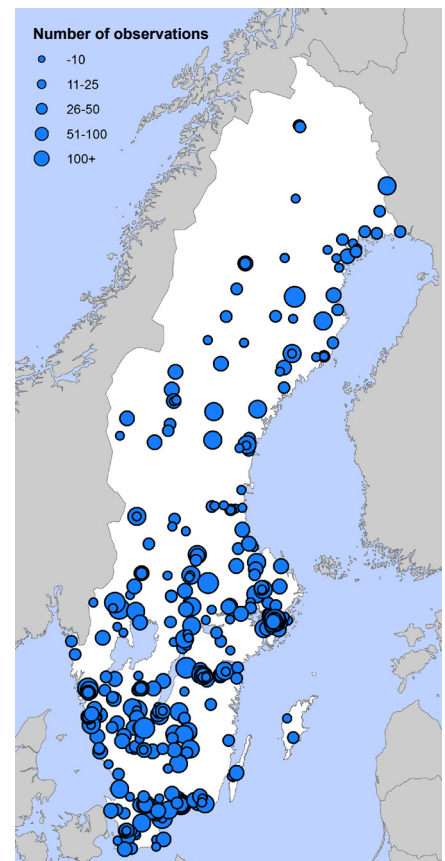
Climate change is impacting when the growing season in nature begins in the spring and when it ends in the autumn. Previous research has shown that changes to the climate seem to be affecting different species of trees in different ways, and that the changes vary in different regions. Although this is an important issue that is fundamentally affecting the ecosystem, little is known about how climate change affects the autumn leaf development of different tree species. Therefore the Autumn Experiment was an important experiment!

Altogether over 10,000 pupils sent in reports on more than 2,000 trees from 378 different locations in Sweden. Using the observations, researchers could examine the differences between various tree species and regions. The researchers also compared the pupils' reports with observations made 100 years ago and with satellite imagery. From the researchers' point of view, the Autumn Experiment was a unique opportunity to get reports from thousands of research assistants around the whole of Sweden.

The pupils' observations showed that autumn colours start to develop from the beginning of August-September to late October. Aspen, birch and maple started to turn 0.5-1 weeks earlier than reported in the 100-year-old observations, while rowan trees were 1.5 weeks and oak trees 2.5 weeks earlier.

A single tree could go through the entire autumn leaf development (from summer green to completely changed colour - see the phases in the figure on the next page) within 1-7 weeks: aspen and maple took a shorter time than oak, birch, downy birch, rowan and silver birch. The autumn period for birch was five weeks in the most southerly observation places; compared with 3 weeks in the most northerly. The trees that started to develop autumn colours early had a much longer autumn period (5-6 weeks) than those that started late (2 weeks).

Although it is not possible to draw any conclusions from just a single year, the results suggest that the impact of climate change on autumn leaf development will vary greatly between different species of trees and regions.



The researchers received reports on 2,054 trees in 378 locations around Sweden. All of the locations are plotted on the map and size of the dot indicates the number of observations made at each location.



Phase 1: Autumn colours starting to show. Not all the leaves are still green.

Phase 2: A third of leaves coloured. At least 1/3 of the leaves are no longer green (or have dropped).

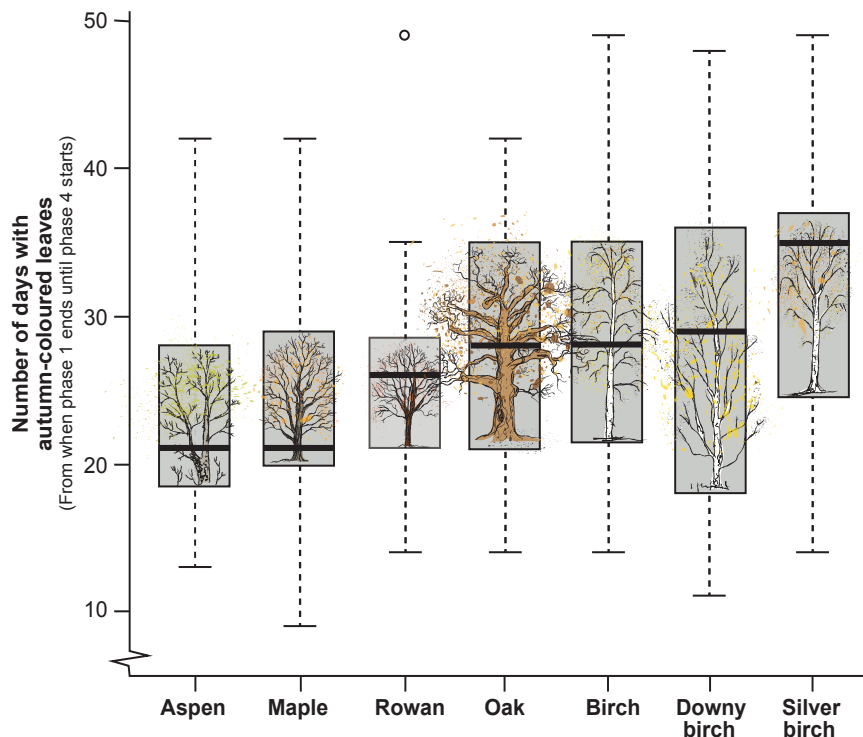
Phase 3: Two-thirds of leaves coloured. At least 2/3 of the leaves are no longer green (or have dropped).

Phase 4: Leaves fully coloured. None (max 5%) of the leaves are green.

The researchers could not find any direct link between the pupils' observations and satellite images taken during the same period. It may be that the satellites "observe" much larger areas, whereas pupils are studying individual trees. In addition to the trees, satellites capture lawns, rooftops and roads in the area. However, when the researchers instead compared how the pupils' reports and satellite imagery described how the end of autumn differed from north to south, the findings of the Autumn Experiment and the satellite images showed the same general trend.

The pupils also collected aspen leaves during the Autumn Experiment. The researchers analysed the leaves to see what aspen genes look like and to investigate which genes influence autumn leaf development. The results from this part of the Autumn Experiment will be published as a separate report by summer 2014. In a video on the Researchers' Night website, Professor Stefan Jansson, a researcher at Umeå University explains how he is going to analyse the aspen genes in his laboratory.

Overall, the Autumn Experiment was a very successful experiment that contributes to a better understanding of the interesting differences between common Swedish deciduous trees and raises new questions to explore in future studies.



Differences between species in the length of the autumn period. The thick line inside each box marks the median and the box includes 50% of the variation within each species observed in the Autumn Experiment. Median = the middle value in a series of observations.

The Autumn Experiment is a collaborative project between **Vetenskap & Allmänhet, VA** (Public & Science), the **Swedish University of Agricultural Sciences, Lund University** and **Umeå University**.



The researchers Kjell Bolmgren, Lars Eklundh & Stefan Jansson from left to right.

A big thanks to all the pupils, teachers and Researchers' Night coordinators that made the Autumn Experiment possible!

Researcher **Kjell Bolmgren** from the Swedish University of Agriculture came up with the idea of the Autumn Experiment and designed it together with researchers **Lars Eklundh** at Lund University and **Stefan Jansson** at Umeå University. They are responsible for analysing the pupils' reports.

VA (Public & Science) coordinated the project with practical support from the Swedish National Phenology Network.

The Autumn Experiment was organised as a part of **Researchers' Night 2013**, a science festival that takes place across the whole of Europe on the last Friday in September each year.

The full report is available in Swedish at: www.forskarfredag.se/massexperiment/hostforsoket-2013/

