Endangered Landscapes & Seascapes Programme | Cambridge Conservation Initiative

Understory Vegetation

Objective: Increase diversity and cover of forest understory vegetation

Carpathian Mountains

status: improving

Problem: Much of the forest habitat across the Fagăraș Mountains has become ecologically degraded due to forestry practices, including clear-felling and planting with spruce monocultures instead of diverse native tree assemblages. This has led to a shift in the composition of understory vegetation, which can be used as an indicator of forest habitat type and condition.

Action: In clear-cut forest areas, Foundation Conservation Carpathia is planting saplings of native trees that occur naturally in mixed intact forests in the area, including European spruce (*Picea abies*), European silver fir (*Abies alba*), European beech (*Fagus sylvatica*), sycamore (*Acer pseudoplatanus*) and rowan (*Sorbus aucuparia*). Foundation Conservation Carpathia also cuts shrubby and grassy vegetation that could prevent the development of the planted saplings – this is required by Romanian forestry regulations. In spruce monocultures, Foundation Conservation Carpathia is cutting down some spruce specimens to thin out the dense monocultures and allow natural regeneration of native species, as well as planting saplings.

Indicator: The abundance of understory plant species characteristic of native mixed forest, as well as understory species richness and diversity, indicate benefits of forest restoration, increased connectivity (for species including wolves, bears, lynx and deer) and the recovery of important ecological functions including tree seedling regeneration, decomposition, and nutrient fluxes. This in turn is hoped to lead to recovery of specialist taxa including arthropods and birds, which are also being monitored.

An area of clear-cut forest. Photo: Foundation Conservation

A spruce monoculture. Photo: Foundation Conservation

A well-preserved mixed forest. Photo: Foundation Conservation

Carpathia. Carpathia. Carpathia.

Methods

Data was collected across clear-cut forest, spruce monocultures, and intact mixed forest in areas owned by Foundation Conservation Carpathia. Since purchase of the forests to be restored is an ongoing process, the baseline survey was conducted in 2019 and 2020 for clear-cuts and mixed forests, and in 2021 for newly purchased forests, which were mainly spruce monocultures. The baseline survey was conducted on 210 sample plots: 70 for each habitat type. From this baseline survey, 150 permanent sampling plots were used for ongoing monitoring: 50 in each habitat type (Fig. 1). Sampling continued at two-yearly intervals at each site, up to 2024. In each year, surveys were conducted between late June and early September.

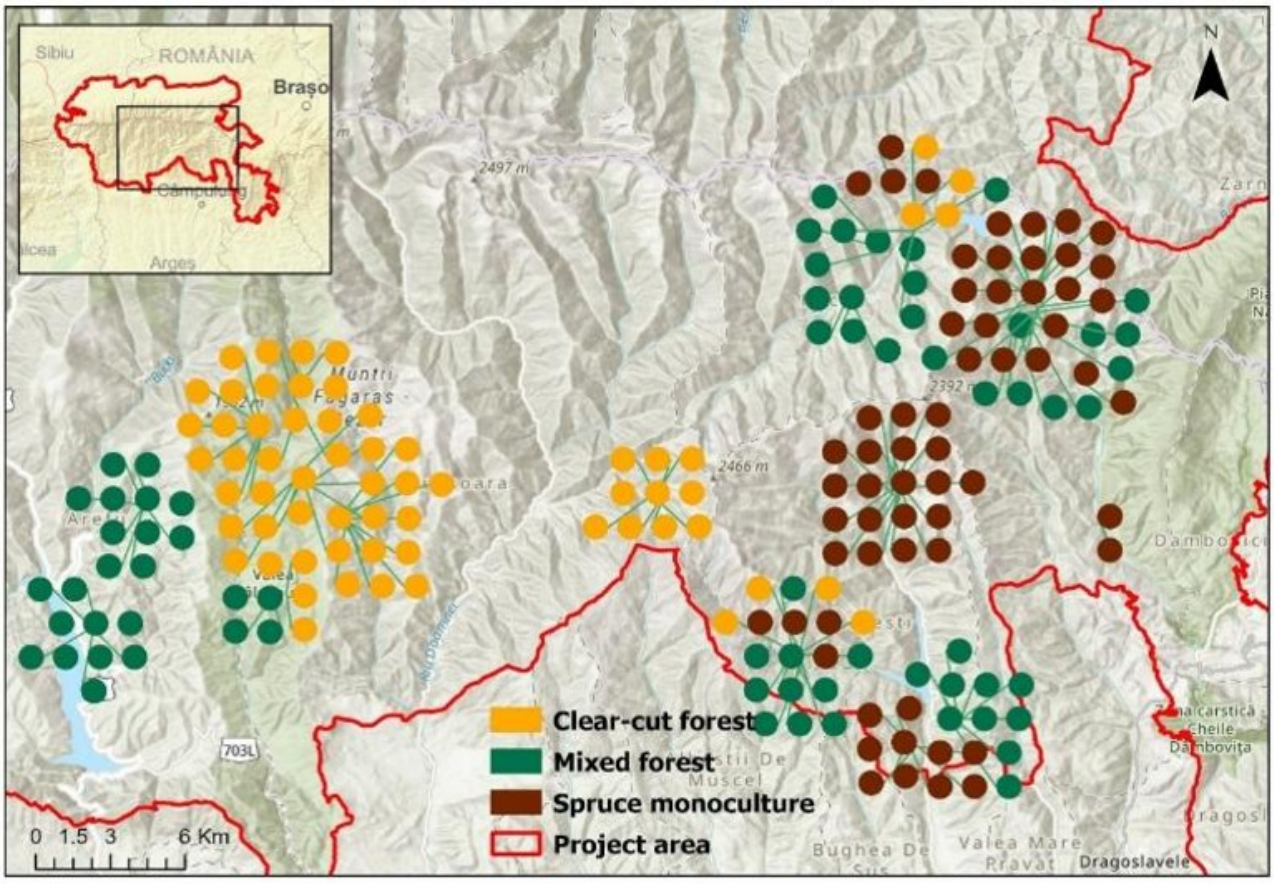

Figure 1: Locations of permanent sampling plots across clear-cut forest, spruce monoculture, and intact mixed forest. Created by Foundation Conservation Carpathia.

For the clear-cut and spruce monoculture plots, most plots underwent restoration while a subset were not restored, to act as controls. For clear-cuts, there were 35 restored plots and 15 control plots, while for spruce monoculture there were 44 restored plots and 6 control plots. The mixed forest plots were used as reference plots representing intact habitat, and did not undergo any intervention.

At each 20 x 30 m sampling plot, surveys were conducted of vegetation cover in three height layers (Fig. 2):

- <1 m: % vegetation cover surveyed within five 1 m^2 quadrats placed at 5m intervals along a central transect
- 1-3 m: % vegetation cover surveyed within three plots of 3.1m radius, located at 10m intervals along the central transect
- >3 m: % tree cover surveyed across the entire 20 x 30 m sampling plot (total area 600 m^2)

This method followed was replicated from previous work in the region (Patriquin et al., 2000; Mountford & Pop, 2009).

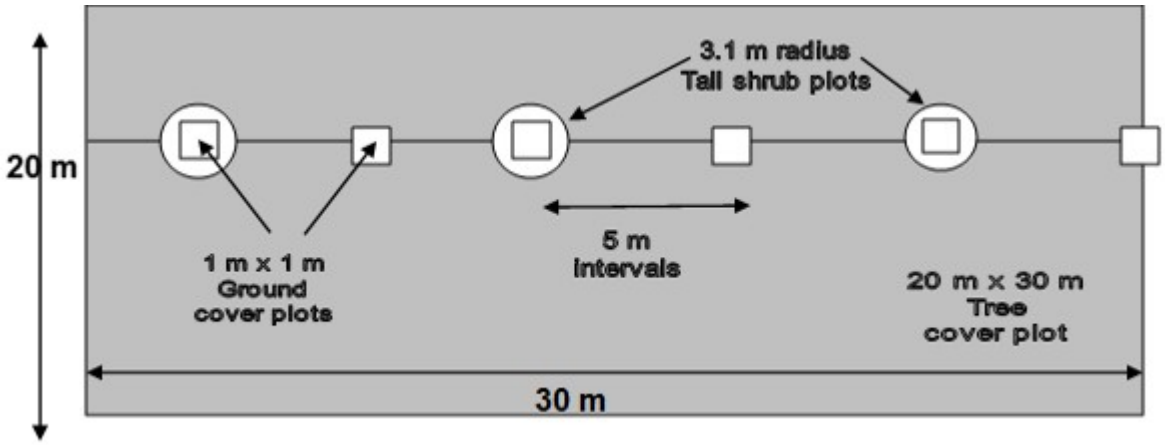

Figure 2: Sampling design, replicated from Patriquin et al. (2000). Created by Foundation Conservation Carpathia.

From the baseline surveys, indicator species associated with each habitat (clear-cut, spruce, and mixed forest) were identified. An initial list of species was generated statistically based on the vegetation recorded in each habitat type and vegetation layer (<1m, 1-3m, and >3m), and these lists were then modified based on prior botanical knowledge of the region and habitats. To analyse the data, the total % cover for all species identified as indicators for mixed forest was calculated for all three habitat types, since restoration aims to restore clear-cut and spruce monocultures to habitats which more closely resemble native mixed forest. Therefore, an increase in mixed forest indicators was considered a sign of ecological recovery. So far, this analysis was conducted only for the 0-1m vegetation layer since it is too soon for regenerating plants to have penetrated higher layers. However, the data collected here will act as a baseline to compare against future monitoring.

Monitoring understory vegetation. Photo: Oliviu Pop.

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Results

There were significant signs of recovery of mixed forest indicator species in the 0-1m understory layer. In both clear-cut forest and spruce monoculture, there was a significant difference in change over time in % cover of mixed forest indicator species between control and restored areas. In control areas, % cover of mixed forest indicators did not change significantly across the three surveys (2020-2024 for clear-cuts and 2021-2024 for spruce). In restored areas, % cover of these species increased significantly across the three surveys in both habitats (Fig. 3). In mixed forest reference sites there was no significant change in the indicator over the period (2019-2024).

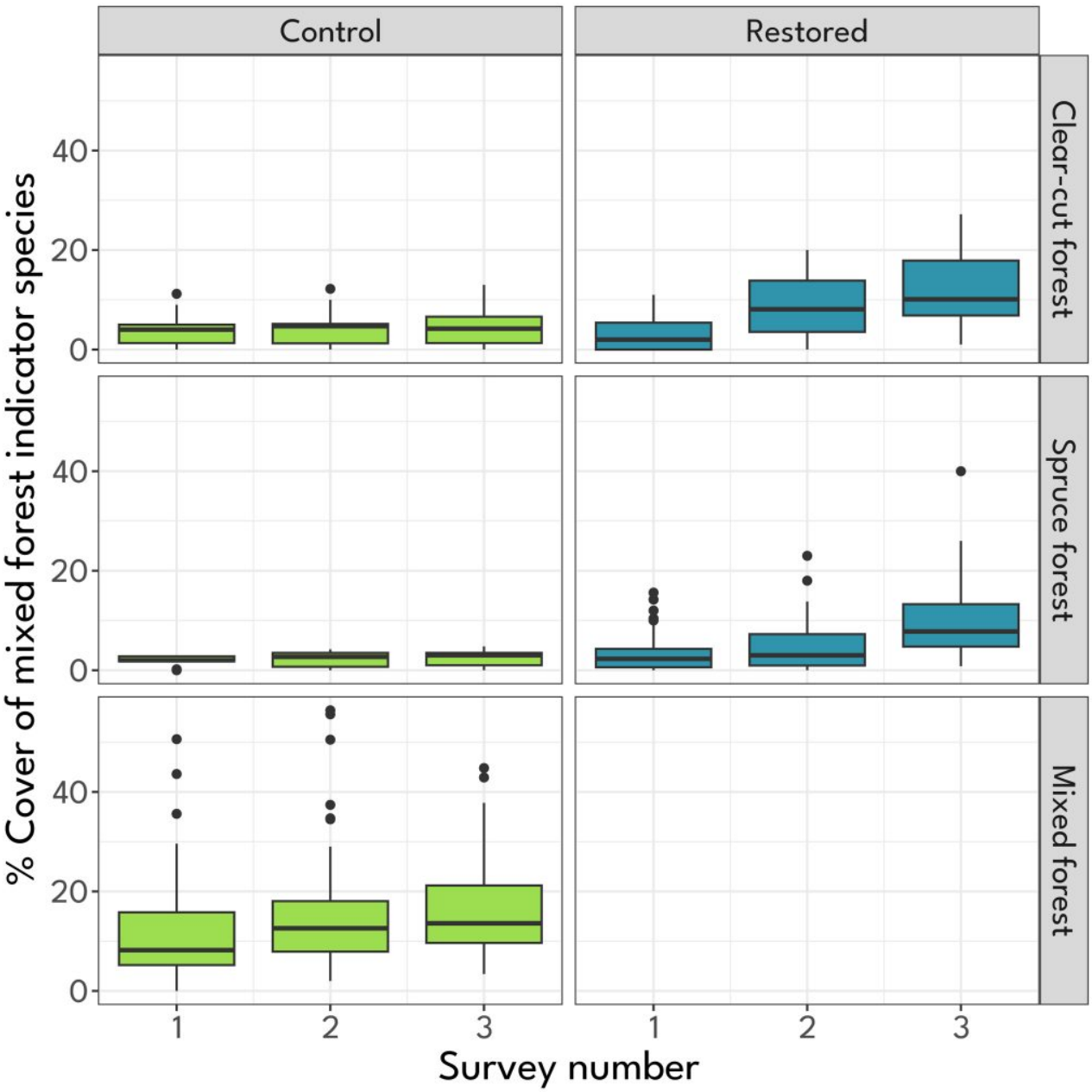

Figure 3: % cover of mixed forest indicator species in the <1m understory layer of clear-cuts and spruce monocultures, across both control and restored areas, and in intact mixed forest reference (control) sites. Note that no restoration occurred in already-intact mixed forest.

Interpretation

In clear-cut forest, restoration treatments involved planting of saplings and removal of shrubby and grassy vegetation (including *Calamagrostis arundinacea*, *Chamaenerion angustifolium*, *Deschampsia flexuosa*, and *Rubus* species) to protect saplings from crowding and competition, in accordance with forestry regulations. This led to an overall decrease in pioneer vegetation cover in the lowest vegetation layer and may have allowed regeneration of native mixed forest species. At lower altitudes, saplings planted were fir (*Abies alba*), beech (*Fagus sylvatica*), spruce (*Picea abies*), ash (*Acer pseudoplatanus*) and rowan (*Sorbus aucuparia*). At higher altitudes, Foundation Conservation Carpathia planted saplings of spruce (*Picea abies*) and rowan (*Sorbus aucuparia*).

In spruce monocultures, felling of some large trees in restored plots to open up the canopy and allow understory regeneration caused a decrease in tree cover. At the same time, beech and rowan saplings were planted, leading to an increase in mixed forest indicator cover in the 0-1m layer; these saplings will also benefit from gaps in the canopy created through occasional felling.

Mixed forest reference plots showed little change, reflecting the fact that these are mature forests which have largely reached a climax vegetation community and did not undergo any intervention. However, there were signs of an increase in mixed forest indicator species, although this was not statistically significant. This may be due to the reduction in human disturbance since the plots were purchased by Foundation Conservation Carpathia.

Ground vegetation of a clear-cut area. Photo: Foundation Conservation Carpathia.

Understory vegetation in spruce monoculture, including Athyrium filix-femina and Oxalis acetosella. Photo: Foundation Conservation Carpathia.

Mixed forest understory vegetation, including beech and fir seedlings and saplings. Photo: Foundation Conservation Carpathia.

Next steps

The monitoring period so far has been too short to observe changes in the structure and composition of taller vegetation in restoration areas. However, this data will provide a valuable long-term baseline, and has enabled identification of potential indicator species for future monitoring. Foundation Conservation Carpathia plan to continue monitoring the plots at 3- to 5-year intervals.

Citations

Patriquin D., Treweek J.R., Petruskevich I., Mountford, J.O., 2000. Baseline survey designs for Retezat National Park, Piatra Craiului Natural Park and Vanatori Neamţ Forest Park: Operational Manual. Komex/CEH final report to Romanian Biodiversity Conservation Management Project.

Mountford J.O., Pop O.G, 2009. Baseline survey as a tool in informing the management of protected areas in Romania, Ivanova D. (ed.), Plant fungal and habitat diversity investigation and conservation. Proceeding of IV Balkan Botanical Congress, Sofia, Bulgaria, 20-26 June 2006, pp. 530-537, Bulgarian Academy of Sciences (ISBN 978-954-9746-14-13).

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