

## Protected and protection-worthy ecological areas or features in the Olkusz Ore-bearing Region

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Calamine areas occur on different continents, and in Europe they can be found in Germany, the Netherlands, Belgium, England and elsewhere (Ernst 1974). Many of these areas are under legal protection. Until recently, in Poland it was widely held that areas associated with zinc and lead mining were of little natural value. In recent years these same areas have been shown to be potentially of high natural and landscape value. The importance of calamine areas is increasingly recognised in Poland and worldwide. Establishment of the Natura 2000 European Ecological Network was one of the largest tasks related to protection of biological diversity ever faced by the European Union nations. The Habitats Directive (92/43/EEC) of 21 May 1992, on the conservation of natural habitats and of wild fauna and flora, lists low calamine grasslands of the *Violetea calaminariae* class as rare and vulnerable biotopes, that is, Sites of Community Importance or potential Special Areas of Conservation.

In Poland, calamine grasslands occur only in the vicinity of Olkusz and Chrzanów,

where lead and zinc mining and industry have been documented dating to at least the 12<sup>th</sup> century (Molenda 1963, 1972; Godzik and Woch – Chapter 3 and Woch – Chapter 4, this volume). The Olkusz Ore-bearing Region (OOR) is characterised by significant natural and landscape diversity. Areas with elevated substrate levels of heavy metals, such as those within the OOR, have been of much interest to biologists for many years. On one hand, they are historical remains of zinc and lead ore mining, and on the other hand they are specific natural habitats favouring the growth of diverse fauna and flora (Grodzińska and Szarek-Łukaszewska 2002). Due to the unfavourable physicochemical characteristics of the substrate, combined with other abiotic factors, these areas are inhabited by a number of specialised species capable of coping with the stress caused by high levels of heavy metals in the soil. These plants are referred to as metallophytes or pseudometallophytes and, in rare cases of accumulation of very high levels of metals in aboveground parts, hyperaccumulators (Brooks 1998). The natural development

of the flora of such areas is very slow; in time, however, biocoenoses featuring some rare and protected species can form. In some cases their biodiversity surpasses that of the habitat that predated the impact of mining (Molenda 2005). Spoil heaps from zinc and lead extraction, particularly the older ones, may therefore serve as refuges for these specific plant species (Szarek-Łukaszewska i Grodzińska 2008).

A total of 736 vascular plant species have been recorded from the Olkusz Ore-bearing Region (Nowak *et al.* 2011; Nowak *et al.* – Chapter 8, this volume). Taxonomically they are highly diverse (102 families, 372 genera). Forty-six of these species are legally protected, including 39 under strict protection and 7 under partial protection. Some of them have only single or a few localities, while others are quite common and form large populations (Nowak *et al.* – Chapter 8, this volume). Rare species of fungi and lichens have also been identified within the OOR (Mleczo 2004; Mleczo *et al.* 2009; Bielczyk – Chapter 10, Mleczo and Beszczyńska – Chapter 11, this volume). These data are enough to demonstrate the high natural value of the Olkusz region.

## Current forms of nature protection in force in the Olkusz Ore-bearing Region

On the list of Sites of Community Importance there are two Natura 2000 areas protecting calamine grasslands (code 6130) in Małopolska Province; they are called Pleszczotka and Armeria.

### Pleszczotka Natura 2000 area

The Pleszczotka nature area (PLH120092) and ecological site is located in the southern part of Bolesław municipality and covers 4.9 ha (Kapusta *et al.* 2010). The name of the site

originates from the Polish name of the alpine plant buckler mustard (*Biscutella laevigata*), a glacial relict for which the old spoil heap is the second documented site in Poland and also the only lowland locality of this species (Mesjasz-Przybyłowicz 2001; Pielichowska and Wierzbicka 2004) (Fig. 1). This species differentiates the Bolesław grassland from other calamine grasslands of the Armerietum halleri association in Europe (Ernst 1974; Matuszkiewicz 2005; Grodzińska and Szarek-Łukaszewska 2009; Szarek-Łukaszewska and Grodzińska 2011). Other interesting species found within the area include *Alyssum montanum*, *Armeria maritima*, *Dianthus carthusianorum*, *Gentiana germanica*, *Gypsophila fastigiata*, *Erysimum odoratum* and *Silene vulgaris*.

This nature area protects a single type of natural habitat (Violetalia calaminariae calamine grassland) listed in Annex I to Directive 43/92/EEC, covering 81.84% of the area (<http://natura2000.gdos.gov.pl/>). The area features a historic spoil heap more than a century old, left from extraction of Zn-Pb ore. The heap was never subjected to any recultivation. Vegetation appeared gradually by spontaneous succession (Grodzińska and Szarek-Łukaszewska 2002, 2009). For many years the area was covered by dense grassland, with isolated trees. Until the 1950s the growth and development of vegetation was restricted by pasturing of goats and sheep (Dobrzańska 1955). By the 1980s, pollution of the air by SO<sub>2</sub> and metallic dust emitted by the Bolesław Mining and Metallurgical Plant in Bukowno was making a significant impact on the area (Kapusta *et al.* 2009). Cessation of pasturing and reduction of industrial emissions led to rapid, unhampered development of tree seedlings, particularly pine. Tree cover shaded more and more of the grassland (Szarek-Łukaszewska and Grodzińska 2008; Zielonka *et al.* – Chapter 12, this volume).



Fig. 1. Pleszczotka Natura 2000 area dominated by *Biscutella laevigata* (photo P. Kapusta)

Ryc. 1. Obszar Natura 2000 Pleszczotka z dominującym gatunkiem *Biscutella laevigata* (fot. P. Kapusta)

The soil of the protected area is shallow, skeletal and alkaline (pH >7); it has high levels of metal ions (Zn 4%, Pb 0.3%, Cd 0.02%) which vary significantly on a small spatial scale due to the heterogeneity of the mining material on which the soils were formed (Jędrzejczyk-Korycińska 2006). Harsh habitat conditions (strong insolation, low substrate humidity, low nutrient content) challenge the plants. This protected area is a habitat for a specific vegetation type, calamine grassland, typical for spoil heaps rich in zinc and lead ore (Grodzińska and Szarek-Łukaszewska 2009; Szarek-Łukaszewska and Grodzińska 2011). Numerous plant species have developed distinctive varieties and ecotypes in the area. Under strong selection pressure they have developed morphological and physiological adaptations that allow them to tolerate above-typical soil loads of heavy metals and to survive in an extremely hostile environment.

In 2008–2009 a qualitative and quantitative assessment of the vegetation cover on more than ca. 20% of the Pleszczotka ecological site was made. Selected habitat conditions were also characterised, including land slope, shading, cover by undecomposed organic matter, and soil physicochemistry. Due to ongoing overgrowth by pine trees over the calamine grassland, leading to a changes in habitat conditions, it was decided that the tree and shrub layers had to be removed from the study area. The need to actively protect the calamine grassland so as to preserve its unique species composition and features was demonstrated (Kowolik 2010; Kowolik *et al.* 2010). In 2011, as part of a scheme of active grassland protection, trees and shrubs were eliminated from the area of interest and it was placed under monitoring. As early as two years after the clearance, the composition of the grassland changed to include



a higher number of species covering a larger percentage of the land (Jędrzejczyk-Korycińska *et al.* 2014). The area is under continuous monitoring.

### Armeria Natura 2000 area

The second nature area in the OOR is Armeria (PLH120091). This protected area (7.4 ha) includes post-excitation areas in the vicinity of the Bolesław Mining and Metallurgical Plant in Bukowno, including older non-recultivated areas and younger areas that were subjected to recultivation in the late 1990s. The oldest part consists of cave-ins and land irregularities secondary to exploratory shafts (Fig. 2). This part probably has remained unchanged since at least the 1920s. The younger part of the Armeria site is what remains of the *Michalska* exposure (3 ha in area

and 10 m in depth), where zinc-lead deposits were excavated in 1953–1969, along with deposits from earlier mining work. The excavation pit was filled with waste, including residue from a zinc smelter; after filling, the pit was covered with a 30 cm layer of soil to plant tree and shrub species including silver birch (*Betula pendula*), European larch (*Larix decidua*), Scots pine (*Pinus sylvestris*), common sea-buckthorn (*Hippophaë rhamnoides*) and wild olive (*Elaeagnus angustifolia*) (Szarek-Łukaszewska and Grodzińska 2008).

The substrate in the oldest part of the area is covered with dense grass. The organic layer is ca. 20 cm thick and has very high heavy-metal content (e.g. Zn up to 8%, Pb 1%). In places subjected to recultivation and tree planting the substrate is somewhat less contaminated and contains ca. 1% Zn and 0.3% Pb.



Fig. 2. Armeria Natura 2000 area dominated by *Armeria maritima* (photo P. Kapusta)

Ryc. 2. Obszar Natura 2000 Armeria z dominującym gatunkiem *Armeria maritima* (fot. P. Kapusta)

The soils are neutral to alkaline (pH 7.0–7.6) (Grodzińska 2007).

The Armeria nature area is covered by calamine grassland composed of species that tolerate high soil loads of heavy metals. There are large shares of sheep fescue (*Festuca ovina*) and sea thrift (*Armeria maritima*); the latter gave this Natura 2000 area its name (Abratowska 2006) (Fig. 2). The nature area serves the purpose of protection of a single type of natural habitat (Violetalia calaminiariae calamine grassland) listed in Annex I to Directive 43/92/EEC, covering ca. 85.37% of the area (<http://natura2000.gdos.gov.pl/>). Calamine grassland habitats are very rare in Poland and Europe.

Other important vascular plant species in this nature area include *Anthericum ramosum*, *Biscutella laevigata*, stemless carline thistle (*Carlina acaulis*), dark red helleborine (*Epipactis atrorubens*), broadleaved helleborine (*Epipactis helleborine*), baby's breath (*Gypsophila fastigiata*), common cock-rose (*Helianthemum nummularium*) and spiny restharrow (*Ononis spinosa*) (Nowak *et al.* 2011).

### Sztoła river valley ecological site

On 18 September, 1996, the Bukowno Town Council placed the Sztoła river valley including the buffer zone under site protection (<http://krakow.rdos.gov.pl/files/artykuly/14223/rejestr2014uzytekol.pdf>). The Sztoła valley has particular landscape value due to its morphology; it is deeply cut into loose sand. It is a meandering valley with steep slopes, particularly in the upper course. Flow in the middle course is high. Another landscape value is that the water (abyssal waters pumped from limestone formations) appears turquoise. Starting from the lower part of the middle course, the valley floor widens and flood basins begin to form. The river bed is entirely natural. The Sztoła valley is subject to strong anthropopression involving constant changes in water

conditions in the reception basin due to mining activity. The river dries up periodically in the upper course, while high water levels are maintained in the remaining courses after it is joined by the southern canal ([http://www.jura.eko.org.pl/doc/srodowisko/Gmina\\_Bukowno.pdf](http://www.jura.eko.org.pl/doc/srodowisko/Gmina_Bukowno.pdf)). The plant cover on the valley bed and slopes is relatively meager and not diversified. It consists mainly of coniferous forest and riparian species grouped in small areas next to the watercourse. High uniformity of habitat conditions leads to low plant diversity. Plant communities associated with humid and fertile habitats are only partially developed. Protected species have been found in the area (Nowak *et al.* 2011).

### Eagles' Nests Landscape Park protection zone

Municipalities in the Olkusz Ore-bearing Region, particularly in its northern part, have sites with outstanding natural values, partially due to their location within the Eagles' Nests Landscape Park buffer zone. The landscape park covers an area protected for its natural, historical, cultural and landscape values, while the buffer zones surrounding the nature preservation areas are established individually for particular forms of nature protection to protect these areas from external threats due to human activity. In Bolesław, the Eagles' Nests Landscape Park buffer zone, in the northern part of the municipality, features interesting and valuable natural enclaves such as Laski-Krzykawka marsh in the Biała river valley, gullies in Krzykawka and Krzykawa, and slopes of the Przemsza river valley in Krzykawka.

### Nature monuments

As of 1 July 2014, the registry of nature monuments in Olkusz contained only one such entry within the OOR (<http://krakow.rdos>.



gov.pl/files/artykuly/14223/rejestr2014pomnprzy\_1212.pdf), a European ash (*Fraxinus excelsior*) with a trunk circumference of 333 cm, located in Bukowno at the border of lot no. 23 and Wodąca Street.

## Nature and landscape features worthy of interest and protection in the OOR

### Historic settlement in Stary Olkusz with xerothermic turf and fringe communities

The old settlement has remnants of the walls of a Gothic church dedicated to St. John. An obelisk was placed on the church ruins in 1937

([http://www.polskaniezwykla.pl/web/place/20183\\_olkusz-grodzisko.html](http://www.polskaniezwykla.pl/web/place/20183_olkusz-grodzisko.html)) (Fig. 3). In 1979, an archaeological survey of the site revealed a number of Gothic stone window arches, ceramics, horse stirrups and items of silver jewelry. The terrain surrounding the settlement is overgrown by turf communities of Festuco-Brometea and fringe communities of Trifolio-Geranietea sanguinei. Species of the area include bloody crane's-bill (*Geranium sanguineum*), white swallowwort (*Vincetoxicum hirundinaria*) and *Peucedanum cervaria*.

### Loess gullies north of Nowy Ujków

This beautiful landscape with loess gullies is home to turf communities of Festuco-Brometea. Broadleaved thyme (*Thymus pulegioides*),



Fig. 3. Historic settlement in Stary Olkusz (photo M. Jędrzejczyk-Korycińska)

Ryc. 3. Grodzisko w Starym Olkuszu (fot. M. Jędrzejczyk-Korycińska)



Fig. 4. Wet meadows in the Krążek-Bolesław region (photo M. Jędrzejczyk-Korycińska)

Ryc. 4. Wilgotne łąki w rejonie Krążka-Bolesławia (fot. M. Jędrzejczyk-Korycińska)

hedge bedstraw (*Galium mollugo*) and dyer's greenweed (*Genista tinctoria*) form a multicoloured carpet of flowers during the vegetation season.

#### Meadows between Nowy Ujków and Kolonia Nowy Ujków

This is a complex of Molinio-Arrhenatheretea meadows with particularly valuable wet and marshy meadows of Molinietalia, rich in rare and protected species. Species include Turkish marsh gladiolus (*Gladiolus imbricatus*), siberian iris (*Iris sibirica*), broadleaved marsh orchid (*Dactylorhiza majalis*), pepper saxifrage (*Silaum silaus*), sawwort (*Serratula tinctoria*) and autumn crocus (*Colchicum autumnale*). A very interesting species of false helleborine (*Veratrum lobelianum*) also grows in the vicinity.

#### Krażek-Bolesław wet meadow complex

This complex of wet meadows preserves numerous valuable patches despite the cessation of traditional exploitation (Fig. 4). Among its rare and protected species are early marsh orchid (*Dactylorhiza incarnata*), Ascherson's march orchid (*Dactylorhiza ×aschersoniana*), broadleaved marsh orchid (*Dactylorhiza majalis*), adder's tongue (*Ophioglossum vulgatum*), variegated horsetail (*Equisetum variegatum*), marsh helleborine (*Epipactis palustris*), broadleaved helleborine (*Epipactis helleborine*) and autumn crocus (*Colchicum autumnale*).

#### Trees

There are a number of beautiful old trees within the OOR. They grow as isolated specimens or in clusters, particularly in old parks.



The parks are mostly adjacent to heritage buildings such as manor houses.

The Old Polish Manor in Krzykawka dates to 1724. Some species of trees growing in the manor park today probably date to that period (Sawicki and Szlęzak 2011). There are some aged trees of monumental size such as a horse chestnut (*Aesculus hippocastanum*) 355 cm in trunk circumference at breast height, two small-leaved limes (*Tilia cordata*) (515, 505 cm), a sycamore maple (*Acer pseudo-platanus*) (303 cm), pedunculate oaks (*Quercus robur*) (560, 370, 325, 300 cm), a European beech (*Fagus sylvatica*) (310 cm), and an orchard tree, sweet cherry (*Prunus avium*) (177 cm). The park has other tree species of beautiful form and spreading crowns, such as eastern white pine (*Pinus strobus*), Norway

spruce (*Picea abies*), European larch (*Larix decidua*), European hornbeam (*Carpinus betulus*) and an old variety of European pear (*Pyrus communis*). The park stand generally is in very good or good condition, with only a few trees requiring attention.

Also of note is a park-type tree stand near the manor in Bolesław (Maria Płonowska Memorial Cultural Centre in Bolesław). The manor dates to the second half of the 19<sup>th</sup> century. On the north side the manor adjoins the erstwhile garden which turns into a huge park on the southern side (Fig. 5). The park tree stand near the Bolesław manor is much younger than the manor park described above, but well worth our attention. There are very large trees both near and inside the park, including white cedar (*Thuja occidentalis*) (150 cm trunk



Fig. 5. Park-type tree stand near the manor in Bolesław (Maria Płonowska Memorial Cultural Centre in Bolesław) photo M. Jędrzejczyk-Korycińska)

Ryc. 5. Drzewostan parkowy przy Dworku w Bolesławiu (Centrum Kultury im. Marii Płonowskiej w Bolesławiu) (fot. M. Jędrzejczyk-Korycińska)





Fig. 6. Pedunculate oak (*Quercus robur*), more than century old growing near Krzykawka (photo M. Jędrzejczyk-Korycińska)  
 Ryc. 6. Okolice Krzykawki – ponad 100-letni dąb szypułkowy (*Quercus robur*) (fot. M. Jędrzejczyk-Korycińska)

circumference), Norway maples (*Acer platanoides*) (320, 295 cm), and trees expected to reach very large circumference in later years. Examples include a beautiful small-leaved lime (*Tilia cordata*) (285 cm), a silver birch (*Betula pendula*) (177 cm), Norway maples (*Acer platanoides*) (215, 220 cm), a black locust (*Robinia pseudoacacia*) (256 cm), a European larch (*Larix decidua*) (204 cm) and a European hornbeam (*Carpinus betulus*) (180 cm). Most trees in the park are in very good shape. It would be advisable to eliminate the overly dense brushwood there, in order give the terrain around the manor a fresher, more attractive look.

An interesting specimen worth protecting is a pedunculate oak (*Quercus robur*) more than a century old, growing near Krzykawka (Fig. 6). The tree has reached monumental size, with ca. 330 cm trunk circumference

at breast height. The oak has a beautifully formed, healthy crown.

#### Protection of natural values

Areas that seem worthy of protection due to their natural and landscape values include the Laski-Krzykawka marsh located in the Biała river valley, as well as gullies in Krzykawka and Krzykawa (Fig. 7).

The Laski-Krzykawka marsh in the Biała river valley in the northern part of Bolesław enhances this interesting and original marsh landscape. Reed communities, mud sedges and riparian forests are developed in the area. Common floral components are sedge (*Carex*) species, as well as marsh cinquefoil (*Comarum palustre*), marsh marigold (*Caltha palustris*) and wood club-rush (*Scirpus sylvaticus*). The terrain provides an optimum habitat for protected



Fig. 7. Laski-Krzykawka marsh in the Biała river valley (photo P. Kapusta)

Ryc. 7. Bagna w dolinie rzeki Białej w okolicy Lasek-Krzykawki (fot. P. Kapusta)

amphibians and reptiles as well as a large number of rare bird and mammal species.

The loess gullies in Krzykawka and Krzykawa, largely covered by deciduous forest, form an area of high natural and landscape value (Fig. 8). The site is covered by a tree stand consisting of pedunculate oak (*Quercus robur*), small-leaved lime (*Tilia cordata*), European

beech (*Fagus sylvatica*), European ash (*Fraxinus excelsior*) and sycamore maple (*Acer pseudoplatanus*). The most frequent undergrowth species include wood anemone (*Anemone nemorosa*), common hepatica (*Hepatica nobilis*), wood bluegrass (*Poa nemoralis*) and *Melica nutans*. The area is a refuge and habitat for various groups of animals.





Fig. 8. Loess gullies in Krzykawka covered by deciduous forest (photo M. Jędrzejczyk-Korycińska)

Ryc. 8. Lasy liściaste porastające jary lessowe w Krzykawce (fot. M. Jędrzejczyk-Korycińska)

## Threats

The largest threats to grassland communities include natural succession or inappropriate recultivation leading to turfs being overgrown by shrub and tree species, with excessive growth of foreign invasive species such as Siberian peashrub (*Caragana arborescens*) and black locust (*Robinia pseudoacacia*), most commonly introduced during land recultivation. Another potential threat is posed by land rezoning for agriculture and construction, littering, and damage from motorised vehicles.

The threats to wet marshes in the OOR include drainage and development of boggy areas, regulation of rivers and small watercourses, abandonment of the traditional uses of meadows, and invasion by foreign species such as wild black cherry (*Padus serotina*), green ash

(*Fraxinus pennsylvanica*) and Asiatic dock (*Rumex confertus*). As in the case of turfs, rezoning also is a potential threat to these habitats.

Invasion of foreign species including Japanese knotweed (*Reynoutria japonica*), Canadian goldenrod (*Solidago canadensis*), New York aster (*Aster novi-belgii*), Himalayan balsam (*Impatiens glandulifera*) and small balsam (*I. parviflora*) constitutes a serious threat to OOR habitats. Uncontrolled dumping of rubble and litter also has a big impact on environmental conditions in this valuable area.

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