



EFFICIENCY ASSESSMENT OF DIFFERENT FORMS OF FLORA AND VEGETATION PROTECTION IN THE OJCÓW NATIONAL PARK (SOUTHERN POLAND)

ANNA SOŁTYS-LELEK, BEATA BARABASZ-KRASNY

A. Sołtys-Lelek, Ojców National Park,
32-047 Ojców 9, Poland, e-mail: ana_soltys@wp.pl

B. Barabasz-Krasny, Institute of Biology, Department of Botany, Pedagogical University,
Podbrzezie 3, 31-054 Kraków, Poland, e-mail: beata_barabasz@poczta.onet.pl

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ABSTRACT. The following paper is summarising the efficiency of the currently known forms of protection of flora and vegetation coat of the Ojców National Park (OPN). The main threat to both the flora and the vegetation coat of OPN occurred to be the changes in the habitat conditions. The most exposed to extinction here are plants and non-forest plant communities: xerothermic grasslands and meadows. The main factors threatening their survival are: afforestation and spontaneous succession of forest vegetation. The lack of measures of active protection until the beginning of the 1980's, caused the significant decrease of the communities surfaces and the elimination of many non-forest species. The active protection aimed at single endangered taxa was managed in barely few cases and did not always bring expected results. Definitely better effects were achieved after covering the whole non-forest ecosystems with active protection, which secured their relative durability. The strict protection in OPN was successfully applied only in case of species and forest communities.

KEY WORDS: nature conservation, flora and vegetation, plant succession, active protection, Ojców National Park, Poland

INTRODUCTION

The Ojców National Park (OPN) is situated in the southern part of Kraków-Częstochowa Upland (Wyżyna Krakowsko-Częstochowska; N – 19°46'55,979"E 50°15'4,086"N, E – 19°51'11,998"E 50°10'29,894"N, W – 19°46'9,501"E 50°12'55,254"N, S – 19°50'47,379"E 50°10'13,017"N; Fig. 1). The flora of the Park includes around 950 vascular plants (MICHALIK 1978), out of which 89 are species protected by law, where 77 are covered with strict protection and 12 with partial protection (Disposition of Minister of Environment on 9 July 2004 – Rozporządzenie Ministra Środowiska z dnia 9 lipca 2004 r.). They consist a relatively large part of flora of rare species in the regional and national scale (*Thymus praecox*, *Carex pediformis*, *Verbascum chaixii* ssp. *austriacum*, *Stipa joannis*, *Cerasus fruticosa*, *Aster amellus*), which proves the high floral value of the Park and its significance in the protection of gene resources. It is also worth noticing that the described area is the smallest national park in Poland.

Populations of all taxa, existing within the borders of OPN are the subject of protection, therefore distinguishing the species which are subject to strict and partial protection of national law in the Park, practically does not change their status. It only may be significant in case of trees and shrubs (*Daphne mezereum*, *Frangula alnus*,

Sorbus intermedia, *Taxus baccata*, *Hedera helix*, *Viburnum opulus*) growing on the areas covered with partial protection. In such mode those species are preserved against tree cutting conducted as a part of silviculture. Still before the foundation of the Park, due to tree cutting and direct destruction of habitats, for example *Taxus baccata* was completely exterminated on natural stands. At the beginning of the 20th century JELENKIN (1901) specified this species as "widespread on woody sides of Ojców Valley (Dolina Ojcowska)". Nowadays all specimens existing in the Park were planted between 1971-1972. Only one specimen on a natural stand was found in Pieskowa Skała hamlet, probably brought by birds from the neighbouring Zamkowy Park (Park Zamkowy; Fig. 1; SOŁTYS-LELEK and BARABASZ-KRASNY 2009).

THE MAIN FACTORS NEGATIVELY AFFECTING THE FLORA AND VEGETATION OF OPN

Among the factors with negative influence on flora and vegetation coat of OPN there are: direct destruction of plants, disturbances and the changes in habitat conditions, changes of the size of the community surfaces, infestation of alien species.

The direct destruction of plants in the OPN did not, and at present also does not, have particular significance

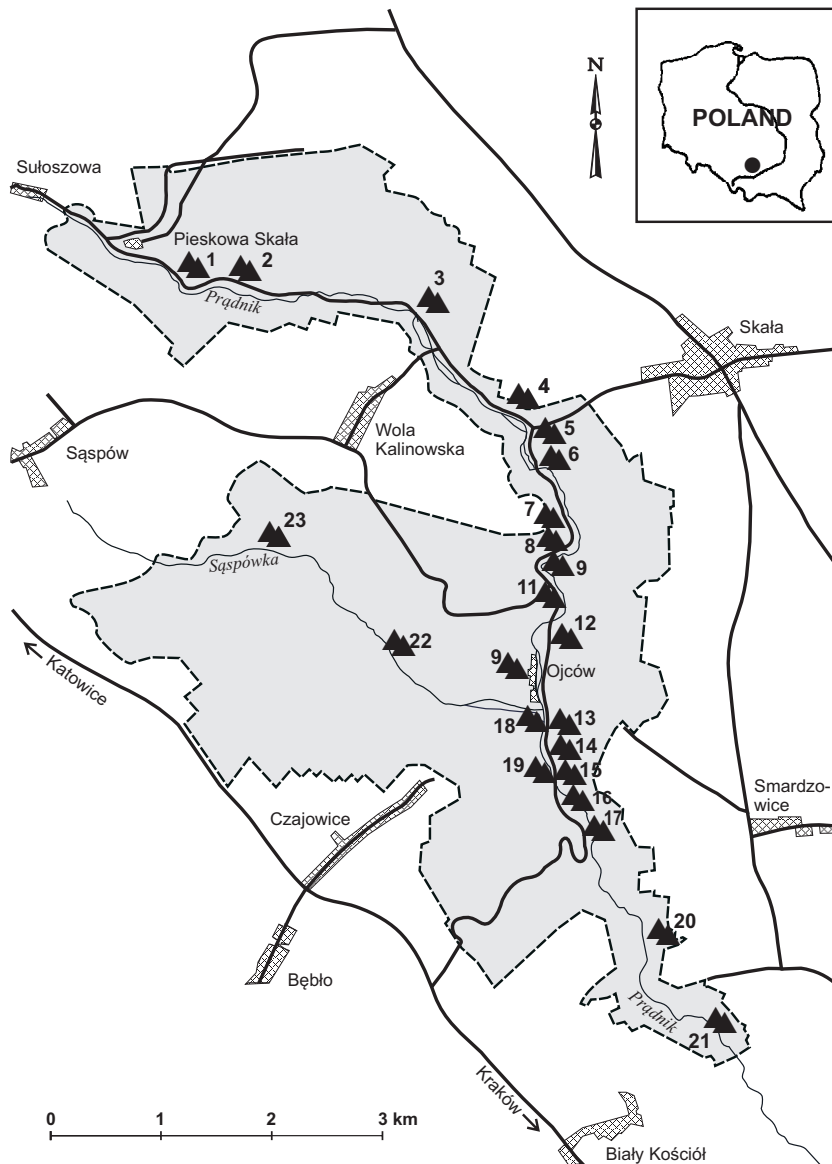


FIG. 1. Map of Ojców National Park with selected rock complexes, located in Prądnik (1-21) and Saspowska (22-23) Valleys: 1 – Rocks in the Pieskowa Skala hamlet, 2 – Wernyhory Rocks, 3 – Wdowie Rocks, 4 – Grodzisko (Długa Rock, Skamieniały Wędrowiec Rock), 5 – Pochylce Rocks, Łamańce Rocks, 6 – Ciche Rocks, 7 – Górkowa Rock, 8 – Górczyna Rock, 9 – Prałatki Rocks, 10 – Zamkowe Rocks, Nad Trzaską Rocks, 11 – Ojców village, Zamkowa Mountain, 12 – Czyżówki Rocks, 13 – Bystre Rocks, 14 – Panieńskie Rocks, Kawalerskie Rocks, 15 – Koronna Mount, 16 – Wapiennik Rock, 17 – Okopy Mount, 18 – Jonaszówka, 19 – Brama Krakowska, 20 – Krzyżowa Rock, 21 – Łaskawiec Rock, 22 – Saspowska Valley (Szalej Rock), 23 – Koziarnia Rock

in the species protection. In the times when Ojców functioned as a health resort well known in Galicia and before the foundation of the Park, this factor affected adversely the population size of taxa that were considered decorative. Due to picking the specimens for decorating and collecting purposes up to the middle of 20th century *Stipa joannis* and *Cypripedium calceolus* were almost completely exterminated (MICHALIK 1991, 2006). Those species are currently the most numerous in places that are difficult to access, where they are not directly exposed to anthropopression (SOŁTYS-LELEK and BARABASZ-KRASNY 2009).

The main threat for plants and the whole communities in the area of the Park were and still are disturbances, as well as changes in habitat conditions. It concerns mainly the grassland and meadow species, growing in semi-natural non-forest ecosystems. Those communities are of the anthropoclimax nature which is stabilised by the traditional pastoral farming and scything methods (BIDERMAN 1990, KORNAŚ 1990, KORNAŚ and DUBIEL 1991, BARABASZ 1994, BĄBA 1999, MICHALIK 1990 b, 2006).

In 1956 14% of the OPN (225 ha) surface was covered with strict protection. In the 70's the area of strict

protection was increased to 22% (353 ha). It included large rock massifs with xerothermic vegetation, that appeared along the left side of the Prądnik Valley (Fig. 1). It soon occurred that it was a wreaking havoc move. Forms of conservation together with the discontinuance of arable cultivation and the forestry planting (accordant with the then regulation of the Council of Ministers) caused the total surface of the thermophilous grasslands to decrease here by 70% (BĄBA 1999). In consequence the diversity of flora and vegetation coat decreased and thereby the fundamental purpose, for which OPN was founded, was threatened (BIDERMAN 1990).

The changes of the surface size and of the species composition of the forest communities also have had a significant impact on the vegetation coat of the Park. In the 60's the dominating forest community was covered with mixed coniferous forest *Pino-Quercetum*, which consisted 38% of the surface of the Park (MEDWECKA-KORNAŚ 2006). High proportion of pines in the forest communities resulted from afforestations executed at the end of the 19th century, mainly in the hilltop part of the present Park, where clear cutting preceded (SUCHECKI 1925, MICHALIK 1974). The second dominating community was dry-ground forest *Tilio-Carpinetum*, which consisted 16% of the surface here. Relatively small percentage of the surface was overgrown with carpathian beech wood *Dentario glandulosae-Fagetum* (9%), thermophilous beech wood *Fagus sylvatica-Crucifera glabra* (0.3%) and sycamore forest *Phyllitido-Aceretum* (0.01%). Between 1960-1990 the total surface of coniferous forests in OPN decreased by 87% and currently it equals only 5%. At the same time the expansion of dry-ground forest (up to 40%) and Carpathian beech wood (up to 31%) took place (PARTYKA 2005). The changes of such extent that took place in the forest communities and the significant extension of the area covered with strict protection essentially influences waning of some coniferous forest species and the spreading of taxa from deciduous forests (MEDWECKA-KORNAŚ and GAWROŃSKI 1990, MICHALIK 1990 d, MEDWECKA-KORNAŚ 2006).

The phenomenon of the species of alien origin expansion is another problem related to the protection of biodiversity in OPN. The processes of anthropogenisation of the native vegetation coat which have progressed intensively in the last years were favourable for the invading of the alien newcomers (TOKARSKA-GUZIŁ 2003). It is estimated that 127 species recorded in the flora of the Park are anthropophytes, out of which 41 are neophytes that have quite recently arrived here (MICHALIK 1978). The most expansive among them are:

- *Impatiens glandulifera* – observed in the 1960's on only one stand (MICHALIK 1978). In 2002 it appeared in the number of about 249 species on six stands and two years later the population numbered already 1245 species on seven stands and in 2009 over 3000 on 28 stands (SOŁTYS-LELEK and BARABASZ-KRASNY 2010). The stands of this species are related to fertile communities such as: *Alno-Ulmion*, *Geranio-Petasitetum*, *Urtica dioica-Cirsium oleraceum*.
- *Impatiens parviflora* – specified in the 1960's as scattered on the area of the Park (MICHALIK 1978). It is counted among the most invasive in the flora

of OPN, because it is present in all forest, ruderal and synanthropic communities of the Park (e.g. *Tilio-Carpinetum*, *Dentario glandulosae-Fagetum*, *Urtico-Aegopodietum*, *Phalarido-Petasitetum*). It is common and it appears in the form of small concentrations as well as fields numbering even several hundreds of specimens.

- *Reynoutria japonica* – a species observed in the 1960's only on one stand (MICHALIK 1978). At present it holds 21 stands in the area of the Park. It grows by the Prądnik stream and along the main communication routes (e.g. *Urtico-Aegopodietum*, *Phalarido-Petasitetum* and *Alno-Ulmion*). The formation of dense patches with its participation has not been observed so far in OPN.
- *Solidago gigantea* – a species specified in the 1960's on three stands only (MICHALIK 1978), but currently they are widespread on the entire area of the Park, in the alluvia of Dolina Prądnika Valley and in humid forests.

The dangers resulting from the presence of alien species are first of all related to the possibility of their quick spreading and displacing the native taxa. It applies especially to *Solidago gigantea* and *Reynoutria japonica*, which originate from a group of arduous and hard to exterminate species (TOKARSKA-GUZIŁ 2003).

THE EFFICIENCY OF THE CURRENT FORMS OF PROTECTION OF THE FLORA AND VEGETATION COAT

Strict protection

The increase of the size of the area of deciduous forests and including them into strict protection enabled the return or even significant expansion of the shade-loving forest species. The greatest percentage increase of the number of stands was observed among others in case of: *Phyllitis scolopendrium* – to 300% of initial number (BODZIARCZYK et al. 2006), *Galium odoratum* – by about 70%, *Aruncus sylvestris* and *Vinca minor* – by about 50% or *Aconitum moldavicum* – by more than 30% (SOŁTYS-LELEK and BARABASZ-KRASNY 2009). *Allium ursinum*, that had not been recorded for 135 years and acknowledged extinct on the territory of the Park, also appeared in the forests of Ojców. In 2006 the population of that species occupied the area of 0.9 sq. m and numbered 22 individuals (SOŁTYS 2007). In 2008 the number of specimens increased to 48 individuals, which attests to the good shape of this population.

Covering the sides of the Prądnik Valley and the Sąspowska Valley with strict protection had a positive effect on forest vegetation, but in case of the species of thermophilous grasslands it started the process of their extinction. It was recorded that, for example, between 1960 and 1996 as many as 20 xerothermic species became extinct, among others: *Dianthus armeria*, *Rosa gallica*, *Orobancha alba*, *Orchis morio*, *O. ustulata* (in the 80's), *Cirsium pannonicum* and *Anemone sylvestris* (at the end of the 90's). The number of stands of *Carlina acaulis*, *Cerasus fruticosa* and *Centaurium erythraea* significantly decreased (MICHALIK 1990 a, c, MICHALIK 2006, SOŁTYS-LELEK and BARABASZ-KRASNY 2009).

Similar changes applied also to the meadow vegetation. The area of *Arrhenatheretum elatioris* decreased from 14.47 ha between 1959 and 1961 to 4.86 ha in 1988 due to the discontinuance of use (MICHALIK 1990 b, KORNAŚ and DUBIEL 1991, PARTYKA 2005). As a result of the forest-brushwood succession of the meadows *Gentiana cruciata* became extinct in the 70's and *Phyteuma orbiculare* in the 1990's. The draining of the waterlogged meadows contributed to the extinction of *Gentiana pneumonanthe*, *Traunsteinera globosa* and *Epipactis palustris* in the 1960's and 1970's (PARTYKA 2005).

Reintroduction

So far the measures of protection of single rare or threatened species in the area of the Park has been conducted in few cases with various effects. The following cases of reintroductions may be regarded as successful:

- *Sanguisorba officinalis* – in the 1960's this species was not numerous, on two stands in OPN (MICHALIK 1978). At the beginning of the 1990's it was planted on a meadow in the Sąspowska Valley, together with the reintroduction of the butterflies from the *Maculinea* genus, being a host plant for them. Currently it remains quite numerous on the reintroduced stand.
- *Anemone sylvestris* – this species became extinct by the middle of the 1990's due to the forest succession on the territory of the Park. The specimens for its reintroduction were obtained from the stand in the Miechowskie Mountains – the Miechowska Upland in 2005 (SOŁTYS and WIŚNIEWSKI 2005). It was the only successful method of reintroduction of this species, since the population study over succeeding of *ex situ* germination of the earlier collected seeds has shown, that the percentage of the germinating seeds is quite small and the mortality of seedling relatively high (KĘDRA 1998). The new populations of *Anemone sylvestris* are under a permanent annual monitoring. Thus species remains in all stands, apart from Grodzisko, where it has probably been excavated. Currently the most numerous population is located in the massif the Koronna Mount (Table 1).

The decrease of the number of specimens on other stands is related to the excessive expansion of grasslands, especially *Brachypodium pinnatum*.

However, the reintroduction of *Trollius europaeus* conducted in the 1990's and the introductions of *Betula oycoviensis* in the 1960's and *Cochlearia polonica* in the 1990's were not successful. Those species had remained on their new stands for few years, but then they became extinct, most probably due to the excessive shadow on the stands (KWIATKOWSKA and KAZIMIERCZAKOWA 1992).

The repeated introduction of *Betula oycoviensis* was planned for 2009 and the regeneration of populations of species that have not been observed in OPN for a dozen or so years e.g. *Cirsium pannonicum* or for even more than thirty years e.g. *Rosa galica* is planned in the future (MICHALIK 1978, POPEK et AL. 2004).

Elimination of the invasive species

Due to the presence of alien invasive species some actions of limiting their expansion on the OPN territory were taken. In 2005 there were trials of removing the overground shoots and underground rhizomes of *Reynoutria japonica* on three stands within the borders of OPN. But after performing those measures neither the decrease of the number of specimens, nor limiting the area of their occurrence was observed. It turned out that pruning the shoots and excavating the rhizomes, that grow even within a 7-metre radius from the parent thicket, does not suffice. Those measures contributed to a temporary attenuation of the vitality of the specimens, but in the next years from the underground rhizomes new plants have sprouted. Currently applying combined measures i.e. joining the mechanical combating with the chemical – injecting the shoots with chemicals directly (ROBLIN 1988, BEERLING 1990) – is being planned.

Mowing of selected patches of *Impatiens glandulifera* has not had positive effects either. Those measures have been repeated for several years, but the surfaces have not been mowed precisely and numerous specimens have been left on the edges of the patches. Nor is the mowing eliminating the seed bank deposited in the soil.

TABLE 1. Number of specimens of *Anemone sylvestris* on the localities in Ojców National Park, noticed in years 2005-2009*

Locality	2005		2006		2007		2008		2009	
	Number and type of specimens									
	OW	OG	OW	OG	OW	OG	OW	OG	OW	OG
Grodzisko	7	3	–	–	–	–	–	–	–	–
Ojców – Zamkowy Park	2	2	1	1	1	1	–	2	–	–
Ojców – Zamkowa Mount	26	6	15	6	6	1	8	–	4	–
Koronna Mount	9	9	6	4	5	4	11	2	16	4
Number of specimens in year	44	20	22	11	12	6	19	4	20	4
Total number of specimens	64		33		18		23		24	

OW – vegetative specimens, OG – generative specimens (fount: own authors data).

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The above examples demonstrate that temporary and single spot focused elimination of the species of alien origin is completely ineffective. Therefore working out the complex plans, that include regular application of the measures of combating those species on the entire area of the Park, becomes necessary.

Active biotopic protection

Western countries such as the Great Britain, Denmark, the Netherlands, where the degree of transformation of the vegetation coat, including the protected areas, is very large, supplied us with the experiences in the field of applying active protection. Earlier, in those countries, the need to carry out research and experiments aiming at working out effective methods of controlling the succession on non-forest protected areas arose. Various models and examples of active methods of protection of semi-natural communities have existed for a long time (HARPER 1971, WATT 1971, WESTHOFF 1971, DUFFEY 1974, NAVEH 1978, CONSERVATION BIOLOGY... 1980, MEYERS and SHELTON 1980, PETERKEN 1981, SHEAIL et AL. 1997). As far as the general ideas were concerned those experiences could be followed, but they had to be adjusted to the local conditions and indispensable control of their results had to be applied.

Unfortunately the protection of grasslands in OPN started to be executed relatively late and to a slight extent at the beginning. First trials were carried out in 1982, on a small patch of grassland on the Jonaszówka Rock, at the outlet of the Sąspowska Valley (Fig. 1). For some years before it had been discussed which place should be chosen for this experimental measure and how it should be carried out, since the majority of the massifs with naturally valuable grasslands at that time were located on the area strictly protected. The direct impulse for executing active protection in that place was a drastic decrease in the number of the *Stipa joannis* population. Those activities definitely started the active protection of the non-forest ecosystems in OPN (PARTYKA 2001).

Moreover, there were two other refugia covered with the scope of protective measures at that time: on Grodzisko hamlet and on the Krukowski Rock (Fig. 1). Yet they had a very limited range, because the chosen surfaces were located either on private grounds or on the area of strict protection. The possibility of planning the measures of active protection in other overgrowing patches of xerothermic grasslands, required excluding them from strict protection (BIDERMAN 1990).

In 1985 by virtue of the decision of the Minister of Forestry and Timber Industry 8.4 ha was excluded from the strict protection (BIDERMAN 1990, PARTYKA 2001). Since then the planned measures of the active protection of the grasslands, that include larger rock groups along the Prądnik Valley, have been performed. The removal of trees and shrubs, as well as their brushwood and also mowing and removing dry plant biomass are

some of the active protection measures performed in OPN. Between 1982 and 1987 the measures were applied quite irregularly and concerned only five refugia (BĄBA 1999). In the 90's of the last century only nine rock massifs were under active protection. Not until 2003 and 2008 the protective measures were expanded on the majority of large rock complexes of the Prądnik Valley (Table 2). Until 2009 about 16 ha of xerothermic grasslands altogether had been revealed.

The active protection of meadows in OPN started in 1984. The contracts of tenancy on part of the meadows being the property of OPN were then terminated and mowing was started. Due to the lack of the equipment and the staff about 7 ha in the Sąspowska Valley were mowed then at one time. In 1985 by the above mentioned decision of the Minister of Forestry and Timber Industry on 34 ha of the meadows partial reserves were founded. In the following years, in spite of complementing the equipment, not more than 10 ha of the reserve meadows yearly were included into mowing, but many of them were mowed only once a year, leaving the cut biomass there (BIDERMAN 1990, PARTYKA 1994). With the progressive degradation, for part of the meadows the tenancy for the local farmers was restored, but for some of them due to the reconstruction of the vegetation there were no candidates for developing it (BIDERMAN 1990). Only just in 1997 in the upper, middle and lower part of the Sąspowska Valley 31.08 ha were mowed (PARTYKA 1998). The regular active measures on this territory have been performed only since 2001. They include single or multiple mowing together with collecting the biomass. Currently about 63 ha of meadows and thickets are covered with active protection. The aim of those measures is keeping and restoring their typical species composition. However, the meadows of OPN consist a convincing evidence that breaking active protection, mistakes or irregularity of the measures contribute to fast degradation of the non-forest biotopes, that later significantly slow down the process of their regeneration.

MONITORING

With the extension of the range of the applied measures of active protection, the monitoring of their effects has been introduced in OPN. This monitoring is conducted on two levels: the observation of the whole endangered communities and the observation of the population of the rare and threatened species.

In case of the meadows of OPN monitoring was as irregular as the measures of active protection. The observations done still in the 90's proved for example that leaving the cut vegetal biomass on the meadow was very unfavourable, because it caused intensive organic fertilisation (composting). As a result poor in species aggregations of nitrophiles with the contribution of: *Urtica dioica* *Rumex obtusifolius*, *Cirsium oleraceum* and *Galium aparine* was generated (KORNAŚ and DUBIEL 1991, MICHALIK 1990 b, BARABASZ 1997). The regeneration of floristically rich meadows on degraded in such way areas in a short time is impossible. The process of regeneration progresses slowly due to the drastic changes

TABLE 2 – cont.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
Panięskie Rocks – protection of xerothermic grasslands	-	-	-	*	-	-	-	-	-	-	*	-	-	-	-	*	*	**	**	**	**	**	**
Kawalerskie Rocks protection of xerothermic grasslands	-	-	-	-	-	-	-	-	-	-	*	-	-	-	-	-	*	*	*	**0.1	**	**	**
Krukowski Rock – protection of xerothermic grasslands	*	-	-	-	-	-	-	-	-	-	*	-	-	-	-	**	**	*	**	**	**	**	**
Koronna Mount – protection of xerothermic grasslands	-	-	-	*	-	-	*	-	*	-	**	*	*	-	-	*	*	**	**	**	**	**	**
Puchacza Rock – protection of xerothermic grasslands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	**	*	*	**	**	*
Krzyżowa Rock – protection of xerothermic grasslands	-	-	-	-	-	-	-	-	-	*	**	*	**	-	-	-	**	**	**	**	**	**	**
Węże Rocks – protection of xerothermic grasslands	-	-	-	-	-	-	-	-	*	(nd)	*	-	-	-	-	*	-	-	-	-	-	-	-
Baszta Rock – protection of xerothermic grasslands	-	-	-	-	-	-	-	-	-	(nd)	(0.06)	(nd)	(nd)	-	-	-	*	*	**	**	**	**	**
Górczyna Rock – protection of xerothermic grasslands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	*	*	*
Górkowa Rock – protection of xerothermic grasslands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	**	**	**	**
Figowa Rocks. Ostrogi. Bystra – protection of xerothermic grasslands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	*	*	*	*
Zabużaje. Sąspowska Valley – protection of xerothermic grasslands	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**	**	**	**
Skala – stone-pit – protection of <i>Tofieldia calyculata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*	*	*	*	*	*	*
Total	(nd)	(nd)	(nd)	(nd)	(nd)	(nd)	1.6	0.8	4.3	0.315	0.73	(nd)	(nd)	2.0	7.2	6.5	22.7	20.7	21.9	20.9	18.9	15.9	

(nd) – no data, * – removal of trees, shrubs and their offshoot, ** – mowing and removal of biomass.

Reference: BIDERMAN 1990, BĄBA 1999, Analysis of activities of Ojców National Park in years 1999-2008; B. Wiśnowski, A. Kulak, B. Batko, Ojców National Park; verbal information, authors' own observations.

of habitat and vegetation (KORNAŚ and DUBIEL 1991, MICHALIK 1990 b). The majority of meadow patches, mainly in the middle part of the Sąspowska Valley, is still greatly overgrown with nitrophile perennial plants (70% to 80% of the coverage in the phytosociological relev). They require mowing and removing the biomass twice a year. In those patches the characteristic species of the *Molinio-Arrhenatheretea* class such as *Arrhenatheretum elatius*, *Trisetum flavescens*, *Geranium palustre*, *Lathyrus pratensis*, *Achillea millefolium*, *Ranunculus acris* or *Leucanthemum vulgate* are found in quite large numbers. However, low, rosette perennial plants, such as *Leontodon hispidus*, *L. autumnalis* are missing. Quite significant is also the contribution of the species from *Quercu-Fagetu* (*Aegopodium podagraria*) or *Artemisietea* class (*Chaerophyllum aromaticum*) – authors' own data from 2008.

The monitoring of the grasslands in OPN is better organised and it includes several research areas: the Grodzisko hamlet, the Górkowa Rock, the Korona Mount and the Krzyżowa Rock (Fig. 1). The results showing the efficiency of the active protection measures are presented on the example of one of seven research transects established in Grodzisko. In the 1960's agriculturally used rich grasslands with tall herb communities *Origano-Brachypodietum*, where regular grazing and mowing took place, appeared there. Since the 1980's practically until the end of the 1990's an intense succession of trees and shrubs, related with the discontinuance of use of this area, took place (Fig. 2). In 2001 the trees and shrubs were removed and the collected biomass was taken away. Since then, the grassland has been mowed regularly once a year and the offshoots of trees

and shrubs have been removed every two years (SOŁTYS and BARABASZ-KRASNY 2006). After applying the measures the increase of the number of grassland species from *Festuco-Brometea* class and of thermophilous species from *Rhamno-Prunetea* and *Trifolio-Geranietea* classes has been noted. Considering the changes of the number of species found in the presented transect, the regeneration of the grassland may be evaluated positively. The number of the xerothermic species has increased significantly e.g.: *Brachypodium pinnatum*, *Coronilla varia*, *Turritis glabra* and some new appeared: *Verbascum chaixii* ssp. *austriacum*, *Inula conyza*, *Agrimonia eupatoria*, *Centaurea scabiosa* and *Poa compressa*, including *Melica transsilvanica* classified as intensely xerothermic (Table 3). In the first year of the research on the analysed area weakly xerothermic (the IV degree) and probably weakly xerothermic (the V degree) species prevailed. During the next four years their number, similarly as the number of the intensely xerothermic species, with the highest, the I degree, of their being xerothermic, remained generally unchanged. However, the number of moderately xerothermic, with the III degree and xerothermic, with the II degree, species significantly increased (Fig. 3).

The monitoring of the rare species population in OPN, which grow in the non-forest ecosystems or in thermophilous thickets, that has been performed in the places covered with active protection, showed a lot of its positive effects, among others:

- the increase of the number of the population of *Aster amellus* on the only stand in the Park in the Grodzisko hamlet (from about 40 clusters in the 1990's to over a 100 in 2006),



FIG. 2. "Grodzisko". The air photographs of the study area in 1957 and 1996 (by PPG-K Warszawa)

TABLE 3. Changes of species cover-abundance scale and sociability in selected transect on the "Grodzisko" study area, noticed in years 2005-2008

List of species with membership to syntaxonomic units	Year			SK
	2005	2006	2008	
Ch. Cl. Festuco-Brometea				
<i>Clinopodium vulgare</i>	+	2.3	2.3	IV
<i>Brachypodium pinnatum</i>	+	1.2	1.2	III
<i>Verbascum chaixii</i> ssp. <i>austriacum</i>	-	+	+	II
<i>Melica transsilvanica</i>	-	+	+	I
<i>Centaurea scabiosa</i>	-	-	+	III
<i>Poa compressa</i>	-	-	+	III
Ch. Cl. Trifolio-Geranietea sanguinei				
<i>Coronilla varia</i>	+	+	1.2	III
<i>Inula conyza</i>	-	+	+	III
<i>Agrimonia eupatoria</i>	-	+	+	III
Ch. Cl. Rhamno-Prunetea				
<i>Cornus sanguinea</i>	+	+	1.2	VI
<i>Prunus spinosa</i>	+	+	1.2	V
<i>Euonymus europaea</i>	+	+	1.1	-
<i>Cornus sanguinea</i>	-	-	2.2	VI
<i>Rosa sherardii</i>	-	-	+	-
Ch. Cl. Epilobietea angustifolii				
<i>Calamagrostis epigejos</i>	-	+	2.2	-
Ch. Cl. Querco-Fagetea				
<i>Carpinus betulus</i>	+	1.1	1.1	-
Ch. Cl. Molinio-Arrhenatheretea				
<i>Galium mollugo</i>	1.2	2.2	2.2	-
<i>Deschampsia caespitosa</i>	-	-	+	-
Others				
<i>Medicago lupulina</i>	3.2	2.2	1.2	-
<i>Pimpinella saxifraga</i>	1.2	1.2	+	IV
<i>Turritis glabra</i>	+	+	1.1	III

SK – degree of xerothermic (fount: own authors' data).

- the increase of the number of the *Cerasus fruticosa* population in Grodzisko and the Górczyna Rock,
- the maintaining of the generative specimens of *Stipa joannis* on the Jonaszówka Rock (where the species was threatened with extinction) and the increase of the population of that species on the stands of the Krukowski Rock and Kawalerskie Rocks (Skały Kawalerskie) by nearly 40%,
- appearing of new stands of the *Atropa belladonna* and *Epipactis atrorubens* in the overexposed thickets.

The above mentioned species are rare in the Park, therefore from the protection of its biodiversity point of view they are particularly valuable.

The positive changes of the communities, especially the xerothermic grasslands and the population of rare and threatened species, observed after the application of the measures of active protection, induce to the conclusion that the best form of protection in the non-forest ecosystems of OPN is the biotopic protection, focused on active measures, securing the durability of the whole communities. The research carried out on the territory of the Park confirms the fact that the regeneration of the xerothermic grassland by mowing is possible when excessively dense thickets have not been formed and notably photophilous species managed to survive the unfavourable period and also when the fragments

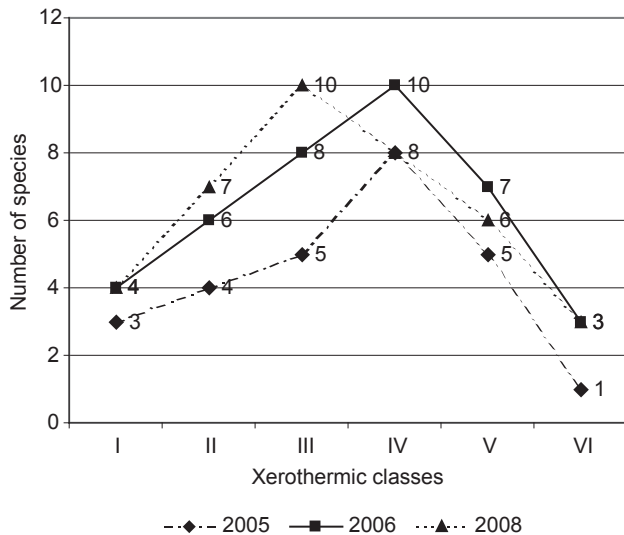


FIG. 3. Number of species with various degree of xerothermic properties, noticed in years 2005-2008, in the selected transect on "Grodzisko" study area: I – strongly xerothermic, II – xerothermic, III – moderately xerothermic, IV – weakly xerothermic, V – very weakly xerothermic, VI – thermophilous (fount: own authors' data)

of the so-called "old grasslands" with rich xerothermic flora, constituting the basis for spreading of the grassland species, have been preserved (BĄBA 2007).

On the surfaces of the former grasslands, where excessively thick and fertile layer of soil has formed, shrub removing and mowing only does not suffice. In spite of the cyclicity of repeating the active protection measures every year, a significant percentage increase of the surface covered with characteristic species form *Rhamno-Prunetea* class e.g.: *Cornus sanguinea*, *Prunus spinosa* and *Euonymus europaea* was observed. It confirms the formation of the habitat conditions favouring the succession in the direction of thermophilous thickets. Therefore the modification of only the measures and combining them with for example grazing should be considered.

Due to the habitat changes, which took place in the past decades within the rock massifs of the Prądnik Valley, a discussion was started over, which places should be chosen for performing further measures of active protection, as well as their purposefulness. The following question arises here: Is the wide range cutting of the forest communities situated along the Prądnik Valley massifs reasonable for the process of grasslands regeneration? Unfortunately during the past 50 years dense forests have been formed which happened due to the succession of trees and shrubs on a part of the former grassland surface. It is suspected that the process of grassland regeneration has become probably impossible. Therefore in those places the focus should be on protecting the currently appearing forest species and vegetation coat.

CONCLUSIONS

The most desirable strict protection in the National Park, should cover the vastest possible territory of the forest communities. At the moment enlarging the strict

protection area in OPN by another 40.29 ha is planned. The measures of protection of single, rare or threatened species consisting in their reintroduction were carried out in some cases, but their effects have not always been positive.

The temporary and single spot focused elimination of the species of alien origin is completely ineffective. Therefore working out complex plans, that would include regular application of the measures of combating those species on the entire area of the Park becomes necessary.

The best form of protection of the non-forest communities and the related with them rare species population on the area of the Park, occurred to be the biotopic protection, focused on active measures securing the durability of the whole communities. Applying active protection on the patches of the xerothermic grasslands influences favourably maintaining their typical species composition and contributes to the increase of the number of the grassland species. Breaking active protection, mistakes or irregularity of the measures contribute to fast degradation of the non-forest biotopes, which in case of the OPN meadows significantly slowed down the process of their regeneration.

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