CONSERVATION STATUS OF PLANTS AND HABITATS UNDER TEN YEARS OPERATION PHASE OF A WIND FARM. CASE STUDY: SFÂNTA ELENA KARST PLATEAU, IRON GATES NATURAL PARK, ROMANIA

Mihaela URZICEANU^{1,2}, Paulina ANASTASIU^{1,2*}, Ioana-Minodora SÎRBU^{1,2}, Tatiana Eugenia ȘESAN^{1,3}

¹University of Bucharest, Faculty of Biology, Independenței Blvd. 91–95, 050095-Bucharest, Romania

²University of Bucharest, Botanic Garden “D. Brandza”, Șos. Cotroceni 32, 060114-Bucharest, Romania

³Academy of Agricultural Sciences and Forestry, Mărăști Blvd. 61, 011464-Bucharest, Romania

email: paulina.anastasiu@bio.unibuc.ro

Abstract: Located in the Iron Gates Natural Park, Romania, at the foot of the Locvei Mountains, the Sfânta Elena Karst Plateau is a very picturesque territory, characterized by a karst relief, covered by High Nature Value grasslands. In the last decade this territory has been subjected to increasing anthropogenic pressures, and specific concerns on biodiversity have been raised after the construction of a wind farm in 2011. Starting from a concern expressed by a scientist, our study aims to provide current data on plant species with conservation value and to assess the conservation status of orchid-rich grasslands around wind turbines after ten years of wind farm operation. During the operation period we identified 19 plant taxa with conservation value, eight of which are orchid species. Four of them are new reports for this territory: *Gymnadenia conopsea*, *Neotinea ustulata*, *Neottia nidus-avis* and *Orchis simia*, as well other rare taxa such as *Cirsium grecescui*, *Lathyrus sphaericus*, *Linum hologynum* and *Rumex thyrsoiflorus*, are mentioned for the first time. The orchid-rich grasslands in the wind farm area correspond to the Natura 2000 habitat 6210* whose structure and floristic composition are within the acceptable limits of Favourable conservation status. The conservation status of plant species is directly dependent on the quality of their habitat, as well as the variety of pressure and threat factors in the area.

Keywords: grasslands, orchids, rare plants, wind turbines, pressure factors, protected areas

Introduction

The Sfânta Elena Karst Plateau (SEKP) is located in the Iron Gates Natural Park, at the foot of the Locvei Mountains, around Sfânta Elena village, Coronini commune (named Pescari in 1964–1995), Caraș Severin County, Romania (Fig. 1). It stretches between the Liuborajdea Valley and the Danube, in a hilly landscape, at altitudes between 200 and 600 m [39]. The relief is characterized by the presence of surface karst forms (sinkholes, dry karst valleys and limestone pavement), as well as deep karst forms, of which the best known is the Gaura cu Muscă Cave [53]. This relief, the cultural history of the old Czech community from Sfânta Elena village [32], and the natural habitats mixed with small-scale arable cultivation have created here an example of a man-made cultural landscape [56].

On the calcareous substrate, specific to the area, grasslands of High Nature Value grow in association with hilly forests and coppices consisting of species such as *Acer campestre*, *Acer pseudoplatanus*, *Carpinus orientalis*, *Cotinus coggygria*, *Fraxinus ornus*, *Quercus* spp., *Syringa vulgaris* and *Tilia tomentosa* [39, 52]. Also, in this territory an interesting situation is an inversion

of forest vegetation due to the climatic conditions back in the Atlantic Period (warmest period of the Holocene), maintained today by the Mediterranean character of the local climate, as here we can find at the lowest altitude in the country the presence of beech (*Fagus sylvatica*) [41, 8]. Thus, nowadays it can be observed, in a low-lying area from an altitudinal point of view, a mixture of boreal and montane flora together with species of Mediterranean origin [39].

Regarding the flora and vegetation, very few studies have been conducted on the grasslands of the SEKP, most of them focusing on the rocky area along the Danube, with insufficient data distribution. The first mentions regarding the local flora were made by Borza [3] from the Coronini Cave. In the biogeographical considerations on the Danube Gorge, Călinescu and Iana [5] indicate some plants from Coronini. Later, Păun et al. [44, 45] published their research on the flora and vegetation of the Berzeasca-Coronini sector, including chorological references for the Coronini area. Flora and vegetation of the Locvei Mountains is presented in detail in Coste's doctoral thesis [13], but the author does not refer to the territory of SEKP. Grigore and Coste [27] published plant associations on the Moldova Veche - Coronini sector, without giving the precise location, except for the plant association *Syringo vulgaris* - *Carpinetum orientalis* which is mentioned on slopes with calcareous substrate from Coronini. Some mentions for Coronini commune are also presented in the volumes of Flora României (red. T. Săvulescu): Beldie [2], Prodan [47], Nyárády [38], Morariu [33, 34, 35], Paucă [43], Grințescu I [28], Todor [58], Prodan and Nyárády [48], Ghișa [25], Dobrescu [17]. Also, in the study about the fungi of the Danube Gorge, Sandu-Ville et al. [49] present some host plants in the Coronini area. Many chorological data on the flora and vegetation of Iron Gates Natural Park can be found in Sorina Matacă's doctoral thesis [30], but for SEKP there are floristic mentions mainly on the rocks along the Danube and Gaura cu Muscă Cave. Also, some plants with conservation value in the area of SEKP are known from chorology papers [46], Comănescu and Ștefănuț [10], Anastasiu [1]. Thus, so far from SEKP are known about 65 taxa with conservative value, reported mainly from the rocks of the Danube Gorge.

The conservation importance of the SEKP is underlined by Milanovici [31] in an extensive study targeting orchids from the southern Banat, in which six orchid species are mentioned for the grasslands of the SEKP (*Anacamptis coriophora*, *Anacamptis morio*, *Cephalanthera longifolia*, *Neottia ovata*, *Orchis mascula* subsp. *speciosa* and *Platanthera chlorantha*). Due to the importance of its orchid-rich grasslands, Milanovici [31] recommends that SEKP should be included in the integral protection zone of the Iron Gates Natural Park.

In the last decade, a large part of this territory was subject to anthropogenic pressure, mainly since 2011 when the construction began of a wind farm with 21 wind turbines. This activity was described as one of the manifestations of the globalization tendencies in Sfânta Elena territory [56]. The wind farm construction produced environmental changes, influencing both the landscape and the land cover. New access roads and platforms around the wind turbines were created instead of arable land, grassland and scrub. Milanovici [31] considered this wind farm an important negative factor on the orchid grasslands on SEKP, wondering itself "what impact will the wind turbines have on grasslands?". Also, given the fact that the wind turbines interfere with the picturesque landscape of the area, some authors were concerned about the risk of negative influence on tourism and the landscape of the Iron Gates Natural Park and the Natura 2000 Network [29, 56].

Based on the concern expressed by Milanovici [31], our study aims to provide current data on plant species of conservation value and to assess the conservation status of orchid-rich

grasslands around wind turbines after ten years of wind farm operation.

Material and Methods

Investigated area

The investigated area is represented by the “Sfânta Elena” wind farm which consists of 21 wind turbines (henceforth being noted as WT). The wind farm is located at a distance of *c.* 600 m from the Danube, some 500 m from the St. Elena village and 600 m from the Coronini village (Fig. 1). The 21 WTs are located in a variety of habitats and vegetation types: arable lands, forests, bushes and grasslands. The area occupied by a WT consists of a cement pad around the tower, an access road and an area cleared of vegetation during the construction period, which is referred to as the technological platform.

Fig. 1: Map of the Sfânta Elena Karst Plateau with the 21 WT (compiled after Oancea et al. 1987)

Data collection and analysis

Field surveys were conducted monthly in 2017–2020, during the vegetation period (March–September). We investigated the plants of conservative value in two types of 2,500 m² established plots: 1) with vegetation affected by construction works corresponding to a technological platform and 2) with vegetation unaffected by construction works corresponding to habitats in the adjacent area. For unaffected plots we surveyed the floristic composition, which we used as support in identifying grassland habitats with conservation value.

We used the concept of “conservation value” in accordance with the significance of Capmourteres and Anand [6], referring to the plants and habitats listed in at least one of the National Red Lists [40, 16, 4], the National Red Book [15] or Habitats Directive [14].

For each plant taxa of conservation value around wind turbines we provide data regarding the WT number and the corresponding GPS coordinates, the habitat and the plots type in which the species were identified, as well as previous literature reporting of the species in the area. The distribution data are presented in the form of maps processed in the ArcGIS 10.4 software [19].

We calculated the number of plant taxa of conservation value around each WT and their frequency in the analysed areas (affected vs unaffected), to identify the areas with the highest conservation value. The frequency is given as a percentage and indicates how often the plants appear in the analysed plots, being calculated according to the formula $F = n / N \times 100$, where n is the number of plots containing plant taxa with conservation value, and N is the total number of plots investigated.

The conservation status of the plants discussed in this study was evaluated based on a three-level scale (Favourable; Unfavourable-Inadequate, Unfavourable-Bad) [11], by taking into consideration the following parameters: habitat quality, size of the species population in the plot, respectively abundance/ dominance (AD) score and the significance of pressures. To determine the AD score we used Braun-Blanquet scale: + = few individuals, low cover; 1 = abundant individuals with reduced cover or few individuals with greater cover (up to $\frac{1}{10}$ of the surface); 2 = very abundant individuals or with a cover of $\frac{1}{10}$ - $\frac{1}{4}$ of the surface; 3 = cover $\frac{1}{4}$ - $\frac{1}{2}$ of the surface, irrespective of the number of individuals; 4 = cover $\frac{1}{2}$ - $\frac{3}{4}$ of the surface, irrespective of the number of individuals; 5 = high cover of $\frac{3}{4}$ of the surface, irrespective of the number of individuals; r = 1-5 individuals with negligible cover.

The nomenclature is in accordance with Euro+Med PlantBase database [20] and Sârbu et al. [51].

The identification of the grassland habitats was made based on the characteristic and dominant species, in accordance with the Interpretation Manual of Natura 2000 Habitats in Romania [24] and the EUR28 Manual [12].

In order to assess the conservation status of the grassland habitats of community interest, the conditions for Favourable conservation status were analysed according to the synthesis paper Habitat fact-sheets [36].

Results and Discussion

Around all 21 wind turbines we registered 19 plant taxa of conservation value (Table 1), of which eight are orchid species (*Anacamptis coriophora*, *Anacamptis morio*, *Gymnadenia conopsea*, *Neotinea ustulata*, *Neottia nidus-avis*, *Neottia ovata*, *Orchis mascula* subsp. *speciosa*, and *Orchis simia*). Thus, the Orchidaceae family is the best represented among the taxa of conservation value, followed by the Compositae family with two taxa (*Cirsium grecescui* and *Echinops bannaticus*), the other families being represented by only one taxon each (Caryophyllaceae, Fabaceae, Plantaginaceae, Linaceae, Asparagaceae, Poaceae, Polygonaceae, Apiaceae, and Lamiaceae) (Table 1).

Also, the total of 19 taxa includes eight newly observed taxa not previously mentioned in the scientific literature for this territory: *Cirsium grecescui*, *Gymnadenia conopsea*, *Lathyrus sphaericus*, *Linum hologynum*, *Neotinea ustulata*, *Neottia nidus-avis*, *Orchis simia*, and *Rumex thyrsiflorus*. With the exception of *Rumex thyrsiflorus*, all these species are known from the literature to be present in the Iron Gates Natural Park, in adjacent areas to the SEKP [30, 31]. Thus, *Cirsium grecescui* is distributed in the sectors Ogradena-Eșelnița, Ilovîța-Vârciorova, Gura Vârciorova - Gura Văii, Cazanele Mici [30], *Gymnadenia conopsea* is distributed in Baziaș, Radimna Valley, Micoș Valley, Belobreșca, Eșelnița, Ogradena, Orșova [31], *Lathyrus sphaericus* is distributed in Baziaș, Pojejena-Măcești-Moldova Veche, Moldova Nouă, Golovârf Hill, Svinița-Tricule, Cazanele Mici, Valea Mraconiei, Orșova, Gura Văii-Schela Cladovei [30], *Linum*

hologynum is distributed in Svinița, Mehedinți Plateau-Duhovnei Hill [30], *Neotinea ustulata* is distributed in Radimna Valley (Zăvoi), Moldova Nouă [13], *Neottia nidus-avis* is distributed in Baziaș, Baziaș – Pojejena, Valea Radimna, Valea Micloș, Moldova Nouă, Valea Mare – Moldova Nouă, Belobreșca, Movita, Velika Lokva, Divici – Ribiș, Velika Reka, Șușca – Poiana Lisa, Valea Mraconiei, Valea Eșelniței, Valea Țarovăț, Tisovița, Plavișevița, Valea Mare – Moldova Nouă, Valea Șirinea [31], *Orchis simia* is distributed in Baziaș, Divici, Vârciorova, Gura Slătanicului and Cracul Ciolane, Gura Văii on Cârlan Hill, Oglănic Forest, Valea Mraconiei, Belobreșca, Ribiș – Divici, Orșova, Vârciorova, Slătinic, Valea Oglănicului [31].

The presence of *Rumex thyrsiflorus* on the SEKP is the first report in the botanical literature, but in a zoological paper Trnka et al. [59] mention *Rumex thyrsiflorus* as a host plant for the beetle (weevil) species *Lixus neglectus*, present in this area. *Rumex thyrsiflorus* was mentioned before in Romania from the counties of Bihor [9, 57], Bistrița-Năsăud, Brașov, Cluj, Galați, Maramureș, Vaslui [15, 51], Mehedinți [7], Satu-Mare [57] and Sălaj [37].

Regarding the zoological status (Table 1), most of the taxa are listed as Rare plants in at least one of the National Red Lists. A special situation occurs in the case of the species *Agrostemma githago* and *Linaria arvensis*, which, although listed in the Red Lists, are considered alien plants (with archaeophytic character) in our country [55]. The species *Agrostemma githago* has a Vulnerable status in the Red List of Boșcaiu et al. [4] and can rarely be seen in our country [51, 55]. Although it was an abundant plant in arable crops during the mid-20th century, due to seed cleaning and modern agricultural practices, this species has been placed on the Red Lists of many European countries [22, 18]. The presence of *Agrostemma githago* in the SEKP, even if it has a small population (2-3 individuals/ plot around WT), can be explained by the specifics of agricultural workings practiced on a small scale, poorly mechanized and with organic fertilizers [50]. The species *Linaria arvensis* is listed in the Red List of Dihoru and Dihoru [16] as a plant for which there is insufficient information on its inclusion in Endemic, Vulnerable or Rare categories. It has a sporadic presence in our country, with preferences for ruderal, cultivated places [51], cited from Cluj, Mureș, Harghita, Brașov, Alba, Iași, Suceava, Tulcea counties [55], and most recently reported by Anastasiu [1] from both Hunedoara and Caraș-Severin counties.

Only two of the taxa are listed in the National Red Book [15], namely *Orchis simia* with Endangered (EN) status and *Rumex thyrsiflorus* with, respectively, Critically Endangered (CR) status (Table 1).

Around each of the wind turbines, except WT 5, we identified at least one or more plant taxa with conservation value, in various types of habitats (Table 2, Fig. 2). The plant taxa with conservation value that we report for the first time are distributed around 16 of the 21 turbines (Fig. 3).

The most numerous plant taxa of conservation value (six taxa) have been identified around WT 4 which is surrounded by grassland habitat. Of these six taxa, five are orchid species (*Anacamptis coriophora*, *Anacamptis morio*, *Gymnadenia conopsea*, *Neotinea ustulata* and *Orchis mascula* subsp. *speciosa*), and the sixth is the Critically Endangered species *Rumex thyrsiflorus*, which gives the conservation value to this habitat area. Numerous plant taxa with conservation value have also been found around the WT 12 which is surrounded by a broad-leaved forest habitat (four taxa, of which two are orchids, *Neottia nidus-avis* and *Neottia ovata*), and also around the WT 15 and WT 16, which are surrounded by arable land with some areas of natural vegetation (four taxa each). Also, around the turbines surrounded by grassland areas mixed with shrubs (WT

20, WT 21, WT 22) we identified a high number of taxa (three different species at each turbine), including the orchid species *Anacamptis morio* and *Orchis simia* (Fig. 2).

Table 1: Plant taxa with conservation value inventoried around wind turbines

No.	Taxa	Family	NRB [15]	NRL [4]	NRL [16]	NRL [40]
1	<i>Agrostemma githago</i> L.	Caryophyllaceae		V		
2	<i>Anacamptis coriophora</i> (L.) R. M. Bateman, Pridgeon & M. W. Chase	Orchidaceae				R
3	<i>Anacamptis morio</i> (L.) R. M. Bateman, Pridgeon & M. W. Chase	Orchidaceae				R
4	<i>#Cirsium grecescui</i> Rouy	Compositae			R	R
5	<i>Echinops bannaticus</i> Schrad.	Compositae			R	R
6	<i>#Gymnadenia conopsea</i> (L.) R. Br.	Orchidaceae		R		R
7	<i>#Lathyrus sphaericus</i> Retz.	Fabaceae		R	R	
8	<i>Linaria arvensis</i> (L.) Desf.	Plantaginaceae			I	
9	<i>#Linum hologynum</i> Rchb.	Linaceae			R	R
10	<i>Muscari neglectum</i> Guss. ex Ten.	Asparagaceae				R
11	<i>#Neotinea ustulata</i> (L.) R. M. Bateman, Pridgeon & M. W. Chase	Orchidaceae				R
12	<i>#Neottia nidus-avis</i> (L.) Rich.	Orchidaceae				R
13	<i>Neottia ovata</i> (L.) Bluff & Fingerh.	Orchidaceae				R
14	<i>Orchis mascula</i> subsp. <i>speciosa</i> (Mutel) Hegi	Orchidaceae				R
15	<i>#Orchis simia</i> Lam.	Orchidaceae	EN	R	R	R
16	<i>Piptatherum virescens</i> (Trin.) Boiss.	Poaceae				R
17	<i>#Rumex thyrsiflorus</i> Fingerh.	Polygonaceae	CR	R	I	R
18	<i>Smyrniium perfoliatum</i> L.	Apiaceae			R	R
19	<i>Teucrium montanum</i> L.	Lamiaceae			R	

New taxa, not previously reported in the scientific botanical literature for SEKP

NRB = National Red Book, NRL = National Red List, VU = Vulnerable, EN = Endangered, CR = Critically Endangered, R = Rare, V = Vulnerable, I = Indeterminate.

In terms of frequency, the most frequent plant species were observed in both affected and unaffected plots (Table 3). The species *Cirsium grecescui*, *Lathyrus sphaericus*, and *Agrostemma githago* have a higher frequency in the affected plots than in the unaffected plots, this situation being associated with the presence of the arable land around turbines (Table 2). This may be due to the preferences of these species for ruderal, or segetal places to the detriment of natural ones [51]. Also, the orchid species *Anacamptis morio* occurs in affected plots, but with a lower frequency than in the unaffected ones (19.05% / 9.52%). The majority of the other plant species has a lower frequency, being present mostly in unaffected plots (*Muscari neglectum*, *Smyrniium perfoliatum*, *Piptatherum virescens*, *Linum hologynum*, *Anacamptis coriophora*, *Neotinea ustulata*, *Neottia nidus-avis*, *Neottia ovata*, *Orchis mascula* subsp. *speciosa*, *Orchis simia*, *Rumex thyrsiflorus*, *Teucrium montanum* and *Gymnadenia conopsea*). We specify that *Orchis mascula*

subsp. *speciosa* was identified on an unaffected plot (corresponding to a nearby grassland), but at more than 100 m from the WT 4.

The high frequency of plant species present in the affected areas shows their good adaptability over time to the revegetation process. This is the case with the species *Anacamptis morio*, which has spread its population from the unaffected grasslands to the WT 2 and WT 4 technological platforms.

Regarding previous mentions in the literature (Table 2), we found little information related to the spot distribution, population size or conservation status of the taxa analysed. The orchid *Anacamptis coriophora* is mentioned by Păun et al. [44] on the area of the Coronini commune and by Milanovici [31] on the grasslands of Sfânta Elena. Milanovici [31] points out the presence of the orchids *Anacamptis coriophora*, *Anacamptis morio*, *Neottia ovata*, and *Orchis mascula* subsp. *speciosa* in the grasslands of SEKP, but the population size and the conservation status are presented for the entire Iron Gates Natural Park (*Anacamptis coriophora* – over 3,000 individuals, with relatively good conservation status, *Anacamptis morio* – over 15,000 individuals, with good conservation status, *Neottia ovata* – less than 1,000 individuals and *Orchis mascula* subsp. *speciosa* – over 3,000 individuals, both with relatively good conservation status). The other taxa identified around the wind turbines were previously reported either from the rocky areas of Coronini (*Echinops bannaticus* and *Piptatherum virescens*), the Coronini commune (*Smyrniium perfoliatum* and *Teucrium montanum*) or from area sectors that include the commune of Coronini (*Agrostemma githago* and *Muscari neglectum*). Also, for none of these taxa did we find any information other than their presence in the area.

Table 2: Distribution of plant taxa with conservation value around wind turbines and previous reportings in the area

Taxon name	Wind turbines	Coordinates	Habitat type around wind turbine	Type area	Previous reportings in the area
<i>Agrostemma githago</i>	WT 6	44°41'13.87"N / 21°42'38.73"E	Arable land	Affected	Moldova Veche – Coronini [27]
	WT 7	44°41'7.93"N / 21°42'59.47"E	Arable land	Affected	
	WT 15	44°39'35.46"N / 21°43'18.61"E	Arable land with areas of natural vegetation	Affected + Unaffected	
	WT 16	44°39'53.55"N / 21°43'14.26"E	Arable land	Unaffected	
<i>Anacamptis coriophora</i>	WT 4	44°41'48.40"N / 21°43'7.70"E	Grassland (6210*)	Unaffected	Coronini [44], Sfânta Elena [31]
<i>Anacamptis morio</i>	WT 1	44°41'25.62"N / 21°43'18.09"E	Arable land	Unaffected	Sfânta Elena [31]
	WT 2	44°41'37.01"N / 21°43'9.49"E	Grassland (6210*)	Affected + Unaffected	
	WT 4	44°41'48.40"N / 21°43'7.70"E	Grassland (6210*)	Affected + Unaffected	
	WT 9	44°41'2.58"N / 21°44'13.15"E	Broad-leaved forest	Unaffected	
	WT 21	44°41'3.71"N / 21°41'48.11"E	Grassland (6210*) and shrubs	Unaffected	
	WT 22	44°41'16.27"N / 21°41'48.79"E	Grassland (6210*) and shrubs	Unaffected	
<i>Cirsium grecescui</i>	WT 1	44°41'25.62"N / 21°43'18.09"E	Arable land	Affected	-

	WT 2	44°41'37.01"N / 21°43'9.49"E	Grassland (6210*)	Affected	
	WT 6	44°41'13.87"N / 21°42'38.73"E	Arable land	Unaffected	
	WT 7	44°41'7.93"N / 21°42'59.47"E	Arable land	Affected	
	WT 8	44°40'57.95"N / 21°43'50.75"E	Arable land with areas of natural vegetation	Affected + Unaffected	
	WT 9	44°41'2.58"N / 21°44'13.15"E	Broad-leaved forest, grassland	Affected + Unaffected	
	WT 10	44°40'53.95"N / 21°44'12.92"E	Broad-leaved forest, grassland	Affected + Unaffected	
	WT 12	44°40'37.43"N / 21°44'47.02"E	Broad-leaved forest	Affected	
	WT 13	44°40'28.74"N / 21°44'47.92"E	Broad-leaved forest	Affected	
	WT 16	44°39'53.55"N / 21°43'14.26"E	Arable land	Affected	
	WT 17	44°40'7.90"N / 21°43'4.86"E	Arable land	Affected	
	WT 18	44°40'13.74"N / 21°42'46.13"E	Arable land	Unaffected	
<i>Echinops bannaticus</i>	WT 15	44°39'35.46"N / 21°43'18.61"E	Arable land with areas of natural vegetation (shrubs)	Affected + Unaffected	The rocks of Coronini [44]
<i>Gymnadenia conopsea</i>	WT 2	44°41'37.01"N / 21°43'9.49"E	Grassland (6210*)	Unaffected	-
	WT 4	44°41'48.40"N / 21°43'7.70"E	Grassland (6210*)	Unaffected	
<i>Lathyrus sphaericus</i>	WT 12	44°40'37.43"N / 21°44'47.02"E	Broad-leaved forest	Unaffected	-
	WT 14	44°40'17.15"N / 21°45'4.06"E	Grassland (6210*)	Affected	
	WT 15	44°39'35.46"N / 21°43'18.61"E	Arable land with areas of natural vegetation	Affected	
	WT 16	44°39'53.55"N / 21°43'14.26"E	Arable land	Affected	
	WT 17	44°40'7.90"N / 21°43'4.86"E	Arable land	Affected	
	WT 18	44°40'13.74"N / 21°42'46.13"E	Arable land	Affected + Unaffected	
<i>Linaria arvensis</i>	WT 11	44°40'43.05"N / 21°44'21.53"E	Broad-leaved forest	Affected	The technological platform of a turbine: 45.500739 N/ 22.947352°E [1]
<i>Linum hologynum</i>	WT 14	44°40'17.15"N / 21°45'4.06"E	Grassland (6210*)	Unaffected	-
<i>Muscari neglectum</i>	WT 19	44°40'38.62"N / 21°41'50.23"E	Grassland (6210*) and shrubs	Unaffected	Coronini - Berzeasca [44]
	WT 20	44°40'53.78"N / 21°41'48.82"E	Grassland (6210*) and shrubs	Unaffected	
	WT 21	44°41'3.71"N / 21°41'48.11"E	Grassland (6210*) and shrubs	Unaffected	
	WT 22	44°41'16.27"N / 21°41'48.79"E	Grassland (6210*) and shrubs	Unaffected	

<i>Neotinea ustulata</i>	WT 4	44°41'48.40"N / 21°43'7.70"E	Grassland (6210*)	Unaffected	-
<i>Neottia nidus-avis</i>	WT 12	44°40'37.43"N / 21°44'47.02"E	Broad-leaved forest	Unaffected	-
<i>Neottia ovata</i>	WT 12	44°40'37.43"N / 21°44'47.02"E	Broad-leaved forest	Unaffected	Sfânta Elena [31]
<i>Orchis mascula</i> subsp. <i>speciosa</i>	WT 4 – R > 100 m	44°41'48.40"N / 21°43'7.70"E	Grassland (6210*)	Unaffected	Sfânta Elena [31]
<i>Orchis simia</i>	WT 22	44°41'16.27"N / 21°41'48.79"E	Grassland (6210*) and shrubs	Unaffected	-
<i>Piptatherum virescens</i>	WT 13	44°40'28.74"N / 21°44'47.92"E	Broad-leaved forest	Unaffected	The rocks of Coronini, between Liubcova and Coronini, Liborăjdii Valley to Sfânta Elena [44], Coronini [35]
	WT 19	44°40'38.62"N / 21°41'50.23"E	Grassland (6210*) and shrubs	Unaffected	
	WT 20	44°40'53.78"N / 21°41'48.82"E	Grassland (6210*) and shrubs	Unaffected	
<i>Rumex thyrsiflorus</i>	WT 4	44°41'48.40"N / 21°43'7.70"E	Grassland (6210*)	Unaffected	-
<i>Smyrniium perfoliatum</i>	WT 15	44°39'35.46"N / 21°43'18.61"E	Arable land with areas of natural vegetation (shrubs)	Unaffected	The forests between Gornea and Coronini [44], Coronini [49]
	WT 16	44°39'53.55"N / 21°43'14.26"E	Arable land	Unaffected	-
	WT 18	44°40'13.74"N / 21°42'46.13"E	Arable land	Unaffected	-
	WT 21	44°41'3.71"N / 21°41'48.11"E	Grassland (6210*) and shrubs	Unaffected	-
<i>Teucrium montanum</i>	WT 20	44°40'53.78"N / 21°41'48.82"E	Grassland (6210*) and shrubs	Unaffected	The rocks of Coronini [44], Moldova Veche - Coronini [27] Coronini - 1039 mile [30]

For 11 taxa we assigned Unfavourable-Inadequate conservation status (*Agrostemma githago*, *Anacamptis coriophora*, *Lathyrus sphaericus*, *Linum hologynum*, *Neotinea ustulata*, *Neottia nidus-avis*, *Neottia ovata*, *Orchis simia*, *Piptatherum virescens*, *Rumex thyrsiflorus* and *Teucrium montanum*), and only for the species *Linaria arvensis* did we assign Unfavourable-Bad conservation status. The Unfavourable conservation status was associated with exceedingly small populations, respectively a lower AD score, significant influence of pressure factors, or poor quality of their habitat (e.g., interference with arable or abandoned land, unstable disturbed soil, heavily grazed areas).

Regarding the conservation status for plants with conservation value identified around wind turbines (Table 4), for seven taxa we assigned a Favourable conservation status [11]: *Anacamptis morio*, *Cirsium grecescui*, *Echinops bannaticus*, *Gymnadenia conopsea*, *Muscari neglectum*, *Orchis mascula* subsp. *speciosa* and *Smyrniium perfoliatum*. These taxa have numerous individuals in the analysed plots, respectively high AD score, stable populations, large and good quality habitat, and the pressure factors do not affect them significantly. Some of them have recolonized the areas affected by the construction of the wind farm (Fig. 4 A, B). Thus we can

appreciate that the long-term survival of these species could be ensured, on condition that these areas should be excepted from the maintenance work necessary for the operation of wind turbines.

Fig. 2: Distribution of plant taxa with conservation value around the turbines of the “Sfânta Elena” wind farm

Fig. 3: Distribution of the new reported plant taxa with conservation value for Sfânta Elena Karst Plateau

Table 3: Frequency of taxa with conservation value in affected and unaffected plots

Taxa	Affected plots (F%)	Unaffected plots (F%)
<i>Cirsium grecescui</i>	47.62	23.81
<i>Lathyrus sphaericus</i>	23.81	9.52
<i>Anacamptis morio</i>	9.52	19.05
<i>Agrostemma githago</i>	14.29	9.52
<i>Muscari neglectum</i>	0.00	19.05
<i>Smyrnium perfoliatum</i>	0.00	19.05
<i>Piptatherum virescens</i>	0.00	14.29
<i>Echinops bannaticus</i>	4.76	4.76
<i>Gymnadenia conopsea</i>	0.00	9.52
<i>Linum hologynum</i>	0.00	4.76
<i>Anacamptis coriophora</i>	0.00	4.76
<i>Linaria arvensis</i>	4.76	0.00
<i>Neotinea ustulata</i>	0.00	4.76
<i>Neottia nidus-avis</i>	0.00	4.76
<i>Neottia ovata</i>	0.00	4.76
<i>Orchis mascula</i> subsp. <i>speciosa</i>	0.00	4.76
<i>Orchis simia</i>	0.00	4.76
<i>Rumex thyrsiflorus</i>	0.00	4.76
<i>Teucrium montanum</i>	0.00	4.76

Fig. 4: Plants with conservation value observed on the affected areas (technological platforms); (A) *Anacamptis morio*; (B) *Cirsium grecescui*

Table 4: Conservation status for the plants with conservation value around wind turbines

Taxa name	AD	Pressures	Conservation status
<i>Agrostemma githago</i>	r	Weed control	Unfavourable - Inadequate
<i>Anacamptis coriophora</i>	r	Invasion of <i>Erigeron annuus</i> subsp. <i>annuus</i> Grazing	Unfavourable - Inadequate
<i>Anacamptis morio</i>	2	Invasion of <i>Erigeron annuus</i> subsp. <i>annuus</i> Grazing	Favourable
<i>Cirsium grecescui</i>	1	-	Favourable
<i>Echinops bannaticus</i>	2	Invasion of <i>Erigeron annuus</i> subsp. <i>annuus</i>	Favourable
<i>Gymnadenia conopsea</i>	1	Invasion of <i>Erigeron annuus</i> subsp. <i>annuus</i>	Favourable
<i>Lathyrus sphaericus</i>	+	Poor habitat quality (ruderalized grasslands, areas with disturbed soil)	Unfavourable - Inadequate
<i>Linaria arvensis</i>	r	Removing vegetation from platforms	Unfavourable - Bad
<i>Linum hologynum</i>	+	Invasion of <i>Erigeron annuus</i> subsp. <i>annuus</i> Expansion of woody vegetation	Unfavourable - Inadequate
<i>Muscari neglectum</i>	2	Grazing	Favourable
<i>Neotinea ustulata</i>	r	Invasion of <i>Erigeron annuus</i> subsp. <i>annuus</i>	Unfavourable - Inadequate
<i>Neottia nidus-avis</i>	r	-	Unfavourable - Inadequate
<i>Neottia ovata</i>	r	-	Unfavourable - Inadequate
<i>Orchis mascula</i> subsp. <i>speciosa</i>	2	-	Favourable
<i>Orchis simia</i>	r	The presence of the invasive species <i>Ailanthus altissima</i>	Unfavourable - Inadequate
<i>Piptatherum virescens</i>	+	The presence of the invasive species <i>Ailanthus altissima</i>	Unfavourable - Inadequate
<i>Rumex thyrsiflorus</i>	r	Poor habitat quality (boundary arable land with grassland)	Unfavourable - Inadequate
<i>Smyrniium perfoliatum</i>	1	-	Favourable
<i>Teucrium montanum</i>	+	Poor habitat quality (areas with disturbed soil)	Unfavourable - Inadequate

The orchid species *Anacamptis morio*, *Gymnadenia conopsea*, *Orchis mascula* subsp. *speciosa*, *Anacamptis coriophora*, and *Neotinea ustulata* have been identified in grassland habitats, while the other three orchids have been identified in forest areas (*Neottia nidus-avis* and *Neottia ovata*), or in scrub vegetation associated with grasslands (*Orchis simia*). The species with the most individuals identified in grassland habitats are as follows: *Anacamptis morio* (over 100), and *Gymnadenia conopsea* (over 30), *Orchis mascula* subsp. *speciosa* (about 20). The populations of the other two orchid species (*Neottia nidus-avis* and *Neotinea ustulata*) are reduced to no more than two individuals. The pressure factors on the orchid species are those acting on their habitats: expansion of arable land in the grassland area, the presence of invasive plants like *Erigeron annuus* subsp. *annuus* and *Ailanthus altissima*, grazing (goat herds are frequently observed in the area), and also the tourist activity that has become very intense in the area (ATV rides are practiced even on grasslands).

Orchid grasslands at the wind farm site correspond to Natura 2000 habitat 6210* Semi-natural dry grasslands and scrubland facies on calcareous substrates (Festuco-Brometea) (*

important orchid sites) that has been identified around five turbines (WT 2, WT 4, WT 14, WT 21, and WT 22) (Fig. 5). The habitat consists of dry or semi-dry grasslands on calcareous substrate which are often in association with scrub and thermophilic forests and contains many species of the *Festuco-Brometea* class, but also various species of orchid [24, 36]. In the area of the wind farm this type of habitat covers an area quite small, being interspersed between the forests and arable land.

Fig. 5: Locations of plots with 6210* habitat and their appearance around wind turbines of “Sfânta Elena” wind farm

The analysis of the structure and floristic composition of this habitat from the grasslands around wind turbines, by comparison with the criteria of the Favourable conservation status [36], showed us that the habitat falls within the acceptable limits, as follows:

- The total area of the habitat 6210* in the five plots of unaffected habitat is 1.25 ha, which represents 0.94 % of the total area of the habitat on the entire site Iron Gates Natural Park (133 ha). In these five plots, we inventoried 229 vascular plant taxa and the species richness varies between 86 and 113 taxa within the five plots. Thus, the species richness significantly exceeds the minimum of 20 plant species needed to qualify under Favourable conditions according to Habitat fact-sheets [36].

- The dominant and characteristic plant species in the plots around wind turbines correspond to 46.87% of the total species mentioned by Mountford et al. [36], namely: *Anthyllis vulneraria*, *Bothriochloa ischaemum*, *Brachypodium pinnatum*, *Campanula glomerata*, *Centaurea scabiosa*, *Dianthus carthusianorum*, *Festuca valesiaca*, *Asperula cynanchica*, *Medicago falcata*, *Anacamptis coriophora*, *Anacamptis morio*, *Neotinea ustulata*, *Orlaya grandiflora*, *Potentilla argentea*, *Sanguisorba minor*. Some other species which identified the floristic composition of the habitat around the five turbines are: *Briza media*, *Calamagrostis epigejos*, *Campanula patula*

subsp. *patula*, *Campanula persicifolia*, *Dactylis glomerata*, *Festuca pratensis*, *Filipendula vulgaris*, *Genista tinctoria*, *Gymnadenia conopsea*, *Helianthemum nummularium* subsp. *nummularium*, *Koeleria macrantha*, *Melica ciliata*, *Muscari neglectum*, *Orchis simia*, *Pimpinella saxifraga*, *Polygala comosa*, *Rhinanthus rumelicus*, *Salvia verticillata*, *Scabiosa ochroleuca*, *Stachys officinalis*, *Teucrium chamaedrys*, *Thymus pulegioides* subsp. *pannonicus*, *Trifolium montanum*, *Vicia cracca*, *Xeranthemum annuum*, etc.

- There is an impressive number of rare plant species in the plots around the turbines, many being represented by orchids: *Anacamptis morio*, *Gymnadenia conopsea*, *Neotinea ustulata*, *Anacamptis coriophora*, *Orchis simia*, *Smyrniium perfoliatum* and *Linum holognum*.

- Although Mountford et al. [36] do not mention the presence of species with negative impact (alien plants) for the 6210* habitat, we found around wind turbines the invasive alien species *Ailanthus altissima*, *Erigeron canadensis*, *Erigeron annuus* subsp. *annuus* and *Robinia pseudoacacia*. The species *Ailanthus altissima* and *Robinia pseudoacacia* are present at the interface of grasslands with woody vegetation (hornbeam scrub) (WT 21 and WT 22). The presence of *Erigeron annuus* subsp. *annuus* and *Erigeron canadensis* can be explained by the fact that the grasslands are fragmented by cultivated or abandoned arable lands that are areas suitable for alien species. Also, the areas covered with the 6210* habitat are grazed by herds of goats and cows, which to a certain extent may be a factor of degradation of the vegetation structure and composition.

- The height of the vegetation corresponds to the limits of 20–100 cm described by Mountford et al. [36]. The maximum height is denoted by the species *Brachypodium pinnatum*, *Briza media*, *Bothriochloa ischaemum*, *Calamagrostis epigejos*, *Dianthus carthusianorum*, *Festuca valesiaca*, etc.

- The grassland areas are mixed with mosaics of scrub vegetation and trees, as described by Mountford et al. [36]. Around WT 21 and WT 22, the grassland habitat intersects with *Carpinus orientalis* scrub, including some individuals of *Quercus pubescens*, *Crataegus monogyna* and *Rosa canina*. Scattered individuals of the invasive species *Ailanthus altissima* and *Robinia pseudoacacia* are present at the edge of the hornbeam bushes. Around WT 14, WT 2 and WT 4, scattered shrubs and trees are present, such as: *Corylus avellana*, *Populus tremula*, *Rosa gallica*, *Tilia tomentosa*, *Sorbus torminalis*, *Pyrus communis* subsp. *pyraster*, *Quercus cerris*, *Quercus pubescens* and *Rosa canina*.

- The vegetation of the habitat 6210* consists of mostly perennial species; the plant associations are at the climax stage. In the case of the plot from the WT 14, the extension of the juveniles of downy oak (*Quercus pubescens*) has been observed.

The negative effects of the wind farm on the orchid-rich grasslands were manifested mainly during the construction period, involving the removal and destruction of vegetation for the construction of various facilities. Some land areas, such as turbine foundations and access roads have remained permanently in use in the study area, which means that those surfaces are permanently lost in terms of vegetation cover during the operation of the wind farm, and the vegetation will not recover in the missing of the decommissioning workings. However, other affected land areas during the construction phase, such as technological platforms, were temporarily cleared of vegetation, and after construction stage they were naturally recovered with vegetation. After about 10 years from the construction of the wind farm, the habitats in the immediate vicinity, unaffected by construction workings, have maintained their structure and

floristic composition described in the literature and are within the limits of Favourable conditions as described by Mountford et al. [36].

In the studied area there are other impact factors that can have a higher negative effect on grasslands as compared to wind farms (e.g., invasive alien species, intensive grazing, conversion of grassland to arable land, the burning of stubble by the inhabitants of the area, tourism, etc.). Most of the invasive alien species recorded in the analysed plots have a common presence in the area, unrelated to the construction of the wind farm. Thus, the presence of invasive woody species *Ailanthus altissima* derives from the plantations in the Iron Gate Natural Park where it was used for ornamental purposes [26]. The presence of herbaceous species such as *Erigeron canadensis* and *Erigeron annuus* subsp. *annuus* is associated with the presence of cultivated or abandoned arable land that either interdigitates with grassland habitats or is located in the immediate vicinity. Intensive grazing represents a strong pressure on the habitats in the area, followed by the presence and activities of tourists. As a result of tourism there is waste (especially plastics like PET, bags, etc.), burnt debris from grills made at the edge of the forest, and the entry of ATVs into grassland habitats. Like the observations of Fagúndez [21], we found that facilitating access to the area allowed the growth of human activities in protected areas, such as grazing, road traffic, searching and collecting plants etc. Although roads and restoration activities are known in the literature as a source of habitat colonization with pioneer and invasive species [23, 42, 54], in the case of grasslands around “Sfânta Elena” wind farm, the presence of alien invasive species was related to other anthropogenic factors manifested in the area (plantations of non-native species or interference with arable or abandoned land).

As Silva and Passos [54] show, an obstacle in estimating the impact of wind farms on natural and semi-natural habitats is the lack of floristic data prior to construction. In the case of the SEKP, the plant species distribution and vegetation data from scientific literature are insufficient for estimating the real impact of the wind turbines. There is also a need for studies outside the wind farm limits, as it is obvious that there are still interesting undiscovered floristic elements in the territory of the SEKP. Moreover, it is necessary to conduct complex studies to assess the cumulative impact of negative pressure factors and to outline effective measures for the conservation of natural habitats present in this territory.

Conclusions

The conservation status of plants and grasslands with conservation value on SEKP is correlated with the various anthropogenic pressures in the area. The operation activities of the wind farm are reduced to the existing infrastructure and the nearby vegetation are not affected.

Insufficient floristic data in the area of the SEKP before the construction of wind turbines (e.g. taxon distribution, population size, habitat mapping and their structural and composition descriptions) represent an impediment in accurately estimating the impact of wind turbines. Further research is needed, outside the site of the wind farm, for a complete image of the floristic elements with conservative value of the SEKP.

Acknowledgements: We express our gratitude to Enel Green Power Romania for agreeing to provide access to the wind farm. We also thank the Iron Gates Natural Park Administration for agreeing this research in the Iron Gates Natural Park. We are very grateful to Dr. Gavril Negrean who helped us find the scientific literature and clarify some taxonomical aspects. We thank the geographer Claudia Tomescu who helped us to elaborate the distribution maps in the ArcGIs software.

REFERENCES

1. Anastasiu, P., 2015, New chorological data for rare vascular plants from Romania, *Acta Horti Botanici Bucurestiensis*, **42** (1): 57-62. DOI: 10.1515/ahbb-2015-0002.
2. Beldie, A., 1952, Fam. Fagaceae. In: Săvulescu, T. (red. pr.), *Flora Republicii Populare Române, Vol. 1* (pp. 217-260), Editura Academiei Române, București.
3. Borza, A., 1931, Botanischer führer durch die umgebung von Băile Herculane (Herkulesbad) bis an die Donau, [Botanical guide about surroundings of Băile Herculane area to the Danube]. In: Borza, A. (ed.), *Guide de la sixième excursion phytogéographique internationale, Roumanie*, [Guide of the Sixth International Phytogeographic Excursion, Romania] (pp. 55-63), Le jardin botanique de L'Université de Cluj, Cluj
4. Boșcaiu, N., Coldea, G., Horeanu, C., 1994, Lista Roșie a plantelor vasculare dispărute, periclitare, vulnerabile și rare din flora României [Red List of extinct, endangered, vulnerable and rare vascular plants in Romania's flora], *Ocotirea Naturii și a Mediului Înconjurător*, **38** (1): 45-56.
5. Călinescu, R., Iana, S., 1964, Considerațiuni biogeografice asupra Defileului Dunării [Biogeographical considerations on the Danube Gorge], *Analele Universității din București, Științele Naturii Geologie-geografie*, **13** (1): 151-168.
6. Capmourteres, V., Anand, M., 2016, "Conservation value": a review of the concept and its quantification. *Ecosphere*, **7** (10): e01476. DOI: 10.1002/ecs2.1476.
7. Ciortan, I., Negrean, G., 2012, Rumex thyrsoflorus in Romania, *Analele Universității din Craiova, seria Biologie, Horticultură, Tehnologia Prelucrării Produselor Agricole, Ingineria Mediului*, **17** (53): 603-608.
8. Coldea, G., Boșcaiu, N., Lupșa, V.P.E., Resmeriță, I., 1970, Vegetația făgetelor din sectorul Valea Eșelnița–Valea Mraconiei al Defileului Dunării [Beech vegetation in the Eșelnița Valley – Mraconia Valley sector of the Danube Gorge], *Studii și cercetări de biologie, Seria Botanică*, **22** (6): 467-474.
9. Comănescu, P., Conțeanu, M., Nagodă, E., 2020, Threatened vascular plants from BUC Herbarium (I), *Acta Horti Botanici Bucurestiensis*, **46**: 55-105.
10. Comănescu, P., Ștefănuț, S., 2011, The chorology of the species *Sesleria rigida* and *Sesleria filifolia* in Romania. *Acta Horti Botanici Bucurestiensis*, **38**: 39-52.
11. Combroux, I., Schwoerer, C., 2007, *Evaluarea statutului de conservare al habitatelor și speciilor de interes comunitar din România – ghid metodologic* [Assessment of the conservation status of habitats and species of community interest in Romania - methodological guide], Editura Balcanic, Timișoara.
12. Commission of the European Community, 2013, Interpretation manual of European Union habitats–EUR 28. European Commission DG Environment, Brussels.
13. Coste, I., 1974, *Flora și vegetația Munților Locvei* [Flora and vegetation of the Locvei Mountains], PhD thesis, "Babeș-Bolyai" University Cluj-Napoca.
14. Council of the European Communities, 1992, Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora. Official Journal of the European Communities L206/7.
15. Dihoru, G., Negrean, G., 2009, *Cartea roșie a plantelor vasculare din România, [Romanian Red Book of Vascular Plants]*, Editura Academiei Române, București.
16. Dihoru, G., Dihoru, A., 1994, Plante rare, periclitare și endemice în Flora României - Lista roșie, [Rare, endangered and endemic plants of Romania's Flora - The Red List], *Acta Horti Botanici Bucurestiensis*, 1993-1994: 173-197
17. Dobrescu, C., 1972, Genul Cleistogenes Keng. In Săvulescu, T. (red. pr.). *Flora Republicii Socialiste România, Vol 12* (pp. 354-365), Editura Academiei Române, București.
18. Eliáš, P. jun, Eliáš, P. sen, Baranec, T., 2007, The New red list of Slovak endangered weeds. In: Eliáš P jun (Ed), *Threatened weedy plant species. Book of proceedings from the international conference*, pp. 23-28, Slovak University of Agriculture, Nitra.
19. Esri, 2016, ArcGIS advanced: realease 10.4. Redlands, CA: Environmental Systems Research Institute.
20. Euro+Med (2006-): Euro+Med PlantBase - the information resource for Euro-Mediterranean plant diversity. Retrieved 2020 September 30 from: <http://ww2.bgbm.org/EuroPlusMed/>
21. Fagúndez, J., 2008, Effects of wind farm construction and operation on mire and wet heath vegetation in the Monte Maior SCI, north-west Spain, *Mires & Peat*, **4** (2): 1-12.

22. Firbank, L. G., 1988, *Agrostemma githago* L. (*Lychnis githago* (L.) Scop.), *Journal of Ecology*, **76** (4): 1232-1246.
23. Fraga, M.I, Romero-Pedreira, D, Souto, M, Castro, D, Sahuquillo, E., 2008, Assessing the impact of wind farms on the plant diversity of blanket bogs in the Xistral Mountains (NW Spain), *Mires and Peat*, **4** (6): 1-10.
24. Gafta, D., Mountford, O., Alexiu, V., Anastasiu, P., Bărbos, M., Burescu, P., Coldea, G., Drăgulescu, C., Făgăraș, M., Goia, I., Groza, G., Micu, D., Mihăilescu, S., Moldovan, O., Nicolin, A., Niculescu, M., Oprea, A., Oroian, S., Paucă-Comănescu, M., Sârbu, I., Șuteu, A., 2008, *Manual de interpretare a habitatelor Natura 2000 din România [Interpretation manual of Natura 2000 habitats in Romania]*, Editura Rosprint, Cluj-Napoca.
25. Ghișa, E., 1972, Genul *Chrysopogon* Trin. In: Săvulescu T. (red. pr.). *Flora Republicii Socialiste România, Vol 12* (pp. 53-57), Editura Academiei Română, București.
26. Goia, I., Ciocanea, C.M, Gavrilidis, A.A., 2014, Geographic origins of invasive alien species in "Iron Gates" Natural Park (Banat, Romania), *Transylvanian Review of Systematical and Ecological Research*, **16**: 115-130. DOI:10.1515/trser-2015-0036.
27. Grigore, S., Coste, I., 1978, Cercetări asupra vegetației dintre Moldova Veche și Pescari (județul Caraș-Severin) [Vegetation research between Moldova Veche and Pescari (Caraș-Severin county)], *Banatica, Caiete de Stiinte naturale, Studii și Cercetări de Geologie, Geografie, Biologie Reșita*, **7**: 173-189.
28. Grințescu, I., 1958, Fam. Vitaceae. In: Săvulescu T. (red. pr.). *Flora Republicii Populare Române, Vol 6* (pp. 283-316), Editura Academiei Române, București.
29. Hamanová, M., 2013, Wind Farms and Tourism in The Romanian Banat. In: Fialová J, Kubičková H (eds), Public recreation and landscape protection – with man hand in hand...Conference proceeding 1st – 3rd May 2013, Brno: Publishing Centre Mendel University in Brno pp 221-224.
30. Matacă, S.Ș., 2005, *Parcul Natural Porțile de Fier. Floră, vegetație și protecția naturii [Iron Gates Natural Park. Flora, vegetation and nature protection]*, Editura Universitaria, Craiova.
31. Milanovici, S., 2012, *Orhidee din sudul Banatului (Orchids from south-west side of Banat region)*, East-West Print, Timișoara.
32. Moisi, Al., 1938, *Monografia Clisurii [Monograph of the Danube Strait]*, Felix Weiss, Oravița.
33. Morariu, I., 1957, Genul *Circaea* L.. In: Săvulescu, T. (red. pr.). *Flora Republicii Populare Române, Vol. 5* (pp. 519-525), Editura Academiei Române, București.
34. Morariu, I., 1972, Genul *Cynosurus* L.. In: Săvulescu, T. (red. pr.). *Flora Republicii Socialiste Române, Vol 12* (pp. 338-341), Editura Academiei Române, București.
35. Morariu, I., 1972, Genul *Oryzopsis* L.. In: Săvulescu T. (red. pr.). *Flora Republicii Socialiste Române, Vol 12* (pp. 186-190), Editura Academiei Române, București.
36. Mountford, O., Gafta, D., Anastasiu, P., Bărbos, M.I., Nicolin, A., Niculescu, M., Oprea, A., 2008, *Natura 2000 in Romania: Habitat fact-sheets*, Romanian Ministry of Environment and Sustainable Development.
37. Negrean, G., Karácsonyi, C., Szatmari, P.M., 2017. General description of the Sălaj flora. *Contributii Botanice*, **52**: 7-21.
38. Nyárády, E.J., 1956, Genul *Rubus* L. In: Săvulescu T. (red. pr.). *Flora Republicii Populare Române, Vol. 4* (pp. 276-580), Editura Academiei Române, București.
39. Oancea, D., Velcea, V., Caloianu, N., Dragomirescu, Ș., Dragu, Gh., Mihai, E., Niculescu, Gh., Sencu, V., Velcea, I., 1987, *Geografia României, Vol. 3 – Carpații Românești și Depresiunea Transilvaniei [Geography of Romania, Vol. 3 - The Romanian Carpathians and the Transylvanian Depression]*, Editura Academiei Române, București.
40. Oltean, M., Negrean, G., Popescu, A., Roman, N., Dihoru, G., Sanda, V., Mihăilescu, S., 1994, Lista roșie a plantelor superioare din România, [Red List of superior plants in Romania]. In: Oltean M. (coord), *Studii, sinteze, documentații de ecologie*, Academia Română, Institutul de Biologie, București.
41. Pașcovschi, S., Leandru, V., 1958, *Tipuri de pădure din Republica Populară Română*, Vol. 14. Editura Agro-Silvică de Stat, București.
42. Passos, I., Silva, M., Mesquita, S., Marques, A.T., Bernardino, J., Mascarenhas, M., 2013, Aliens in wind farms preventing and monitoring impacts on vegetation, [Abstract]. In: Conference on wind power and environmental impacts, Naturvårdsverket rapport pp 80.
43. Paucă, A., 1958, Fam Anacardiaceae. In: Săvulescu, T. (red. pr.). *Flora Republicii Populare Române, Vol 6* (pp. 214-219), Editura Academiei Române, București.
44. Păun, M., Cîrțu, M., Cîrțu, D., Popescu, G., 1968, Materiale pentru flora dintre Berzasca și Pescari, Județul Caraș-Severin, *Buletin Științific Craiova*, **10**: 47-62.

45. Păun, M., Popescu, G., Cîrțu, M., Cîrțu, D., 1970, Aspecte din vegetația teritoriului dintre Berzeasca și Pescarii (Jud. Caraș-Severin), *Analele Universității Craiova Seria Biologie- Științe Agricole*, **2** (12): 61-70.
46. Pop, O., 2001, Distributon of *Asplenium lepidum* and *Asplenium ruta-muraria* ssp. *ruta-muraria* in România, *Acta Horti Botanici Bucurestiensis*, **29**: 139-147.
47. Prodan, I., 1953, Genul *Cerastium* L.. In: Săvulescu, T. (red. pr.). *Flora Republicii Populare Române, Vol. 2* (pp. 39-65), Editura Academiei Române, București.
48. Prodan, I., Nyárády, E.J., 1964, Genul *Centaurea* L.. In: Săvulescu T. (red. pr.). *Flora Republicii Socialiste Române, Vol. 9* (pp. 785-951), Editura Academiei Române, București.
49. Sandu-Ville, C., Eliade, E., Comes, I., Iacob, V., Manoliu, A., Mititiuc, M., Rusan, M., Toma, M., Gutu, E., Ene, I., Costescu, M., Glodeanu, C., 1973, Micoflora din zona sistemului Hidroenergetic și de navigație "Porțile de Fier" [Mycoflora in the area of the Hydropower and navigation system "Iron Gates], *Acta Botanica Horti Bucurestiensis*, 1972-1973: 579-645.
50. Šantrůčková, M., Pákozdiová, M., Hamanová, M., 2014, Local community versus globalization tendencies: Case study of Czech villages in Romanian Banat Region, *Journal of Landscape Ecology*, **7** (2):73-89. DOI:10.2478/jlecol-2014-0017
51. Sârbu, I., Ștefan, N., Oprea, A., 2013, *Plante vasculare din România. Determinator ilustrat de teren*, Editura Victor B Victor, București.
52. Šebesta, J., Maděra, P., Řepka, R., Matula, R., 2017, Comparison of vascular plant diversity and species composition of coppice and high beech forest in the Banat region, Romania, *Folia Geobotanica*, **52**: 33-43. DOI: 10.1007/s12224-016-9279-3
53. Sencu, V., 1972, Carstul din Defileu [The Gorge Carst]. In: Vulcănescu, R. (coord.), *Atlasul Complex "Porțile De Fier"* (pp 151-152), Editura Academiei Române, București,
54. Silva, M.R., Passos, I., 2017, Vegetation. In: Perrow, M.R., (ed.), *Wildlife and wind farms, conflicts and solutions*, Vol. 1 Onshore: potential effects (pp 40-62), Pelagic Publishing, Exeter, UK.
55. Sîrbu, C., Oprea, A., 2011, *Plante adventive în flora României [Alien plants in the Romanian flora]*, Editura "Ion Ionescu de la Brad", Iași.
56. Št'astná, M., Vaishar, A., Pákozdiová, M., 2015, Role of tourism in the development of peripheral countryside. Case studies of Eastern Moravia and Romanian Banat, *Forum Geografic*, **14** (1): 83-93. DOI: 10.5775/fg.2067-4635.2015.198.i
57. Szatmari, P-M., 2015, Additional Glacial Relicts in Carei Plain natural protected area, north-western Romania, *Acta Horti Botanici Bucurestiensis*, **42**: 23-40.
58. Todor, I., 1958. Fam. Umbeliferae. In: Săvulescu, T. (red. pr.), *Flora Republicii Populare Române, Vol. 6*. (pp. 326-652), Editura Academiei Române, București.
59. Trnka, F., Stejskal, R., Skuhrovec, J., 2016, The morphology of the immature stages of two rare *Lixus* species (Coleoptera, Curculionidae, Lixinae) and notes on their biology, *ZooKeys*, **604**: 87-116. DOI: 10.3897/zookeys.604.9018.

STAREA DE CONSERVARE A PLANTELOR ȘI HABITATELOR DUPĂ 10 ANI DE FUNCȚIONARE A UNUI PARC EOLIAN. STUDIU DE CAZ: PLATOUL CARSTIC SFÂNTA ELENA, PARCUL NATURAL PORȚILE DE FIER, ROMANIA

(Rezumat)

Localizat în Parcul Natural Porțile de Fier, România, la poalele Munților Locvei, Platoul Carstic Sfânta Elena este un teritoriu foarte pitoresc, caracterizat de un relief carstic, acoperit de pajiști de mare valoare conservativă. În ultimul deceniu, acest teritoriu a fost supus unor presiuni antropice în creștere, iar îngrijorările cele mai mari asupra biodiversității au apărut odată cu ridicarea unui parc eolian în anul 2011. Pornind de la o îngrijorare exprimată de un cercetător român, studiul nostru își propune să furnizeze date actuale privind starea de conservare a speciilor de plante cu valoare conservativă și a pajiștilor cu orhidee din jurul turbinelor eoliene, după zece ani ai fazei operaționale. În această perioadă am identificat 19 taxoni cu valoare conservativă, dintre care opt specii de orhidee. Patru dintre orhidee fac obiectul unor noi raportări privind flora acestui teritoriu: *Gymnadenia conopsea*, *Neotinea ustulata*, *Neottia nidus-avis* și *Orchis simia*, alături de alți taxoni care sunt menționați pentru prima dată, precum *Cirsium grecescui*, *Lathyrus*

sphaericus, *Linum hologynum* și *Rumex thyrsiflorus*. Pajiștile cu orhidee din zona parcului eolian corespund habitatului Natura 2000 6210* a cărui structură și compoziție floristică se încadrează în limitele acceptabile ale stării de conservare Favorabile. Starea de conservare a speciilor de plante depinde în mod direct de calitatea habitatului lor, precum și de varietatea factorilor de presiune și amenințare din zonă.

Received: 7.09.2021; Accepted: 30.09.2021.