Common Hackberry (*Celtis occidentalis* L.): a warning from Hungary

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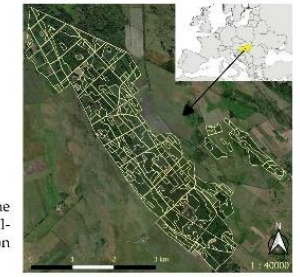

Figure 8: the location of the Peszér Forest in Central-Hungary and its subdivision into forest stands

Introduction

C. occidentalis is a North American deciduous tree species, which was introduced to Europe in 1636 and to Hungary in the early 1800s. It has been widely planted in settlements and along roadsides as an ornamental tree, but has also been embraced by foresters, used e.g. for mixing purposes and for binding sand dunes. Its importance has now declined, but the legacy of the plantations has remained. Its invasion may have started only 2-3 decades ago after a long lag time, and today *C. occidentalis* is a clear problem for both conservation and forest management.

Methods

Our research was carried out within the framework of the OAKEYLIFE project in the Central Hungarian Peszér Forest (HUKN 20002). The Natura 2000 site is one of the best preserved forest-steppe forests in the country, which is still home to several protected species and valuable habitats (e.g. 91I0).

Our work followed the classic BACI design, but instead of sampling, we aimed for full area coverage. To achieve this, we surveyed each forest stand with 625 m^2 quadrats delimited by a 25x25 m grid. In each quadrat the number of seed-bearing individuals (**S**) (dbh* ≥ 5 cm) was counted and the number of vital saplings (**VS**) (dbh < 5 cm & after seedling stage) was estimated on an ordinal scale. The baseline was recorded in 2018 and re-surveys were carried out in 2022.

In the meantime, selective chemical and mechanical treatments of varying intensity have been implemented to control the species. Four different types can be distinguished: 1. control / no intervention; 2. stem-injection / search and treatment of **S**; 3. stem-injection + partial bark sripping / 2nd round of **S** + search and treatment of larger **VS**; 4. stem-injection + partial bark sripping + manual pulling / 3rd round of **S** + 2nd round of **VS** + pulling out smaller **VS** and even seedlings

The project also included a complex habitat mapping (based on the General National Habitat Classification System (Á-NÉR)). The invasion of *C. occidentalis* (change in **VS**) was compared according to the different treatments with the main groups of the local forest habitat types: 1. European steppic woods with *Quercus robur*; 2. native poplar stands; 3. *Robinia pseudoacacia* (native in North America) stands; 4. dry scrublands; 5. dry grassy clearings.

* diameter measured at breast height (1.3m)

Results and discussion

C. occidentalis was monitored in altogether 6782 quadrats in 88 different forest stands during approx. 220-220 field days. The baseline survey resulted in 9,617 individuals of **S**, and 262,000 individuals of **VS**. In the control stands (1), **S** increased by 67% and **VS** by 253%. After the 1st round of treatments (2), **S** decreased by 90%, while **VS** increased by 334%, which was actually higher, than the value for the control. This can be explained primarily by the loss of larger individuals, which results in reduced canopy closure, ultimately providing better conditions for seed germination, seedling and sapling growth. In the 2nd-round treatment stands (3), **S** was reduced by 95% and **VS** by 46%. Only in the stands targeted by the 3rd round of treatments (4) was it possible to find and treat almost all **S**. In these areas, the initial number of 2,216 individuals was reduced to only 21. However, **VS** could only be reduced by 54%, which is similar to the results of the 2nd round of treatments. It is safe to say that just 3 years is not enough to eradicate the species, as its seed bank is likely to last longer. On the other hand, young individuals are very difficult to detect and may therefore miss out on treatments. In all of the main habitat types, increases/decreases were found in line only with the intensity of the treatments. This suggests that all habitat types are threatened by the species, and its invasion is certain without interventions (see control).

Figure 1 & 2: changes in the abundances of *C. occidentalis*. The dots indicate the different forest stands

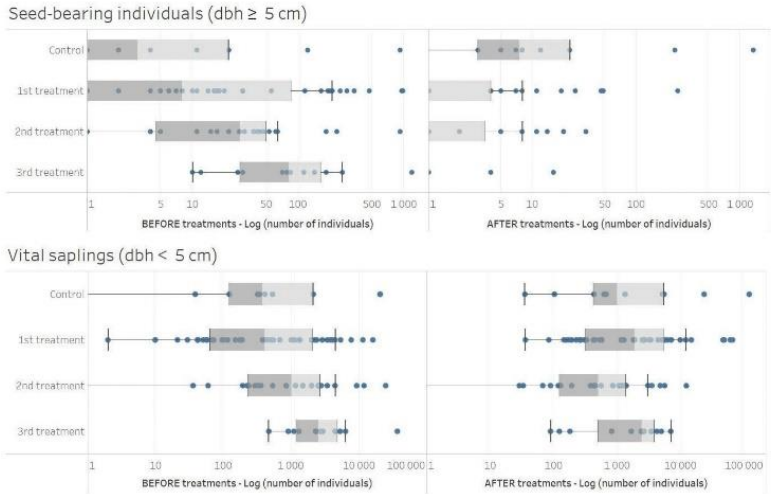

Figure 3: changes in the abundances of *C. occidentalis* according to the main habitat and the management types

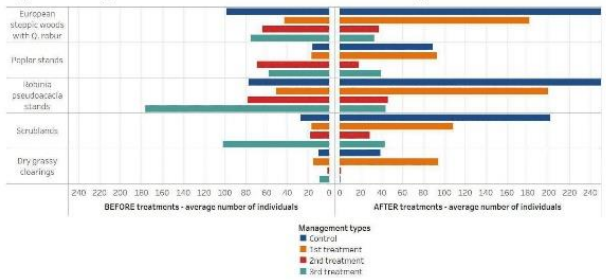

Figure 4-7, from left to bottom right: 4. *C. occidentalis* seedlings emerged from bird droppings; 5. seed-bearing individuals; 6. stump sprouts 10 years after cut; 7. a case invasion in a poplar stand

Highlights

- The continuous invasion of *C. occidentalis* is currently most severe in forest-steppe forest habitats in Hungary, but it can also be observed from riverine forests to mountain foothills
- However, its current invasion has undoubtedly been accelerated by its deliberate spread over the past 2 centuries
- The tree species has been introduced to many other countries, but it may still only be found in settlements or e.g. botanical gardens
- We therefore recommend its monitoring as soon as possible, as it may also start a rapid invasion in areas with a similar climate to Hungary