INCIDENCE OF INVASIVE PLANT SPECIES IN PROTECTED AREAS IN NORTH-WESTERN ROMANIA

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Abstract: Biodiversity has become a priority in modern times. Over the past two centuries, the explosive development of human economy has led to the occupation of formerly natural areas for economic infrastructure or residential purposes. These replacements have resulted in the transformation of natural habitats into anthropized ones, disrupting the balance between species. Moreover, human activities have facilitated the migration of species from one continent to another, and the introduction of alien species to habitats different from their origin often has a significant impact on local biodiversity. This study aimed to investigate the incidence of alien species in three types of forest habitats (91E0*, 92A0 - riparian woods, and 9110 - beech forests) and three types of grassland habitats (6430 - *Hydrophilous* tall herb fringe communities of plain and of the montane to alpine, 6510 - lowland hay meadows, and R3803 - hillside hay meadows) within a set of protected natural areas in North-Western Romania (Central Europe). Out of the 23 species identified in habitats of community interest within the protected areas, 5 species are common to all of them. Among all the analysed habitat types, 91E0* riparian woods are the most affected due to human pressures, such as agricultural fragmentation, weakening of their structure, and the presence of road networks in their immediate vicinity. Beech forests, even though they have been mostly managed without considering their inclusion in Natura 2000 sites, show resistance to the spread of invasive alien species (IAS) due to their cohesive cenotic structure. For herbaceous vegetation, the pattern of IAS behaviour is similar - the most numerous and widespread IAS are found in narrow and ecotonal wet grasslands, while in well-connected, stable, and sustainably managed meadows, the incidence of IAS is minimal.

Key words: protected natural areas; habitats; invasive species; fragmentation; cenotic structure.

INTRODUCTION

A major environmental concern in the Anthropocene is posed by invasive species, whose spread is amplified by both direct and indirect human activities [4, 17, 29, 34, 55, 57, 73], climate change [52], and their abilities to outcompete native species. The study of invasive species has become the subject of numerous works [28, 38, 43, 48, 65] as unaffected areas become increasingly restricted [38, 49]. Moreover, the number of alien species at the global level is expected to increase by 36% in the next three decades [15, 63].

Invasive species have multiple and major impacts on the environment, with significant consequences for protected natural areas. They generate economic impacts, resulting in enormous expenses for prediction, prevention, monitoring, and population control, as well as replacing and reducing plant species of economic value [15]. Invasive plant species are competitors that reduce and eliminate native species, significantly contributing to biodiversity reduction and the structural deterioration of phytocenoses and ecosystems. They also have a major impact on production and protection functions, reducing the full range of ecosystem services [13, 19, 30, 54, 74].

Regardless of their competitive strategy through propagules, high stress tolerance, or association with ruderal conditions [7, 24, 26, 27, 51, 58,], their entry into native communities can disrupt pollinator visitation rates and seed production [8, 9]; create shaded habitats unfavourable for pollinators [45]; exacerbate allelopathic phenomena in ecosystems; disrupt mutualistic relationships; and decrease native plant growth rates [69]. In many situations, invasive plant species interfere with nutrient cycling through modifications of litter quality or root exudates [10, 16, 21, 41] or can affect the timing and intensity of natural fires [10, 16]. Due to their high competitiveness, resulting from rapid propagation and allelopathic activity, invasive species affect the structural components of plant communities [64], with repercussions on the behaviour of herbivores that may overexploit native species, leading to their extinction [61]. They can also disrupt predation [5], modify the availability of resources within the food web [25, 38, 75], as well as genetic flows, natural cycle components [33], and ecological regimes [22, 60]. Established Invasive Alien Species (IAS) continue to spread, potentiated by climate changes that alter species distribution and may exacerbate the impact of invasive species [31, 35, 48]. From an economic perspective, the efforts to reduce invasion and the abundance of IAS consume millions of euros [32, 73, 74] and the effectiveness of adopted measures is rarely reported in scientific studies [47, 74]. Due to rapid global changes and environmental degradation, protected areas (PAs), including those within the Natura 2000 network, play a crucial role in conserving biodiversity and ecosystem functions [3, 6, 14, 50, 60, 73] Although specific measures for the direct conservation of species and habitats are designated within natural areas, coexistence with human factors leads to the perpetuation of factors such as habitat disturbance, climate change, and an increasing diversity, frequency, and intensity of anthropogenic vectors associated with the globalization of commercial and transport networks [11, 46, 62, 71, 72], resulting in the infiltration of new IAS and their expansion. Among all taxa analysed in terms of invasive potential by various studies, IAS represent the greatest ongoing threat, and their number has increased in 31% of protected areas [60]. The presence and spread of IAS in protected areas are not without consequences; in many cases, these species gradually compromise the conservation objectives of the respective PAs.

Any sets of management measures, whether preventive or promoting biological control, adopted in the long term or ad hoc, must be based on improved monitoring and data collection [60]. Starting from the understanding of the dramatic effects caused by invasive species, as well as from monitoring and comprehending threats to biodiversity, it is essential to adopt effective legislative measures and policies to guide management strategies [44].

Even though these premises are known, long-term monitoring is lacking in many of the protected areas. Currently, there is an urgent need of rigorous evaluations to analyse trends, successes, failures and to guide management efforts in the future. Although Romania harbours high biodiversity (3829 taxa of vascular plants and 979 non-vascular plants, of which 1453 species are vulnerable) [2] and 19.29% of its territory is included in the network of protected natural areas [36], this study represents one of the first attempts to assess and monitor invasive plant species in protected areas in north-western Romania. Literature data indicate the presence of 102 species in Romania that are susceptible to be categorized as IAS [68]. Tracking invasive species is a useful endeavour as it can draw attention to IAS in very early stages of invasion, when early detection and rapid response efforts often have the highest success [1, 35, 56].

MATERIAL AND METHODS

a) Site Description

Part of Central Europe, Romania currently holds significant reserves of species and habitats of community interest, managed through the Natura 2000 network. To adopt effective measures for biodiversity resource management in north-western Romania, data were collected from four Natura 2000 sites of community importance: ROSCI and ROSPA Upper Tisa, ROSCI Pricop-Huta-Certeze, and ROSCI and ROSPA Câmpia Careiului, Câmpia Ierului, along with a regionally protected natural area called Pădurea Ronişoara (Fig. 1).

The two types of protection, ROSCI and ROSPA, overlap on the same territory in Upper Tisa (Fig. 1, a). ROSCI is designated for the protection of fish, amphibians, reptiles, mammals, and riparian woodland habitats, while ROSPA is designated for the protection of 49 bird species [79]. The territory stretches along the northern border with Ukraine, following the course of the Tisa River. Despite being biodiversity protection areas, the territory is heavily impacted by human activities, bordered for most of its length by National Road DN 18, which passes through 9 localities, including one municipality, Sighetu Marmației. Natural

Figure 1. Study area location in NW Romania and survey site locations – Protected Areas map

habitats are interspersed with settlements, agricultural lands, road infrastructure, and other human activities. Consequently, the habitats of community interest, namely the 91E0 and 92A0 riparian forests, are currently fragmented woodlands, with limited areas, deficient structure, and extensively invaded by IAS, as will be further discussed.

Pădurea Ronişoara is a regionally protected natural area covering 62 ha, consisting of an old-growth forest with a special ecotype of *Quercus petraea*. The arboretum, preserved as a germplasm reserve, is part of a larger region covered by beech and mixed beech and fir forests, managed over the past century using CWS (Continuous Wood Supply) management. This type of management involves cutting almost all the trees on a short rotation period, except for a small number of uncut trees known as "standards" [8, 12, 77].

ROSCI Pricop-Huta-Certeze (Fig. 1, b) is a protected natural area on the north-western border of Romania, spans 3168 ha and includes forest habitats of beech and hornbeam (habitats 9130, 9170, 91V0), populations of amphibians, bats, and large mammals such *as Ursus arctos, Lynx lynx* and *Canis lupus*, for which it provides passage corridors and connections to less anthropized areas. The localities within the site are few, and anthropogenic impact is moderate. The forests have been managed using CWS, reflected in their current structure.

ROSCI 0020 Câmpia Careiului (Fig. 1, c) covers an area of 23,641 hectares on the western border of Romania and includes a zone predominantly covered by sand dunes of aeolian origin, as well as interdunes with streams of low and fluctuating flows, drainage channels, and marshy areas. It comprises a mosaic of habitats, including marsh formations, water-adjacent formations, swamps, wet grasslands, meadows, and forests (habitats 2190, 2340, 3260, 3270, 6120, 6410, 6430, 6440, 6510, 91F0, 91I0, 92A0). As for species, it hosts plants - *Adenophora lilifolia, Aldrovanda vesiculosa, Angelica palustris, Cirsium brachycephalum, Eleocharis carniolica, Iris aphyla susp. hungarica, Iris humilis susp. arenaria, Pulsatilla pratensis susp. hungarica, Marsilea quadrifolia;* amphibians - *Bombina bombina, Triturus cristatus, Triturus dobrogicus;* reptiles – *Emys orbicularis*; invertebrates - *Cerambyx cerdo, Euphydryas maturna, Lucanus cervus, Lycaena dispar, Maculinea teleius, Odontopodisima rubripes*; fish - *Misgurnus fosilis, Rhodeus amarus, Umbra krameria*; and mammals - *Spermophylus citellus*. The site is subject to high anthropogenic pressures, including agricultural practices, historical deforestation, road infrastructure, and urbanization [70].

ROSCI 0021 Câmpia Ierului (Fig. 1d) is located in north-western Romania, covering 21224.6 ha of relatively flat terrain. The site's biodiversity includes species of plants - *Aldrovanda vesiculosa, Eleocharis carniolica, Cirsium brachycephalum, Marsilea quadrifolia*; amphibians - *Bombina bombina, Bombina variegata, Triturus cristatus, Triturus dobrogicus*; reptiles – *Emys orbicularis,* invertebrates - *Anisus vorticulus*, *Euphydryas maturna, Lycaena dispar, Maculinea teleius, Euplagia quadripunctata, Leptidea morsei*; fish - *Misgurnus fosilis, Rhodeus amarus, Umbra krameri, Romanogobio vladykovi*; and mammals - *Lutra lutra, Spermophylus citellus*. The site includes habitats of community interest - 1530, 3130, 3150, 3260, 3270, 40A0, 6430, 91F0, 91I0, 92A0. The pressures faced by the site are related to grazing, crop cultivation, human impact, as well as IAS. The site is connected to ROSCI 0020 Câmpia Careiului, and for the purposes of the present study both areas were approached as a single territory [79].

b) Data collection and analysis

The data regarding the presence and quantitative evaluation of invasive plant species were collected as a derivative activity from the mapping/monitoring of habitats of community interest in the reference sites. Data collection occurred during the vegetation seasons of 2020 and 2021. Each vegetation sample, based on the analysis of characteristic species and vegetation structure, was classified into a specific habitat type [18, 23]. Within 117 sample areas recorded with geographic coordinates distributed across 20 vegetation transects, the presence of invasive plant species was noted (Table 1, Fig. 1). The invasive species were analysed based on the occupied habitat, the Abundance-Dominance Index (Braun-Blanquet), as well as their constancy within each analysed habitat type.

To highlight the vulnerability of habitat types to the penetration and numerical growth of invasive plant populations, the average coverage was calculated. Furthermore, for habitat multivariate analysis, classical clustering was conducted where habitats were simultaneously compared concerning the presence of invasive plant species, as well as the minimum and maximum coverage values. The analyses and graphs were generated using the software Past. Maps were generated using QGIS.

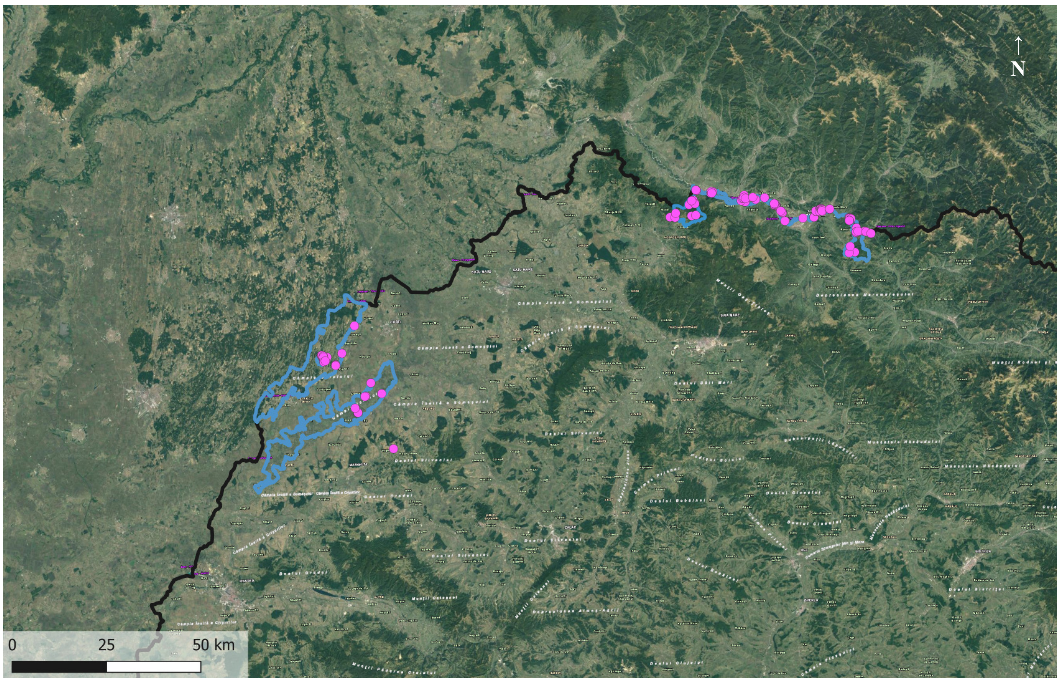

Figure 2. Sample areas with IAS (Protected areas maps in blue). The coloured dots correspond to the investigated zones.

Table 1. Distribution of points where invasive plants were identified

Sites	Transects	Nr. of points with IAS species and location	Total
ROSCI and ROSPA Upper Tisa	5	10 - Piatra: riparian forest, weedy areas and meadows 14 - Săpânța: riparian forest and weedy areas 15 - Sarasău: riparian forest 21 - Sighet/Bocicoi: riparian and forest weedy areas 10 - Lunca la Tisa - riparian forest and weedy areas	70
Pădurea Ronișoara	4	4 - Valea Vișeului: forest, weedy areas and grasslands 9 - Rona de Sus: 9110 beech forests 3 - Coștiui: 9110 beech forests 0 - Pădurea Ronișoara *Qercus petraea* reserve	16
ROSCI Pricop-Huta-Certeze	4	4 - Piatra: 9110 beech forests 1 - 9110 beech forests 2 - 9110 beech forests 3 - Moișeni: beech forests and weedy areas	10
ROSCI Câmpia Careiului and ROSCI Câmpia Ierului	7	4 - Scărișoara: sand dunes and weedy areas 4 - Resighea: weedy areas and meadows 1 - Sanislău: weedy areas and meadows 1 - Foieni: weedy areas and sand dunes 6 - Pir: weedy areas and meadows 4 - Dindești: weedy areas and meadows 1 - Păgaia: riparian forests	21

RESULTS

A total of 23 eterogeneously distributed species of IAS were identified in the studied habitats of riparian woodlands, beech forests, grasslands, and meadows within the Natura 2000 sites in north-western Romania (Table 2).

According to previous studies, the number of allochthonous plant species present in sites is much higher [2, 37, 66, 67, 68, 70], but the present research has only recorded the species identified on designated transects for monitoring habitats of community interest. Without being an exhaustive study, assessments regarding the presence and proportion of invasive plant species provide an image of the degree of deterioration of the main habitat types in the reference protected areas. The analysed territory, despite being under protective measures, is vulnerable to the expansion of allochthonous plant species. These species are not only spreading in anthropized habitats but also in conservation-interest habitats.

Among the analysed species, 5 were present in all the analysed territories, with some, the majority, including *Ambrosia artemisiifolia, Robinia pseudoacacia, Erigeron annuus, Xanthium orientale subsp.italicum,* and *Galinsoga parviflora*.

The distribution of invasive species within the analysed samples highlight that in 70.68% of the relevés occupied by IAS only one invasive species is present, in 15.38% two invasive species coexist, and in 23.93%, minimum three species are present. The co-occurrence of multiple species amplifies the quantitative impact and increases the number of detrimental effects on the habitats compared to the

Table 2. The presence of invasive plant species in each of the studied Protected Areas.

Species/site	ROSCI and ROSPA Upper Tisa	Ronișoara Forest	ROSCI Pricop-Huta-Certeze	ROSCI Câmpia Careiului and ROSCI Câmpia Ierului
Reynoutria species: (R.japonica & R.xbohemica)	X	X	X	-
Erigeron annuus	X	X	X	X
Ambrosia artemisiifolia	X	X	X	X
Robinia pseudoacacia	X	X	X	X
Impatiens parviflora	X	X	X	-
Helianthus tuberosus	X	X	-	-
Galinsoga parviflora	X	X	X	X
Medicago sativa	X	-	-	X
Solidago canadensis	X	X	-	X
Heracleum mantegazzianum	X	-	-	-
Xanthium orientale subsp. italicum	X	X	X	X
Sisyrinchium montanum	X	X (6430 Habitat)	-	-
Acer negundo	X	-	-	-
Parthenocissus quinquefolia	X	-	-	-
Erigeron canadensis	X	-	-	X
Echinocystis lobata	X	-	-	X
Asclepias syriaca	X	-	-	X
Impatiens glandulifera	X	-	-	-
Datura stramonium	-	-	-	X
Amaranthus retroflexus	X	-	-	X
Prunus serotina	X	-	-	X
Quercus rubra	-	-	-	X
Total	**21**	**11**	**8**	**14**

Table 3. Distribution of the number of invasive species in relation to the analysed habitats

Site	Habitat	No. of IAS/relevé	No. of relevés
Upper Tisa	91E0	1 species	13
		2 species	10
		Minimum 3 species	14
		Total/habitat	37
Upper Tisa	92A0	1 species	4
		2 species	0
		Minimum 3 species	2
		Total/habitat	6
Ronișoara & Pricop-Huta-Certeze	9110	1 species	6 (4 & 2)
		2 species	2 (Pricop-Huta-Certeze)
		Total/habitat	8
Ronișoara & Câmpia Careiului	6430	1 species	27 (16 & 11)
		2 species	2
		Minimum 3 species	6 (2 & 4)
		Total/habitat	35
Upper Tisa & Câmpia Ierului	6510	1 species	17 (4 & 13)
		2 species	3 (2 & 1)
		Minimum 3 species	5 (3 & 2)
		Total/habitat	25
Upper Tisa & Ronișoara	R3803	1 species	4
		2 species	1
		Minimum 3 species	1
		Total/habitat	6
		Total	**117**

mere sum of the results generated by individual species [21, 38, 40, 53, 74, 76, 78]. The most vulnerable habitats (due to anthropogenic pressures) are riparian woodlands, with 31.62% of the identified IAS points belonging to this habitat type. The 6430 habitat comes in second place.

Among the three types of forest habitats (91E0 riparian woodlands, 92A0 riparian woodlands and 9110 beech forests), the most heavily invaded are the riparian woodlands composed of black alder and willows.

Species such as *Reynoutria japonica* and *R. x bohemica* (which form dense clusters, especially in sparse groves, or replace them entirely), *Helianthus tuberosus*, *Solidago canadensis*, and *Acer negundo* are encountered in the majority of monitored habitats (Fig. 3).

These species are widespread and favoured by habitat fragmentation, deforestation, and intense agricultural activities on neighbouring agricultural plots. The mentioned species also record the highest quantitative values in the analysed samples, which negatively impacts the floristic diversity of habitats. In the sampled areas where invasive species, particularly those mentioned as "aggressive," have been identified, the floral composition of the woodlands is reduced by 30 to 50% compared to the characteristic composition of habitats typical of the geographical region [18, 23].

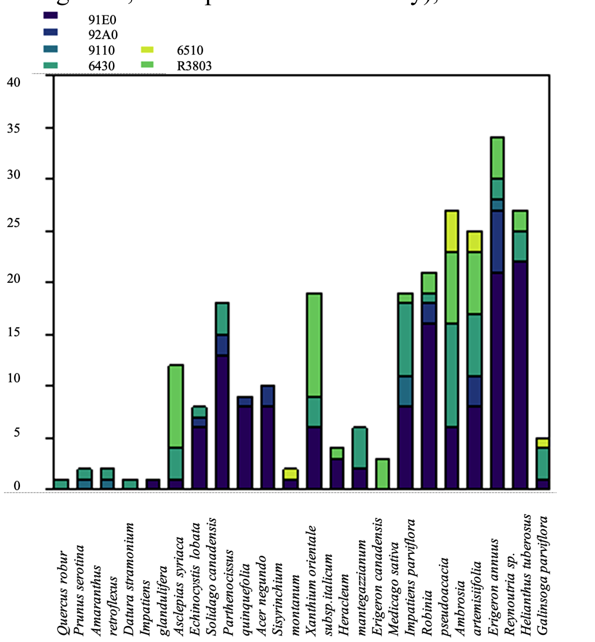

Figure 3. Presence of invasive plant species in monitored habitat types

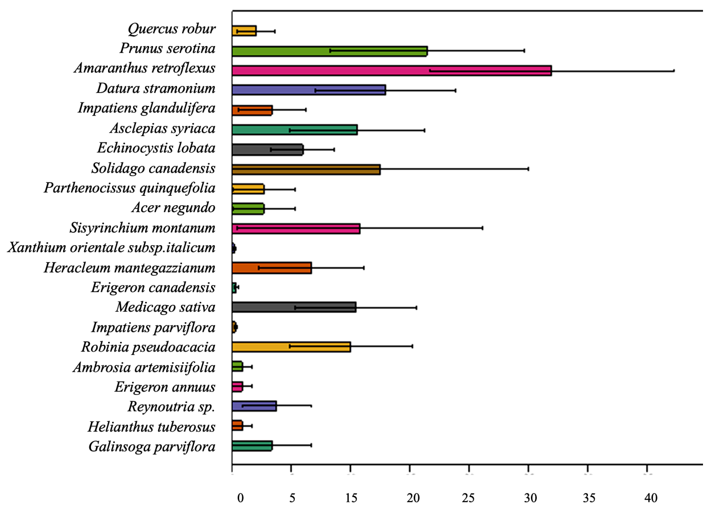

Figure 4. ADm (%) of invasive plant species in samples from monitored habitats

DISCUSSION

In the protected natural area Pădurea Ronișoara, as well as in the Natura 2000 site Pricop-Huta-Certeze, beech forests are the most well-represented habitats. Despite maintaining floristic composition and structure traits derived from past logging activities, with clear-cutting parcels about 20-30 years ago, invasive species have a weak presence in these woodlands. In the 9110 beech forests of these two protected areas, only 8 points with the presence of IAS have been identified, mainly located at the forest edge. *Impatiens parviflora* is the most prevalent, alongside *Robinia pseudoacacia,* growing in isolated patches along the DN18 road due to the removal of native trees that bordered the road. Although in the past, both the Ronișoara forest and the forests within the Natura 2000 site Pricop-Huta-Certeze have been subjected to high pressures, in recent decades, since they have been under protective regimes, they have contributed to a gradual return of favourable conservation status characteristics. The reduced level of human impact on these habitats, especially the absence of repeated annual interventions, preserves the cenotic structure and slows down the spread of alien species. No points with invasive plant species were identified within the *Quercus petraea* woodland. Researchers and forest management authorities should take into consideration the observation that after woodland restoration, progressive improvement in structure, increased maturity level of trees, and low invasion levels of alien species are correlated with a high degree of ecosystem multifunctionality conservation [8]. The degree of invasion can be considered one of the more easily observable indicators of the conservation status of forests.

The 6430 *Hydrophilous tall herb fringe communities of plain and of the montane to alpine levels*, located at the edge of the forests, borders forest roads or other access paths in the sites. These patches of vegetation are highly dependent on repeated human interventions, such as road edge clearings or soil disturbances, in certain points, for their dynamics. All these factors lead to increased vulnerability to the presence of IAS. In the points where alien species have been reported, the native vegetation is practically replaced by populations of a single species - 27 out of the 35 samples are populated by a single species: *Erigeron annuus, Impatiens parviflora, Ambrosia artemisiifolia*, or others, with AD (Abundance-Dominance index) ranging from 1 to 80%. In the mountainous sites such as Tisa Superioară and Pădurea Ronișoara, the herbaceous vegetation is dominated by *Erigeron annuus* and *Impatiens parviflora*, while in Câmpia Careiului and Câmpia Nirului, *Ambrosia artemisiifolia* is the most widespread species. Literature sources emphasize that the distribution of *Ambrosia artemisiifolia* has a wide altitudinal range [68].

A number of 13 species considered potentially invasive have been recorded in the herbaceous communities belonging to the 6510 habitat. *Xanthium orientale subsp. italicum* is present in 10 points belonging to this habitat type, with coverages ranging from 1% to 30% in the Tisa Superioară site, while in Câmpia Ierului, it can reach AD indices of 5 (on the Braun-Blanquet scale)(Fig.4). *Asclepias syriaca* is recording increasing coverage and is considered an extremely invasive species [67, 68].

The R3803-type grasslands (coded according to the Romanian classification system [21], as they are characteristic habitats of the Carpathian-Getic region) are present on the hillsides in the Ronișoara and Pricop-Huta-Certeze areas. They are weakly invaded by IAS, most likely due to their intensive use as hay meadows. Only five such species have been identified, present in 9 points, located towards the ecotone area, along agricultural roads. These species are *Robinia pseudoacacia, Erigeron annuus, Sisyrinchium montanum,* and *Galinsoga parviflora*.

Heracleum mantegazzianum is a relatively new presence in northwestern Romania. Previous studies at the national level cited fewer than 10 recorded points [67], and for northwestern Romania, we consider these to be the first records.

Field observations, especially in the Upper Tisa Protected Area showed that the most "aggressive" species towards native species are those that achieve high coverages: *Reynoutria x bohemica and R. japonica, Solidago canadensis, Acer negundo,* and *Robinia pseudoacacia*. These same species were previously described as being higly aggressive in literature [2, 37, 66, 67, 68, 70]. Most of these highly invasive species are large-sized and form dense clusters that inhibit and smother native species, deteriorating the structural integrity of habitats.

The analysis of the number of presence points and the minimum and maximum coverages of each of the species analysed in the reference sites highlights three behavioural groups of species:

High aggression group: *Reynoutria sp., Solidago, Ambrosia, Robinia,* and *Helianthus tuberosus*, along with *Medicago sativa*. *Medicago sativa* (alfalfa) was used by humans in an attempt to prevent the spread of the other species in this group on deforested areas. Alfalfa is expanding on the one hand being cultivated in a strategic attempt by humans to reclaim lost lands to invasive species, but on the other hand, it is escaping control and becoming invasive itself.

Medium aggression group: *Xanthium italicum, Erigeron annuus, Impatiens parviflora, Galinsoga parviflora, Heracleum manteganzzianum, Acer negundo,* and *Erigeron canadensis*. These species are either small sized with high incidence but low coverage, successfully fitting into the habitat, or they have punctiform presences but with a high risk of spreading. The latter being the case of *Heracleum mantegazzianum*, which is sparsely recorded on Romanian territory.

Thirdly, there is a group of species that either appear in a few relevés, such as *Sisyrinchium montanum* and *Quercus rubra*, or have a high presence but low coverages in relation to the coenosis in which they are established, such as *Parthenocissus quinquefolia* and *Echinocystis lobata*.

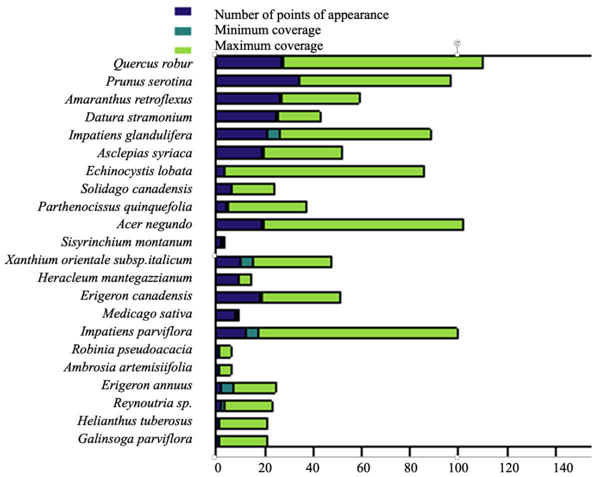

Figure 5. Quantitative aspects of the analysed species

IAS are among the main global factors contributing to biodiversity loss, posing significant challenges for nature conservation and protected area administration [42]. În vederea managementului eficient în ariile protejate, administratorilor acestor suprafețe le sunt utile informații privind diversitatea specifică a IAS în fiecare tip de habitat, precum date cantitative ale populațiilor. Besides presence, the coverage of each IAS is also important for protected area administrators [20, 39, 59], as well as how predictions of their presence are linked to their coverage. The multivariate comparative analysis of the studied habitats through classical clustering of input data-species constancy in each habitat type, as well as the minimum and maximum coverage values achieved in each habitat type-resulted in a hierarchy of habitats. Such data can serve as a basis for directing financial resources towards addressing the most acute issues related to invasive alien species in the most vulnerable habitats.

Habitats 92A0 and 9110 appear to have similarly low numbers of invasive species. However, they are fundamentally different - 92A0 has restricted areas due to anthropogenic causes, explaining the low number of records, while habitat 9110 covers extensive areas with high stability and favourable community cohesion, making it resistant to IAS invasion. The few species found in habitat 9110 are in ecotone zones.

Like beech forests, grasslands classified under habitat R3803 have well-structured communities sustainable anthropogenic exploitation through mowing, and even though invasive species are present on the edges of the roads traversing these habitats, they do not succeed in infiltrating among native species.

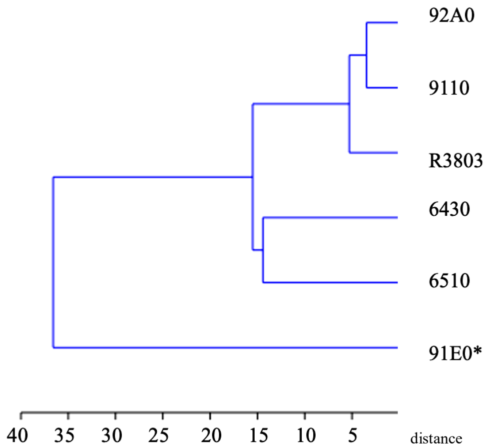

Figure 6. Comparative analysis of the types of analyzed habitats, from the perspective of the presence and quantity of invasive species

The 6510 lowland grasslands have a high number of populations and occurrences of invasive species, while the 6430 *Hydrophilous tall herb fringe communities of plain and of the montane to alpine levels*, even though they have slightly smaller surfaces, have a wider altitudinal range, being present both in the plain and mountainous regions. The hydrophilous tall herb fringe communities of plain and of the montane to alpine levels are strongly infiltrated by invasive species, and in some places, all native species are replaced by compact clusters of one of the IAS. On the other hand, due to their altitudinal range and numerous neighbouring habitats, the 6430 *hydrophilous tall herb fringe communities of plain and of the montane to alpine levels* can facilitate the migration of invasive species and pose a threat to the adjacent and/or overlapping habitats.

It is important to highlight the high degree of infestation of riparian woodland habitats compared to other habitat types. They are strongly infiltrated by "aggressive" species that rapidly develop dense populations and eliminate native species, causing serious damage to the structure of these priority habitats.

The data presented suggests a need for prioritization in the management of Natura 2000 sites, due to limited resources. Cost assessment represents a useful resource for communication with decision-makers and the general public since impacts expressed in economic terms are more tangible and understandable than complex ecological impacts.

First and foremost, the presence of a large number of invasive species distributed across numerous points within the sites and over large areas underscores the importance of making the management of IAS a priority. Failure to control these species could lead to the disappearance of habitats of community interest and conservation objectives within protected areas. Secondly, it is necessary to channel financial, human, and logistical resources towards priority interventions in 91E0 and 6430 habitats. Rapid interventions are needed in the Upper Tisa, Câmpia Careiului and Câmpia Ierului PAs.

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