

## Aspen – host to a unique world of lichens

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Populärvetenskaplig sammanfattning av Självständigt arbete i biologi 2013

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*Aspen has declined in Sweden during the 20<sup>th</sup> century due to less forest fires, forestry and a high number of elks that eat the shoots of young aspen trees. This decline is a big problem since aspen is host to a unique flora and fauna. Especially the lichen flora found on aspen is unique, many of the lichens use no other tree as a host which make them completely dependent on aspen. So what happens with these lichens when aspen starts to decline in the forest?*

### What makes aspen such an important host for lichens?

Aspen, *Populus tremula*, has a unique lichen flora and many of the lichens found on aspen are so called host specific, meaning that they only live on aspen. There are several factors that make aspen a unique habitat for lichens. The bark is probably the most important one. It has a higher pH value than other common trees, it is very thick which give the lichens a better grip and a bigger surface to grow on and it has a big water holding capacity. This plays a major role for lichens, which are very sensitive to dehydration. There is also a high level of nutrients available on the bark compared to other trees. All of these factors create a unique microenvironment on the trunk of aspen trees. It is not only the chemistry of the bark that affects the lichen community, the bark structure affects it as well. Generally lichens prefer a rough bark since it gives a better grip and more surfaces to grow on. Old aspen trees are more important for lichens because they have this rough bark that young trees simply have not had time to develop yet. The structure and density of the canopy can also have an impact on the trunks microenvironment. Among other things it affects the amount of light that reaches the trunk.

### Conservation of aspen and its lichen flora

The best way to preserve lichens dependent on aspen is to preserve aspen itself. Because of efficient combating of deciduous trees during the middle of the 20<sup>th</sup> century there is a lack of middle-aged aspen in today's forests. This will lead to a lack of old aspen in large parts of Sweden in 30 years time. Many lichen species are dependent specifically on old aspens and therefore this will most likely have a negative effect on them. To preserve lichens, it is important to have both young and old aspen stands in the same forest. Lichen species can then disperse from the old stands to

the young when these develop the old tree qualities the lichens need. Therefore it is equally important to preserve old aspen trees as ensuring the continued reproduction of aspen.

#### What make lichens a good indicator species?

Lichens

- have high and specific demands on the environment they live in
- are sensitive to environmental change
- can be used to identify old-growth forests

Indicator species need to

- identify environments with high conservation value
- be easily identified all year
- be common enough to appear when the environmental factors are right

A way to make sure old aspens do not disappear from the forest is to save aspen trees when making clear-cuts. However, the microclimate on the trunk is changed when the tree is no longer surrounded by forest and because of this, not all lichens can survive in the clear-cuts. One way to benefit more lichen species is to leave groups of trees instead of single ones, but still there will be species that cannot survive in the changed microenvironment. Therefore it is important to conserve aspen stands inside the forest as well. Aspen reproduction is dependent on regular disturbances, especially forest fires. Conservation burnings, that is planned and controlled forest fires, is a way to benefit the aspen reproduction. Also a reduced elk population, by increased hunting or an increased population of natural predators, such as wolves, would reduce grazing on young aspen trees and allow more of them to reach maturity.

### **Could aspen in agricultural land make up for the decline of aspen in the forest?**

Today a large part of the aspen reproduction takes place in abandoned agriculture lands instead of the forest. If the lichen flora is the same in both these habitats this could be a solution for the problem with declining aspen reproduction in the forest. Unfortunately there is a significant difference between them. Some lichens seem to have a hard time to survive in the open and more exposed landscape. This is most likely because of higher light intensity, lower humidity and less stable temperature on the trunks in the agricultural landscape compared to the forest.

### **Aspen – a pioneer species of great importance for biodiversity**

Aspen is probably the most widespread deciduous tree in the northern biosphere. There are five subspecies and one of these, the Eurasian aspen *Populus tremula*, is found in all of Sweden. It is a pioneer species, meaning that it is one of the first to establish itself after a disturbance in the forest, for example a forest fire. It can reproduce both sexually with seeds and asexually with shoots from the tree roots. The sexual reproduction is rare because both the seed and seedling are very sensitive to drought. The asexual reproduction, with shoots from the tree roots produces new individuals that are genetically identical to each other, so called clones.

Most of the Swedish deciduous trees do not occur north of the river Dalälven but aspen does. This combined with the fact that it develops old tree qualities, e.g. rough bark, thick trunk and holes, quicker than most trees make it unique in the conifer-dominated environment. It is probably one of the most diverse trees in the north of Sweden. A very large number of organisms are dependent on aspen. Only in Sweden there are 312 fungi, 15 bryophytes, around 350 beetles and 110 lichens using aspen as their host. Many of these species are threatened and listed on the Swedish red-list of endangered species.

### **Lichens – two species in one organism**

Among lichens there is a great diversity of shapes, colors and size. The most fascinating fact about lichens is that they consist of a symbiosis. That means two different species living together with benefits for both species as a result. In the case of lichens they create an entirely new organism that consist of a fungi and a green algae or a cyanobacteria. The fungi provide the algae or bacteria with shelter from the sun and more efficient water retention. Both the bacteria and algae provide the fungi with energy by photosynthesis. Humidity is very important to lichens because they cannot control their own water level. Instead it varies passively with the surrounding environment. This makes them very sensitive to dehydration.

There are three main factors that limit lichen growth; the water level inside them, light intensity and the available nutrients.

**Lichens are divided into three main groups based on appearance**



Crustose lichens – tightly attached to the surface



Foliose lichens – have a flat leaf-like structure



Fruticose lichens – have a hairy or bushy appearance

**Three main reasons for the aspen decline in Sweden**

During the 20<sup>th</sup> century the amount of old aspen trees and the aspen reproduction have both declined drastically in Sweden. This is a result of a combination of factors, but three main ones can be distinguished; efficient forest fire extinction, forestry and a high elk population.

**Efficient fire control disfavor aspen reproduction**

Fires have always been an important part of the conifer-dominated ecosystems. Other disturbances like windstorms and landslides have mainly a local impact compared to fire that have the ability to affect an entire landscape. Fires alters the forest in many ways, for example by affecting important factors like tree species composition, stand structure, soil conditions, topography and climate.

Before human impact forest fires were large and quite common.

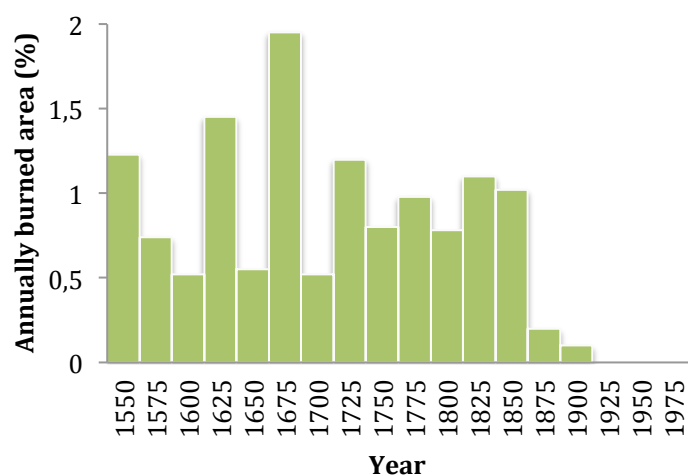


Figure 1: Percentage of forestland burned from 1550 to 1975 along the Vindel River valley in north Sweden.

However in connection with the industrialization the intensity, frequency and number of forest fires changed. The number of fires increased after the mid 17<sup>th</sup> century due to increased human activity, but the fires size and intensity decreased. This was the normal pattern until the end of the 19<sup>th</sup> century when there was a dramatic decrease in the number of firers (figure 1). Today the extinguishing of fire is so efficient that a fire normally do not have time to spread more than a few hectares before it is put out.

Fires benefit both the sexual and asexual reproduction of aspen. An intense fire destroys the seed bank in the ground and thus benefits seedlings by destroying the competing seeds. The asexual reproduction is benefitted by less intense fires because the burned ground is warmer than usual, a lot of nutrient is added by the ash and all the old vegetation is burnt away leaving room for new establishments. Because of the reduced number of fires, aspen reproduction has become unusual in the Swedish forests.

### **A large elk population is a threat to the young aspen shoots**

Many animal species use aspen as a food source, but no other animal has such a big impact on the number of aspen trees in the forest like the elks have. In Sweden the elk population have increased during the 20<sup>th</sup> century with a peak during the 80's due to changed forestry practices that lead to an increased food supply of young deciduous trees, including aspen (figure 3). Elk prefer aspen before other tree species and especially the shoots on young aspens. Grazing by elk do not affect fully-grown trees, probably because their branches and leaves are out of reach, but it can severely reduce the growth of young trees or even kill them. This can have large effects on the tree species composition in the forest and severely decrease the number of fully grown aspen trees in the next generation.

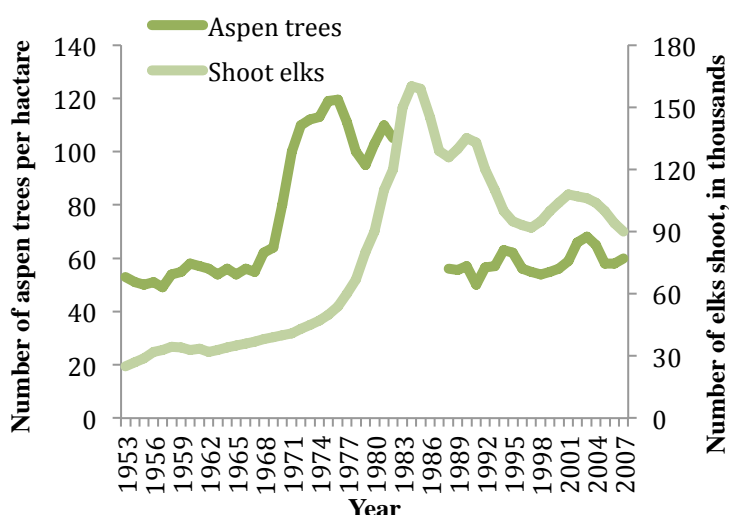


Figure 3: Number of young aspen trees per hectare and the number of elk shoot in Sweden. Data missing for the number of aspen trees between 1983-1987.

### **Forestry combating trees with low commercial value**

Up until the late 40's the dominating forestry practice in Sweden was based on culling but this changed and instead final felling became dominating. This practice can be divided into four stages: rejuvenation, clearance, culling and final felling, and it is still the dominating forestry practice today. The final felling results in clear-cuts that imitate natural disturbances in the forest and therefore benefits aspens asexual reproduction. Because of this, the aspen reproduction increased during the 50's. This was not appreciated by the forest industry because the young deciduous trees at the time lacked a commercial value and competed with the commercially important coniferous trees. Both mechanical and chemical methods were used to get rid of them and the use of herbicides increased rapidly during the 50's. Approximately 30 000 hectare of young forest were sprayed with herbicides every year

between 1968 and 1986. This very efficient combating resulted in a decreasing aspen reproduction during the 70's and a steady decline of old aspen trees from the 50's until 1995.

From 1983 the use of herbicides to combat deciduous trees was prohibited and in 1993 the Swedish parliament decided that production and environmental objectives should be equally important in forestry. This has resulted in more old aspen trees being left in clear-cuts with the purpose to benefit species dependent on them. Also since 1995 the amount of old aspen trees has started to increase again and the felling of aspen has decreased with 70 % since the 80's. The reproduction is back at the same level it was before the 50's but today most of the young trees are found in abandoned agriculture land instead of the forest.

### **What does the future hold for the lichens?**

The unique lichen flora on aspen face an uncertain future if active measures is not taken to preserve it. It is not enough that aspen exist in the landscape but they have to grow in the right kind of environment. The lichens are sensitive to changes in their environment and this is one of the many reasons that they are worth preserving.

### **Further reading**

Petersson L. 2013. Aspens (*Populus tremula*) roll för biodiversitet av epifytiska lavar i boreala ekosystem. Bachelor thesis. Uppsala universitet, Uppsala. (In Swedish)

Hedenås H. 2002. Epiphytic lichens on *Populus tremula*: Implications for conservation. Doctoral. Umeå Universitet, Umeå.