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Selected Aspects of the Protection of Biotopes... on the Example of the Ojców National Park (Southern Poland)

Introduction

Ojców National Park (ONP) is located in the southern part of the Kraków-Czestochowa Upland macroregion, which is a part of the "Polish Highlands" province within "Post-hercynian Western Europe" megaregion (Kondracki 1998). It occupies the space of 2 145.62 ha. It consists of two deep karst valleys: the Prądnik Valley (Dolina Prądnika) and the Sąspowska Valley (Dolina Sąspowska), both carved in limestone rocks from the Upper Jurassic Age. Numerous side canyons and gorges come down to the above-mentioned valleys. Their depth ranges from 40 to 100 m. Two permanent streams – Prądnik (12 km in length) and Sąspowka (4.5 km in length) go down the valleys. Both streams are supplied with water by about 30–50 springs. The total length of permanent waterstreams in the Park is over 17 km (Partyka 2012). The climate of the Park shows the characteristics of the mountain climate. The average annual temperatures range from 7.5°C in the flattened upper part of the Sąspowska Valley to 6.2°C at the bottom of the valley. The average annual rainfall in the valley comes to 731.7 mm (Partyka & Klasa 2008).

Vegetation of the OPN is characterized by a mosaic of plant layout. These communities are the second richest mainstay of mountain plants (5% flora) right after mountains and a valuable mainstay of xerothermic species (25% flora). Rare species make relatively high contribution to the OPN flora on a regional and national scale, for example *Aster amellus* L., *Carex pediformis* C.A. Mey, *Cerasus fruticosa* Pall., *Orobanche bartlingii* Griseb., *Stipa joannis* Čelak. s.s., *Thymus praecox* Opiz, *Verbascum chaixii* ssp. *austriacum* (Schott ex Roem, & Schult) Hayek. The presence of fungi is characteristic for the local biota, which is unique and has not been found anywhere else in the country outside of Ojców, for example *Hemimycena mairei* (E.-J. Gilbert) Singer, *Lepiota boudieri* Bres., *Agaricus placomyces* Peck, *Conocybe subpallida* Enderle, or *Merulicium fusisporum* (Romell) J. Erikss. & Ryvarden (Wojewoda 2008). One of the lichen species, *Verrucaria polonica* J. Nowak (Kiszka 2008), coming from the Prądnik Valley has already been described for the science. In addition, several

species of invertebrates inhabit these areas, which is very rare in the country, for example *Falniowskia neglectissima* Falniowski & Šteffek, *Truncatellina claustralis* Gredler (snails), *Atypus muralis* Bertkau and *Sintula corniger* Blackwall (arachnids), *Leptothorax sordidulus* Müller, *Palloptera venusta* Loew (insects). The most valuable finds here are relict species, e.g. tertiary *Plutomurus carpaticus* Rusek & Weiner or glacial *Crenobia alpina* Dana (Partyka & Klasa 2008).

The examples mentioned above demonstrate high natural values of ONP and its importance for the protection and conservation of genetic resources. The purpose of this paper is to present some issues concerning the protection of biotopes within the premises of the Park and the benefits of its implementation, as well as general importance of nature conservation in Poland.

Transformation of biotopes in ONP and conservation concept development

The aim of nature conservation in ONP is to maintain its resources, objects and components. Natural resources of the park include above all: plant communities (more than 40 distinguished in the rank of communities), vascular plants *Tracheophyta* (950–970 species), bryophytes *Bryophyta* (311 species), algae *Algae* (325 species), lichens *Lichenes* (196 species), macrofungi *Macromycetes* (about 800 species), microscopic fungi *Micromycetes* (about 420 species), slime moulds *Myxomycota* (97 species) and animals (about 7267 species, including some vertebrates 167 *Vertebrata* and about 7100 invertebrates *Invertebrata*). Among the vertebrates the most numerous group are birds *Aves* (100 species) and mammals *Mammalia* (53 species), and among invertebrates – beetles *Coleoptera* and wasps *Hymenoptera* (Partyka & Klasa 2008). In addition, natural resources of ONP include habitats, creatures of inanimate nature and landscape. ONP is on the Natura 2000 network (PLH 120004) under the Habitats Directive of the Council of Europe 92/43/EEC of 21 May 1992. A detailed list of habitats that require protection in the form of Natura 2000 areas was presented in Table 1.

Table 1. Habitat types in Ojców National Park which require protection in the form of designation of Natura 2000 sites, with indication of priority habitats (by Załącznik nr 1. Załączniki do Rozporządzenia Ministra Środowiska z dnia 6 listopada 2013 r. (poz. 1302)).

Typy siedlisk przyrodniczych OPN, które wymagają ochrony w formie wyznaczenia obszarów Natura 2000, ze wskazaniem siedlisk o znaczeniu priorytetowym (wg Załącznika nr 1. Załączniki do Rozporządzenia Ministra Środowiska z dnia 6 listopada 2013 r. (poz. 1302)).

No.	Habitat code[1)]	Name of the habitat	Priority habitat
1	6210	Xerothermic grasslands *Festuco-Brometea* and thermophilous grasslands with *Asplenion septentrionalis, Festucion pallentis*) Subtype: 6210-1 Grasslands on rocks Subtype: 6210-2 Grasslands with *Stipa* sp. Subtype: 6210-3 Flowery xerothermic grasslands	yes, so when they contain important orchid localities

2	6510	Lowland and mountain hay meadows, used extensively *Arrhenatherion elatioris* Subtype: 6510-1 *Arrhenatheretum elatioris*	no
3	7230	Mountain and lowland bogs, alkaline marshes, sedge meadows and fens 7230-P *Cirsietum rivularis*	no
4	8160	Foothills and upland limestone rubble with the communities of *Stipion calamagrostis* Subtype: 8160-1 Rubble with *Gymnocarpium robertianum*	yes
5	8210	Limestone rock walls with communities *Potentilletalia caulescentis*	no
6	8310	Caves not open to exploring	no
7	9110	Acidic beech forests *Luzulo-Fagetum*	no
8	9130	Fertile beech forests *Dentario glandulosae Fagenion*	no
9	9150	Thermophilous beech-orchid forests *Cephalanthero-Fagenion*	no
10	9170	Central European and subcontinental linden-oak hornbeam forest *Galio-Carpinetum, Tilio-Carpinetum*	no
11	9180	Sycamore-maple, lime forests on slopes *Tilio plathyphyllis--Acerion pseudoplatani*	yes
12	91E0	Willow, poplar, alder and ash forests *Salicetum albo-fragilis*, *Populetum albae, Alnenion glutinoso-incanae* and alder forests of spring niches	yes

[1)] Habitat codes based on the European Commission's interpretative manual – Interpretation Manual of European Union Habitats – EUR28 version containing amendments adopted in 2013.

Right after the ONP opening in 1956, 225 ha (14%) of the Park's surface was given strict protection, the so-called conservator-passive protection (Partyka et al. 1996–1997). In the 1970s the strict protection area has been increased to 22%. The protection also included numerous rock massifs of xerothermic vegetation occurring along the left edge of the Prądnik Valley. It was believed then that the best way to protect large areas of natural beauty is to keep it free from human interference (Szafer 1932). In the first 25 years of ONP existence no protective treatments or interventions in the natural processes were conducted (except for breeding procedures performed in some parts of the forest) (Medwecka-Kornaś 2008). It turned out that in the case of non-forest ecosystems it was a disastrous move. The combination of passive form of protection and termination of the usage of agricultural and forestry activities (according to the decree of the Prime Minister) resulted in the decrease of total area of non-forest ecosystems in ONP in the 1990s by about 70% (Bąba 1999). As a consequence of the changes described above the non-forest species composition was disturbed and the related species started becoming extinct.

It is estimated that between 1960-1996 approximately 60 species of plants related to non-forest ecosystems became extinct. In the group of herbage and shrub plants nearly 10 species died, for example *Epipactis palustris* (L.) Crantz, *Equisetum*

variegatum Schleich., *Molinia caerulea* (L.) Moench s.s., *Poa palustris* L., or *Valeriana dioica* L. s.s. (Michalik 1985, 1991b). In the 1960s there was also a decrease in the number of rare mountain plants, for example *Alchemilla walasii* Pawł. At that time this species had 21 localities in ONP, and in 1990 there was only 6 (Michalik 1996). The ecological group of flora, which in that period suffered the greatest losses, were xerothermic and heat-loving plants; the ones which died were among others: *Campanula bononiensis* L., *Carex praecox* Schreb., *Gentiana cruciata* L., *Gentianella amarella* (L.) Börner, *Hieracium echioides* Lumn., *Onobrychis arenaria* (Kit.) DC., *Orchis morio* L., *O. ustulata* L., *Orobanche alba* Stephan ex Willd., *O. lutea* Baumg., *Rosa gallica* L., *Salvia nemorosa* L. (Michalik 1990a, 1996, Michalik 2006, Sołtys-Lelek & Barabasz-Krasny 2008). Other species, such as *Aster amellus*, or *Inula ensifolia* L., reduced the area of occurrence and were threatened with extinction. The decay process of light-loving species was also observed in other taxonomic groups. For example bryophytes *Grimmia anodon* Bruch & Schimp. and *Weissia condensa* (Voit) Lindb. have disappeared as a result of overgrowth of rocks and grasslands (Stebel *et al*. 2008). The overgrowing of rocks and xerothermic grasslands resulted not only in the loss of natural, but also scenic and landscape values of ONP valleys (Sołtys-Lelek & Barabasz-Krasny 2007).

Similarly to xerothermic grasslands, ONP meadows and pastures were a subject to adverse changes. In the 1950s the bottoms of the valleys were dominated by fresh meadows of Ryegrass *Arrhenatheretum elatioris* (Br.-Bl. 1925) Koch 1926, with a balanced and rich floristic composition – an average of 50 species/100 m^2 (Medwecka-Kornaś & Kornaś 1963, Michalik 1990b, Kornaś & Dubiel 1990, 1991a, b). Since the end of the 1960s in connection with the abandonment of farming, grazing and mowing in the Park, the accumulated natural organic matter caused overfertilization of meadows, resulting in a drastic depletion of the species composition of sward. At that time the characteristic meadow species died and high nitrophilous perennials including *Cirsium oleraceum* (L.) Scop., *Rumex obtusifolius* L. and *Urtica dioica* L. spread. This established a new community which had not been previously listed in the Park. The lack of grazing led to the almost complete disappearance of grazing communities *Lolio-Cynosuretum* R.Tx. 1937, which occurred fairly commonly in the 1950s in the form of small patches.

Significant changes of the flora of meadows greatly influenced the entomofauna inhabiting them. Studies conducted in 1995-1999 showed that in the meadows mown regularly there were 21 species of flies of the *Tephritidae* and *Pallopteridae* families, in the not-mown meadows or the ones mown occasionally there were only 1 to 7 species (Klasa 2001). Witkowski (1969) observed the process of fauna change in not-mown meadows on the example of weevils *Curculionidae*. Although he did not demonstrate differences in species composition, he found a greater number of insects from this group in the mown meadows. At the same time the number of trees and shrubs polyphages in the mown meadows that had been quite rare before increased.

The aquatic biotopes were also a subject of change. According to the Statistical Yearbook of the Cracow province 1998 (*Rocznik statystyczny woje-wództwa krakowskiego z* 1998 r.) the water of Prądnik was described as not classified. Deterioration of water quality of the area resulted in the extinction of three species of bugs *Hemiptera*, 25 species of beetles *Coleoptera* and five species of caddisflies *Trichoptera* (Dumnicka & Szczęsny 2008).

Due to unfavourable changes in non-forest ecosystems, in the late 1970s people recognized the need for adjustments in the Nature Conservation conducted in ONP. However, these were individual voices which did not turn into practical solutions, and the views of conservative protection were firmly established in the minds of many people from the world of science and decision-makers (Partyka & Sołtys-Lelek 2014). Passive protection – the strict one – was still considered to be an effective strategy for the existence of plant communities. However, people began to think of ways to protect the landscape and xerothermic vegetation of the Prądnik Valley, which this park was created for. In 1985 they officially demanded the protection of biological diversity in the context of preserving the rich gene pools in the changing environmental conditions (Biderman 1990, Michalik 1991a, Medwecka-Kornaś 2008). Then the concept of the so-called active protection arose, which was meant to preserve the natural values of non-forest ecosystems, especially in small areas. The first study by S. Michalik (1985), was published, in which the author identified the needs and goals of conducting active protection. This researcher indicated an active protection zone within ONP, which also covered the idea of restitution of the natural landscape. This was a breakthrough in the discussion and perception of active protection of nature and landscape in the Park (Partyka & Sołtys-Lelek 2014).

The first experimental trial of active protection in ONP was carried out in the year 1982, in Jonaszówka – a small piece of land at the entrance of the Sąspowska Valley (Figure 1).

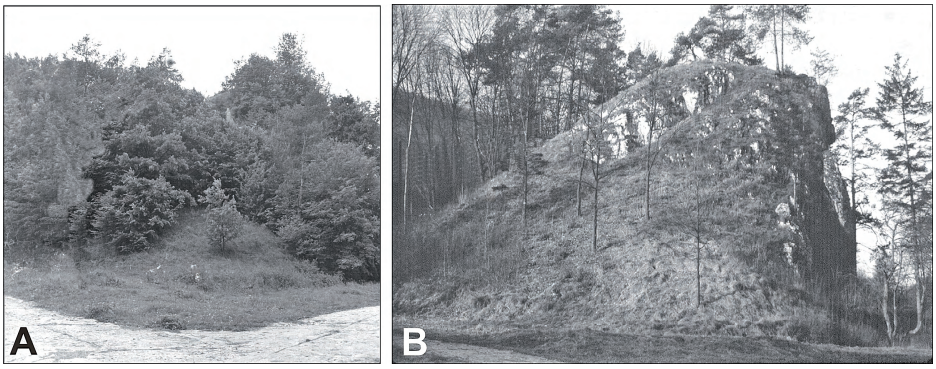

Figure 1. "Jonaszówka Rock" in Ojców National Park with the locality of Stipa joannis L.; A – year 1982, B – after partial exposure in 1995. Photo J. Partyka

A small monadnock limestone with valuable species of flora – *Stipa joannis* was discovered then. Expanding the area of these activities was only possible in 1985, after excluding 8.4 ha of the park from the strict protection, by decision of the Minister of Forestry and Wood Industry (Biderman 1990, Partyka 2001). Since then numerous planned active conservation measures on non-forest ecosystems have been conducted, including the larger massifs along the Prądnik Valley. Between the years 1982-1987 treatments were conducted fairly irregularly and referred to only 5 refuges of the xerothermic grasslands (Bąba 1999). Only since 2003 the acreage of performing active protection has been expanded. Between the years 2003–2010 protective measures covered most of the major rock complexes of the Prądnik Valley, an area of approximately 16 ha (24 refuges). In total, since the year 1982, protective measures have been conducted in 28 refuges of large rock complexes in the Prądnik Valley (Figure 2).

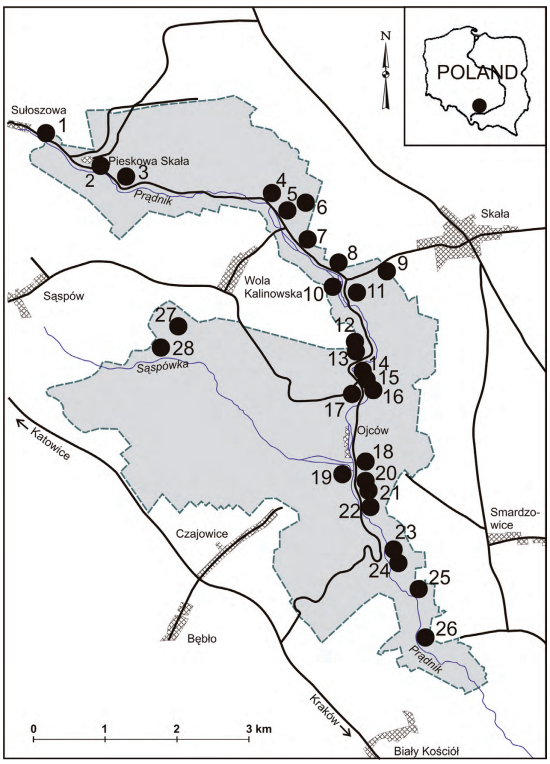

Figure 2. Refuges of xerothermic vegetation treatments under the active protection in the Ojców National Park in the years 1982–2013

1 – Kocica Rock, 2 – Pieskowa Rock, 3 – Wernyhory Rocks, 4 – Wdowie Rocks, 5 – rocks between Wdowie Rocks and Pilny Dół, 6 – Pilny Dół, 7 – between Pilny Dół and Grodzisko, 8 – Grodzisko, 9 – old quarry in Skała, 10 – rock opposite Łamańce Rocks, 11 – Łamańce, Pochylce, Ciche Rocks, 12 – Górkowa Rock, 13 – Górczyna Rock, 14 – Prałatki Rocks, 15 – Dziurawiec Rocks and Castle Rocks, 16 – Rocks above Trzaska, 17 – Góra Zamkowa in Ojców, 18 – Figowa, Ostrogi, Bystra Rocks, 19 – Jonaszówka Rock, 20 – Panieńskie Rocks, 21 – Kawalerskie Rocks, 22 – Krukowskiego Rock, Koronna Mountain, 23 – Okopy Mountain, 24 – Puchacza Rock, 25 – Krzyżowa Rock, 26 – Baszta Rock, 27 – Węzie Rocks, 28 – Zabugaje

The disappearance of biotopes for a species is the most common cause of its decline in numbers, and consequently extinction. Giving a ban on the destruction of a species is not enough to secure its sustainability if the habitat in which it occurs transforms. That is why modern protection of species emphasizes the importance of conservation of the species habitats (Pawlaczyk & Jermaczek 2008). Hence, currently the most important and essential way to protect the species richness and natural resources of ONP is to protect biotopes.

Protection of non-forest biotopes

The main threat to semi-natural non-forest communities of ONP is secondary succession towards forest-shrub communities, which results from the cessation of traditional use – mowing and grazing. This situation leads to regression, for example rocks (*Festucetum pallentis* (Kozł. 1928) Kornaś 1950) and xerothermic grasslands (*Origano-Brachypodietum pinnati* Medw.-Kornaś et Kornaś 1963, *Koelerio-Festucetum rupicolae* Kornaś 1952), spreading of shrub communities (*Rhamno-Prunetea* Rivas Goday et Garb. 1961, *Peucedano cervariae-Coryletum* Kozł. 1925 em. Medw.-Korn. 1952), followed by spreading of forest communities (thermophilic lime-oak-hornbeam forest *Tilio cordaetae-Carpinetum betuli melittetosum* or beech orchid *Carici-Fagetum* Moor 1952). The second important concern is the high degree of fragmentation of well-preserved and species-rich patches and isolation in the landscape. This is a result of both secondary succession after the cessation of agricultural use, as well as former afforestation of slopes of the valleys, for example Grodzisko, Ojców and Mount Koronna (Góra Koronna) region. This factor greatly limits the dispersion of non-forest species (Bąba 2013).

To retain valuable non-forest ecosystems of rich flora and fauna, they should be cultivated in a traditional way. Unfortunately, since the 1970s agriculture in the ONP area is not economical, so non-forest biotope protection applies only to the maintenance tasks performed by the Park. In the case of xerothermic grassland these treatments apply to cutting trees and shrubs in the first phase, and then in subsequent years, to the removal of their offshoots. At the same time the turf is mechanically mowed every year using flue gas trimmers. Mown sward is removed and exported from the uncovered surface. Treatments are carried out in late summer or autumn, after the plants had shed ripe seeds.

Even though it is believed to be one of the most effective methods of active protection of non-forest communities, ONP has not used grazing so far, with a few exceptions (Bąba 2002/2003, 2013, Pawlaczyk & Jermaczek 2008, Sołtys-Lelek & Barabasz-Krasny 2011a, b). The impact of grazing on different species varies. It is recommended to keep "the preservation of traditional usage", which means keeping grazing in such form, intensity, time and rhythm of the same species of animals or even their races, as it was done previously in the area (Pawlaczyk & Jermaczek 2008). Animal grazing on the grasslands plays a significant role, in particular for spreading the moving plant diaspores on the hair or the gastrointestinal tract (Bąba

2013, Dzwonko 2013). In year 2014, ONP conducted an experimental study on grazing on the test "Grodzisko" surface (Figure 3).

Figure 3. Experimental sheep grazing on "Grodzisko" study area, 21.06.2014. Photo A. Sołtys-Lelek

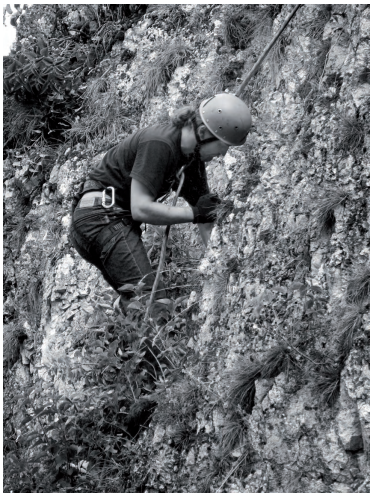

Figure 4. Removing offshoots of trees and shrubs on "Panieńskie Rocks" area, year 2012. Photo J. Ślizowski

A flock of approx. 40 sheep, of Olkusz breed, grazed from May to August on the surface of approx. 2 ha, for about 6-8 hours per day. After one season of grazing no substantial effects and changes in the species composition of grasslands could be observed, but the process evidently provoked the erosion of the slope, which will certainly be used by many grassland plants. It was also observed that the sheep were leaving offshoots of trees and shrubs, which had to be removed mechanically after the end of the grazing.

In subsequent years it is planned to extend the grazing and include other xerothermic grassland refuges. However, it is dependent on obtaining subsidies for this purpose coming from different funds supporting conservation. Costly active conservation measures of non-forest ecosystems are possible to implement, mainly due to the support of the National Fund for Environmental Protection and Water

Management. Works related to the active protection are partially carried out by employees of the Park (which refer mainly to meadows), while uncovering the steep cliffs, and treatments on the slopes of the valleys are performed by specialized companies, selected by means of tenders (Figure 4).

In parallel with the protective treatments, the Park has conducted a monitoring of changes in grassland biotopes since 1996. For this purpose, the network of permanent research plots has been selected, where detailed floristic lists are made and phytosociological relevés are taken annually or at intervals of 2–5 year. The test results clearly show the positive effect of the active treatments applied to the floristic composition and structure of the well-preserved xerothermic grasslands – the so-called "old grassland", or not strongly degraded ones (Bąba 2002/2003, 2013, Bąba & Kompała-Bąba 2011, Sołtys-Lelek & Barabasz-Krasny 2011b). This has also been confirmed in the monitoring run on bee insects living in the grasslands (*Apiformes*). The test conducted at the turn of the 1960s and 1970s on the "Grodzisko" test surface confirmed 61 species of this family. During the grassland overgrowth in the years 1985-1989 the number dropped to 21, and after the application of the active protection in 2001-2004, the number increased to 93 bee species. There were also some species found which had not been previously reported in the area of ONP, and which represented the Mediterranean and Ponto-Mediterranean geographical element, for example *Andrena pontica* Warncke, *Hylaeus cornutus* Curtis, or *Nomada sheppardana* Kirby (Partyka *et al*. 2014).

It turned out, however, that the restoration of the proper status of grassland species depends on the degree of transformation. Natural grasslands on shallow skeleton soil were slightly modified in a fluctuating way. Overgrowing grasslands in deeper soil profiles are much harder to restore. On the surface, where compact scrub developed prior to the application of treatments, grassland restoration in a short time, only by cutting, is virtually impossible (Bąba 2002/2003, 2007). Many studies show that the seeds of xerothermic plants live no longer than 5 years, so the chance to restore heavily degraded grassland with seeds lingering in the soil is infinitesimal (Loster 2013). Therefore, the presence of the so-called "old grassland" fragment rich in xerothermic flora in close vicinity is absolutely essential for seeding (Bąba 2002/2003, 2012, 2013).

Despite the annual removal of offshoots, there was an increase of forest and scrub plants reported on the highly transformed surfaces. Too frequent root repetition leads to the disappearance of small grassland plants and the dominance of grass, such as *Brachypodium pinnatum* (L.) P. Beauv. (Bąba 2002/2003. 2013, Sołtys-Lelek & Barabasz-Krasny 2011b). There may also appear some species associated with disturbed habitats, for example *Calamagrostis epigejos* (L.) Roth i *Solidago canadensis* L., which can be treated as a signal that the method of active protection used is insufficient. The grasslands that were previously covered with pine plantings seem to regenerate the best. On surfaces heavily overgrown by deciduous trees and shrubs, despite cyclical and repetitive measures of active protection, there was

a significant increase in surface coverage by shrubs of the *Rhamno-Prunetea* class, for example *Cornus sanguinea* L, *Euonymus europaea* L., or *Prunus spinosa* L., which can be perceived as a proof that there is still an ongoing succession in the direction of thermophilic scrub (Sołtys-Lelek & Barabasz-Krasny 2011b).

Meadows in ONP, just like grasslands, developed as a result of the centuries-old traditional economy, which included regular mowing, collecting hay, moderate fertilization and grazing. Active conservation measures for meadows involve its mowing once or twice including the collection of biomass. Mowing is performed by a tractor with a rotary mower. These treatments protect habitats against secondary succession, but do not bring a significant improvement in their species composition. Mechanical mowing with a tractor will certainly not substitute mowing with a scythe. Stage mowing that allows for the maturation and dispersal of propagules of meadow plants is very limited. Although the biomass is harvested, the hay is dried in the swath regardless of the weather, which means that the overfertilized soil is supplied with still nitrogen compounds favourable for nitrophilous perennial plants. In the case of the most degraded patches of grassland some experimental activities may be considered, such as overseeding of the seed harvested selectively on local meadows or transplantation of pieces of turf from the well-preserved nearby patches. It is important to conduct regular mowing, since the cessation of mowing, even for a short time, can eliminate some of the sward grassland species sensitive to shading, for example wobblers plants (Pawlaczyk & Jermaczek 2008). Despite the mistakes, active conservation measures carried out in the meadows of ONP give partially positive results. It is visible by monitoring *Bombini* bumblebees. In 1998 on 100 m^2 of meadows 18 individuals were reported on average, and in 2010 the result ranged from 16 individuals in the Prądnik Valley to 22 in the Sąspowska Valley (Partyka *et al.* 2014).

To protect non-forest biotopes effectively and to secure the associated populations the preventive measures must be conducted comprehensively. The protection of the habitat of a single patch basically means the protection of a small, isolated population of the species associated with this patch (Pawlaczyk & Jermaczek 2008). Therefore, ONP does not protect only the best preserved fragments of xerothermic grasslands and meadows, but the treatments are also apply to even impoverished and degenerate patches that do not have high natural value, but create an essential gap between the refuges.

Protection of forest biotopes

Currently, forests in ONP cover about 1529 ha, which takes up 71% of its surface. Various forms of human activity carried out here had a significant impact on the size of the forests and their species composition. In the 1960s, a mixed coniferous forest was the predominant forest community in the Park, as it occupied 38% of its surface. This dominance was associated with afforestation carried out at the end of the nineteenth century, mainly in the flattened upper part of the present

Park, where clearcutting had been performed (Suchecki 1924). The second most important community included lime-oak-hornbeam forest *Tilio cordatae-Carpinetum betuli* Tracz. 1962 – 16% of the area. A small percentage was occupied by beech *Dentario glandulosae-Fagetum* W. Mat. 1964 ex Guzikowa et Kornaś 1969 (9%), *Fagus sylvatica-Criciata glabra* (0.3%) and sycamore forest *Phyllitido-Aceretum* Moor 1952 (0.01%). In the years 1960-1990 the area covered by forests decreased to only 5% of the Park. At the same time the following expansions were reported: lime-oak-hornbeam forest (up to 40%) and the Carpathian beech forest (31%) (Partyka 2005, Michalik 2008). Retreating forests transformed into various regeneration forms of deciduous forest.

There are two types of forest ecosystems protection used in ONP: partial and strict protection. The aim of partial protection is to restore disturbed ecosystems through appropriate care and breeding measures, while strict protection is to retain the natural processes occurring in nature (Partyka 2005). The forest area under active (partial) protection is now 960.20 ha. In contrast, the surface area of strict protection in the Park in the early 1960s was 225.73 ha (14% of the area), and in 1971 it was increased to 344.08 ha, which accounted for 22% of the ONP (Partyka & Stanowski 1974). Between 1985-1995 some minor adjustments were introduced in this zone, due to the exclusion of massifs with xerothermic grasslands of its premises (Partyka 2005). As to 2013, the Park conservation area is 292.41 ha.

The process of active reconstruction of the park stands, which is performed on areas of partial protection, involves thinning and removal of species unsuitable for the particular type of habitat. It is called naturalization of stands and from the very beginning of the Park it has been one of the main protective tasks (Chwistek 2008). Sanitary cuts performed in the partial protection zone provide deadwood of such species as: *Larix decidua* Mill., *Picea abies* (L.) H. Karst., *Pinus sylvestris* L. Conifers are replaced with deciduous species, for example *Acer platanoides* L., *A. pseudoplatanus* L., *Carpinus betulus* L., *Fagus sylvatica* L., *Fraxinus excelsior* L., *Tilia* sp. (Partyka 2005). Species of foreign origin are also removed, for example *Quercus rubra* L. introduced in the 1960s. It should be underlined, however, that in most cases, restoration of natural stand in OPN was performed in the way of spontaneous regeneration, which is better than the artificial reconstruction of the stands, as the latter eliminates the possibility of natural progress and spontaneous processes in ecosystems (Buchholtz 2001, Chwistek 2008).

Strict protection of forest communities requires their complete release from the pressures of economic and human interference. To effectively preserve the richness of the forest fauna and flora of the park, strict protection encompassed old trees and forests most similar to the natural, for example beech *Dentario glandulosae-Fagetum* and, to a lesser extent *Tilio-Carpinetum* and *Phyllitido-Aceretum* (Michalik 1991c, Chwistek 2008). These areas are free from conscious human pressure, with few exceptions, when single trees growing along the hiking trails that directly threaten the safety of tourists are cut. In the forests of ONP which are under strict protection

we can observe many features of natural forests, for example spontaneous course of fluctuate processes in the locality, mosaic of habitat's groundcover, the occurrence of natural gaps in the locality, or the presence of significant amount of deadwood at various stages of decomposition (Buchholz 2001).

The increase in the surface area of deciduous forests (from 25.91% in the 1960s to 72.27% in the 1990s) as well as the fact that they were provided protection, allowed species associated with forest biotopes to return or even expand significantly. This process included many rare and valuable species for the wildlife of the Park. During the monitoring of flora an increase in the number of localities was observed, for example *Aconitum moldavicum* Hacq., *Aruncus sylvestris* Kostel., *Galium odoratum* (L.) Scop., *Phyllitis scolopendrium* (L.) Newman, *Vinca minor* L., or the mountain species *Lunaria rediviva* L. (Bodziarczyk *et al.* 2006, Sołtys-Lelek & Barabasz-Krasny 2009). In the forests of Ojców there also appeared *Allium ursinum* L., which had not been reported for 135 years and had been considered extinct in the Park. In the year 2006, the population of this species occupied the surface of 0,9 m^2 and consisted of 22 individuals, and in the year 2008 the number of plants increased to 48 individuals (Sołtys 2007, Sołtys-Lelek & Barabasz-Krasny 2011a).

Strict protection areas also protect the relict fauna of the mountain insects, such as Carpathian species *Chrysolina lapidaria* Bechyné, or ones considered to be the oldest elements of the current fauna of ONP Carpatho-Sudeten – *Trechus pulchellus* Putz. and *Stenus carpathisuc* Ganglb. (Pawłowski & Kubisz 2008). In addition, this zone determines the existence of saproxylobiotic and mycetophagous species related to fungi growing on deadwood and not present or rarely encountered in the zone of partial protection. *Gampsocera numerata* Heeger (*Chloropidae*) is an example of saproxylobiotic species which is rare in Europe and which so far has only been found in ONP and nowhere else in Poland. Another example is *Hyperoscelis eximia* Boheman (*Canthyloscelidae*), present only in Roztocze Region and the Holy Cross Mountains (the Świętokrzyskie Mountains) except for Ojców (Klasa 2004). The condition for the occurrence of these species is the presence of natural forest with a lot of dead wood. Among the mycetophagous species we may list *Agathomyia wankowiczii* Schnabl, the species preying and reproducing on the fruiting bodies of the *Ganoderma lipsiense (Batsch) Atk* fungus*.* Flies constitute an indicator of old natural forests (Klasa 2004, Klasa & Palaczyk 2005, Palaczyk 2008). Only in the zone of strict protection ONP can we find *Palloptera venusta* Loew, whose larvae probably develop in the corridors hollowed out by beetles colonizing dead wood (Palaczyk 2008). Generally, in the protection of entomofauna associated with rotting wood one should pay attention to the size of dead trees. Trees cut with combustion saws into one meter lumps provide different conditions, for instance moisture, than a several meters long tree (Figure 5). The literature also draws attention to the fact that the dead tree cut with the saw has different properties as a biotope entomofauna than the broken tree (Pawlaczyk & Jermaczek 2008).

Figure 5. Tree trunks cut into meter-long pieces along the border of the area of strict protection, 2011. Photo A. Klasa

Forest areas of ONP under strict protection constitute the biotope of the highest natural beauty and require special care in order to preserve biodiversity. Therefore, it is important to understand their resources, structure and functioning. Hence, monitoring of natural processes is allowed and what is more, it is possible for the researchers to conduct studies there.

Protection of aquatic biotopes

Given the seasonal increase in the concentrations of Na^+, K^+, SO_4^{2-}, Cl^-, NO^{3-} and PO_4^+ in 2001, the water of Prądnik and Sąspówka within ONP was classified as the second class, with periodic decrease to lower classes (Kostrakiewicz 2001). Research conducted on the Prądnik stream which was based on the Water Framework Directive (RDW) showed that the contamination varied (Niewiadomska 2006, Kowalik 2006). In the upper part, the stream was classified into the third category, and in the middle part (down to the boundaries of the Park) it was the second class of purity. In contrast, the water of Sąspówka was classified as the second purity grade in its entirety (Masiarz 2006). Spring waters in the ONP are frequently characterized as purity class II due to the relatively high concentration of nitrates, related to the delivery of sewage from rural areas (Siwek 2006). They are characterized by a high variability of nutrients concentration, which proves their high sensitivity to local pollution (Miśkowiec *et al.* 2013).

Surface waters of ONP are polluted with municipal, agricultural and industrial sewage. They are also exposed to particulate pollution and gases from the atmosphere. Until the construction of two wastewater treatment plants, municipal sewage from Skała and Sułoszowa was drained directly to Prądnik, which flows through the Park. In recent years, the problem of stream contamination has been

solved thanks to the construction of the sewerage system in the Park and the surrounding villages. Additionally, apart from several domestic ones there were four large sewage treatment plants built: in Skała (1994), Młynnik (2003, expanded in 2008), Ojców – for the Nursing Home (2004) and in the village (2009). Some additional activities would definitely improve the water quality in the Park. They above all include: inhibition of erosion on the slopes descending into the valley, the solution of the sewage problem from the "fish farm" in Ojców, systematic removal of rubbish from the rivers (Klasa & Sołtys-Lelek 2013).

In order to maintain the full diversity of aquatic ecosystems one should not just care about the purity of water but protect all habitats. Aquatic biota of the ONP is particularly sensitive to human pressure. Because of the strong impact of anthropogenic water fauna, the upper part of Prądnik is highly degraded. Fully developed clusters of aquatic invertebrates are found in the southern part of the Park, where they deserve special attention, including *Isoperla grammatica* Poda, a species threatened with extinction in Poland, as well as *Orthocladius rivinus* Potthast (*Chironomidae*), which was reported in our country for the first time in Ojców (Dumnicka & Szczęsny 2008). An important component of aquatic ecosystems are specific macrohabitats created by dead deciduous trees fallen and rotting in the current of the stream. An example of a species existing in ONP and associated with the analyzed habitat is a saprolobiotic which is very rare – *Chalcosyrphus eunotus* Loew (*Diptera: Syrphidae*), whose larvae develop in dead wood lying in the water. The habitat preferred by this species is critically endangered throughout Europe, and at the same time it is also crucial for the other flies of the *Lipsothrix* (*Tipulidae*) genus and many other taxa (Boardman 2005). Unfortunately, even in the area of ONP fallen trees, logs and branches are often removed from the river for fear of stemming the flow of water and flood risk (Soszyńska-Maj *et al.* 2009). This applies especially to the Prądnik stream, which is the main watercourse of the Park – there is a dead wood lying only on its side in the inlet pipe of Sąspówka. Therefore, it is very important for the protection of these specific habitats to raise awareness of local people about the need to preserve them and not interfere with the natural processes of nature. The example of Ojców village lying in the centre of ONP shows that even if the river flows in the boundaries of the protected area and flows through residential areas, it is difficult to keep its wild, natural character.

The main threats to the biotopes protection in the ONP

The ONP has no natural ecological connections with other protected areas and nearest forest refuges located in the neighbourhood. The lack of such connections makes it difficult for the populations to contact each other through migration, which is relevant for their genetic diversity. Only rare species of plants reach the limits of their range, for example *Arum alpinum* Schott & Kotschy, *Stipa joannis* and *Thymus praecox* Opiz, which can be found only here in Poland (Biderman & Bąba 2001). Also populations of typical forest mammals that live in the trees, such as *Glis glis* L., are

isolated here. The same applies to invertebrates associated with forest biotopes and with poor chances to move in open areas, such as *Carabus intricatus* L. On the other hand, the habitat of many larger mammals, for example *Sus scrofa* L., *Vulpes vulpes* L., or *Capreolus capreolus* L., reach far beyond the boundaries of the Park, where it is not possible to protect them. The size of the area implies the lack of predators – *Canis lupus* L. and *Lynx lynx* L., indispensable to maintain ecological balance (Wierzbowska *et al*. 2008). This requires the introduction of a controlled hunting to reduce the numbers of particular species, for example boars, which is contrary to the protective function of the Park. A small area of the Park makes many occurring populations of plants and animals quite limited and isolated from its range, or the nearest locality. They are also more susceptible to the detrimental effects of chance, which may lead to their elimination. This seems to come down to the eco-limiting factor principle, which is based on the area of the Park – the smaller the area, the greater the impact of the risks on the functioning of biotopes (Klasa & Sołtys-Lelek 2013).

There are no clear migration routes as forest belt connecting the ONP area with the closest forest complexes limits the migration. The further away from the borders of the Park, the more different barriers there are, for example heavily burgeoning buildings in the buffer zone of the Park, fences around plots and roads, etc. These factors make the migration routes of species form in strips of land with the width ranging from just a few to a few hundred meters, which is certainly not sufficient to maintain genetic diversity within the population. Widening and ensuring patency of migration corridors is one of the conditions to prevent the extinction of species in the ONP on isolated positions (Klasa, Sołtys-Lelek 2013).

Conclusions

- Active protection treatments of biotopes in patches of xerothermic grasslands have a beneficial effect on the maintenance of their typical floristic composition and contribute to an increase in the number of species of grassland; preferably it also affects populations associated with grasslands species of fauna.
- Thanks to active protection (removing bushes, mowing, grazing) landscape values of the former non-forest communities are restored.
- Strict protection (passive) is the most effective form of protection of forests biotopes and should be used widely in national parks; old trees, dead ones, decaying wood and intact groundcover are valuable biotopes for species of forest flora, fungi and lichens.
- Stand conversion may be allowed in National Parks in case of stands with the domination of alien species.
- Caring about water quality is an important factor in the protection of aquatic biotopes, but it is still not sufficient for the conservation of habitats; one of the key elements is a general reduction of human pressure.

– In order to protect biotopes and ensure their proper functioning it is necessary to ensure patency of ecological corridors which enable the exchange of genes between populations.

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Selected Aspects of the Protection of Biotopes on the Example of the Ojców National Park (Southern Poland)

Abstract

The paper contains a discussion of one of the forms of protection – the biotope protection on the example of Ojców National Park (ONP). In ONP all species occurring within its boundaries are protected as in other national parks. The biggest threat to nature in this park are changes in habitat conditions entailing the changes of the species composition of fauna and flora. Non-forest biotopes are most threatened with extinction and the main factor threatening their values is forest and scrub succession. Active protection of single endangered species conducted in some cases has not brought the expected results. Very positive results were obtained only after the entire biotopes were protected. In case of non-forest communities (mainly xerothermic grasslands and grasslands on rocks) the best form of protection proved to be active protection of biotopes and in case of forests – passive protection, conservation.

Key words: nature conservation, active protection, Ojców National Park, Poland

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