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The Western Carpathian forests are of extraordinary importance, not only as production forests but also in terms of general and local public interest. Apart from being the source of economically vital products for local people, they play a very important role for neighboring countries in protecting soil and water resources in which these countries also have an interest. The total forest acreage in Slovakia has increased by more than 10% during the last 40 years, and total growing stock represents 190 m^3 per hectare. But the condition of forests in the last decades has markedly deteriorated (Figures 1 and 2). Slovakia is currently exploring ways and means of restoring its forests to a healthy condition.

FIGURE 1 The beginning of the collective spruce decline in 1988, Nálepkovo district, Western Carpathians, Slovak Republic. (Photo by Ladislav Šomšák)

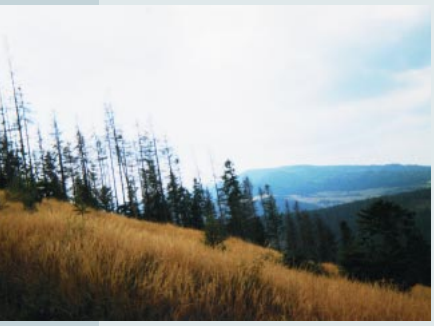

FIGURE 2 Disastrous gap as a result of collective decline of spruce stands in 1993, Nálepkovo district, Western Carpathians, Slovak Republic. (Photo by Ladislav Šomšák)

A long tradition of research and training

The Slovak Republic is a country with an established forestry tradition in the Western Carpathians. In 1762, on the basis of a decision made by the Empress Maria Theresa, a Mining and Forestry Academy was founded in Banská Šiavnica. In 1824, the Forestry Institute was added. It was the world's first institution of higher learning of its type; foresters from almost every European country studied there. By the end of the 19th century, an independent Research Forestry Institute had also been founded in Banská Štiavnica—one of the first in Europe.

Carpathian forests in the Slovak Republic cover approximately 2 million hectares—this represents 41% of the country's total surface. About 40% of this forest cover is state forests; the remaining 60% consists mainly of forests that belong to cooperatives, individuals, municipal communities, or churches. By comparison with surrounding countries, a special feature of the forests in Slovakia is the variety of different natural conditions and types of forests in a relatively small area, from lowland to mountain formations. Furthermore, a wide range of original tree species and mountain communities has been preserved. Mixed stands of spruce, fir, and beech are the typical forest community of mountain areas in Slovakia.

European-wide deterioration

The massive and disastrous decline of the mountain forests of Central Europe is not a new phenomenon. In the past, it occurred particularly in forests whose composition had changed. Wind and snowstorm disasters damaged the forests to such an extent that it was impossible to process the fallen wood in time; damaged areas developed into centers for the dispersion of bark beetles to surrounding stands, causing harm to the spruce monocultures planted for productive purposes. Although such forests may seem to be healthy and stable, when they are 80–100 years old, epidemics of wood beetle (mainly *Ips typographus*) can appear rapidly, damaging hundreds of hectares.

In recent years, the most severe deterioration has been observed in the mountains of Germany, the Czech Republic, Poland, and Slovakia. The main factors leading to the declining condition of tree species have been drought and subsequent insect attacks, exacerbated by air pollution from distant sources as well as local industries. In Slovakia, coniferous forests dominated by Norway spruce (*Picea abies*) were hit first. In the Western Carpathians, the condition of secondary spruce forests has declined over the past 20 years, but wind and snowstorms have not been the primary cause of bark beetle dispersion. In 1996, the infestation of spruce forests in Slovakia decreased by 29% (570,000 m^3) compared with the previous year but is still at the second highest level since 1972, when the physiological decline of these forests began. Rare, randomly found cases of forest damage occurred on a large scale starting around 1985 and were identified as the first and fourth stages of forest damage severity. In 1989, the general forest tree injury for all stages of severity accounted for 85% of all damage. Present monitoring reveals a relative stagnation in the condition of forests; however, further deterioration is expected for the next 2–5 years.

Nálepkovo forest: A very slow process of recovery

The municipal spruce forest of Nálepkovo, situated in central-eastern Slovakia at

FIGURES 3 AND 4
Consequences of the group decline of spruce forests during 1986–1996, Nálepkovo district, Western Carpathians, Slovak Republic. (Photos by Ladislav Šomšák)

an altitude of 450–1200 m and 3200 ha in area (60% with slopes of 20–45°), has been damaged significantly. The composition of today's forest is different from the original forest, dominated by common beech (*Fagus silvatica*), hornbeam (*Carpinus betulus*), silver fir (*Abies alba*), linden (*Tilia cordata*), and sycamore maple (*Acer pseudoplatanus*). Three to four centuries ago, this forest was converted to a secondary spruce forest in order to produce more coniferous timber for the region's expanding mining industry. The yearly allowable harvest is now about 5000 m^3, 70% for logs and 30% for fuelwood. Over the centuries, the coniferous monocultures have increased the soil acidity significantly, from pH 5–6 to pH 3.8–4. This increased acidification seems to be one cause of the decline in the region's spruce forests.

In 1990, the Forest State Authority declared the Nálepkovo forest to be "extremely endangered" (Figures 3 and 4) and began research to evaluate the causes of this condition. The following causes of forest decline were explored: drought, soil acidification, toxic pollutants (mostly heavy metals and arsenic elements from local or remote sources), the degree of organic matter accumulation, disorders in microbiological processes, and secondary succession changes.

The participation of local people and communities in the research has been significant and very helpful in routine monitoring and in collecting various environmental data, including climatic data. From the beginning, the Nálepkovo municipal authorities covered all research expenses.

In 1995–1997, because of the need to extract dead trees in order to limit the expansion of bark beetle populations, harvests of wood were four to five times higher than allowed. Local forest and wood processing industries processed the wood into industrial roundwood, lumber, and wood-based panels.

Reclamation experiments began in 1995–1996, when sycamore maple and linden trees able to survive under such conditions and to act as hyperaccumulators of pollutants from soil were planted in small groups. Subsequently, a new tree composition for the damaged areas was proposed, with 20% of each of the following species: common beech (*Fagus silvatica*), silver fir (*Abies alba*), Norway spruce (*Picea abies*), sycamore maple (*Acer pseudoplatanus*), and linden (*Tilia cordata*). These were planted in small groups at two monitoring plots at altitudes of 600 and 900 m. Due to the high acidity of the soil, half of each plot was limed (4 tonnes/ha). Scientists from the Department of Soil Science, Faculty of Natural Science, Comenius University in Bratislava, will carry out further monitoring and analytical activities to continue to evaluate the causes of collective decline of Norway spruce in the area.

The decline of spruce forests continues across the region. Reclamation experiments—including liming, as the first 'gentle' action to stop the process—have not influenced environmental conditions at the site, in the local area, or downstream. Fish breeding, game keeping, and tourism have all been affected and, with these, the livelihoods of local people. Any progress in identifying and addressing the causes of forest decline will be of great value to local communities and in further improvement of the environmental conditions of the entire region.

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