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The active protection and monitoring of xerothermic reserves based on the example of the Skowronno reserve in Ponidzie

Ochrona czynna a monitoring rezerwatów kserotermicznych na przykładzie rezerwatu Skowronno na Ponidziu

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Streszczenie. Murawy kserotermiczne stanowią jedne z najbogatszych siedlisk roślinnych polskiej flory z licznymi gatunkami rzadkimi i zagrożonymi roślin i zwierząt. Rezerwat kserotermiczny Skowronno jest jednym z najciekawszych rezerwatów Garbu Pińczowskiego Ponidzia i jednocześnie najbardziej zagrożonym w utrzymaniu swojej funkcji ochronnej. Stąd teren rezerwatu wymaga ochrony czynnej, która powinna wynikać z kompleksowej diagnozy potencjału zasobów przyrodniczo-kulturowych rezerwatu. Nie bez znaczenia jest właściwe zarządzanie tym potencjałem. Istotną rolę w niniejszym zarządzaniu powinien pełnić monitoring środowiska rezerwatu. Dlatego niezbędne jest wypracowanie zasad funkcjonowania monitoringu dla terenów szczególnie cennych i wrażliwych na antropopresję i zanieczyszczenie środowiska. Opracowanie jest próbą wskazania zasad monitoringu dla terenów rezerwatów kserotermicznych Ponidzia na wybranym przykładzie rezerwatu Skowronno.

Key words: reserve, landscape, xerothermic grasslands, landscapes, potential of natural environment, pollution, active protection, monitoring the Skowronno Reserve

Słowa kluczowe: *rezerwat, krajobraz, murawy kserotermiczne, walory krajobrazowe, potencjał środowiska przyrodniczego, zanieczyszczenie środowiska, ochrona czynna, monitoring, Rezerwat Skowronno*

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INTRODUCTION

Xerothermic grasslands are one of the richest, and at the same time, the most endangered plant habitats of extrazonal vegetation. They are the steppe communities of non-forest and thermophilic character. They provide species-rich refugia that were brought into Central Europe from Asia and Eastern Europe at the beginning of the last interglacial of the Ice Age – the Pleistocene (approximately 10 thousand years ago). The etymology of the word "*xerothermic*" suggests that the world is derived from Greek, where the word '*kseros*' means 'dry' and '*thermos*' – 'hot').

The first Annex to the EU Habitats Directive indicates that the xerothermic grasslands are greatly endangered habitats of the particular importance for the Community and they require the protection in all EU member states. Such high placement of the xerothermic grasslands is caused by their floristic richness of the plant communities with many rare and protected species, in many cases, they are the relict species of flora and fauna.

The areas of xerothermic grasslands, until the time of creating the nature reserves, were used as pastures for grazing animals, mainly sheep and goats and only sometimes cows and horses. Animals ate Arrhenatherion grass species and plants of Arrhenatherion kind selectively and omitted the species of the xerothermic structure what could allow the growth of the xerothermic grasslands.

The intensification of the agriculture and the progressive natural succession resulted in the dramatic decrease of the xerothermic vegetation. The decrease reached approximately 70% comparing it to the first half of the 70s of the 20th century (Barańska et al. 2014). Hence, the introduction of the active protection creates the possibility of the xerothermic grassland maintenance, i.e. preserving the state of the environment that was before the protection of the areas of the nature reserve, national park, or 'Natura 2000'. In the actively protected areas, the protection treatments must be only referred to in case of the scientifically justified needs. The active protection that takes place in the nature reserves can involve:

- stabilization – maintaining the existing environmental potential,
- re-naturalization – the restoration of the pre-existing environmental potential,
- creation – the conversion of the existing environmental potential,
- experiment – actions required to solve scientific problems present in the environmental potential,
- restitution – the restoration of the existence of the species/populations of plants, or animals,e.g. the restitution of noble crayfish (*Astacus astacus*), the European

beaver (*Castor fiber*), the European bison (*Bison bonasus*), peregrine falcon (*Falco peregrinus*).

The active protection treatments in the areas of the xerothermic grasslands most commonly involve:

- removing the shrubs and trees that overgrown the grasslands,
- removing the regrowth of woody vegetation, that is regrowth of shrubs and trees,
- eliminating the invasive and undesirable species,
- late summer mowing of xerothermic grasslands.

The xerothermic reserve of Skowronno is one of the most interesting reserves of the Pińczów Hump in Ponidzie and, at the same time, the most endangered one in terms of the preservation of the valuable xerothermic grasslands.

RESEARCH METHODS AND MATERIALS USED

The research of the system conditions of the natural and cultural reserve of Skowronno was conducted from July to September in 2013. It included intimate, field and laboratory parts

In the intimate part the careful studies of the existing (unpublished and published) materials in terms of the analyzed issues were carried out. Particularly valuable materials on such issues related to the xerothermic grasslands were presented in May in 2013 in Raclawice during the conference dealing with "The Protection of Thermophilic habitats in Poland". They also appeared in the publication: *Maintaining the biodiversity of xerothermic habitats in Małopolska*. Furthermore, the research also involved the materials gathered in the very valuable publications of the Naturalists' Club, in particular, the report on the implementation of the project: *Protecting xerothermic grasslands in Poland – theory and practice LIFE08/NAT/PL/513*.

In the field part of the research, however, the field inventory of the reserve was dealt with, i.e. in August 2013. The fieldwork was enriched with great number of the photographic documentations, which is partly used in the demonstrated studies. In addition, during the fieldwork the soil samples were collected so as to prepare the laboratory analysis.

The samples of soil were collected from three places in the reserve after receiving the permission from the Regional Director for Environmental Protection in Kielce. The laboratory analysis was carried out in the certified laboratory in Kielce and their purpose was to determine the origin and the type of soil found in the reserve. It should be highlighted that the soil from the Skowronno Reserve had not yet been identified. The conducted analytical- laboratory research allowed to establish the conclusions related

to the direction of the formation and protection of natural and cultural systems of the examined reserve.

Additionally, the available cartographic materials were also used (among others, the topographic map – the scale of the map was 1:10 000; the geological map – the scale of which was 1: 50 000 – the Pińczów Sheet), moreover, the remote sensing of land of the Skowronno Reserve and its nearby areas were used (2009).

RESEARCH AREA

The floral xerothermic reserves in Poland are found on the dry, sunny slopes that are of limestone or gypsum character in the area of macro- and meso-regions: The Lower Older Valley (313.24), the Lower Vistula Valley (314.8), the glacial valley of Toruń and Eberswalde (315.3), the Volyn Upland (851.1), the Lublin Upland (343.1), the Kielce Upland (342.3), the Nida Basin (342.2) – Fig. 1, the Kraków – Czestochowa Upland (341.3), The Silesian Upland, the Sudetes, the Pieniny Klippen Belt (514.12) also called the Pieniny (Kondracki 2009).

They are covered with xerothermic grasslands (*Festuco-Brometea*) of grasses or herbal semi-natural communities. The area of xerothermic grasslands in Poland covers approximately 10,000 hectares and in the Alps only 50 hectares (Barańska, Jermaczek 2009). However, the area of xerothermic grassland reserves in the Nida Basin constitutes 36.98 hectares, including the area of the Skowronno Reserve, which includes 1.93hectares (CRFOP 2014).

The floristic strict nature reserve of relict xerothermic plants in the Skowronno Quarry was created nearly 100 years ago (1915) due to the initiative of prof. Wladyslaw Szafer and it was reactivated in 1960 on the basis of the Ordinance of 20/03/1960 (MP. 34/1960, pos. 170). The objects of the protection in the reserve involve the natural relict positions of the xerothermic vegetation with the protected and endangered species, such as: Stipa Pennata/Feather Grass (*Stipa joannis* Čelak), Scorzonera (*Scorzonera purpurea*), Capillary Feather Grass (*Stipa capillata*), Spring Pheasant's Eye (*Adonis vernalis* L.), Anemone Silvestris (*Anemone sylvestris* L.), Corn Mignonette (*Reseda phyteuma* L.), Cowslip (*Primula veris* L.) and wild beetle (*Rhynchites Aethiops*).

The surrounded farmlands create the borders of the area of the reserve from the north, the south and the west. Below them, there are two county roads, namely Brzeście – Skowronno Dolne (No. 0017T) and Sobowice – Pińczów (No. 0168T). Along the roads, there are farm buildings and single-family residential buildings of the two-row type as far as the villages are concerned, namely Brzeście, Skowronno Górne and Skowronno Dolne.

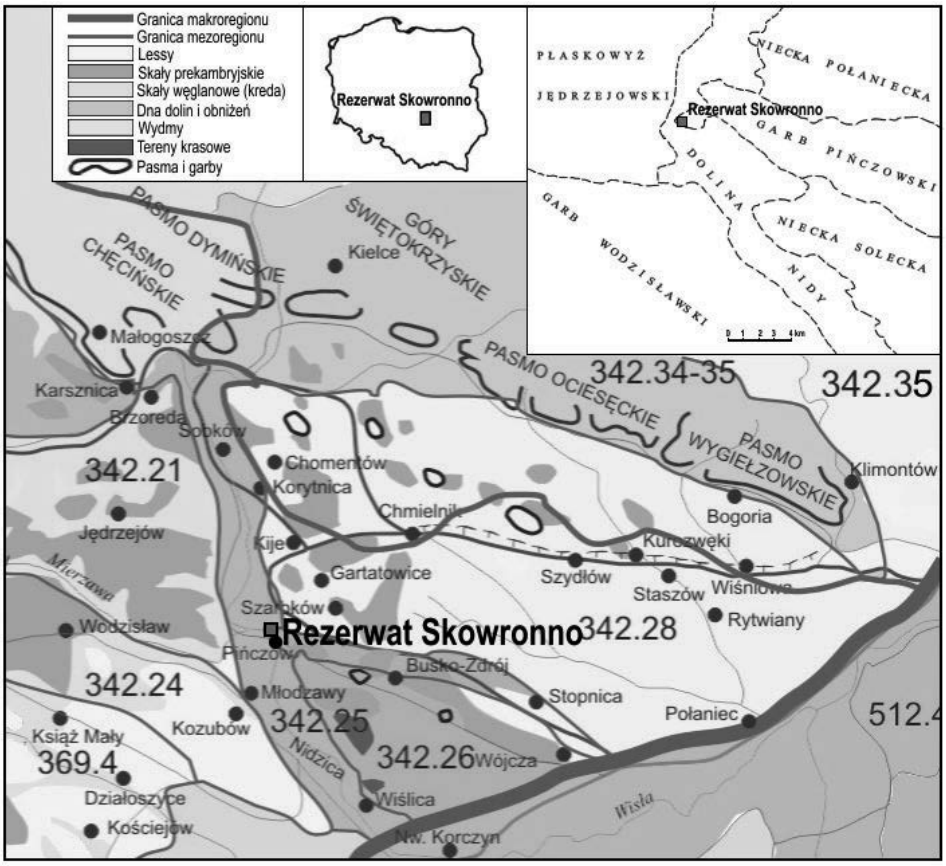
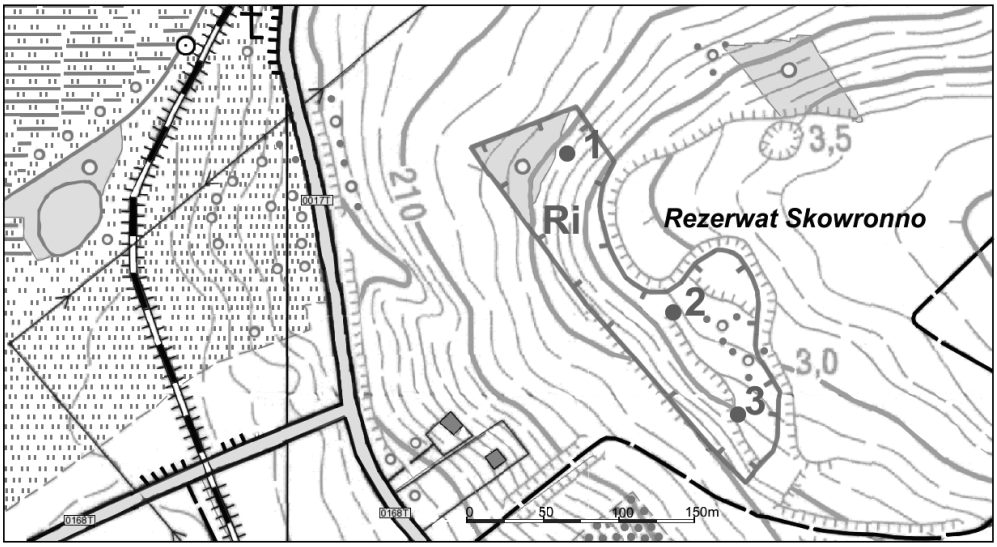


Fig. 1. The Skowronno Reserve in the division light of the regional and geological conditions
Rys.1. Rezerwat Skowronno na tle podziału regionalnego i uwarunkowań geologicznych

Photo 1. The Skowronno Reserve
Fot. 1. Rezerwat Skowronno

Photo 2. The Skowronno Reserve
Fot. 2. Rezerwat Skowronno



Explanation: 1, 2, 3 – the displayed places for soil samples collections; Ri – Calcaric Leptosols on limestone

Objaśnienia: 1, 2, 3 – odsłonięcia poboru prób glebowych; Ri – rędziny inicjalne wapienne

Fig. 2. The location of soil sampling in the Skowronno Reserve

Rys. 2. Lokalizacja poboru prób gleby na terenie rezerwatu Skowronno

Photo 3. Calcaric Leptosols on limestone in the display of No. 1

Fot. 3. Rędzina inicjalna wapienna w odsłonięciu nr 1

Photo 4. Calcaric Leptosols on limestone in the display of No. 2

Fot. 4. Rędzina inicjalna wapienna w odsłonięciu nr 2

Photos 5–7. Calcaric Leptosols on limestone in the display of No. 3
Fot. 5–7. Rędzina inicjalna wapienna w odsłonięciu nr 3

The Skowronno Floral Reserve is located on the western edge of the Pińczów Humb in the eleventh century Pińczów limestone quarry derived from the Badenian (Miocene – approximately 15 million years ago). The quarry is located on the western slope of the hill – Okrąglica (291.7 m). The flat highland plateaus of the Okrąglica slope constitutes the convenient viewpoint of the extensive Nida Valley, and the villages of Skowronno Górne and Dolne. The visible part of the Nida Valley in the area of Sobowice and Umianowice reaches the width of approximately 5,4 km. Such valley width from 2.0 to 5.4 km proves its Pleistocene origin. It is most likely that the valley was eroded by fluvioglacial water of Middle Poland glaciation. The elevation of Okrąglica itself is situated approximately 1.85 km to the east of the reserve and it is covered with the forest, therefore, only flattening parts of the western part of the slope can be convenient viewpoints in terms of the landscape. The variety of the landscape is also enriched by the elevation of the area reaching the height differences of over 104.0 m around the nature reserve.

The reserve area (1.93 ha) is irregular in shape, that is elongated, and its border from the south reaches the length of about 200 m and it is directed towards the borders of the village buildings of Skowronno Dolne. The remaining border areas of the reserve are next to the fields (Fig. 2).

At the foot of the western slope of Okrąglica, there are the county roads, i.e. Brzeście – Skowronno Dolne (No. 0017T) and Sobowice – Pińczów (No. 0168T). Along the roads, there are farm buildings and single-family residential buildings of the two-row type as far as the villages are concerned, namely Brzeście, Skowronno Górne and Skowronno Dolne (the beginnings of the eleventh century settlement).

On the western side of the reserve, there is the traction trail of the narrow gauge tourist train "Ciuchcia Express Ponidzie". Behind the traction, the Nida Valley stretches widely reaching almost 2km. It is covered with the numerous species of Common

Reed (*Phragmites australis*), bulrush (*Scirpus* L.), and others. oxbow lakes and meadows vegetation (Photos: 1–2).

Moreover, near the reserve two beds/deposits of "Skowronno" and "Pińczów" were documented. The Skowronno deposit was first documented in 1961. (limestone of C1 and C2 categories with the geological resources reaching 1,146 thousand. T (C1) and 3,925 thousand. T (C2) – according to the state from the year 1990. The beds/deposits are created by limestone lying horizontally of the fine and coarse litotamnia limestone in gray or cream colours exploited until 1975. In contrast, Pińczów beds/deposits contain limestone of light cream colour in the coarse, medium and fine structures placed horizontally. The resources in the B category reach the amount of 5,009 thousand tones (1954.) and are operated by 'Kamienie sp. z o.o.' (previously 'Pińczowskie Zakłady Kamienia Budowlanego S.A.'– Pinczowski Stone Plant Construction Joint Stock Company). Limestone is used for the production of building cladding panels.

Halizna – the ecological site (U-034) is located further east. It is the swampy area in Brzeście, which is the remaining part of the ecosystem of its importance for the maintenance of the unique biodiversity of the nearby areas.

In the neighbourhood of the Skowronno bed, to the west in the direction of the Pińczów bed, the so-called 'wild' excavation of the Quaternary fluvioglacial sands is located. The excavation partly serves the role of the illegal dumping of waste.

In Skowronnie Dolny, there are two drinking water spots, around which the depression pit was designated. In the south, it reaches the border of the Skowronno Reserve. The reserve is also located near the protective zone of the drinking water area.

The southern part of the slope of the Pińczów Hump near the reserve has the obvious signs of the intense landslide processes. The Hump plateau with the Nida Valley in the areas of Skowronno Dolne and Skowronno Górne villages is under special regulations dealing with the protection areas of the landscape.

The Skowronno Reserve is located in the area of the Nadnidziański Landscape Park, the Special Area of the Conservation of the Nidziański Refuge and in close neighbourhood of the Special Protection Area 'Natura 2000' PLB260001– the Nida Valley.

RESULTS

It should be noticed that the cause of the reserve creation was the anthropogenic activity – the Pińczów limestone exploitation, which in this area has been functioning for almost a thousand years (sculpture 'Wawel weevil' dated back to the 10th/11th century). The Skowronnie Quarry was already known in the 11th century due to the exploitation of cut limestone by the Cistercians from Jędrzejów.

The Skowronno Reserve is located in the western end of the Cretaceous-Tertiary Pińczów Hump (the Pińczów Mountains) creating the cuesta from the litotamnia limestone. The direct contact of the elevation (up to 291.7 m) with the bottomed, over five-kilometer of the Nida Valley (5.4 km) highlights the main features of the relief of the western part of the Pińczów Mountains. In some places, the slopes of the Pińczów Mountains are covered with patches of fluvioglacial sands, in which gorges and dry valleys are formed. Such processes are related to the course of the intense erosion (Photos: 19–21), karstic weathering (Photos: 15–16), the accumulation in the form of small screes (Photos: 17–18) and the denudation in the form of weak neogenic movements causing the cracks of rocks (Photos: 8–14), in conditions of the significant height difference, and the low resistance of litotamnia sand and limestone rocks.

The natural and cultural system of the Skowronno Reserve is connected, as mentioned above, with almost a thousand years of the exploitation of limestone rocks in this area and in the close neighbourhood. Such exploitation would not have been possible if it had not been for the natural wealth of the area. In the Skowronno Reserve, there are outcrops called "Pinczak" in the form of ten different rock fragments. There is no exposed geological documentation of the values of the geological conditions. However, there are places of the relief creation character with the active processes (Photos: 8–22). All these processes together with the forms ought to have the detailed description to provide visitors to the Skowronno Reserve with the cognitive and educational objectives.

The existing enclosing of the cut squared block limestone from Pińczów is of the horseshoe shape with the diameter of about 25 m and it is located in the north-eastern part of the quarry. It should be emphasized that the exploitation of limestone was carried out in slope part of Okraglica Mountain (293 m) of the Pińczów Hump. This elevation is situated in the north-west culmination of the Hump, which at this point, creates the edge of almost 100 meters. At its foot the groundbreaking part of the broad Nida Valley is observed. It has the clearly open morphological space and clear morphological boundaries. Similarly, such clear morphological boundaries are observed in case of the analyzed part of the Pińczów Hump.

The variation of the relative height of the reserve ranges between 248.5 m and 262.5 m This comparatively small difference in relative height is the outcome of the earlier exploitation of 'Pinczak' in the quarry.

Almost the entire pit was covered with the limestone of Calcaric Leptosols kind, which is successively covered with the xerothermic vegetation. The layer of the soil and the plant succession clearly smoothes the perceptual character of the reserve relief, creating its almost natural character.

The Skowronno Reserve has some of the most interesting forms of the natural transformations that occur in the post-mining area in the collection of the Nida Basin or

even the Polish one. The geomorphologic elements exposed here, although they are not numerous, but they are very interesting and even model examples of the relief creation processes on micro- and macro scale that have been taking place in the Skowronno Reserve (Photos: 8–22).

The bock structure of limestone inclined the method of exploitation of the raw material and had the impact on anthropogenic shape of the physiognomic relief of the existing post-mining pit. Due to the strong conversion of the slope, the well varied landforms were created here. They additionally show the essential elements of the geological structure of this part of Pińczów Hump.

The lithology of Okrąglica Hill, on the western slope of which the reserve is located, is based on the bedrock of the sandy limestone. The carbonate rocks occurring on the hills of the Pińczów Hump are referred to as Pinczowski limestone ('litawskie', 'lejtańskie', "Pinczak") – the rocks in Poland that are characterized by the longest uninterrupted tradition of the exploitation and used in sculpture and architecture. The Pińczowski limestone – it is the detrital limestone, composed mainly of limestone fragments, the natural strains of marine algae (red algae, or *Rhodophyta*) from the *Lithothamnium* family. The Pińczowski limestone (especially of the coarse structure), a variety of animal remains (fossils), including mollusks (*Bivalvia*), foraminifera, sea urchins can be found. In the 50 s and in 1993 of the 20th century, in the Pińczów beds, two well-preserved skeletons of the new species of whale of the baleen whale (*Mysticeti*) type were found. They were named *Pinocetuspolonicus* (Barcicki 2007).

Lithologically, the Pińczowski limestone belongs to the group of the so-called light limestone (according to tab. 1. it is of the high porosity – 35%, the small dimensional weight – 1.75 g/cm^3) It is very soft and can be easily treated even with the ordinary carpentry tools just after its extraction from the bed. Under the process of weathering, this material slowly hardens and remains all the smallest details of profiling or sculpture event after many years,. Over the years, the exposed to the atmospheric factors material has become covered with natural protective layer called patina. This layer has the thickness of about 2–4 mm is hard, of the little porosity and to a insignificant extent, water permeable, moreover, it changes the colour into iron-gray. The Pińczowski limestone even under the influence of water does not decompose, therefore, it can be used in water engineering and constructions as well as for building foundations.

In the reserve, the shallow layer of the initial soil was formed, to be precise on the weathering rock surfaces. The soil of the Skowronno Reserve being the part of the state geodetic-cartographic soil classification are listed as unclassified. This kind of soil strictly refers to the geological structure of the basement rocks (bedrock) of the reserve, thus it can be concluded that the soil has been generated residually *in situ* (there) on the basis of the carbonate rocks.

Tab. 1. The chemical and physical and mechanical characteristics of Paleogene limestones – Pińczów litotamnia – bedrock in the Skowronno Reserve

Tab. 1. Cechy chemiczne i fizyczno-mechaniczne paleogeńskich litotamnia wapieni pińczowskich – skały macierzystej w rezerwacie Skowronno

Characteristics *Cechy*	The indicators of the examined rocks *Wskaźniki badanej skały*	Test results *Wyniki badań*
Chemical *Chemiczne*	Contents of CaO – % *Zawartość (contents) CaO w %*	51,6– 54,8 śred. 53,3
	Contents of MgO – % *Zawartość MgO w %*	0,8
	Contents of SiO_2 – % *Zawartość SiO_2 w %*	2,2
	Contents of FeO_2 – % *Zawartość FeO_2 w %*	0,6
	Contents of Al_2O_3 – % *Zawartość Al_2O_3 w %*	0,2
Physical and Mechanical *Fizyczno-mechaniczne*	Specific weight – g/cm^3 *Ciężar właściwy w g/cm^3*	2,7
	Dimensional weight – g/cm^3 *Ciężar objętościowy w g/cm^3*	1,8
	Porosity – % *Porowatość w %*	29,00– 37,37
	Absorptivity – % *Nasiąkliwość w %*	15,45– 16,06
	Resistance to dryness – MPa *Wytrzymałość na sucho w MPa*	9,6
	Resistance to humidity – MPa *Wytrzymałość na mokro w MPa*	8,2
	Abrasion by the use of Böhme dial – cm *Ścieralność na tarczy Böhmego w cm*	2– 2,19
	Abrasion by the use of Deval drum – % *Ścieralność w bębnie Devala w %*	17,3
	Humidity – % *Wilgotność w %*	0,99
	Frost resistance *Mrozoodporność*	Sufficient (from good to poor) *Dostateczna (od dobrej do słabej)*

Source: Osika 1987, Barcicki, 2007.
Źródło: Osika 1987, Barcicki 2007.

The field research conducted from July to September in 2013 and the analytical testing of soil samples taken from 1– 3 different places in the Skowronno Reserve allowed to diagnose the following types of limestone soils of the cover character, i.e.:

- Limestone of Calcaric Leptosols kind – Rendzina (Ri),
- Common limestone of Rendzic Leptosols kind – Rendzina (Rw) – fractional existence in the north-western part of the reserve,
- Brown limestone of Rendzic Leptosols kind – Brown Rendzina (Rbr) – fractional existence in the eastern part of the reserve.

The name 'Rendzina'comes from the old Polish word "rzędzić" – to 'chat'. Since such soils contain a lot of skeletal parts, during plowing they chat with the farmer.

The recognized soil kinds are in various stages of the initial development, starting from limestone of Calcaric Leptosols kind (Ri) of a typical soil cover up to the parts of cover rendzinas evolving towards the common limestone of Rendzic Leptosols kind (Rw) and Brown Rendzina – rendzinas (Rbr) – Fig. 1.

The process of creating such cover soil kinds is a complex phenomenon of the predominant natural character.

It must be remembered that the factors influencing the final character of the investigated soil covers involve:

- above mentioned geological conditioning and mainly the bedrock,
- geomorphologic conditions
- climate conditions,
- length of the soil formation process,
- impact of the living organisms.

The influence of bedrock is most evidently seen in the initial soils, in which the minerals have not yet been completely transformed. The soil covers of the investigated reserve are strongly limited by the local conditions while at the same time they maintain the essential characteristics of the bedrocks, therefore, the soils belong to the zonal soil kinds.

The Skowronno Reserve has its own microclimate closely associated with different topoclimatic conditions in relation to the surrounding areas. At the base of the reserve, there is the extensive, invasive Nida Valley. The diversified orographic western side of the slope in the part the Pińczów Mountains has the good insolation of approximately 1,550–1,600 hours per year and it is subject to the influence of prevailing western and northwestern winds approximately 40% of the year. There is also the characteristic occurrence of the specific wind calms in the late summer and fall. The average annual rainfalls are similar to the national average amount, that is, from 550–600 mm. The microclimate conditions influence the process of soil drying, which is also caused by the rapid infiltration of the rainwater, which occurs in the Neogene limestone in Pińczów Mountains.

The system of the slope relief is a characteristic element of creating the dry, shallow and gravitationally unstable soil covers exposed mainly to slow downhill creeping.

The grassy xerothermic vegetation has the significant impact on the formation of the humus layer of the investigated soil covers. The degree of the humification of organic substances in the investigated soil covers is very high (70–80%).

The limestone of Calcaric Leptosols type (forming the initial stage of the soil cover development, mainly in the exposed parts and the slope parts with the inclination to 30° of Okrąglica elevation.

Such soils have a profile constructed as Acca-Cca-R, where: A is the level of humus, C – the level of the bedrock, R – level of the solid rock and ca – the significant share of calcium in the soil level.

The initial level of the investigated humus soil covers (ACca) reaches up to 10 cm in the thickness and in the thill part contains varied crumbs of bedrock.

Such soils are due to the its very tiny thickness and poor abundance of absorbable potassium, phosphorus and magnesium are unsuitable for agricultural crops and difficult to afforestation. Most often it is covered with the rock and grassland vegetation. Due to the rapid infiltration of the rainwater, mainly by the numerous cracks in the soil carbonate blocks, they belong to the dry kind of soils.

The soils have a neutral pH in the range of 6.7–7.4.

The common limestone of Rendzic Leptosols kind and the Brown limestone of Rendzic Leptosols kind – Brown Rendzina also have the construction of the ACca-Cca-R profile, but the level of ACca thickness is included in the range of 6 to 15 cm. The humus content of the humus level is over 3%. Such soils have the average abundance of the absorbable forms of potassium and low absorbable forms of phosphorus and magnesium. Potassium and magnesium is clearly cumulated in the humus level. The pH of the soils is slightly acidic and the humus level of pH_{H_2O} reaches 6.7. The size of the ratio depends on the nature of bedrocks.

The grain size analysis (particle size) of the investigated soils confirms their soil typological classification. The laser studies involved smaller fractions than stone fractions (ø>20 mm) and gravel (ø 20–1.0 mm) to het the composition of the sand fraction (ø 1.0–0.05 mm), silt/dust fraction (ø 0.05–0.002 mm) and clay fraction (ø <0.002 mm) – Table 2, Fig. 3.

In the sample test No. 2 on the A level, there is 59.12% of sand fraction, 40.7% of dust/silt fraction and 0.10 of clay fraction. However, at Cca level, there are 59.12% of sand fraction, 40.7% of dust/silt fraction and 0.10% of clay fraction. Similar to the remaining levels of the sample tests 1, 2 and 3, which grain size analysis showed the presence of soil formations in the form of clay, dust/silt (gpl).

The soils of the Skowronno Reserve create the very good habitat for the development of the xerothermic vegetation. Conversely, due to their location in the former quarry and their very weak class of the bonitation efficiency value, i.e. classes number 5 and 6 along with the function of the reserve protection of the investigated areas cannot be used in terms of the agriculture.

The presence of soils in the reserve is a very important part of the re-naturalization of the natural systems. Hence, it can be used as a partial, experimental phytomelioration of the studied area in the selected parts of the shrubs, maintained for the active protection of the reserve.

Tab. 2. The grain size distribution of initial Calcaric Leptosols in the Skowronno Reserve
Tab. 2. Skład granulometryczny badanych rędzin inicjalnych w rezerwacie Skowronno

Fractions *Frakcja*		The diamiter of fractions *Frakcja o średnicy* [mm]	Sampie 1/*Próba 1*		Sampie 2/*Próba 2*		Sampie 3/*Próba 3*	
			Level/*Poziom*		Level/*Poziom*		Level/*Poziom*	
			A	Cca	A	Cca	A	Cca
			Depth *Głębokość* [cm]		Depth *Głębokość* [cm]		Depth *Głębokość* [cm]	
			1–8	9–15	1–9	10–20	1–5	6–15
The diamiter of fractions *% frakcji o średnicy* [mm]	Sand fractions *Frakcja piasku*	2,0–1,0	6,91	7,64	11,28	7,11	6,39	8,39
		1,0–0,5	9,83	9,58	8,44	10,32	10,32	12,41
		0,5–0,25	17,05	18,87	15,19	16,2	13,83	16,2
		0,25–0,10	17,28	18,63	23,17	18,31	17,31	18,31
		0,01–0,05	6,79	5,14	1,04	7,05	5,14	7,05
	Dust fruction *Frakcja pyłu*	0,05–0,02	12,41	10,36	10,59	12,27	9,36	10,36
		0,02–0,005	16,33	18,84	28,6	26,4	17,94	18,07
		0,005–0,002	12,04	11,58	1,59	2,11	12,57	1,86
	Silt fruction *Frakcja iłu*	<0,02	1,36	2,65	0,10	0,23	3,97	2,01
Soil formation *Utwór glebowy*			Dust Clay *Glina pylasta* (gpl)	Dust Clay *Glina pylasta* (gpl)	Dust Clay *Glina pylasta* (gpl)	Dust Clay *Glina pylasta* (gpl)	Dust Clay *Glina py-lasta* (gpl)	Dust Clay *Glina pylasta* (gpl)

Source: Report of the analysis of the results of laser grain size composition performed by the certified laboratory analyzes of soil in 2013.
Źródło: Raport z analizy wyników badania laserowego składu granulometrycznego wykonanego przez certyfikowane laboratorium analiz glebowych w 2013 r.

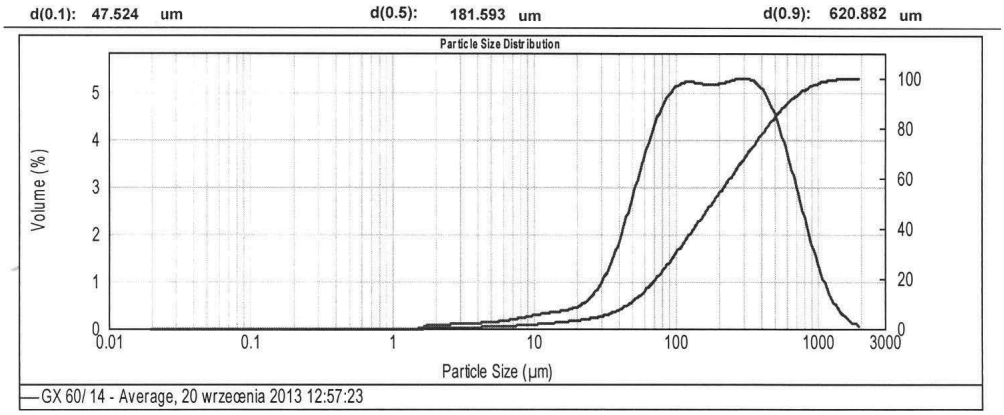


Fig. 3. The graph of grain composition for samples – number 1– level A – Table 2
Rys. 3. Wykres składu granulometrycznego dla próby nr 2 poziom A – tabela 2

The phytomelioration would support the watertable control in the reserve. It would also be the additional naturalised positive factor for functioning of the watertable control in the biotic environment and abiotic natural systems of the reserve. Otherwise, the increasing water loss from the natural system of the reserve may result in the longer consequences, namely, in the significant activation of the processes of desertification of the studied soils, therefore it may lead to the extinction of the xerothermic vegetation.

The Skowronno Reserve is the valuable landscape object. Its diversity of the landscape is the result of the well-defined boundaries of the landscape facies (the smallest elementary landscape units) which have their conditioning in the geological, geomorphologic and cultural genesis of the area. The mapping of the landscape is necessary to be carried out. It should be done at the landscape facies level in this reserve in order to consider the needs of extending its protective function by the landscape function.

The large parts of the visible rock of various sizes and varying degrees of preservation are located at the edge of the bottom of the pit and quarry – photographs from 11 and 13. Furthermore, the photographs 19 and 20 have the characteristic signs of weathering. The weathered layer on the surface of rocks does not play the role of the so-called 'protective patina'. On the other hand, it slows down weathering and/or the deterioration for a short period of time. Such situation is caused by the changes in the physical and mechanical properties of this layer with respect to the bedrock. Due to the favorable weather conditions, the process of the disintegration and the loss of the material from the surface is rapidly increasing, mostly due to the physical and chemical weathering, or together with the participation of microorganisms (algae, fungi, lichens, and others), up to the bounder, followed by the exfoliation of the created layer to the bedrock. The speed of this weathering process depends, inter alia, on the presence of

pollutants in the air in the investigated area, the pressure of microorganisms, which in case of lichens are considered to be the bioindicator of the atmospheric air quality status – photographs from 25 to 27.

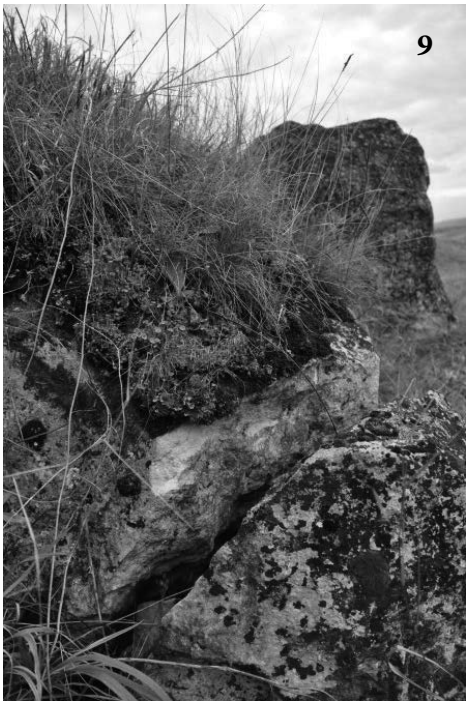
In the area of the Skowronno Reserve and its surrounding areas there are no objects that cause the air pollution and the violations to the noise intensity level. The roads No° 0168 and No° 0017 located at the distance of approximately 1 km as well as the narrow gauge railway line "Ciuchcia Ponidzie Ekspress" (Choo-choo train) are not the threat to functioning of the reserve. In contrast, the air and soil in the reserve are exposed to the risk of the low emission coming from the rural households of Skowronno Górne and Skowronno Dolne villages. However, the state of the contamination/pollution has not been yet subjected to the investigation. The situation is similar in case of the influence of the chemical interaction of the fertilizers and chemicals used in agricultural in the surrounding areas of the reserve.

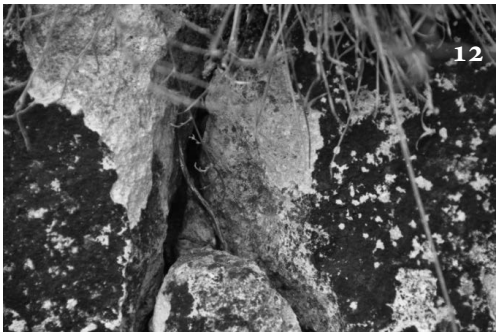
It is also advisable to carry out the research dealing with the contents of heavy metals in soils of the reserve and to compare the results with the results of the similar studies available for Rendzina of Ponidzie. The existing research results clearly indicate no contamination of such soils and they respectively reach: Zn – 59.9 mg /kg^{-1}, Cu – 24.9 mg/kg^{-1}, Pb – 23.4 mg/kg^{-1}, Cr – 15.4 mg/kg^{-1} (Świercz 2007).

In the investigated reserve, there is no violation to the CO_2 level, which has the crucial impact on deepening of the surface and underground kinds of the erosion of limestone rocks. This is clearly demonstrated by the development of lichen – bioindicators – photographs from 25 to 27.

Yet the examinations of the Ponidzie reserves dealing with the particulate pollution, conducted in 1995 by the team of J.L. Olszewski et al. (1995) demonstrated the small dust pollution from the so-called "White Basin" (Polish: „Białe Zagłębie"). However, during present field studies, there was no presence of carbonate dust pollution found in the reserve.

The xerothermic grasslands of Ponidzie as culture habitats, partly natural were also created due to the people's pasture activates. The failure of its use in the area of the reserve and in the surrounding areas may cause the progressive impoverishment of the grasslands and the disappearance of many valuable species of fungi, invertebrates and vertebrates.



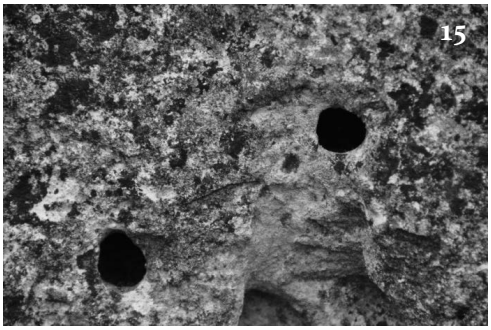


Photos 8–13. Example of mechanical weathering and neotectonic cracks

Fot. 8–13. Przykład wietrzenia mechanicznego i pęknięć neotektonicznych

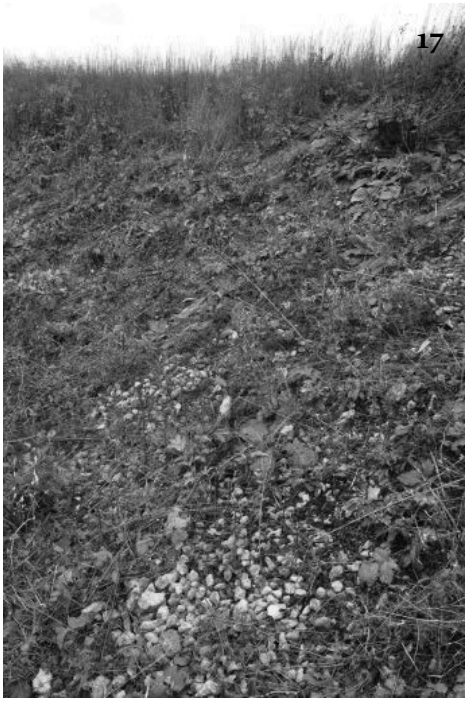
Photo 14. Example of mechanical weathering and neotectonic cracks

Fot. 14. Przykład wietrzenia mechanicznego i pęknięć neotektonicznych



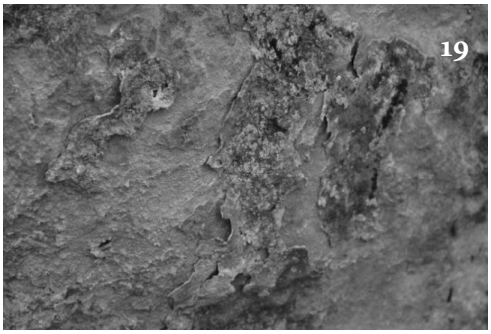
Photos 15–16. The example of karst weathering "Pinczak"

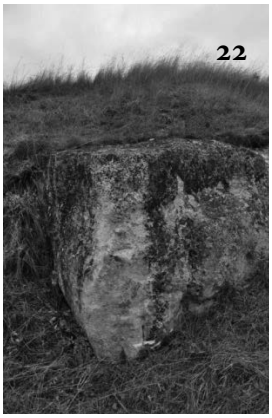
Fot. 15–16. Przykład wietrzenia krasowego „pińczaka”



Photos 17–18. The weathering process of subsidence in the form of small limestone screes

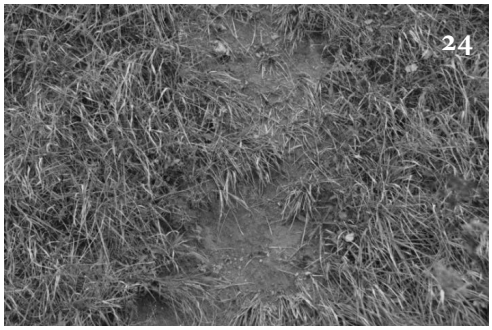
Fot. 17–18. Proces osuwania się zwietrzeliny wapiennej w formie niewielkich piargów





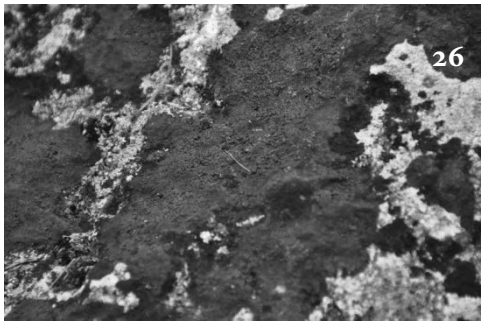
Photos 19–22. The weathering process occurring on the surface of "Pinczak"

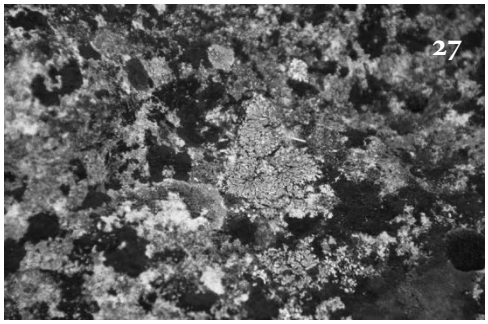
Fot. 19–22. Proces wietrzenia zachodzącego na powierzchni „pińczaka”



Photos 23–24. The anthropogenic pressure caused by treading parts of the reserve and the release of the erosion processes on the slope surfaces

Fot. 23–24. Presja antropogeniczna wywołana przez wydeptywanie fragmentów rezerwatu i uwalnianie procesów erozji na powierzchniach stokowych





Photos: 25–27 The presence of bioindicators in the Skowronno Reserve

Fot. 25–27. Występowanie bioindykatorów na terenie rezerwatu Skowronno

Photos 1–27. by M. Strzyż 2013.

Fot. 1–27. M. Strzyż 2013.

It should be highlighted that while dealing with the extensive agriculture, the sheep guaranteed the maintenance of the biodiversity, and the existence of xerothermic vegetation. The presence of these animals was the guarantor of the proper soil structure and the maintenance of the vegetation (biting the grasslands and the regrowth of shrubs and small trees) and the genetic exchange between the distant populations of the xerothermic grassland. The sheep fur can be the means of the transport for up to 80 plant species as well as in its stomach (Barańska et al. 2013, Dzwonko 2013). At present, there is no direct exchange of genes between the xerothermic reserves of Ponidzie (Skowronno, Krzyżanowice, Skotniki Dolne, Przęślin, the Easter Mountain), which can also be one of the main reasons for the trends of xerothermic grassland disappearing in the smaller reserves. Originally, the xerothermic grasslands of Ponidzie were the dominant succession, which was limited by other successions, e.g. forest succession.

Additionally, the grassland habitats were fragmented by the field stolons, the rural and urban buildings (Pińczów), roads and other forms of the development, which in many cases led to the creation of landscape and functional barriers including those reducing the patency of ecological corridors.

According to the plan developed for the protection of the Skowronno Reserve for the period from 1 January 2013 to 31 December 2033 (2013), the majority of flora and fauna species inventoried in the reserve is closely related to the xerothermic grasslands. Therefore, their genetic movement is restricted and causes the isolation due to the lack of the patency considering the local ecological corridors, which results in the lack of the adequate possibility to protect habitats and species. In particular, the patency of the second ecological corridors is specially important, since there are habitats and environmental conditions similar to those in the reserve, or they provide the possibility of increasing the area of xerothermic grasslands (with the appropriate natural resource management aiming at stimulating such process).

It is noteworthy to demonstrate that there are new places of the occurrence of smooth snake (*Coronella austriaca*) in the Skowronno Reserve, which requires the presence of the xerothermic vegetation together with the bushes and tree plantings. Furthermore, the birds and bats use the space above the reserve, which forms the important ecological node connected to the ecological corridor of the Nida Valley. The ecological corridors allowing the migration of plants and animals require the improvement of the conditions of the xerothermic habitats surrounding areas, the increase of the areas of the boundaries of the reserve, the maintenance of the field balks, the introduction of the controlled grazing the areas of xerothermic grasslands, and the appropriate (at least 300 m) limitation of trees and shrubs growths in the reserve.

The small area of the Skowronno Reserve is exposed to the natural and anthropogenic threats. To those of the natural character involve:

- overgrowing that stimulates the growth of nitrophilous and ruderal species (mainly shrub vegetation – *Crataegus*, *Rosa*, *Prunus spinosa*) in the north-west parts and in the excavation of the quarry (*Euonymus europaea*, *Rhamnus cathartica*, neophyte, e.g. *Syringa vulgaris*) in the central part of the reserve) that limits the growth of rock vegetation in the exposed parts of the rock quarry and limits the habitats of *Campanula bononiensis*, *Orobanche lutea* in the north-west part.
- The formation of the "felt" layer (the layer of the dead organic remains), which causes the extinction of xerothermic species. The long term accumulation of plant remains limits the supply of air and sunlight into the soil. Hence, it is difficult to observe the water evaporation and ventilation of the soil, what leads to the changes in the physical and chemical characteristics, i.e. the increase in moisture level and fertility. At the same time such layer provides the good habitat conditions for, e.g. the valuable and rare species of snails.

However, the risks of the anthropogenic character include:

- the eutrophication of habitats caused by the close neighbourhood of field (agricultural land). Its symptom appears as the increase in the number of nitrophilous and ruderal species in the habitats of *Lactuca seriola*, *Urtica dioica* on the border of the reserve,
- the deterioration of the preservation of xerophyte habitats due to the increase of the soil fertility, which causes the growth the expansive mesophilic grasses forming xerothermic grasslands, e.g. *Arrhenatherum elatius*, *Brachypodium pinnatum*, *Elymus hispidus*,
- dusting caused by the mining and the gypsum and limestone processing (particulates, oxides, acid rain),
- the low emission from neighbouring areas of the reserve, i.e., households using the coal, the composition of which contains approximately 6% of sulfur,
- the inflow of pollutants with the masses of air from other areas mainly the industrialized Silesian conurbation,
- the limitation of the use influences the impoverishment of the communities considering the composition of xerothermic grasslands, e.g. *Elymus hispidus* such as. *Elymus hispidus* (slope in the western part), the appearance of the dominance of one species or the species that are not related to the existing habitat – *Calamagrostis epigejos*,
- progressive building on land near the borders of the reserve or in its close neighbourhood,
- uncontrolled grass burning, or bonfires in the reserve, which lead to the extinction of rare species of plants and animals, including the smooth snake,

- potential threat is the use of the reserve and the surrounding areas by people who practice extreme motor sports (quad bikes, motocross),
- excessive trampling and littering in the reserve (Photos: 23 and 24).

CONCLUSIONS

The beautiful, colourful and mostly partly natural xerothermic grasslands are one of the richest Polish plant habitats of many flora species, as well as rare and endangered plants and animals. The reserve protection of these, partially under anthropogenic processes, habitats must be dealt with as a whole taking into account the peculiarities of their surroundings. For this reason, the protection apart from the habitat area should include species of flora and fauna, natural processes, existing ecological corridors, landscapes but also some aspects of human activities as the cultural, ethnographic and traditional values. Only the holistic concept of protecting the anthropogenic habitat in a small area can be successful with the purposes of maintaining the favorable conservation state. Thus, the present studies suggest the transformation of the floristic reserve into the floristic and geological one. In case of the restoration of grazing animals in the Ponidzie reserves as the well-established, effective and systematic nature of the control and subject to the procedure, the whole Pińczów Hump must be protected regarding all the xerothermic reserves. Particularly, the xerothermic grasslands must be protected e.g. in the context of the cultural park creation as a form of the open natural museum.

The appropriate monitoring is a complex and long-term activity. As a consequence of the need of preserving the xerothermic grasslands in Poland, the monitoring should be of the national character and should be carried out in accordance with the specified research procedure adapted to the needs of the effective protection of such areas.

Hence there is the need for developing the principles of operating the mentioned monitoring based on the intensive control of the process of active protection in the xerothermic grassland areas, including the investigated Skowronno Reserve. Furthermore, there is the need for implementing the effective actions limiting the signs of the devastation of the examined reserve (trampling of xerothermic vegetation surfaces, bonfires, littering – photographs: 23, 24).

Tab. 3. Monitoring xerothermic grasslands in the xerothermic reserves of Ponidzie
Tab. 3. Monitoring muraw kserotermicznych rezerwatów kserotermicznych Ponidzia

Monitoring activities	Results/effects
Updating the laws according to the requirements of sustainable protection of habitats of xerothermic grasslands	Updating the activities according to the requirements of national and international laws, taking into special consideration the Berne Convention
Provide the detailed inventory of the selected groups of organisms and regular monitoring of their populations	The preservation of the diverse reliefs and natural geological structures.
Annual chemical soil examination	The preservation of soil conditioning
The introduction of mowing and cutting in the range of the invasive and common species	Improving the conditions of habitats remaining in an unsatisfactory or poor conditions
According to the guidelines of the protection plan of the reserve	Maintaining and increasing the area of habitats in the appropriate state (FV)
According to the guidelines of the protection plan of the reserve	Maintaining stable populations of valuable plant species on the national and regional level, as well as those protected by the law
According to the guidelines of the protection plan of the reserve and the guidelines resulted from additional scientific studies, i.e. maps of the local ecological corridors, recognition and occurrence of bioindicators (photos from 25 to 27).	The maintenance of the patency of ecological corridors and the patency of the existing ones by the active protection (maintenance of field balks and preventing of the further functional isolation of the reserve from the remaining part of the Pińczów Hump
According to the guidelines of the protection plan of the reserve	The increase of the biodiversity in the range of the communities of xerothermic grasslands and vascular plants
According to the guidelines of the protection plan of the reserve	The maintenance and the increase of the number of endangered and rarer species populations .
Providing the protection treatments by the Regional Director for Environmental Protection, supervision and functioning of the reserves especially in spring and summer	The maintenance of the significant cultural and landscape values of the reserve

Source: Personal studies
Źródło: badania własne.

The harmful phenomenon of the devastation of such areas is very common in our country, and it refers almost to all areas of xerothermic grasslands.

Table 3 contains the initial suggestions of the monitoring activities and results (effects) of such activities for the areas covered with the xerothermic grasslands included in the reserve protection in Ponidzie.

The range of monitoring should include the control of the effectiveness of the active protection undertaken in relation to the species of wild plants (rare in the country and the region, and strictly protected ones) and their habitats. The particular attention should be paid to:

1. The structure (and particularly the number) of populations of species, such as *Adonis vernalis*, *Anemone sylvestris*, *Campanula bononiensis*, *Campanula sibirica*, *Carex supina*, *Linum hirsutum*, *Orobanche lutea*, *Scorzonera purpurea*, *Stipa joannis*, *Veronica praecox*. The observations should be carried out annually, i.e. including all quarters of the year, especially intensively in spring and summer.

2. The condition of habitats should be assessed on the basis of the following parameters:

- the range of the habitat (the area that could be potentially occupied by the habitat),
- the area of the habitat of the particular position (the existing habitat area and the tendencies to its changes),
- the specific structure and functions (existing species: characteristic ones, alien invasive ones, alien geographically and ecologically, the share of the expansive native plants – including trees and shrubs; maintaining the ecotone zone around the borders of the reserve).

The phytosociological studies (on solid surfaces – 25 m^2) should be conducted annually.

3. The presence of the expansive native species, however, ecologically foreign ones influence the change of the phytocoenoses structure (e.g. *Calamgrostis epigeios*). Their existence in the various sheets of communities consider, as well as in the whole reserve should be taken into consideration.

The annual inspections are recommended.

4. The existence of neophyte, especially the potentially invasive species.

5. Providing new bushes and shrubs – their composition of species, and above all the area occupied by them in the reserve. The share of the shrubs and bushes should be checked every 2, or 3 years.

6. Monitoring of the wildlife populations of fungi (including snails, insects, smooth snake and *Pelobates Fuscus*) in accordance with the specific methodologies.

The environmental monitoring and monitoring of the effectiveness of the arrangements (plan) should be planned and implemented after consulting the Regional

Director of Environmental Protection in the particular provinces. To conduct monitoring system research the appropriate people are needed, namely, scientists, naturalist practitioners with the relevant experience and preparation, gathered in the non-governmental organizations involved in the environment protection, moreover, specialized companies acting to protect particularly valuable natural environments.

The most important tasks in the sphere of the active protection of habitats and species in the Skowronno Reserve include:

1) mowing, cutting and grubbing of the succession vegetation aimed at increasing the surface area of xerothermic grassland habitats and to maintain their proper conditions; each treatment must be preceded by the monitoring and the consultations of the scientific team. The task should be carried out by individuals, businesses, organizations, or institutions, which have the equipment, skills, and knowledge dealing with the natural resources of the reserve and can, after the consultations with the naturalists carry out the treatments without the risk of damaging the environment;

2) grazing sheep and goats in the selected locations; the conditions for carrying out such tasks are the same as mentioned in the first point. The detailed refinement is required in the range of the concept dealing with the issue of how to maintain and use of the 'itinerant' flock of sheep. This task should be combined with the possibilities of use of grazing with tasks in the field of the environmental education and the protection of the cultural landscape;

3) maintaining the ecological corridors due to the preservation of the field balks, owing to grazing and cutting in the range of the entire plateau, maintaining the appropriate distance between the reserve and the shrubs and woodlands of the Pińczowski Hump so as to get the area of the character similar to the linear, loose and exposed to the sun trail;

4) determining the total area of 200 m in the reserve so as to create the protection zone for the smooth snake; Such 200-meter belt should refrain from the process of burning the grass, in addition to the methodology of monitoring and protecting the positions of the thermophilic species, should be initiated;

5) maintaining the landscape values by avoiding the location of the infrastructures which could have the negative impact on the landscape in a radius of 2 km; such records should be included in planning documents for this particular area;

6) in the case of the confirmation of the importance of creating the so-called Estwing prybar place (in Polish: łomiki), the place and the way of doing it should be indicated, and such task should be carried out according to the appropriate procedure;

7) the development and implementation of the concept of the cultural park (open museum) and the protection of the phenomena in the range of anthroposphere (grazing, mining, archaeological sites, monuments of culture and architecture) with the

wide range of research and educational activities in the area of the reserve in connection with other such objects in Ponidzie . It is the activity that should be divided into several stages. For example, the first two years should be devoted to building a team and developing the detailed concept of the park (open museum) and preparing the documentation in order to formally establish it; the next five years constitute the period of the implementation of the concept in the area of the reserve and other xerothermic reserves;; throughout the period of seven (ten) years, the actions should be undertaken so as to establish an open "Ponidzie Museum" with the headquarters located in Krzyżanowice (the place of the Holy Cross and Nadnidziańskie Landscape Parks) with the tourist information centers in Busko Zdrój, Pinczów, Wiślica, Staszów and Osiek.

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