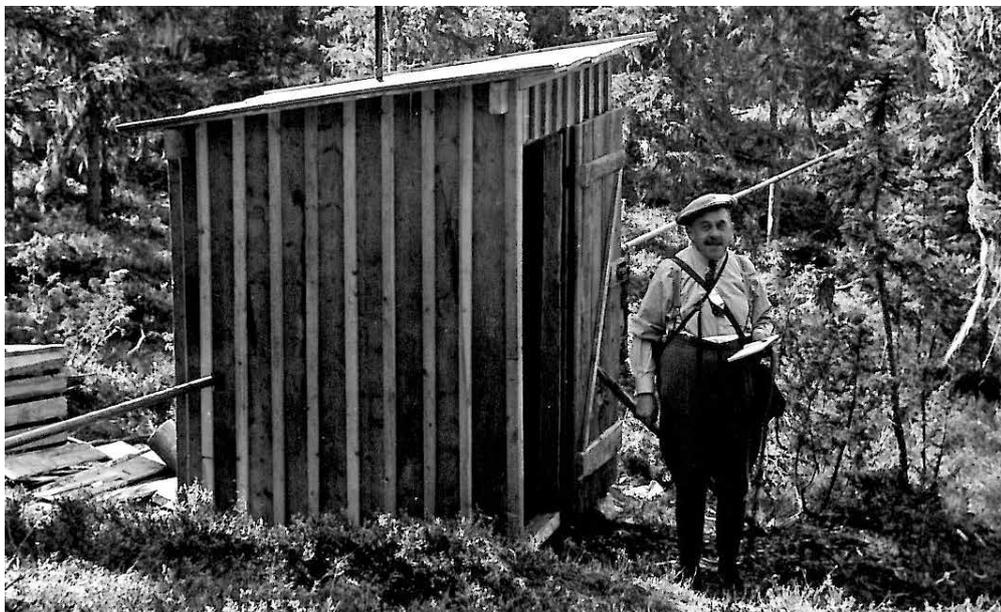


# Research has been returning to nitrogen for 100 years

Photo: Historical forest image archive, SLU



◀ Henrik Hesselman next to the pump house for his irrigation experiment, 1930s. The pump house still stands today, at a place known as Hesselman's Spring.

In Sweden, soil nitrogen levels vary between 1 kg and 10 kg per hectare, while in Europe nitrogen levels can reach up to 30 kg per hectare. The low levels of nitrogen in northern Sweden and Finland make these environments ideal for research into what happens when nitrogen availability is increased. Exhaust gases, agriculture and industrial production increase atmospheric nitrogen levels, which means that levels have risen since the dawn of industrialisation.

Several research experiments in supplemented nitrogen levels have been conducted at Kulbäcksliden Experimental Forest in Vindeln. In the 1930s, nitrogen-laden water was sprayed on spruce trees and they began to grow better. As a result of this discovery, research into forest fertilisation grew in the 1950s.

A more recent nitrogen experiment revealed that certain types of lichen exhibit poorer growth in the presence of increased nitrogen levels while another experiment at Degerö Stormyr noted that peat moss disappeared when nitrogen levels were increased within smaller areas. A large-scale nitrogen experiment has just been initiated on three different mires to see how levels corresponding to nitrogen deposition in Europe affect the water balance, solar radiation reflection and vegetation; effects that cannot be studied in small-scale experiments.

## Nitrogen

Nitrogen is an important nutrient for all living organ-

isms. Nitrogen increases vegetation in many cases, but can also disadvantage some plants, causing them to die out. In Sweden, nitrogen levels vary between 1 kg and 15 kg per hectare and year. In Europe, on the other hand, nitrogen levels can be as high as 30 kg per hectare.

When researching how vegetation is affected by increased nitrogen deposition, the initially low levels of nitrogen found in northern Sweden and Finland make these particularly ideal environments.

## Increased nitrogen deposition

Atmospheric nitrogen has increased and is included in what is known as acid deposition. This deposition makes the environment more acidic and affects, for example, animals and plants. Before the rise of industrialisation in the late 1800s and early 1900s, nitrogen levels were half of what they are today. Industrial production, agriculture and exhaust gases from cars form nitrogen. Acid deposition with nitrogen content

Photo: Historical forest image archive, SLU



▲ The irrigation tower at Kulbäcksliden Experimental Forest erected by Henrik Hesselman. The man in the picture is unidentified.

increased until the year 2000, but has fallen since. Levels are, however, still high.

### Hesselman's Spring

A nitrogen fertilisation experiment at Kulbäcksliden Experimental Forest in Vindeln was begun in 1924, and thirteen years later it was apparent that the spruce trees had grown more than they would have otherwise done, in both height and diameter. The results led to another nitrogen fertilisation experiment being conducted near Flakastugan, Storliden at Kulbäcksliden. The experiment was conducted by Henrik Hesselman and as such is known as Hesselman's Spring. He assumed that nitrogen availability affected the growth rate, size and exterior appearance of all vegetation. Accordingly, a tower was

Photo: Otilla Johansson



▲ A six-meter tower surrounding a spruce with lichen. Lichen experiment at Kulbäcksliden Experimental Forest, 2005.

built to pump water laden with nitrogen, and this was used to water the spruce trees to examine the effect on forest growth. In the experiment, they added not only nitrogen, but also phosphorus and wood ash in various combinations.

Due to the favourable outcomes of the experiments at Kulbäcksliden, research into forest fertilisation grew during the 1950s. The methods that have been used in practical forestry originate from this research. In the 1990s, an exact replica of the tower was built in the same place where the old tower stood, and where the old pump house remains standing.

### Nitrogen experiment on lichens along pathway

Lichens are susceptible to altered nitrogen levels. Previous studies from the Netherlands have shown that lichens are negatively affected in urban areas, by forest fertilisation and by agriculture. Accordingly, a research experiment was started at Kulbäcksliden Experimental Forest to investigate how lichens are affected by nitrogen.



Photo: Pernilla Löfvenius

▲ Fertilisation experiment at Degerö Stormyr, Kulbäcksliden Experimental Forest.

Fifteen 6-metre high wooden towers were built around an equal number of spruce trees. Each tower is fitted with plastic hoses encircling the spruce tree. Water supplemented with nitrogen is pumped through the hoses and sprayed onto the spruce trees and lichens. The premise was that hanging lichens would exhibit poorer growth with increased levels of nitrogen as they are adapted to the low levels of nitrogen found in nutrient-poor coniferous forestlands.

The research experiment showed that different types of lichens were affected in different ways after extended exposure to nitrogen supplementation. Several of the lichens decreased as nitrogen levels increased, although after a few years tube lichens showed increased growth again. Contrary to this, varied rag lichens continued to increase regardless of the level of nitrogen added. As it turned out, three out of four lichen have a fundamental defence mechanism against chemical factors. The results changed



over time, underlining the importance of long-term studies into how lichen are affected by nitrogen. This is important if we are to research how climate change affects lichens. Phosphorus played a significant role in the experiments and could either lessen or worsen the effects of nitrogen supplementation.

### Nitrogen fertilisation at Degerö Stormyr

Degerö Stormyr began as a group of small lakes, eventually transforming into a nutrient-poor mire. Some 8,000 years ago, lake sediment formed on the lake beds, and then 6,000 years ago the lakes disappeared and peat began to form. Sedges and peat moss are among the flora that grow on the mire since these plants thrive in nutrient-poor environments.

Since 1995, experiments in nitrogen fertilisation have been conducted at Degerö Stormyr at Kulbäcksliden Experimental Forest. The experiments entail adding nitrogen and sulphur, which are found in acid deposition, to the surface of the mire. The researchers hope to find out how nitrogen and sulphur affect the uptake and emission of methane and carbon dioxide. Nitrogen and sulphur in various combinations have been added to areas measuring two metres by two metres.

The reason for researching sulphur and mires is that increased sulphur reduces methane emissions from the mires. The reason for researching nitrogen is that it causes increased vegetation. However, when nitrogen is added to a mire, some plants increase while peat moss, which is one of the most important plants on the mire, disappears. The entire vegetation

The reason for researching sulphur and mires is that increased sulphur reduces methane emissions from the mires.

changes significantly in the presence of very high nitrogen levels. And when the vegetation changes, so does the formation of carbon dioxide and methane in the mire.

### Large-scale nitrogen experiment

Large-scale nitrogen experiments have been initiated on mires at Kulbäcksliden Experimental Forest. These experiments, which are conducted across entire mires, are studying effects that cannot be seen on small land areas measuring two metres by two metres.

The research experiment will begin by gathering baseline data from measurements conducted on three mires. Following this, nitrogen fertiliser corresponding to the nitrogen content found in acid deposition in Europe will be added to two mires. The ambition with this research is to investigate how vegetation is changed by higher nitrogen levels in large areas. In addition, it will enable the study of the effects on the water balance and how solar heat is reflected, which has not been possible using small land areas.

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## visa skogen

Project PINUS, a project for innovative experiences in managed forests, aims to gather the tourism industry, the forest industry and forestry academia in efforts to create opportunities for tourism in managed forests. Project PINUS began in August 2016 and runs until November 2019. The Museum of Forestry in Lycksele is the project owner.



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