Doctoral (PhD) thesis abstracts

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Gödöllő

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Hungarian University of Agricultural and Life Sciences
Doctoral School of Environmental Sciences

ASSESSING THE CONSERVATION AND SOCIO-ECONOMIC CONTEXT OF CERTAIN ALIEN INVASIVE BEEPASTURE SPECIES

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Table of contents

1. Background and objectives of the research

The spread of invasive alien plant species has become a global problem. These species can cause damage on every continent. Invasive plant species have a serious impact on native species, communities and ecosystems in many ways. The invasion may reduce the species richness of native vegetation and overall species diversity at the local level.

Like many European countries, Hungary is home to many non-native species in addition to native plant species, but many of these do not cause problems in the native vegetation. However, there are also invasive alien plant species that have excellent reproductive and dispersal characteristics, giving them a competitive advantage over native vegetation. These are called invasive or also known as alien invasive species. Most of these species have no particular economic or other value, so all the sectors concerned agree on their eradication. However, some plant species, including beepasture species, are exceptions. While their excellent properties are particularly useful for certain sectors, other sectors tend to view the presence and rapid spread of these species as a problem.

During the research, we selected four beepasture species that are also alien invasive species. These are the black locust (*Robinia pseudoacacia L.*), the common milkweed (*Asclepias syriaca L.*), and the Canadian and tall goldenrod (*Solidago canadensis L.* and *Solidago gigantea Aiton*).

I first began working on this research topic during my master's degree in conservation engineering, when I conducted a questionnaire survey among conservation rangers and beekeepers. My results showed that this research topic revolves around extremely topical issues, that is why I wanted to explore it in much greater depth. To achieve this, I have expanded the scope of stakeholders: in addition to nature conservation and beekeeping, forestry and agriculture also play an important role in my doctoral thesis. We considered it important to investigate this topic at both the national policy and local levels, from both a natural science and social science perspective. This provides an opportunity to gain a much deeper understanding of the views and motivations of the sectors concerned. With regard to the natural science research part, we conducted a vegetation survey at the local level, in the area of Lake Kolon.

Our research was based on a combination of natural science and social science research methods, for which we formulated our objectives in a complex manner. The main objectives of the natural science research section **(C1)** were to compare the changes in vegetation in the stands dominated by white acacia and common milkweed in the vicinity of Lake Kolon and in the natural control stands located close to them (2021-2022, spring/autumn) based on several criteria (species richness, diversity, types of social behaviour). The main objective of the social science research section **(C2)** was to identify the positions and relationship systems (conflicts, discourse) of the main stakeholder groups (nature conservationists, beekeepers, foresters, farmers) regarding the examined beepasture species.

Objective **C1** includes the following research questions (K1-K3) and hypotheses (H1-H3):

K1. Are the control populations more species-rich than those dominated by the invasive species under investigation?
H1. In the case of natural control populations, a higher number of species is to be expected.
K2. How does the number of species change over the two examined years and in terms of the two aspects?
H2. The number of species will be higher in the examined year with higher precipitation around the surveyed vegetation periods.
K3. What types of social behaviour best characterize populations dominated by invasive species and the natural controls?
H3. In terms of social behaviour types, a high proportion of alien, aggressive competitors (AC) is expected in populations dominated by the examined invasive species. In the control stands of black locust, generalists (G) and competitors (C) will be present in high proportions thanks to the native tree species. In the control stands of common milkweed, the number of competitors (C) will be decisive, given the dominance of grasses.

Objective **C2** includes the following research questions (K4-K9) and hypotheses (H4-H9):

K4. What are the spreading trends for the examined plant species (black locust, common milkweed, invasive goldenrods)?
H4. The opinion of the sectors concerned will show a more mixed picture of the distribution trends of the examined species, especially in the case of herbaceous species.
K5. How are the examined species viewed by the sectors concerned?
H5. Due to differing interests, the assessment of the examined invasive species are likely to be divisive among the sectors concerned.
K6. To what extent does the current legal and subsidy system help or hinder the control of the examined invasive species?
H6. The current legal and subsidy system tends to help control invasive species (including the examined plant species).
K7. Are beekeepers open to replacing invasive beepasture species?
H7. Beekeepers are likely to be open to replacing invasive beepasture species, except of the most important beepasture species (e.g. black locust).
K8. What is the relationship between the sectors concerned with regard to the examined plant species?
H8. Due to differences in interests, there are conflicts between the sectors concerned, also in relation to the examined species.
K9. How common is the discourse between the sectors concerned? What are the typical topics discussed?
H9. Continuous communication is not typical among representatives of the sectors concerned, including the topic of the examined beepasture species.

2. Materials and methods

During our research, we first selected the examined alien invasive beepasture species (black locust, common milkweed, invasive goldenrods: tall goldenrod and Canadian goldenrod), and identified the main stakeholder groups (representatives of the nature conservation, beekeeping, forestry, and agricultural sectors). Subsequently, we defined the scope of the field studies. During the research, we focused on two different levels: national and local level (the area of Lake Kolon). In terms of natural science research, we conducted botanical surveys in the area of Lake Kolon regarding black locust and common milkweed. In terms of social science research, we first conducted interviews at the national level with representatives of national organizations involved with all of the examined plant species. We also organized a workshop with the participants of the interviews (except for forestry experts), supplemented by researchers and beekeepers, on issues related to the examined beepasture species (common milkweed, invasive goldenrods). Subsequently, we conducted interviews at the local level with experts in the area of Lake Kolon regarding all the examined plant species (Figure 1).

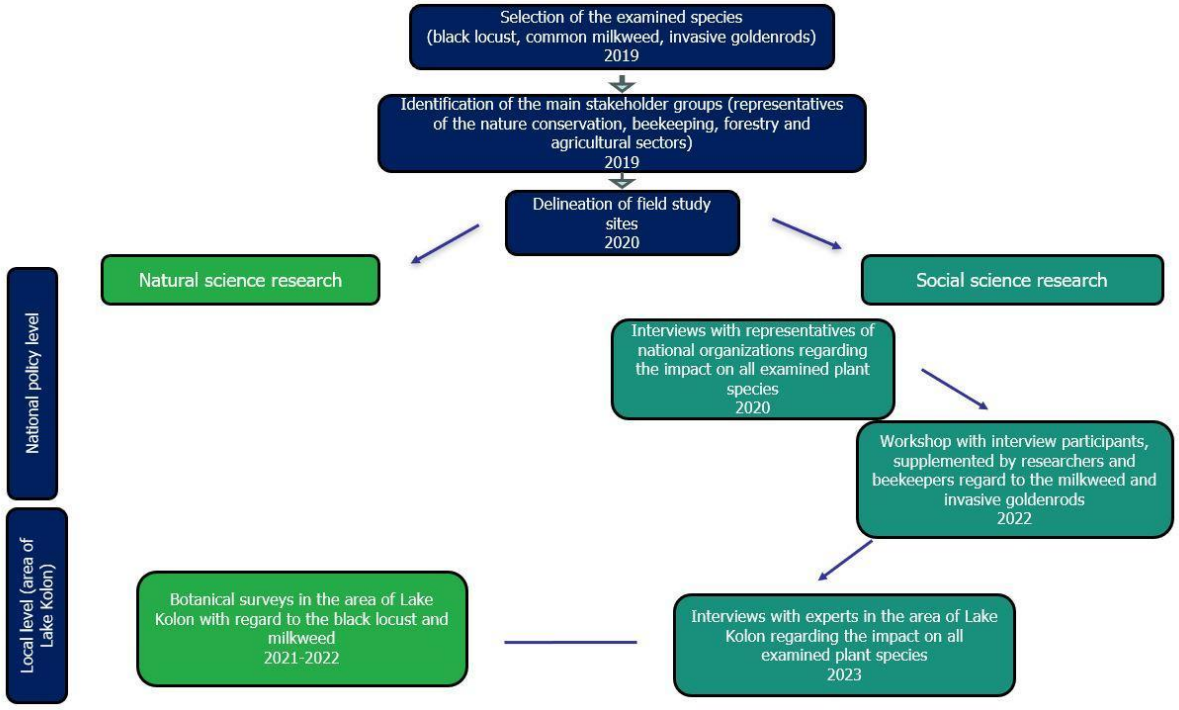

Figure 1: Flowchart of doctoral research.
Source: own compilation

The sample areas related to the **botanical survey** are located near Izsák and Soltszentimre. Areas marked with "A" are dominated by *A. syriaca*, areas marked with "R" are dominated by *R. pseudoacacia*, and areas marked with "C" are natural controls (Figure 2). We excluded areas close to roads in advance to avoid the impact of such disturbances on our results (edge effect).

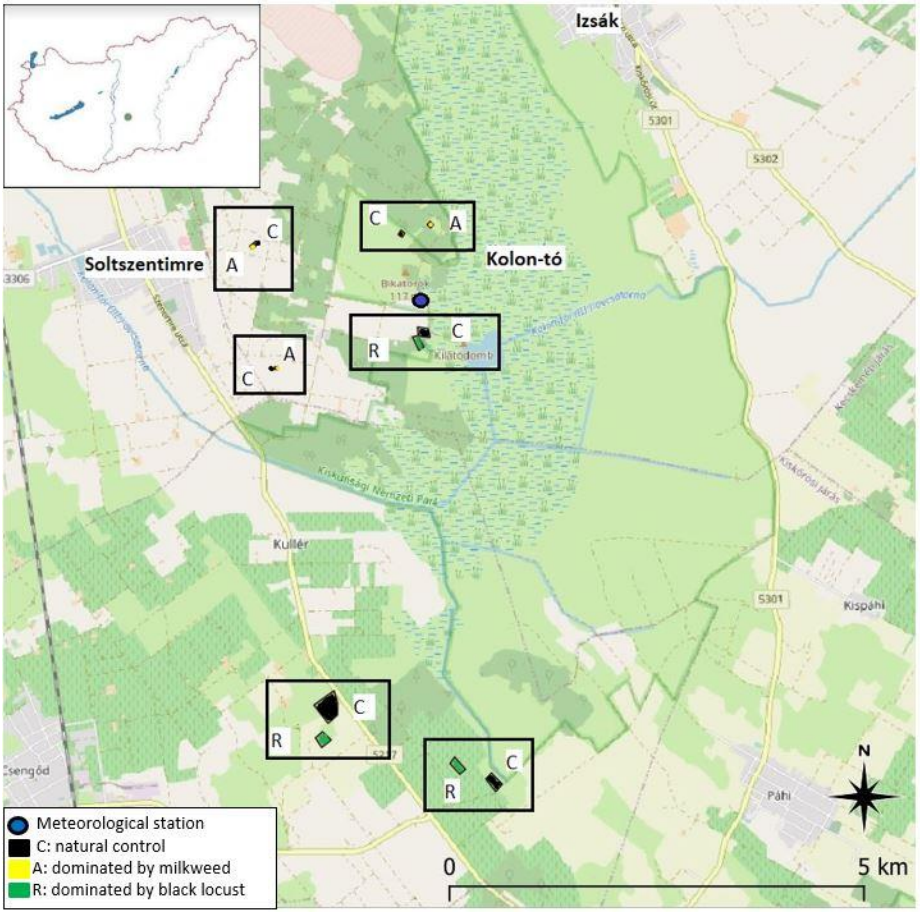

Figure 2: Location of sample areas (source: Open Street Map, own editing).

Botanical surveys were conducted in several aspects (in spring (May) and autumn (September-October)), with two repetitions (2021, 2022). For both species, we surveyed three invasive species-dominated stands and three natural (control) stands. During the vegetation survey, we worked in permanent quadrats. We surveyed five quadrats per stand, which meant a total of 60 quadrats, which were selected at random. The size of the quadrats was 10x10m in forest stands and 2x2m in grassland stands. Within the quadrats, we estimated the percentage cover of flowering plant species; mosses and lichens were not examined in our study. In forest stands, we estimated the percentage cover at three levels (canopy, shrub, grass). Following these investigations, we compiled species lists to map seasonal and interannual cover dynamics. The data were recorded in the field on vegetation data sheets, which were particularly important for subsequent statistical analyses. Finally, the data were entered into Microsoft Excel. Statistical analyses were performed using the statistical software packages PAleontological STatistics (PAST) versions 3.21 and 4.05. In order to compare the areas dominated by the examined beepasture species (black locust, common milkweed) and the natural control areas, the data sets were analysed using multivariate statistical methods. We used Rényi diversity profiles to compare the diversity of plots, seasons, and years. To make sure our results were comparable with other research projects, we also looked at diversity, specifically using the most common Shannon and Simpson diversity indices. To examine the composition and naturalness of the plant communities in greater depth, we used Borhidi's classification of social behaviour types (SBT). Finally, we applied distance-based classical cluster analysis (unweighted pair group method with arithmetic mean (UPGMA)).

As part of our **social science research**, we conducted semi-structured interviews between May and August 2020 with representatives of the four main sectors concerned (nature conservation, beekeeping, forestry, and agriculture) at the national policy level. All of the examined plant species were covered during the interviews (black locust, common milkweed, invasive goldenrods). We conducted a total of 17 interviews with six nature conservation specialists, five forestry experts, three beekeepers and three agricultural specialists. Thirteen interviewees were interviewed in person, while four were interviewed online or by telephone. The interviews lasted an average of 1.5 hours. Notes were taken during each interview, and with the consent of the interviewees, audio recordings were also made. We prepared detailed summaries from the notes taken during the interviews, which served as the basis for qualitative content analysis.

In connection with national level, in February 2022 we held a workshop with researchers from the pollination group at the HUN-REN Ecological Research Centre and relevant experts from the Nature Conservation Department of the Ministry of Agriculture, together with participants in the national policy interviews (except foresters), supplemented by other researchers and beekeepers, on the impact of milkweed and invasive goldenrods. A total of 21 participants took part in the workshop, six of whom represented the nature conservation sector, four the beekeeping sector, two the agricultural sector, and nine were researchers, including us, the organizers. The workshop took place online and lasted approximately 3.5 hours. Notes and audio recordings were made. Based on these, we compiled a detailed summary, which served as the basis for qualitative content analysis.

Subsequently, between March and October 2023, semi-structured interviews were conducted with representatives of the main stakeholder groups (conservationists, beekeepers, foresters, farmers) in the area of Lake Kolon. All of the examined plant species were discussed during the interviews (black locust, common milkweed, invasive goldenrods). A total of 12 interviews were conducted at the local level, with three experts from each sector. The interviews were conducted online or by telephone and lasted an average of 45 minutes. Notes were taken during each interview and in most cases (where permission was granted) audio recordings were also made. We prepared detailed summaries from the notes taken during the interviews, which served as the basis for qualitative content analysis (Table 1). As the interviews were conducted between 2020 and 2023, the results contain information up to that year and do not reflect changes that have occurred since then (e.g., the new Common Agricultural Policy (CAP)).
We compiled the information contained in the interview summaries, which served as the basis for qualitative content analysis by sector, which was very helpful in our further analysis. We structured the summary of the workshop discussion around the most important issues that arose during the discourse. We then carried out a comparative analysis of the interviews and the workshop discussion based on the main topics.

Table 1: Detailed data of the applied qualitative research methods.
Source: own compilation

	National interviews	Workshop	Local interviews
Date/interval	05.-08.2020	25.02.2022.	03.-10.2023.
Location/platform	in person/online, by telephone	online	online/ by telephone

	National interviews	Workshop	Local interviews
Stakeholder groups (person)	nature conservation (6), beekeeping (3), forestry (5), agriculture (3)	nature conservation (6), beekeeping (4), agriculture (2), researcher (9)	nature conservation (3), beekeeping (3), forestry (3), agriculture (3)
Concerned plant species	black locust, milkweed, invasive goldenrods	milkweed, invasive goldenrods	black locust, milkweed, invasive goldenrods
Total number	17	21	12

3. Results

Based on a comparison of Rényi's diversity profiles within the years, it can be said that the diversity of the two studied years shows a similar picture regarding the grass layer of the black locust-dominated and natural control stands. In both study years, the spring control stands, then the autumn control stands showed the highest diversity values. Stands dominated by black locust had higher diversity in spring 2021 and 2022 than stands surveyed in autumn. Overall, 2022 showed higher diversity values in both black locust-dominated and natural control stands (Figure 3).

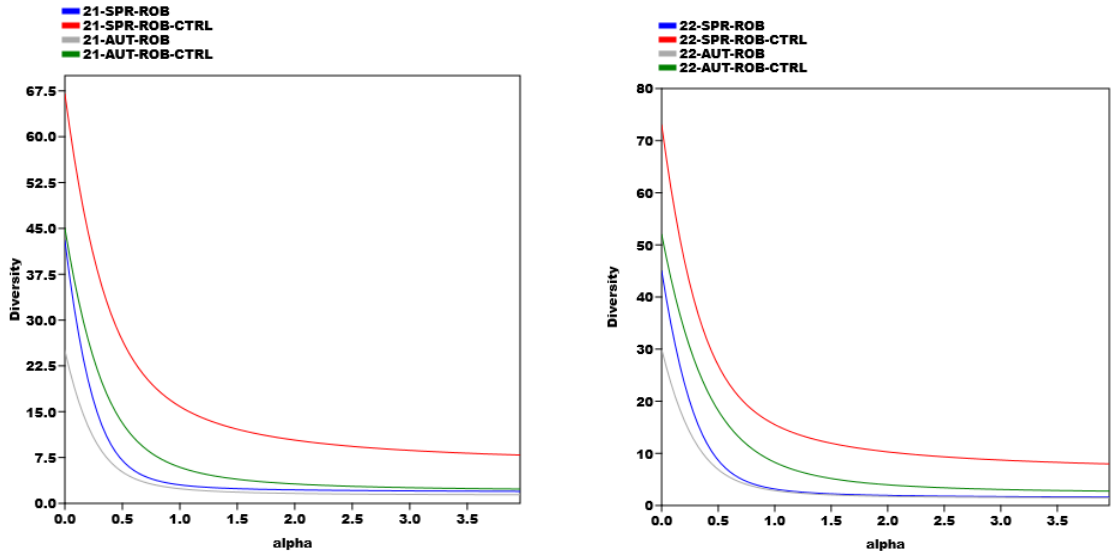

Figure 3: Diversity of grassland levels in the studied years by stock type and seasons, based on Rényi diversity profiles in areas dominated by black locust and in control areas (21-2021, 22-2022, SPR-spring, AUT-autumn, ROB-*Robinia pseudoacacia*, CTRL-natural control).

In the case of Borhidi's social behaviour types, it is clear that in both years, in spring and autumn, the native ruderal competitor (RC) species dominated the grass layer of stands dominated by black locust, with a high proportion of sterile brome (*Bromus sterilis L.*). The proportion of RC species was more than 60% in all cases. In addition, native weed species (W) were also present in higher proportions, such as garden chervil (*Anthriscus cerefolium (L.) Hoffm.*) and cleavers (*Galium aparine L.*). In the case of natural control stands, the picture was more mixed. In both studied years, spring and autumn, generalists (G) were dominant, such as

the wood false-brome (*Brachypodium sylvaticum (Huds.) P.Beauv.*) and the common dogwood (*Cornus sanguinea L.*). Their proportion exceeded 50% in both years in autumn. In addition, disturbance-tolerant plant species (DT) such as European blackberry (*Rubus caesius L.*) and common hop (*Humulus lupulus L.*) were present in greater proportions. In both years, the proportion of native weed species (W) was higher in spring, while in autumn there was a significant presence of non-native, aggressive competitors (AC), especially in 2021, such as common ragweed (*Ambrosia artemisiifolia L.*) (Figure 4).

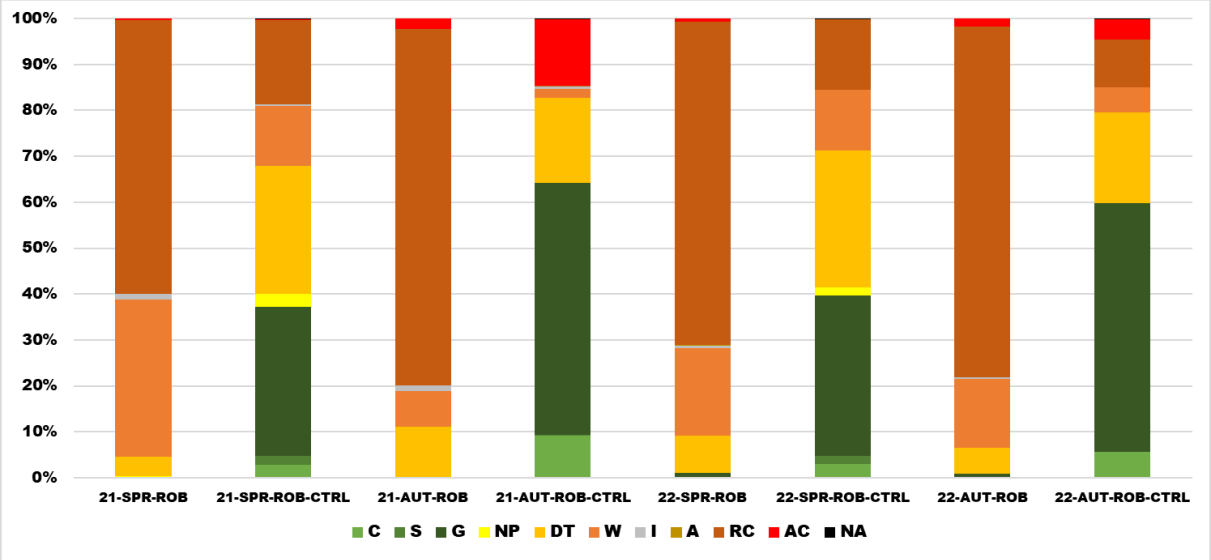

Figure 4: Distribution of social behaviour types in the grass layer of black locust-dominated and control stands (21-2021, 22-2022, SPR-spring, AUT-autumn, ROB-*Robinia pseudoacacia*, CTRL-natural control).

Looking at the comparison of Rényi's diversity profiles within years, it can be said that in 2021, the diversity of the milkweed-dominated stands in spring was greater than the diversity of the spring and autumn vegetation of the control areas. In 2022, we established that the control areas had greater diversity in spring than in autumn. Comparing the areas infected with the invasive milkweed and the control areas, it can be said that the diversity of the milkweed-dominated stands can not be compared based on the Rényi diversity profiles, while in the case of control areas, vegetation diversity was greater in spring of 2021 than in autumn of 2022. Looking at the diversity profiles between recording times, i.e., between seasons, it can be said that in spring, the diversity of the vegetation of the areas infected by milkweed in 2021 was higher than the diversity of both the 2021 and 2022 control areas. From the examination of the data collected in the autumn, it can be concluded that in 2022, the diversity of the areas characterized by invasive species was greater than that of the control area, and that the diversity of the control areas was greater in 2021 than in 2022 (Figure 5).

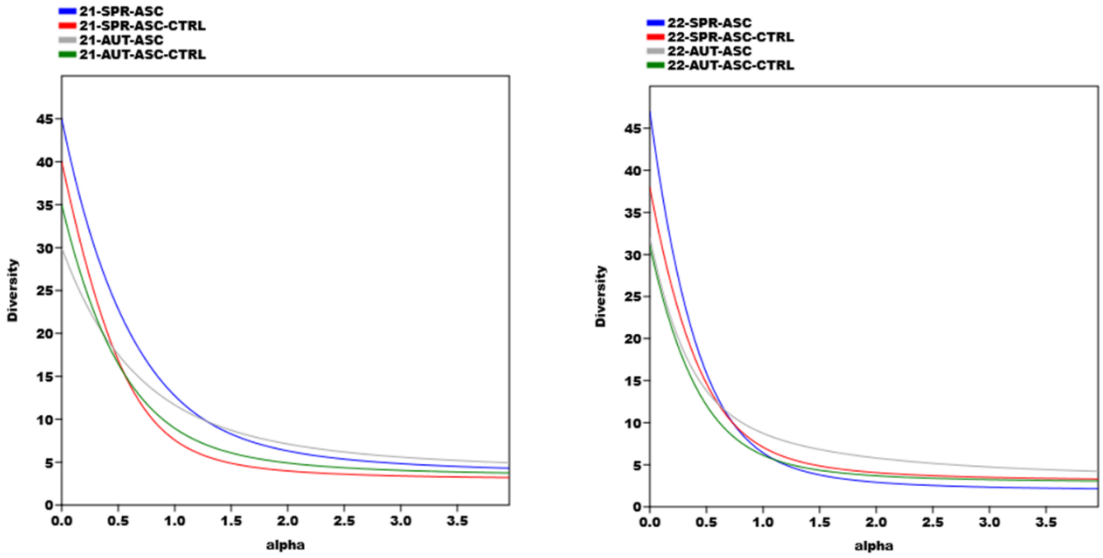

Figure 5: Diversity of the studied years by stock types and seasons, based on Rényi diversity profiles in stands dominated by milkweed and control stands (21-2021, 22-2022, SPR-spring, AUT-autumn, ASC-*Asclepias syriaca*, CTRL-natural control).

In the case of Borhidi's social behaviour types, it is clear that in stands with common milkweed, alien, aggressive competitor (AC) species dominated in both spring and autumn, which is mainly due to milkweed. In this type, natural pioneers (NP) like wild rye (*Secale sylvestre Host*) were still present in significant proportions in spring, while in autumn, specialists (S) like steppe spurge (*Euphorbia seguieriana Neck.*) increased significantly. In natural control stands, specialists (S) like sand feather grass (*Stipa borysthenica Klokov ex Prokudin*) and competitors (C) like Hungarian fescue (*Festuca vaginata Waldst. et Kit. ex Willd.*) were dominant in both years and seasons. The proportion of generalists (G) and natural pioneers (NP), which were even more prevalent in spring, decreased in both autumn periods (Figure 6).

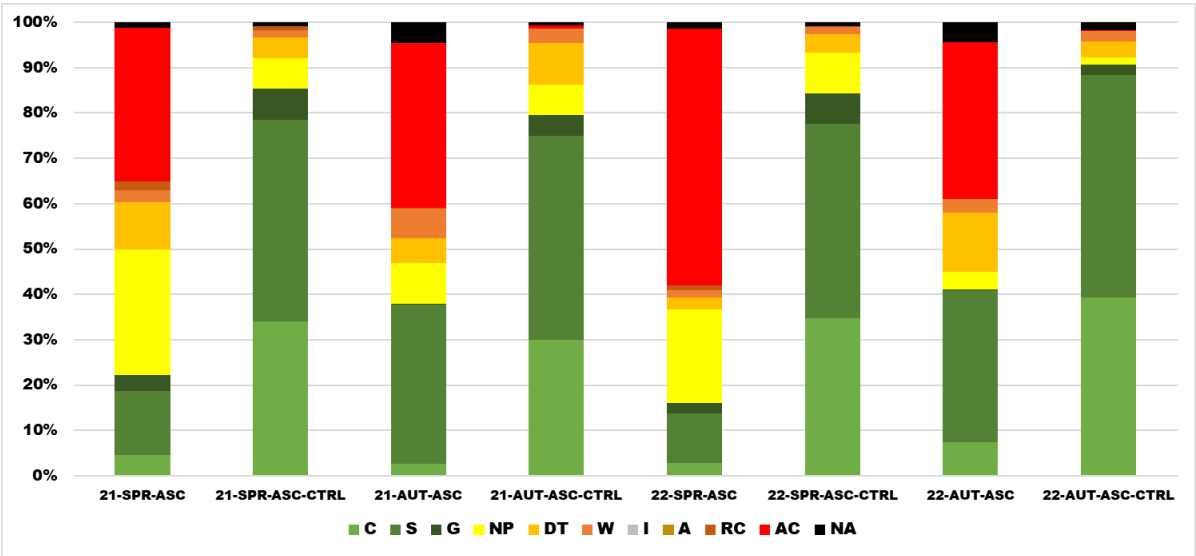

Figure 6: Distribution of social behaviour types in stands dominated by milkweed and control stands (21-2021, 22-2022, SPR-spring, AUT-autumn, ASC-*Asclepias syriaca*, CTRL-natural control).

The sectors concerned were relatively unanimous in their assessment of the spread of black locust, with most perceiving an increase in the species' population. Opinions were more divided

on the examined herbaceous species. Most sectors considered the spread of common milkweed to be increasing or area-specific, with only beekeepers unanimously considering milkweed populations to be declining. Even within the sectors, there was no consensus on the assessment of the spread of invasive goldenrod species (Table 2).

Table 2: Spreading trends of the examined plant species, based on the opinions of the sectors concerned.

Sectors/examined species	Black locust	Common milkweed	Invasive goldenrods (giant and canadian)
Nature conservation	-national, local interviews: increasing	-national, local interviews: increasing, -workshop: spread rate area-specific	-national interviews: increasing -workshop: spread rate area-specific -local interviews: stagnant
Beekeeping	-national interviews: increasing -local interviews: stagnant	- consistently: decreasing	-national interviews, workshop: decreasing -local interviews: decreasing/increasing
Forestry	-national, local interviews: increasing	- no direct involvement	- no direct involvement
Agriculture	-national interviews: stagnant -local interviews: no direct contact	-national, local interviews: increasing -workshop: spread rate area-specific	-national interviews: proportion of abandoned areas is decisive -workshop: spread rate area-specific -local interviews: no direct involvement
Researchers	-	-workshop: spread rate area-specific	- workshop: spread rate area-specific

Due to their differing interests, the sectors concerned typically assess the examined plant species differently. For nature conservationists, black locust is clearly an undesirable invasive species that must be suppressed. In contrast, it is the most important honey producing plant for beekeepers and one of the most important commercial tree species for foresters. Common milkweed is considered an invasive species and weed by nature conservationists and farmers, whose mass presence can cause serious problems for both sectors. However, it is an important honey producing plant for beekeepers, although its significance is declining. Invasive goldenrods are also undesirable plant species for nature conservation and agriculture, but they are important for beekeepers, playing a key role in preparing bees for winter, as this is the last mass flowering bee pasture of the year (Table 3).

Table 3: Attitudes of the sectors concerned towards the examined species.

Sectors/examined species	Black locust	Common milkweed	Invasive goldenrods (giant and canadian)
Nature conservation	-consistently: invasive species (to be controlled)	- consistently: invasive species (to be controlled)	- consistently: invasive species (to be controlled)
Beekeeping	-national, local interviews: most important honey producing plant species	-consistently: good honey producer, but its importance is declining	- consistently: important source of pollen in late summer and autumn
Forestry	-national, local interviews: one of the most important economic tree species	- no direct involvement	- no direct involvement
Agriculture	- no direct involvement	- consistently: weed species, causes problems (e.g. during harvesting)	-national interviews, workshop: weed species -local interviews: no direct involvement

Figure 7 shows that the greatest differences in interests, by all examined plant species, are found between nature conservation and beekeeping. In the case of black locust, the conflict is between nature conservation and forestry, while in the case of milkweed and invasive goldenrods, it is between agriculture and beekeeping.

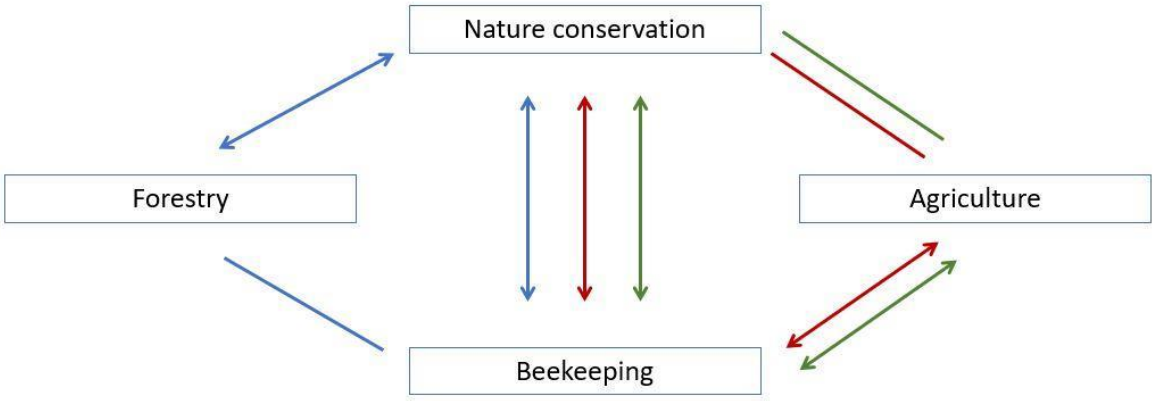

Figure 7: Relationship between the sectors concerned with regard to the examined species. (Legend: blue: black locust, burgundy: milkweed, green: invasive goldenrods, straight line: common interests, two-way arrow: conflicting interests with regard to species population control)

4. Conclusions and recommendations

Conclusions

Natural science research section (C1):

(K1) In the case of black locust, natural control stands proved to be clearly more species-rich in both study years and aspects. We obtained much more nuanced results for common milkweed. In both studied years in spring, stands dominated by milkweed were more species-rich.

(H1) I partially accept the hypothesis because, in the case of milkweed, it was not typically fulfilled, that natural control stands were more species-rich.

(K2) In the case of black locust-dominated and natural control stands, we recorded a total of 180 species in 2021 and 200 species in 2022. In terms of common milkweed, this meant 150 species in 2021 and 148 species in 2022. We recorded a total of 330 plant species in 2021 and 348 plant species in 2022.

(H2) I partially accept the hypothesis because, although the difference is not significant, the number of species was higher in the year (2022) when there was less precipitation during the surveyed vegetation periods (May, September-October). However, an important factor in terms of species numbers may be that in the months preceding the survey (April and August), there was more precipitation in 2022 than in 2021.

(K3) In stands dominated by black locust alien, aggressive competitive species (AC) were strongly dominant in the canopy and shrub layers thanks to the black locust, while in the grass layer, native ruderal competitor species (RC) were dominant in both years, in spring and autumn. In natural control stands, the canopy and shrub layers were dominated by generalists (G) and competitors (C) thanks to native poplar species and Hungarian ash. In terms of grass cover, generalists (G) were dominant in both studied years, in spring and autumn, and disturbance-tolerant plant species (DT) were also present in greater proportions. In milkweed-dominated stands alien aggressive competitor (AC) species were dominant in both years, spring and autumn, which was mainly due to the examined species. In this type, natural pioneers (NP) were still present in significant numbers in spring, while in autumn the proportion of specialists (S) increased noticeably. In natural control stands, specialists (S) and competitors (C) were dominant in both years and seasons.

(H3) I partially accept the hypothesis because, compared to our preliminary statement, other social behaviour types were also represented in higher proportions, such as sand feather grass in the control stands, which belongs to the specialist (S) type.

Social science research section (C2):

(K4) The sectors concerned perceived the spread of black locust as increasing, with a smaller proportion perceiving it as stagnating. In the case of milkweed, beekeepers unanimously considered the species' populations to be declining, while the other sectors concerned considered its spread to be increasing or area-specific. The assessment of the spread trend was most mixed in the case of invasive goldenrod species, with no consensus even within the sectors.

(H4) I accept the hypothesis because the assessment of the spreading trends of the examined plant species typically showed a more mixed picture, especially in the case of invasive goldenrod species.

(K5) The presence of the examined plant species is undesirable for the nature conservation sector. From a beekeeping perspective, the examined species are important, albeit to varying degrees. From a forestry perspective, black locust is one of the most important commercial tree species, while for the agricultural sector, the presence of these species (herbaceous plants) also causes a problem, similar to nature conservation.

(H5) I accept the hypothesis because the assessment of the examined invasive beepasture species was divisive among the sectors concerned due to differences in interests.

(K6) The current legal and subsidy system helps to control the invasive beepasture species in most cases. However, there are cases where the relevant legislation/subsidy may have an indirect but detrimental effect. Examples include the designation of black locust as a Hungaricum, or the support for afforestation within the Rural Development Program, where forest planting and the creation of industrial tree plantations can also be carried out with black locust.

(H6) I accept this hypothesis because, overall, the current legal and subsidy system tends to help control invasive plant species (including the examined species).

(K7) Based on interviews and workshop discussions, beekeepers are open to replacing certain invasive beepasture species, provided that these are not among the most important honey producing plants (e.g. black locust).

(H7) I accept this hypothesis because, with the exception of the most important invasive honey producing plants (e.g. black locust), beekeepers have shown openness to the idea of replacing invasive beepasture species.

(K8) Representatives of the sectors concerned reported several cases of conflict regarding invasive plant species (including beepasture species) and other issues (e.g., placement of hives).

(H8) I accept this hypothesis because representatives of the sectors reported several conflicts arising from differences in interests with regard to the examined plant species.

(K9) In many cases, there is no targeted, continuous communication between representatives of the sectors. In some cases, regular contact has been reported, e.g., between the Kiskunság National Park Directorate and foresters regarding protected areas, and between beekeepers and foresters regarding black locust flowering.

(H9) I partially accept this hypothesis because, although in many cases there is no targeted, continuous contact between the main stakeholders, there are projects, for example, where consultation is currently frequent.

Recommendations

Several projects have previously been carried out in the area of Lake Kolon to eradicate invasive species, affecting the examined black locust, common milkweed and invasive goldenrods. Thanks to these treatments, the populations of invasive species were significantly reduced, but in the absence of follow-up, they have begun to grow again in recent years, especially black locust and milkweed, as we have also observed during our botanical surveys.

- Consequently, it would be worthwhile to monitor the areas even after the management projects have been completed and, if necessary, carry out periodic treatments to prevent the populations of these species from rebounding.
- In addition, it would be particularly important to explore the spreading routes of invasive species, prepare updated distribution maps, and take regional differences into account during treatments.

• It would also be useful to know the total area covered by certain invasive plant species (including beepasture species) in Hungary. Due to its economic importance, this information is available for black locust, but not for the examined herbaceous species (milkweed, invasive goldenrods).
• Furthermore, it would be necessary to inform the public (including in the area of Lake Kolon) about the eradication and prevention of invasive plant species (including beepasture species) through leaflets, online platforms, or even forums.
• Knowledge of the quantity and diversity of honey producing species found in a given area would provide important information about potential pollen sources, which could be obtained by analysing pollen samples collected.
• In the case of bee products, it would be important to indicate on the jar that they are natural and native (e.g., natural, mixed flower honey from diverse grasslands), and it is also crucial to educate consumers. Honey from diverse grasslands is better for both bees and humans.
• In place of arable land threatened by erosion and deflation, it would be more appropriate to plant grasslands and/or perennial bee pasture crops, which would pose a much lower risk in this regard.
• It would be particularly important to sow seed mixtures and species that flower during the dormant period, e.g. between mid-June and the end of July (after black locust and before sunflowers), as ensuring continuous flowering is crucial for bees. Field-protecting forest strips and bushes (e.g. privet, wild rose, hazel) are sorely lacking for beekeepers, so it is worth leaving them and not clearing.
• The subsidy system definitely needs to be changed so that it is not worth destroying the environment. This should be regulated within the CAP, and an appropriate subsidy framework should be provided for this, which would also encourage farmers in the Kolon Lake area e.g. to be open to subsidies related to bee pastures.

5. New scientific results

1. The novelty of our research lies in the fact that we applied both natural science and social science methods, which complemented each other well. We first conducted a botanical survey in the area of Lake Kolon in stands dominated by black locust and common milkweed and natural control stands located close to them. At the national and local (in the area of Lake Kolon) levels we mapped the opinions of the most important sectors concerned: nature conservation experts, beekeepers, foresters, and farmers, related to four invasive beepasture species (black locust, common milkweed, tall goldenrod and Canadian goldenrod), through interviews and workshop discussions.

2. We found that the mass presence of black locust around Lake Kolon has a much greater impact on the plant community at the grass level than milkweed. In the case of black locust, natural control stands were clearly more species-rich in both studied years and seasons (spring and autumn). In contrast, in the case of common milkweed, stands degraded by invasive species were more species-rich in both studied years in spring.

3. We found that natural pioneers (NP) were most tolerant of the allelopathic effect of milkweed in the area of Lake Kolon. In general, specialists (S) have a much harder time in a milkweed-dominated stand, but since these stands are more open and have already been treated in a previous project, and since the coverage ratio of milkweed is much lower than the black locust, these species were also able to appear in large numbers in the area.

4. We found that in the grassland sample areas around Lake Kolon, specialists (S) and competitors (C) dominated the natural control populations in both years and seasons. Based on this, we concluded that the control stands truly reflect natural, good grassland conditions. This is demonstrated by the higher proportion of specialists (S), including sand feather grass, which is particularly sensitive to the presence of milkweed.

5. We found that the sectors concerned (nature conservationists, beekeepers, foresters, farmers) were much more unanimous in their statements about the spread of black locust than about the examined herbaceous species. The sectors concerned perceived the spread of black locust as increasing, with a smaller proportion perceiving it as stagnating. In the case of milkweed, beekeepers unanimously considered the species' populations to be declining, while representatives of the other sectors concerned considered its spread to be increasing or area-specific. Opinions were very mixed in the case of invasive goldenrod species.

6. We have concluded that the current legal and subsidy system helps to control the examined invasive beepasture species in most cases. These include, for example, the provisions of Act LIII of 1996 on the protection of nature concerning the eradication of invasive species, or the LIFE and KEOP projects concerned with invasions. However, there are cases where the relevant legislation or subsidy may have an indirect detrimental effect. Examples include the designation of black locust as a Hungaricum, or the support for afforestation within the Rural Development Program, where black locust can also be used for forest planting and the creation of industrial tree plantations.

7. Based on interviews and workshop discussions, it was shown that beekeepers consider certain species, such as field scabious, phacelia, certain legumes, and certain medicinal plants, to be suitable for replacing certain invasive beepasture species, while others (e.g., viper's bugloss, daffodil) should be avoided. Beekeepers pointed out that when selecting replacement species, it is worth considering several factors from both a human and bee health perspective.

6. Relevant publications

Meinhardt S (2019): Egyes méhlegelő növények vizsgálata méhészeti érték és természetvédelmi helyzet, valamint konfliktusok alapján. Tájökológiai Lapok (Journal of Landscape Ecology) 17(1):16-22., Q4 https://doi.org/10.56617/tl.3451

Demeter A, Saláta D, Tormáné Kovács E, Szirmai O, Trenyik P, **Meinhardt S**, Rusvai K, Verbényiné Neumann K, Schermann B, Szegleti Zs, Czóbel Sz (2021): Effects of the Invasive Tree Species Ailanthus altissima on the Floral Diversity and Soil Properties in the Pannonian Region. Land 10(11), 1155; Q2 https://doi.org/10.3390/land10111155

Meinhardt S, Czóbel Sz, Kovács-Hostyánszki A, Szigeti V, Tormáné Kovács E (2022): Egyes mézelő idegenhonos özönfajok értékelése ágazati interjúk alapján. Tájökológiai Lapok (Journal of Landscape Ecology) 20(2):23-39., Q3 https://doi.org/10.56617/tl.3447

Meinhardt S, Saláta D, Tormáné Kovács E, Ábrám Ö, Morvai E, Szirmai O, Czóbel Sz (2024): The Multifaceted Botanical Impact of the Invasive Common Milkweed (*Asclepias syriaca L.*) in a Protected Sandy Grassland in Central Europe. Land 13(10), 1594; Q1 https://doi.org/10.3390/land13101594

Meinhardt S, Czóbel Sz, Ábrám Ö, Morvai E, Tormáné Kovács E (2024): Perception of local stakeholder groups about certain invasive alien bee pasture species around Lake Kolon. Tájökológiai Lapok, Journal of Landscape Ecology 22(2): 67–84., Q4 https://doi.org/10.56617/tl.6537