



Forest Restoration in Krkonoše National Park, Czech Republic

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Introduction

The Czech Republic inherited a legacy of pollution from the former Communist regime. Pollution problems are particularly acute in the area termed, the "Black Triangle", in the corner of the former East Germany, Poland and the Czech Republic. Krkonoše National Park in Northern Bohemia, Czech Republic is a mountainous area with unique biodiversity in this heavily impacted area. By the early 1990's, the ecological devastation from pollution was so severe that trees were killed over entire hillsides. Some of the forests have been replanted since 1990, and the park is the site of numerous scientific studies that monitor the ecosystem and provide a basis for management.

Krkonoše National Park is an example reforestation efforts in a seriously impacted area of Eastern Europe. This paper outlines and assesses the impact of the reforestation program in Krkonoše National Park. The geographic context, ecosystem stressors and funding will be described, followed by an assessment the reforestation efforts.

Geographic Context

Krkonoše National Park is part of the Sudeten Mountain chain, which follows the borders of Germany, Poland and the Czech Republic. The area became a park in 1963 and a UNESCO Biosphere Reserve in 1992. The park contains unique biodiversity including alpine grasslands, subarctic peatbogs, sudetic dwarf mountain pine (*Pinetum mughi Sudeticum*) stands, glacial corries, flower-rich mountain meadows, as well as conifer and mixed forests (UNESCO, 1996). Many rare plants, glacial relics and endemic plants exist in the park, such as the basalt saxifraga (*Saxifraga moschanta ssp. basaltica*), Karkonosze bellflower (*Carpanula bomemica*), cloudberry (*Rubus chamemorus*), and arctic saxifrage (*Saxifraga nivalis*) (Goczol-Gontarek, 1996).

Ecosystem Stressors

This ecologically diverse area has been seriously impacted by human activity. Logging has occurred since the middle ages; industrial pollution and tourism have also contributed to the decline of the ecosystem in recent times.

Logging

The primordial forests in the park were mixed stands of beech (*Fagus sylvatica*) and mixed beech-fir-spruce (*Fagus sylvatica-Abies alba -Picea abies*) forests at lower elevations and Norway spruce (*Picea abies*) at higher elevations, according to pollen analysis (Emmer et al, 1998). However, the forests have been harvested since the middle ages with intensive logging beginning in the 15th century. Starting in the 17th century, intensive logging continued and logged areas were replanted with Norway spruce (*Picea abies*). As a result, only six percent of

the original beech (*Fagus sylvatica*) and one percent of the original beech forests still exist in remnant patches in the western part of the park (Emmer et al, 1998).

Pollution

The park has also suffered the effects of industrial pollution. Large-scale Communist industrialization programs began in the 1950's in the surrounding region of Poland, Czech Republic and East Germany. The Communist governments relied on energy intensive industry and locally available high-sulfur coal as an energy source. The resulting industrial pollution, particularly sulfur-dioxide, increased virtually without limit, since pollution was considered a State secret.

Sulfur dioxide forms sulfuric acid due to a reaction with water in the atmosphere. The resulting acid rain increases rock weathering and reduces plant nutrient uptake, particularly of calcium and other cations (Schlesinger, 1991). Some sulfur dioxide is also absorbed directly by vegetation and pollutants may accumulate in the needles of conifers (Kryuchkov, 1993).

The effects of the pollution related stress on the forests was first seen in the Krkonoše mountains during the 1970's. By 1990, 60 percent of the forests in the northern part of the country showed signs of decline. In the Krkonoše Mountains, 8000 hectares of higher altitude forests died as a result of acid deposition and related problems, such as insect infestation and windthrow. Furthermore, as the forest overstory began to dieback, the aggressive grasses *Calamagrostis villosa* and *Deschampsia flexuosa* dominated the herb layer, crowded rare species, and reduced the biodiversity of the herb layer (Emmer et al. 1998).

Since the 1980's, air pollution has decreased in the entire country by 50 percent (Fronk, 1999). This drop in air pollution is due to the closing of inefficient industries and switching from high sulfur coal to natural gas as an energy source. Furthermore, a clean air act was also passed in 1991 that required the installation of pollution control equipment in utilities and factories by 1998. Despite these actions, 23 percent of Czechs still breathe polluted air that does not meet international quality standards (Fronk, 1999).

As one would expect, air pollution has also decreased in the park significantly (Schwartz, 1996). However, research on pollution deposition shows that there are still sources of pollution to the west and south of the park (Schwarz, 1996). The residual effects of past air pollution continues to degrade soil quality and contributes to long-term forest decline (Schwarz et al, 1997).

Tourism

Besides logging and pollution, the park also faces ecosystem stressors from six to eight million people who visit the park each year (Goczol-Gontarek, 1996). The park includes 1000 km of ski and hiking areas. One of the main impacts of tourism is the construction of trails, ski runs, and ski lifts. A major dispute occurred in 1994 over the construction of a ski resort cable car (CTK, 1994). Tourists also trample vegetation, increase air pollution from automobiles, contribute to water pollution and produce solid waste.

Early Restoration Efforts

Until recently, the Czech forest management institute, Lesprojekt, attempted to restore the declining forests by planting Norway spruce (*Picea abies*). Unfortunately, this management plan exacerbated the acidification problems caused by acid rain through borealization (Emmer et al, 1998). Borealization is the process by which conifer needles increase acidity of the litter, retarding decomposition of litter and reducing nutrient cycling. As the pollution stressed conifers lost needles, the soils became even more acidic due to borealization (Emmer et al 1998).

Current Restoration Efforts

The current park management (KRNAP) changed forest restoration goals as a result of ecological research. The current management goal is to preserve remaining biodiversity and restore the natural ecosystem. The restoration sites fall within the four zones of the park, established in accordance with UNESCO Biodiversity Reserve guidelines. In all zones, a high priority is given to salvage management of endangered species. The plants most in danger of extinction are cultivated and then replanted in restored areas (Schwarz, 1996). A high priority is also given to planting trees that decrease the acidification of the soil, such as beech (*Fagus sylvatica*) (Schwartz, 1996).

Within the park zones, different restoration goals are established depending on the severity of the ecosystem damage (Schwartz, 1996). In zone one (4152 hectares) and zone two (3046 hectares), the goal is to preserve areas that are only slightly damaged and to replant damaged areas with native trees and plants. These two zones comprise the most sensitive high altitude areas of highest biodiversity. In zones three and four, the lower elevations in the park and the buffer area outside the park, the goal is to preserve water quality, restrict land use and manage the meadow herb layer (Schwartz et al. 1997).

The main focus of the park administration in implementing these goals has been data collection and restoration planning. For example, over 90 research projects in the park and buffer zones had been completed by 1993 (KRNAP, 1997). Research has been underway to monitor air pollution, model forest and ground layer growth under pollution stress scenarios, develop management techniques for root cuttings, cloning, herb coverage, and reduce avalanche danger to settlements. The planning and research has culminated in the reforestation of 2700, hectares of forests, or 34 percent of the damaged area, between 1992 to 1996 (Hrebacka, 1997).

Restoration Funding

Until 1994 the park obtained funding for operations and restoration from the Ministry of Agriculture. In 1994, the Ministry of the Environment became the responsible for the park, yet lacked sufficient funding. However, since 1992 the park has received international funding. KRNAP implements a Global Environment Facility (GEF) project and receives significant funding from the Dutch FACE (Forest Absorbing Carbon Dioxide Emission) foundation.

KRNAP received 2,000,000 USD from the GEF. The GEF is implemented by the International Bank for Reconstruction and Development for international environmental projects. The projects

in Krkonoše Park include forest restoration planning, mountain meadow restoration, environmental education, survey of game animals, evaluation of sustainable development prospects, the purchase of computer and monitoring equipment and training of employees (KRNAP, 1995).

Since 1992, The FACE foundation has funded restoration projects in the park. In 1996, the foundation contributed 16 percent of the total budget of the Forest Management Department (Hrebaka, 1997). The foundation is an association of Dutch power engineering companies, Sep (The Electricity Generating Board) which charge consumers and extra 0.00018 USD/kilowatt hour to fund international forest restoration projects. (Schwarz et al, 1997).

Analysis of Restoration Efforts

The park administration has completed numerous research in the park and has restored some of the damaged forest. However, the park management can improve the restoration program by critically analyzing the restoration success, amending the soil, improving relations with the local citizens and diversifying funding sources.

Krkonoše National Park administration has collected data on the park and has successfully changed the forest management due to the research results. However, the results of the restoration efforts are not systematically evaluated. For example, during the winter of 1995 and 1996 a large number of trees died on both the Czech and German sides of the mountains (CTK, 1997), yet this is not noted in the park management documents. A critical analysis of the success and failure of the plantings needs to be completed to guide restoration in the park and other similar Eastern European parks.

The park administration can also improve the restoration success by concentrating on soil restoration. Acid rain is not as acute as prior to 1990, and it is unlikely that the type of unconstrained emissions will increase again in the area, due to the change in governments in the early 1990's. However, the soil has been so acidified that natural regeneration of forests may not be possible within a reasonable timeframe without significant soil amendments, donor soils or intensive soil management. Although the park management does promote the planting of trees that will improve soil quality, there is a lack of published information on other ways to improve soil processes.

Furthermore, the project will not succeed in the long term without support from the local citizens. Problems between the local authorities and park administration are apparent. For example, in 1995 the park administration was not able to establish a Council of KRNAP, as required by FACE funding. The council requires four of five representatives from local towns, and the local authorities were not interested in joining (Hrebacka, 1996). A disagreement over the construction of a ski resort cable car in 1994 divided the local citizens and soured opinions of the park management. Overcoming these disagreements and cultivating local support is crucial for long term success of the restoration projects.

Finally, funding sources need to be diversified. Although the ecosystem problems in the park are due to international pollution problems and it makes sense to have international funding to

complete the restoration. However, a relying on international funding can prove problematic in the future when funding may not be available. The park management should look at additional ways to diversify the funding for ecosystem restoration and monitoring.

Conclusion

Krkonoše National Park illustrates the problems and successes of restoring a degraded Eastern European park. The ecosystems suffered severe decline due to pollution and poor forestry management practices. The current park management has undertaken numerous scientific studies and aims to restore the native forests. However, the park management needs to critically analyze the restoration efforts, consider additional soil amendments, work with the local people in the area, and diversify their sources of funding.

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