INSPECTION OF ENVIRONMENTAL PROTECTION

# Methodology of nature monitoring

Methodological guide for:

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## Contents:

# 1308 **Barbastella** *Barbastella barbastellus* (Schreber, 1774)

Photo 1 Barbastelle Barbastella barbastellus(© I. Gottfried)

Photo 2 Hibernating barbastelles (© I. Gottfried)

## I. INFORMATION CONCERNING THE SPECIES

### 1. Systematic position

Order: *Chiroptera* bats

Family: *Vespertilionidae*

### 2. Legal status and threat to the species

**International law**

Habitats Directive - Annex II and IV

Berne Convention - Annex II

Bonn Convention - Annex II

EUROBATS - Annex I

### National law

protection of species - strict protection (the species requiring active protection)
zone protection - hibernation sites where during 3 consecutive years the number of over 200 bats was ascertained (irrespective of the species): year-round protection zone - rooms and roosts occupied by the bats.

### IUCN threat category

IUCN Red List (2011) - NT
Red list of vanishing and endangered animals in Poland (2002) - DD
Red list for the Carpathian Mountains (2003) - VU (in PL - VU)

## 3. Description of the species

### Appearance

The barbastelle Barbastella barbastellus is an average-sized species of bat, whose length of the forearm is 36-44 mm. Pelt on the back is black with yellow or white endings and dark grey on the belly with low contrast with the back side. The barbastelle is the only bat in Poland whose colouration is so dark, almost black, and thanks to this fact it is relatively easy to distinguish it from other species when at rest. Additionally, a short snout, a distinctive arrangement of skin folds around nostrils and wide, short triangle-shaped ears, joined at the base in the middle of the head, give the bat its characteristic appearance (Photo 1, 2). Knife-shaped tragi go as far as the middle of the length of the ear. The wing membrane in this species is attached to the base of the toes. The barbastelle's wings are dark, relatively long and not too wide. They enable the bat to fly slowly, but they also allow for high manoeuvrability and even suspending in the air. At rest the wings are folded and held at the sides of the body. The calcar extends to the half of the distance between the heel and the tail. A lobe of skin reaches out of the calcar and it is not strengthened with a transverse cartilage. The end of the tail projects about 1 mm beyond the interfemoral membrane. Sexual dimorphism is not present in this species. A male can be distinguished from a female only after being caught: in males, on the ventral side, a penis can be seen. A young animal can be distinguished from an adult one in the period of about two months after birth. In this period, on the wings, when bones are being lit with a flashlight, epiphyseal plates will be visible before joints in the form of lighter stripes (Photo 3).

When at rest, it is hard to confuse a barbastelle with other species of bats. Whilst, when flying, correct designation on the basis of the silhouette is virtually impossible. There are no features that would help distinguish it, in the light of a flashlight, from pipistrelles, a whiskered bat or a Brandt's bat, which are of similar size, relatively dark, with slight contrast between their back and belly.

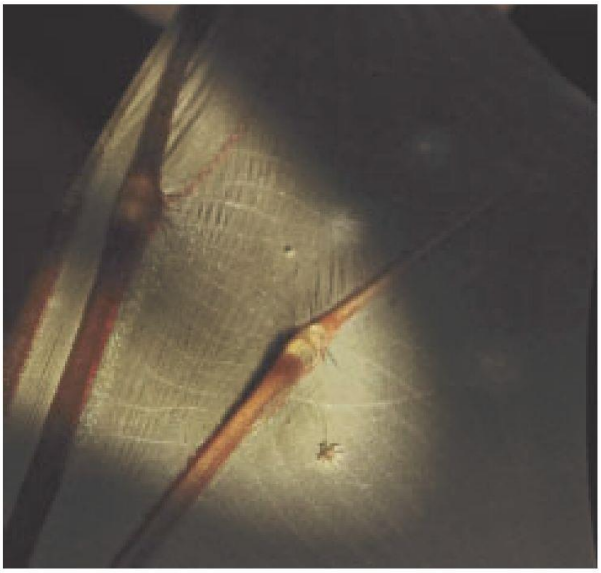

Photo 3 Young barbastelle - epiphyseal plates in the form of lines are visible on the wing (© I. Gottfried)

## Echolocation

The barbastelle is a species producing calls of high variability, which are emitted by the bat both via their mouth and via their nostrils. The diversification is exceptional among European species of bats (Rydell et al. 1996, Dietz et al. 2009, Barataud 2005). The species regularly emits, alternately with a basic call, a substitute call - an alternative one.

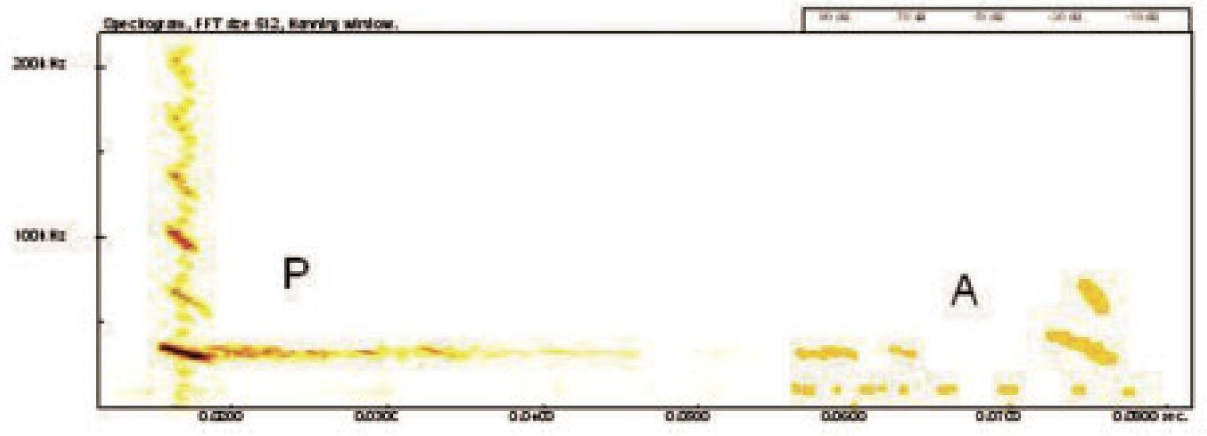


Fig. 1 Two echolocation calls used by the barbastelle alternatively, P = basic call, A - alternative call

Basic call (Fig. 1) is an FM sound (frequency modulated),of a short duration (normally 2.2-2.5 ms), with the best hearing frequency of 32-33 kHz. An average distance from which the call is heard is about 30 m. The alternative call is also an FM sound, of a much longer duration (3-6 ms in an open environment), with maximum energy of 41-45 kHz (Ahlen, Baag 0e 1999, Denzinger et al. 2001). It is heard from a distance of up to 15 metres (Barataud 2005).

The first type of the call is always more intensive and louder than the second one, so sending them alternately reminds of the sound of castanets (Barataud 2005). Such a way of emitting the basic call, alternately with the substitute call, results probably from the strategy of the hunt. Barbastelles hunt mainly for small species of flying insects that belong to the order of Leidoptera and of the net-winged insects Neuroptera, which have developed tympanal organs, so they hear echolocation signals of bats ranging 20-50 kHz. They account for 70-100% of their diet (Rydell et al. 1996, Sierro,

Arlettaz 1997, Sierro 2003, Barataud 2005). Probably the fact the barbastelle uses two types of calls makes it more difficult for insects to determine the location and distance from the bat.

The barbastelle may change the basic call depending on the structure of environment in which it is flying and because of that it may be similar to signals emitted by the bats of three other genera: long-eared bat Plecotus, mouse-eared bat Myotis, pipistrelle bat Pipistrellus (Barataud 2005). It may cause some difficulties in the correct determining of the species.

## 4. Biology of the species

### Migration

The barbastelle is considered by some authors to be a sedentary species, i.e. its winter roosts are most often located up to a dozen kilometres from its summer roosts (Roer 1995, Steffens et al. 2004), whilst other researchers consider it to be a medium-distance migrant. In Central Europe flights on the distance of almost 300 km from Austria to Hungary were noted, which indicates that in this part of the continent this species may migrate (Rydell, Bogdanowicz 1997). Also Czech researchers classify this species as able to migrate (Gaisler et al. 2003). In Poland the longest registered flight of a barbastelle was 150-km-long (own data, not published). During migration the species avoids flying into open space and uses linear elements of the environment, forests and woodlots (Hermanns et al. 2003).

### Non-winter season

Males live separately or form small groups. Females, after leaving hibernation sites, form groups, the so-called maternity colonies, where their pups are born. A single maternity colony can consist of between a couple and over 100 females. In the roosts located in trees there are usually 10-20 females (Dietz et al. 2009, Hermanns et al. 2003, Hillen et al. 2011, Russo et al. 2004, Weidner 2000). About the middle of June females give birth to 1-2 pups, which are being suckled for almost 6 weeks (Dietz et al. 2009). Colonies disperse in September-October (Sachanowicz, Ciechanowski 2005).

### Mating season

The barbastelle, living in temperate climate, has to limit its mating season to one, short period in a year. The mating season for this species is in late summer and early autumn. Barbastelles fly in large numbers to their winter roosts at the turn of August and September. The mating season lasts for about two weeks. At that time dozens of bats fly round entrances to underground structures and also inside. One may hear then social calls, observe bats chasing one another and mating (Gottfried 2009).

### Wintering

Barbastelles arrive at hibernation sites in November. The maximum number of bats of this species can be noted in January. Later the number of hibernating bats decreases. In March it is hard to observe one in their underground roosts (Fuszara et al. 2003a). Only insemination is the result of mating. A female stores sperm in her reproductive tract until spring. Conception takes place after the female emerges from hibernation (Dietz et al. 2009).

In Poland (starting from winter 1980) over 1000 objects are studied each year. In 2003 the results of winter counts were summarized. Over 700 winter roosts were controlled then and in about 31% of them hibernating barbastelles were found (Fuszara et al. 2003a). As their hibernation sites they most

often used forts (24% of hibernating barbastelles), large, brick cellars (22%) and bunkers (18%); caves, adits, canals or wells were used less often. In two types of roosts: bunkers and forts, the barbastelle was a dominating species, representing respectively 85 and 60% of the bats hibernating in these objects (Fuszara et al. 2003a, Fuszara et al. 2003b).

Międzyrzecki System Umocniony in Nietoperek was not included in those counts; each year 1000-1400 of barbastelles winter there, which, up to 2003, constituted about 22% of bats of this species wintering in Poland (Urbańczyk 1987, Fuszara et al. 2003a). The counts also included the tunnel of an old factory in Krzystkowice, discovered in February 2005, where 1870 barbastelles hibernated (Wojtaszyn et al. 2005). Those sites are now, in terms of the number of hibernating barbastelles, the second and the third most known hibernation sites of this species in the world. Barbastelles are very attached to their roosts; especially to the winter roosts where they return to each year and the knowledge of them is passed from generation to generation.

That is why the biggest threat for the species is the loss of winter roosts where a high number of bats hibernate.

Photo 4 A fragment of a forest used by barbastelles in the mating season (© I. Gottfried)

Photo 5 Barbastelles eagerly use flaking bark for summer roosts (© I. Gottfried)

## 5. Habitat requirements

### Feeding grounds

Occurrence of this bat is highly limited to forests. It forages in forests, on forest edges, in gaps in forest stands, on forest trails but also in areas covered with bushes or over waters with overgrown edges. The barbastelle flies relatively quickly and hunts mainly for insects which are flying. Such a style of hunting requires a more open habitat, which is probably one of the causes why the bats select old stands. Tree species composition may not be as important for the barbastelle as the presence of a complex age structure and of numerous gaps among threes is (Eriksson 2004, Dietz et al. 2009). However, most often the barbastelle can be found in deciduous forests (Photo 4, 5), although in the Swiss Alps they are most common in pine forests. Most common occurrence of the barbastelle in deciduous forests may be also connected with the availability and abundance of food. Small nocturnal butterflies represent up to 94% of diet of this bat (Rydell et al. 1996). Abundance of insect species of this order in spruce and pine forests is definitely smaller than in oak forests (34, 43

and 137 species respectively) (Eriksson 2004). The Barbastelle prefers stands which are over 60-year-old (Sierro 1999, Eriksson 2004, Hermanns et al. 2003, Hillen et al. 2011). The territory where one bat hunts is from 9 ha to as much as 2 500 ha (Sierro 1999, Hillen et al. 2011). Hunting grounds are usually 3-4.5 km away from their day roosts but they may also be as far as 10 km away. At night barbastelles visit 3-4 different feeding grounds, covering even 30 km (Sachanowicz, Ciechanowski 2005).

### Summer roosts

For their mating colonies roosts barbastelles choose crevices under flaking bark, cavities in the trunk or branches. They prefer roosts in cavities in the trunks with a diameter of about 40 cm - mainly oaks and beeches. In trees of a similar diameter they occupy crevices formed in bifurcations in the trunk. Barbastelles were also found under flaking bark of dying trees with a diameter of at least 20 cm, but usually with a larger diameter. Often barbastelles' roosts were located in dead tries which, most probably, offer more roosts of this type. In beech forests in central Italy, 20 out of 33 localized roosts of barbastelles were found in dead trees, eight - in trees with boughs which were dead in 50%, and another five roosts - in trees with boughs dead in 50-90% (Hermanns et al. 2003, Russo et al. 2004). Barbastelles were also found behind shutters, in bridge crevices and, in Southern Europe, also in caves (Rydell et al. 1996, Rydell, Bogdanowicz 1997, Sachanowicz et al. 2004).

### Mating sites

At the turn of August and September barbastelles arrive in large numbers to their hibernation sites. This phenomenon is called swarming, and can be also observed in other species of bats. Recent research has shown that barbastelle swarming near underground sites may be connected to mating (Gottfried 2009). The highest number of barbastelles mate in large, spacious objects, with easy access and including high passageways and rooms. Such structure of roosts enables them to perform mating flights, which probably play an important role in the mating ritual of bats (Parsons et al. 2003), and also creates better conditions for sound propagation, including mating signals. Those signals, just like physical fitness, may be a marker of a bat's quality and determine the choice of a partner.

### Hibernation sites

The barbastelle hibernates in various types of underground sites, such as: cold stores, cellars, caves, adits, forts, bunkers and tunnels (Rydell and Bogdanowicz 1997, Fuszara et al. 2003a, Ciechanowski et al. 2006). It was also found in attics (Kowalski 1955). Most of the found hibernation roosts of the barbastelle are artificial, man-made objects. The world's largest known hibernation sites of this species are not of natural origin, either. They are: a railway tunnel in central Slovakia, where 6800-7800 bats hibernated (Uhrin 1995), an adit in Bavaria, which was a roost for 3000 barbastelles in 1970's (now 300-400 bats) and an adit in Slovakia, where 2000 bats spent the winter of 1963 - recently about 550 bats (Fuszara et al. 2003a).

For their hibernation roosts barbastelles select cool objects with good air circulation, where temperature in winter oscillates around 0°C: between -1°C and 6°C (Rydell, Bogdanowicz 1997, Jurczyszyn et al. 2003). The barbastelle is a bat that is one of the most frost-resistant ones. It can tolerate short lasting drops of temperature down to -9°C and it freezes in the temperature as low as -16°C (Weidner 2000, Sachanowicz, Ciechanowski 2005). Usually in hibernation sites of this species, alongside the low temperature, there is also low air humidity, even 40%. Such conditions are too

harsh for many bat species, especially of the mouse-eared bat genus Myotis (Rydell, Bogdanowicz 1997, Weidner 2000).

The bats are strongly attached to their roosts and they return to them each year, if the conditions have not changed. What is more, the barbastelle is considered to be a timid species that changes its roosts, especially when it is disturbed (Russo et al. 2004). That is why securing its hibernation sites, where large numbers of bats hibernate, seems to be one of the most important actions that can be undertaken in order to protect it. Uncontrolled penetration of underground sites during hibernation period may not only lead to reduction of the barbastelle roost, but also to death of bats. Frightened bats waste lots of energy before they find new roost, which makes them lose body fat before spring and the time insects occur.

It is also important for barbastelles to have free access to their roosts. It is best, if the entrance is at least 13-cm-high and about 50-cm-wide, which enables the bats to fly in without the risk of wing injuries.

### Migration corridors

In the case of bats like the barbastelle - with a short range of echolocation signal, linear elements of the environment map out the flight/migration route (Hermanns et al. 2003). They are also an important element of the environment, as they provide shelter from unfavorable weather conditions and protect from predators. Thus, they are often used by the species which have a long range of signal.

## 6. Species distribution

In Poland the species is known almost all over the country (Fig. 2). It is relatively common in eastern, central and south-western part of Poland; in the Carpathian Mountains and Pomerania they are uncommon and occur locally.

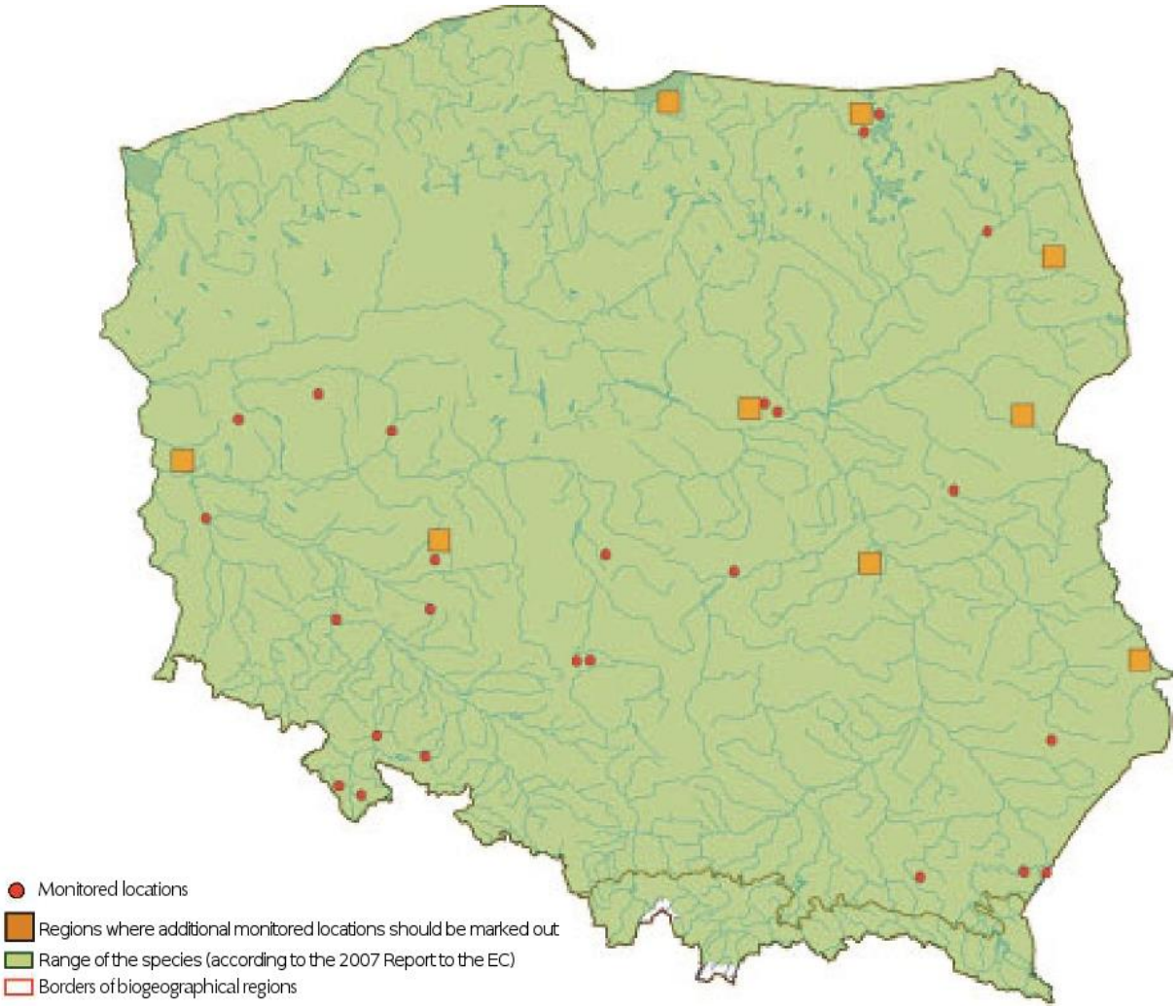


Fig. 2 Distribution of the barbastelle monitoring locations in Poland against the range of the species

Distribution of hibernation roosts of this species is relatively well known, which results from winter monitoring of bats conducted for years now (Fuszara et al. 2003a, Wojtaszyn et al. 2005, Piksa et al. 2011). Outside the winter season, knowledge on the barbastelle in Poland is based only on a couple of studies (Furmankiewicz et al. 2005, Ciechanowski 2008, Wojtaszyn et al. 2008, Gottfried 2009).

# II. METHODOLOGY

## 1. Concept of monitoring of the species

Although the barbastelle is one of the most common bats in hibernation sites in the whole lowland part of Poland (Jurczyszyn et al. 2003, Fuszara et al. 2003a and 2003b, Gubańska et al. 2002, Gottfried 2009, Lesiński et al. 2011), little is known about biology of this species outside the winter season. The knowledge on the barbastelle in the period following the hibernation period, i.e. of its migrations, feeding grounds, summer roosts and mating, is based only on a few studies. Mating roosts are difficult to detect without involving telemetry studies, which results from the low abundance of barbastelles in colonies and also from the character of preferred roosts. No monitoring of summer roosts or feeding grounds was conducted. That is why the basic knowledge of the size of

the national population of the barbastelle comes from the results of winter counts in selected objects.

For about a dozen of years, the barbastelle has been included into studies which are a part of winter bat monitoring activities conducted independently by various research institutions and non-governmental organizations. Each year, within the same time limit (15.01-20.02) the majority of most important bats' winter roosts, including the barbastelle's roosts, are controlled. In Poland there is no central system for collecting and analyzing the data coming from bat monitoring, that would gather data coming from the whole country. Most of the hibernation sites are, however, controlled by non-governmental organizations and institutions which are members of the Agreement for Bat Protection (Porozumienie dla Ochrony Nietoperzy - PON). The studies are conducted with application of a uniform methodology by licensed counters (people who were trained properly, undertook traineeship and passed practical and theoretical examinations attesting their knowledge and skills connected to counting bat roosts).

The concept of summer monitoring is based on confirmation of the barbastelle reproduction in the studied area and evaluation of the activity in the roost. Moreover, condition of the roost is evaluated through establishing the number of dying and dead trees, number of trees with a large diameter and the deciduous forest areas and old forest areas within the study area. In the future, it would be advisable to extend the monitoring activities by monitoring of mating colonies and mating locations.

As the knowledge on the biology of the barbastelle is still not extensive, it would be advisable to label individuals outside the winter season, e.g. during autumn swarming near underground sites, in order to discover migration distances, length of life, connection between the observed decrease in the number of individuals in hibernation sites or in summer
roosts and various threats. In order to ring bats, it is necessary to obtain consent of a competent authority for environmental protection (at present, the consent of the General Director for Environment Protection) and of the area administrator.
In the future, the proposed methodology of the barbastelle summer monitoring may be modified, based on experiences from the subsequent stages of monitoring activities and the results of independent research.

The concept of monitoring of the barbastelle in hibernation sites, similarly like in the case of other species of bats (compare the chapter "Methodology of bat monitoring in hibernation roosts") is based mainly on controlling its abundance in selected roosts and determining accessibility to those roosts, protecting them against disturbances and controlling their microclimate conditions.

## 2. Indicators and assessment of the species conservation status

### SUMMER ROOSTS

### Indices of population status

The assumed indices for population status are supposed to define if a given forest area is used by the species during the period of breeding based on netting bats or finding breeding colonies in the monitored area (including the use of independent, current information on their location) and determining how intense their activity in that area is (Tab. 1, 2) through registering echolocation signals and analyzing them.

## Indices of roost status

The offered indices are supposed to determine the condition of forest areas used by the barbastelle during the period of breeding. The indices concern the area of the studied complex of forests, structure of stand and the number of trees with a large diameter, dying and dead, preferred as roosts by this species of bat (Tab. 1, 2).

Table 1 Indices of population and habitat status - summer roosts

| Index | Unit | Measurement/determination |
|---|---|---|
| **Population** | | |
| Reproduction of the species | Descriptive index | Determining the number of lactating females and/or juveniles on the basis of netting bats in the period between 10.07 and 30.07 (acceptable up to 15.08) during 1-3 control nights and/or determining the number of individuals in the maternity colony found in the study area or near its boundaries - up to 500 m (newly discovered or known from literature) |
| Activity of the species | Number of signals per hour | Determining the number of registered flights of barbastelles per one hour of detector listening on the basis of recordings made in the period between 10.07 and 30.07 (acceptable up to 15.08) during catches |
| **Roost** | | |
| Forested area | ha | Determine from forest management plans, tree stand management maps and orthophotomaps |
| Surface area of deciduous forests | ha | Determine from forest management plans and tree stand management maps |
| Surface area of historic stands | ha | Surface area of stands aged > 80 years should be determined from forest management plans and stand management maps |
| Surface area of deciduous historic stands | ha | Surface area of stands aged > 80 years should be determined from forest management plans and stand management maps |
| Number of dying and dead trees | N/1600 $m^2$ (median and min. - max. range) | Dying and dead trees with a diameter at breast height > 25 cm should be counted in randomly chosen test areas |
| Diameter of live trees that ensure potential day roosts | cm (median and min. - max. range) | Diameter at breast height of all trees in the randomly chosen test areas should be measured with a calliper and the trees with a diameter at breast height of >25 cm should be counted |

The way of valuing indices of population status and habitat of the species is presented in Tab. 2.

Table 2 Valuation of indices of population status and the barbastelle habitat - summer roosts

| Index | Evaluation[1] | | | |
|---|---|---|---|---|
| | FV | U1 | U2 | XX |
| **Population** | | | | |
| Reproduction of the species | Reproduction of the species was confirmed, i.e. a maternity colony of the barbastelle was found in the monitored area or near its boundaries (up to 500 m) and/or at least 1 lactating female and/or at least 1 juvenile of the barbastelle was caught | No maternity colony was found, no lactating female or a juvenile was caught, but reproduction was reported during previous control within the monitoring scheme | No maternity colony was found, no lactating female or a juvenile was caught during two consecutive controls within the monitoring scheme | No data enabling confirmation or lack of confirmation of reproduction of barbastelles in the monitored area |
| Activity of the species[2] | Number of recorded echolocation signals of the barbastelle is not lower than 5 flights/hour and if it is lower, the reproduction is assessed as FV | Number of recorded echolocation signals of the barbastelle is lower than 5 flights/hour, and the reproduction is assessed as U1 or U2 | No echolocation signals of the barbastelle have been recorded. | No data enabling confirmation or lack of confirmation of occurrence of barbastelles in the monitored area |

[1] FV - satisfactory condition, U1 - unsatisfactory condition, U2 - bad condition, XX - no data available

[2] When valuing the indicator of activity of the species, the short range of echolocation signal of the barbastelle was taken into account, which is reflected in the number of the registered flights

| Index | Evaluation[1] | | | |
|---|---|---|---|---|
| | FV | U1 | U2 | XX |
| **Roost** | | | | |
| Forested area | Surface area of the forest complex is close to the condition of the reference year (commencement of monitoring) or greater | Surface area of the forest complex is reduced when compared to the condition of the reference year (commencement of monitoring) but not more than by 50 ha, that is by the surface of 5 minimal home ranges | Surface area of the forest complex is reduced when compared to the condition of the reference year (commencement of monitoring) by more than 50 ha | No information available, e.g. because of extension of boundaries of the monitored area |
| Surface area of deciduous forests | Surface area of deciduous forests is close to the condition of the reference year (commencement of monitoring) or greater | Surface area of deciduous forests is reduced when compared to the condition of the reference year (commencement of monitoring) but by no more than 30 ha, that is by the surface of 3 minimal home ranges | Surface area of deciduous forests is reduced when compared to the condition of the reference year (commencement of monitoring) by more than 30 ha | No information available, e.g. because of extension of boundaries of the monitored area |
| Surface area of historic stands | Surface area of historic stands is close to the condition of the reference year (commencement of monitoring) or greater | Surface area of deciduous historic stands is reduced when compared to the condition of the reference year (commencement of monitoring) but by no more than 20 ha, that is by the surface of 2 minimal home ranges | Surface area of deciduous historic stands is reduced when compared to the condition of the reference year (commencement of monitoring) by more than 20 ha | No information available, e.g. because of extension of boundaries of the monitored area |
| Surface area of deciduous historic stands | Surface area of deciduous historic stands is close to the condition of the reference year (commencement of monitoring) or greater | Surface area of deciduous historic stands is reduced when compared to the condition of the reference year (commencement of monitoring) but by no more than 20 ha, that is by the surface of 2 minimal home ranges | Surface area of deciduous historic stands is reduced when compared to the condition of the reference year (commencement of monitoring) by more than 20 ha | No information available, e.g. because of extension of boundaries of the monitored area |
| Number of dying and dead trees | Median above 2 trees/1600 $m^2$ | Median between 1-2 trees/1600 $m^2$ | Median below 1 tree/1600 $m^2$ | No information available |
| Diameter of live trees that ensure potential day roosts | Median above 40 cm | Median between 30-40 cm | Median below 30 cm | No information available |

## Cardinal indices

Not distinguished

## Evaluation of population status

Evaluation of indices of the population status of the species in a summer position is based on comparison of the results obtained in the given year, and in the case no reproduction was confirmed in the given area, on reference to two last seasons that were included into monitoring scheme (analysis of long-term changes).

Evaluation of the population parameter is determined as follows:

FV - if both indices were evaluated as FV;

U1 - if one index was evaluated as U1, lack of U2;
U2 - if one or both indices were evaluated as U2;
XX - if both evaluations were XX

### Evaluation of roost status

When evaluating the roost status on the basis of individual indices, one should follow the rule:
FV - if all indices were evaluated as FV or almost two as XX or at most one as U1, and the rest as FV;
U1 - two or more as U1 or at most one as U2,
U2 - two or more as U2,
XX - if all evaluations were XX, or three or more were XX, and the rest as FV.

### Conservation prospects

Evaluation of conservation prospects is an attempt to predict the conservation status of the barbastelle in the given site in the perspective of 10-15 years by the contractor of monitoring activities (expert assessment). If in such a perspective there are chances of maintaining satisfactory status or improve unsatisfactory status, then the conservation prospects should be evaluated as satisfactory (FV). If we assume that the satisfactory status will get worse or that the unsatisfactory status will be maintained, then the conservation prospects should be assessed as unsatisfactory (U1). If we think that the present unsatisfactory status will get worse or that bad status will be maintained, we assess the prospects as bad (U2). When assessing this parameter we take into account the current status of the population and habitat, current influences and expected threats for the species within the site (planned changes in use of the area, among others), the way the area is protected and also protection activities that have been undertaken so far. An interview with a manager of the area may be useful.

### Overall assessment

The lowest score from one of the three parameters (population, habitat, sonservation prospects) is a decisive factor when evaluating general species conservation status at the site.

## HIBERNATION ROOSTS

### Indices of population and habitat status

Assumed indices of population status and habitat status of the species are presented in Tab. 3.
Notice: Indices regarding habitats relate to potential unfavorable changes in the area of the hibernation site available to the bats when compared to the year monitoring activities commenced, possibility of disturbing the animals as well as presence and passability of entrances to the roost (Tab. 3,4). The evaluation of the status of the habitat also includes potential changes in microclimate conditions underground and in the surroundings of the object, concerning the share of forested areas and migration corridors that ensure communication with other areas.

Because changes in those indices shall be assessed in relation to the reference year, one should really carefully describe location of the sites with conditions optimal for hibernation of barbastelles and also the places where temperature measurements were performed. A detailed description of measurements is presented in the next chapter.

Table 3 Indices of population and habitat status - hibernation roosts

| Index | Unit | Measurement/determination |
|---|---|---|
| **Population** | | |
| Abundance | Number of individual bats | Counting hibernating bats in a roost in the period between 15.01 - 15.02 and additionally 20.12-31.12 |
| **Roost** | | |
| Surface area of a hibernation site | Descriptive index | Expert evaluation concerning changes in the area of the roost convenient for bats (changes relate to the status in the reference period - the year monitoring commenced) |
| Ensuring that the bats are not disturbed | Descriptive index | Expert evaluation concerning the presence, appropriateness and status of securing a roost |
| Passability of entrances for bats | Descriptive index | Expert evaluation concerning the number of inlets available for bats, their passability, among others |
| Air temperature | oC | Measurement with use of a thermometer or thermohigrometer |
| Share of forested areas in the surroundings of the hibernation site | % | To be determined on the basis of an orthophotomaps (within the radius of 1 km from the roost) |
| Connection of the roost with potential summer biotopes | Descriptive index | Based on orthophotomaps and observations in the area, the number of linear elements (alleys, rivers) in the surroundings of the roost, connecting them with forests should be determined and if the forest surrounding the hibernation site is connected to other forest complexes |

The way of valuing population status index and habitat status index of the species is presented in Tab. 4.

Table 4 Valuation of population status index and habitat status index - hibernation roosts

| Index | Evaluation[3] | | | |
|---|---|---|---|---|
| | FV | U1 | U2 | XX |
| **Population** | | | | |
| Abundance | Number of individual animals is not lower than the one determined during the last control, and if the data is available, average abundance from the last 10 years is greater than 70% of the maximum abundance determined at the site | Intermediate results between FV and U2 | Number of individual animals is lower than 50% of the number from the last control, and if the data is available, average abundance from the last 10 years is smaller than 40% of the maximum quantity abundance at the site | No comparative data from the previous year and from the multiannual period available or no data from this year available |

[3] FV - satisfactory condition, U1 - unsatisfactory condition, U2 - bad condition, XX - no data available

| Index | Evaluation[3] | | | |
|---|---|---|---|---|
| | FV | U1 | U2 | XX |
| **Roost** | | | | |
| Surface area of a hibernation site | Surface area of the hibernation site available and used by barbastelles without changes or greater when compared to the reference period (the year monitoring commenced) or smaller, but abundance assessed as FV | Surface area of the hibernation site available and used by barbastelles decreased when compared to the reference period (the year monitoring commenced), but it does not refer to the fragments of key importance for barbastelles, and abundance of the species assessed as U1 | Surface area of the hibernation site available and used by barbastelles decreased when compared to the reference period (the year monitoring commenced) by the fragments of key importance for this species | Surface area of the hibernation site available and used by barbastelles decreased when compared to the reference period (the year monitoring commenced), but it is not known if the excluded fragments were important for barbastelles |
| Ensuring that the bats are not disturbed | The roost secured and hibernating bats are not disturbed by people | Access of people to the inside of the roost is difficult but still possible and there are cases of bats being disturbed or the access not being secured; however, the pressure is low | The roosts are not secured or secured ineffectively and the pressure from people is significant or potentially significant | Access of people to the inside of the roost is difficult or hard to determine and there is no data available that would allow assessing the existing or potential pressure |
| Passability of entrances for bats | Sufficient number of passable entrances continuously available in each of the separate parts of the hibernation site and there are no factors hindering barbastelles using them | Considerable number of entrances in each of the separate parts of the hibernation site are not passable any more, but there are entrances that barbastelles may freely use to fly into the underground site | All entrances in each of the separate parts of the hibernation site are not passable any more or there are obstacles that make it difficult for barbastelles to fly into the underground sites | No information available on the exact number and availability of entrances |
| Air temperature | Temperature in the parts of the site preferred by barbastelles in the range from -5°C to +4°C | Temperature in the parts of the site preferred by barbastelles in the ranges: below -5°C down to -7°C or above +4°C up to +8°C | Temperature in the parts of the site preferred by barbastelles below -7°C or above +8°C | No information available on microclimate conditions at the site |
| Share of forested areas in the surroundings of the hibernation site | Share of forested areas in the surroundings of the roost close to the condition of the reference period (the year monitoring commenced) or reduced by more than 10% | Share of forested areas in the surroundings of the roost reduced by 10-50% when compared to the condition of the reference period (the year monitoring commenced) | Share of forested areas in the surroundings of the roost reduced by more than 50% when compared to the condition of the reference period (the year monitoring commenced) | No information that would enable evaluation available |

| Index | Evaluation[3] | | | |
|---|---|---|---|---|
| | FV | U1 | U2 | XX |
| Connection of the roost with potential summer biotopes | Number of continuous (distances between elements are not longer than 10 m), linear elements of the environment (alleys, rivers) and/or connection between the forest surrounding the hibernation site and other forest complexes close to the condition of the reference period (the year monitoring commenced) | Number of continuous linear elements of the environment and/or connection between the forest surrounding the hibernation site and other forest complexes reduced when compared to the condition of the reference period (the year monitoring commenced) by 10-50% | Number of continuous linear elements of the environment and/or connection between the forest surrounding the hibernation site and other forest complexes reduced when compared to the condition of the reference period (the year monitoring commenced) by over 50% | No data available on linear elements ensuring safe flight and connected to forests and/or connection between the forest surrounding the hibernation site and other forest complexes |

## Cardinal indices

Not distinguished

## Evaluation of population status

Assessment of population status of the species in the hibernation site corresponds to the assessment of the only abundance index, which is based on a comparison of the abundance observed in the given year with the data from the previous season and on an analysis of long-term trends in abundance. When designing indexation of the abundance index, various characteristics of the barbastelle population dynamics were taken into account; however, the assumed percentage limit values are arbitrary, taking into account the past experience.

## Evaluation of roost status

When making an evaluation of the status on the basis of evaluations for indices, one should follow the rule applicable in drafting reports for the European Commission from the results of monitoring of the condition of conservation of species and types of natural habitats:
FV - if all the evaluations for indices are FV or one is XX, and the remaining are FV;
U1 - if one or more are U1, there are no U2;
U2 - one or more are U2;
XX - if all are XX, or two or more are XX, and the rest are FV.

## Conservation prospects

It is a prognosis of the species population and habitat status in the perspective of 10-15 years. It should refer to the current status of the population and habitat, take into account the observed trends in changes in those parameters and all the actions and plans (threats), whose results may influence the current conservation status of the population and habitat in the studied site (e.g. changes in the use of land where the site is located, applied or possible to apply protection activities). An expert evaluates whether there are chances of maintaining current good status or improvement of unfavorable status or deterioration of the condition is inevitable. The expert should also take into account other information, e.g. existing data on the species in the given site.

### Overall assessment

The lowest score out of the three partial evaluations (population, habitat, conservation prospects) is a key factor when carrying out the general evaluation of the species conservation status at the site.

**Notice:** The adjustment of population and habitat indices, both during the period of breeding and hibernation, presented above, is the first proposal in this scope, that is why during the next control within the national barbastelle monitoring scheme (after about 6 years), it is advisable to verify the way of evaluation of indices and of selection of the indices, especially when referring to summer sites.

## 3. Description of monitoring studies

### Selection of monitored locations and their suggested size

### SUMMER ROOSTS

When selecting study areas, one should take into account preferences of the species. The barbastelle is a species connected to woodlands. It is most often noted in deciduous forests and its roosts were usually found in oaks and beeches (Hermanns et al. 2003). Thus, a whole forest complex or its fragment is a monitored summer site/study area. When selecting a monitoring area, one should take into account that the surface area of the habitat of one barbastelle covers from 9 to over 2500 ha (Eriksson 2004, Hillen et al. 2011, Sierro 1999). For the research carried out in Germany (no such data available from Poland), the median of a habitat size of one bat was 403 ha (Hillen et al. 2011). Feeding grounds are usually up to 4.5 km away from their roost, but they may also be as far as 10 km away. At night barbastelles visit 3-4 different feeding grounds (Hillen et al. 2011). That is why the area selected for monitoring activities in summer season should have at least 1000 ha.

Study areas should be located all over the national range of the species (considering unequal reconnaissance in various regions). Moreover, in the first place, areas where reproduction of barbastelles has been ascertained should be included into the monitoring.

Inclusion of about dozen of forest areas into monitoring activities in the following locations is suggested (compare Fig. 2):

- The Śnieżnik Mountains,
- Czeszowska plain,
- Pniewy Forest District,
- Kłobuck Forest District,
- Poddębice Forest District,
- Naruszewo Protected Landscape Area,
- Łuków Forests,
- Roztocze National Park
- Knyszyn Primeval Forest,
- Strzelce Forests,
- Forests near Gierłoż and/or forests near Mamerki,
- Rzepin Primeval Forest,
- Kozienice Primeval Forest,
- Krotoszyn Oak Forests,
- Wysoczyzna Elbląska.

**HIBERNATION ROOSTS**

A winter monitoring site is a single underground object or a complex of such objects situated close to each other (about 200 m between entrances). These usually are caves, adits, fortifications, tunnels and, less often, spacious cellars. Barbastelles hibernate also in household cellars or wells, however, in objects of this type few bats can be found, so most probably they do not have a significant impact on trends in abundance of the national population. Monitoring should include all possible known hibernation sites, especially those composed of at least 100 hibernating animals, and for the needs of the national population status monitoring such data should be analysed jointly.

The following criteria should be taken into account when winter monitoring sites are selected:

- they should be located all over the national range of the species (considering unequal reconnaissance in various regions);
- hibernation sites of at least regional importance should be included into the annual monitoring activities as first, according to the criteria adopted in relation to this species for Poland by PON and repeated by the Regulation of the Minister of Environment of 16 May 2005 on types of natural habitats and plant and animal species requiring protection in the form of designation as Natura 2000 areas - Journal of Laws of 2005 No. 94, item 795 (simplified: the hibernation sites with 100 or more barbastelles; however, if there are high numbers of other bats in the hibernation site or the site is important for some other reason - e.g. it is located on the verge of the range of the species, the numbers may also be lower).
- the largest hibernation sites of this species in Europe, namely a tunnel in Krzystkowice, an underground system of Międzyrzecki Rejon Umocniony (Nietoperek), and also a bunker in Konewka, Modlin Forts, Szachownica Cave, Fortifications in Gierłoż and Mamerki and a circulation adit in Młoty should definitely be included in annual monitoring. A list of national hibernation sites proposed for monitoring activities, where more than 100 of barbastelles in the period of hibernation were noted in previous years, is presented below (Jurczyszyn et al. 2002, Mleczek 2002, Fuszara et al. 2003a, Wojtaszyn et al. 2005, Gottfried 2009). These are the largest barbastelle hibernacula in Poland, which are a good representation of the wintering population of this species. The sites are located within the main area in the country where the species is found, in the following regions:
- South-East: forts near Przemyśl, adits in Węglówka;
- South-West: adit in Młoty, adit in Skałki Stoleckie, forts in Nysa;
- Central-East: Modlin Forts; Koszewo II Fort, Fighting bunker in Anusin (Brest Fortified Region);
- Central: Konewka, Szachownica Cave, Cold Storage Room in Cieszków;
- Central-West: Nietoperek, Fort I in Poznań, tunnel in Krzystkowice, Monastery in Lubiąż;
- North-East: Gierłoż, Mamerki, Central Fort of the Osowiec Fortress. All the sites listed above are under protection within the Natura 2000 European

Network. If a new, large hibernation site of the barbastelle is discovered (like in 2005, when the tunnel in Krzystkowice was discovered), it should be included into monitoring activities.

## Study method

## SUMMER ROOSTS

### General remarks

In the year a given site is included into the barbastelle monitoring activities, the condition of the habitat should be documented, which aims at recording changes over the years. A map of the studies area should be drawn (1:25 000 scale) and coordinates of catches, detector listenings and locations of the discovered maternity colonies should be noted.

### Indices for population status should be determined

**Reproduction.** Finding a maternity colony roost of barbastelles in the studied area would be irrefutable evidence that the bats use the selected area during the period of breeding. Maternity colonies are formed by a few to several dozens of females that relatively quickly change their roosts. Thus, finding a roost for a maternity colony without application of a specialist, costly method of telemetry is really difficult. However, one may search crevices and cracks in trees, flaking bark or wooden siding of houses located near a forest (study area). Another way that enables one to confirm that the given area is used by the barbastelle during the period of breeding is the method of netting the bats in the monitored area.

A few rules should be followed when conducting the barbastelle catches in order to confirm reproduction:

- Group leaders are responsible for obtaining consents of competent authorities for environmental protection (at present it is a consent of the General Director for Environment Protection) and of the area administrator.
- Catches should be performed be people whose ability to distinguish bats and knowledge of the rules of conduct during the activity is confirmed (e.g. by a chiropterological license of appropriate level issued by PON). The group performing catches may additionally be composed of inexperienced persons, provided that they have been instructed by the leader on the rules of conduct during the activity.
- 1-3 nights of catches should be conducted. If during the first control reproduction is confirmed (a lactating female - Photo 6 - or a juvenile is caught), no additional controls are necessary.
- Controls should be conducted in as good weather conditions as possible, during warm nights, without rainfalls and wind, so as to eliminate the influence of weather on the result. In the period of cool weather and rainfalls bats are less active or they do not leave their roosts at all. Catches should be conducted during the first 4 hours after the sunset - during the highest activity of the bats.
- During each control 3-5 chiropterological nets should be strung and they should be checked at least every 15 minutes. Thus, at least two persons experienced in disentangling bats from the net need to take part in the catches. Nets should be positioned on forest trails, where at the sides
- of the trail there is dense underbrush and the overhanging branches of the trees adjoin. In this way the nets will be positioned in a “tunnel”, which will increase the prospects for catching bats.

Photo 6 In the period of suckling swollen nipples are visible in a lactating female of the barbastelle (© I. Gottfried)

**Activity.** In order to determine this index, simultaneously to net catches one should also record barbastelles' calls with an ultrasound detector working in the high frequency recording system, divider or zero-crossings analysis, enabling recording on an internal memory card or a connected digital recorder and later computer bio-acoustic analysis and determining the species of the bat. Listening activities should be performed for the first 4 hours after the sunset (during the catches). The number of the recorded signals of barbastelles should be calculated for 1 hour of recording and in this way determine activity of the species in the studies area as the number of flights/1 hour.

It should be stressed that in case of negative results of the catches (bats detect the nets and avoid them), thanks to the listening activities a researcher can determine if the species is present in the area during the period of breeding but it just was not caught or if barbastelles do not use this habitat at this time of the year.

Results of the monitoring of individual areas do not allow evaluating the population trends in the whole country. In order to do this a statistical analysis of the results coming from many areas and from a longer period of research is necessary.

## Determining indices of the habitat status

Initially a study over six indices was assumed (Tab. 3, 4). Evaluation of indices relating to the area of the studied forest complex and the area of various types of stands requires a reference of the current values to the "zero" values from the year monitoring commenced, so in the reference year the indices are not evaluated. In the year the area was included into the barbastelle monitoring scheme a map of the study area should be drawn and the coordinates of the places where catches and detector listenings took place should be marked.

**Forested area.** This index is used to take account of the changes in the degree of afforestation in the selected area of the forest complex/fragment of the forest complex which is being included into

monitoring of the barbastelle during the period of breeding. Those changes should be defined by an analysis of an orthophotomap and forest management plans and also stand management maps. Borders of the study area are defined by an expert in the year monitoring commenced (the reference year). They should be marked on maps in the 1:25 000 scale so that, when the study is repeated in the following years, there are no doubts concerning the boundaries of the studied area.

**Area of deciduous forests.** This index enables the researchers to track changes in the area of the deciduous stand within the limits of the determined study area, in relation to the year monitoring commenced. Those changes should be defined by analyzing forest management plans and also stand management maps and summing up the area of forest management units which are dominated by deciduous species.

**Area of historic stands.** This index enables the researchers to track changes in the area of the historic stands (stands aged > 80 years) within the limits of the whole study area, in relation to the year monitoring commenced. Those changes should be defined by analyzing forest management plans and also stand management maps and summing up the area of forest management units in which the age of the stand was determined as > 80 years.

**Surface area of deciduous historic stands.** This indicator enables us to track changes in the area of deciduous historic stands (deciduous forests aged >80) all over the studied area in relation to the year monitoring commenced. Those changes should be defined by analyzing forest management plans and also stand management maps and summing up the area of forest management units in which deciduous species dominate and in which the age of the stand was determined as > 80 years.

**Number of dying and dead trees.** This indicator allows tracking changes in the number of dying and dead trees with the diameter at breast height >25cm, that offer potential day roosts for barbastelles and insects of the orders of Lepidoptera butterflies, in relation to the year monitoring commenced. During each monitoring cycle, measurements are made in 30 randomly chosen plots (squares sized 40 x 40 m) in deciduous historic stands (within borders of the outlined study area). Stands of this type are preferred by this species. Before the field work commence, on the basis of forest management plans and also stand management maps, fragments of area where deciduous species dominate and in which the age of the stand was determined as > 80 years should be mapped out. They should be divided with a net into 1600 $m^2$ squares and numbered. Then choose randomly 30 plots, mark them out with a string and count all dead and dying trees with a diameter at breast height > 25 cm. Researchers should measure the diameter at breast height of each dying and dead tree with a tree calliper (calliper) and count the ones whose diameter at breast height is >25 cm. The result has a form of a median and the range defining limit values of the measurements obtained after comparing them with the rest of the data from all studied squares.

**Diameter of live trees that offer potential day roosts.** This index also enables tracking changes in diameter of all trees with the diameter at breast height above 25 cm (trees of those sizes are preferred by the species), in relation to the reference year. On the same plots where the number of dying and dead trees was determined, the diameter at breast height of all live trees is measured and those with the diameter at breast height bigger than 25 cm are counted. The result has a form of a median and the range defining limit values of the measurements obtained after comparing them with the rest of the data from all studied squares.

## HIBERNATION ROOSTS

Detailed requirements for winter counts of the barbastelle can be found in the chapter “Methodology of bat monitoring in hibernation roosts”, as they are the same for other bat species.

Below, there are several guidelines concerning winter barbastelle monitoring activities specific for the species.

### Indices for population status should be determined

An index that is monitored is the abundance of barbastelles in hibernation sites, which is determined by comparing it with the results of the previous control, and, if the researcher has the data from the last 10 years, then the calculated average abundance of this period relates to the maximum abundance determined in the object. Data concerning the greatest abundances of the barbastelles at the site should be determined on the basis of information available in literature or in the SDF form of the given Natura 2000 site in which the hibernation site is located. Description of the research on the index can be found in the next chapter.

### Determining indices of the habitat status

Initially a study on six indices was assumed (Tab. 1). Evaluation of the indices of the habitat status requires reference of the current status to the status of the year monitoring commenced, so values from the reference year are not evaluated. Situations, when winter counts of the barbastelle had been conducted earlier in the given roost, in accordance with the methodology generally accepted in Poland, by the same persons, are the exception here. Then the researchers have the data from previous years and evaluation of the status of the given hibernation site is possible as early as in the first year of it being included into the national monitoring of this species.

In the year the given site is included into the barbastelle monitoring, status of the habitat should be documented, which aims at recording changes at the site. A detailed sketch of the hibernation site should be drawn, with all the parts and elements which are crucial for the species marked. On the sketch the entrances accessible for the bats and spots where temperature was measured should also be marked. It is also necessary to document entrances and protections on the object. A sketch of the surroundings of the roost should be drafted and all wild-life corridors and forests within the radius of 1 km from the sites should be marked. During each control it should be noted if the counts of hibernating bats included the whole object or its fragment. It is also advisable to note the number of bats hibernating in underground sites for each fragment of the hibernation site separately so that, when the part of the object is collapsed, researchers would know how important it was.

Description of the research on the indices: Surface area of the hibernation site, Protecting the bats against disturbances, Availability of entrances to bats and Air temperature can be found in the chapter “Methodology of bat monitoring in hibernation roosts”.

**Share of forested areas in the surroundings of the roost.** This index relates to large-area changes in the degree of afforestation of the closest surrounding of the object (within the radius of up to 1 km from the site) that may occur as a result of deforestation, road investments or development of spatial infrastructure. Forested area within the radius of 1 km from the hibernation site should be measured on the basis of orthophotomaps and compared with the area of the reference year.

**Ecological connection of the roost with potential summer biotopes.** This index determines changes in the number of continuous (distances not longer than 10 m) linear elements of the environment (alleys, rows of bushes, hedges, etc., and rivers) in the surroundings of the hibernation site, ensuring safe flight to the closest forests. It also relates to the number of linear elements connecting the forest surrounding the hibernation site with other forest fragments. Number of linear elements of the landscape within the radius of 1 km from the hibernation site should be determined on the basis of orthophotomaps and their presence in place should be confirmed (distance between

the trees forming alleys, retention of natural river banks among others) and compared with the area of the reference year.

## Time and frequency of the studies

### SUMMER ROOSTS

Monitoring of summer sites used during the period of breeding should be performed at least once in 2-3 years, between 10.07 and 30.07, exceptionally up to 15.08., in the case of weather breakdown, for example. In this period bats will be caught when the young bats are able to fly and are independent. Therefore, females will not be disturbed in the period of raising their young and the opportunity to confirm bat reproduction in the area (catching a lactating female or a juvenile) at that time is greater. Later time increases the risk of catching migrating bats.

Each study area should be controlled 1-3 times in good weather conditions (without any rainfalls and wind, on warm nights).

Indices of the habitat status should be determined with the frequency of about 6 years, as the status of a forest habitat does not change quickly. It is also advisable to include into monitoring the known roosts of maternity colonies, identify mating location and study migration routes to feeding grounds, locations of feeding grounds from roosts of maternity colonies and determine habitats used by the species as feeding grounds.

### HIBERNATION ROOSTS

Hibernation sites monitoring should be performed every year. At least one control is required. Experience gained from monitoring activities show great dynamics of abundance of the species in the controlled objects. Only regular controls of hibernation sites during the deepest hibernation of barbastelles, that is between 15.01 and 15.02, will enable proper evaluation of abundance of the species. It is advisable to perform an additional control in the period between 15.12 and 30.12, as the abundance of barbastelles in hibernation sites depends largely on the conditions outside. Barbastelles quickly react to an increase in temperature during winter and in such a situation they leave their hibernation sites. If the object is controlled only once in the season

and the control is during a thaw, then the registered abundance will be low. Thus, it is required that during the barbastelle winter counts the counting activities were performed at time when at least 5 days before the control the day temperature (both during the day and at night) stays below 0°C.

## Equipment and materials used in the studies

### SUMMER ROOSTS

- at least 2 torches, including one headlamp;
- a camera, macro and wide-angle lens, tripod, flash;
- night vision goggles;
- 3-5 mist nets, poles and strings to attach them;
- pesola scales (10 g) and a calliper;
- ultrasound detectors with internal memory card or connected to recorders (with batteries);
- GPS receivers;
- exact topographic map (1 : 10 000 recommended);

- aerial photos of the area;
- tree calliper (calliper);
- 90-m-long string to allot study squares (plots) within the selected area;
- notebook, writing implements.

**HIBERNATION ROOSTS**

The list of equipment and materials can be found in the chapter “Methodology of bat monitoring in hibernation roosts”.

# 4. Sample species observation sheet for the site

## SUMMER ROOSTS

| Species observation sheet for a monitored location | |
|---|---|
| Code and name of the species | Code of the species as in the Habitats Directive, Polish and Latin names, author, as in the current terminology<br>1308 barbastelle Barbastella barbastellus (Schreber, 1774) |
| Site name | Name of the monitored location<br>Czeszowska Plain |
| Site type | Write: research/reference<br>Research |
| Protected areas where the site is located | (Natura 2000, nature reserves, national and landscape parks, sites of ecological interest, documentation positions, etc.)<br>Unprotected area |
| Geographic coordinates | Give geographic coordinates (GPS) of the central point of the site<br>N XX°XX'XX.X"; E XX°XX'XX.X" |
| Elevation a.s.l. | Give elevation a.s.l. of location of the site: range from... to...<br>120-228 m. a.s.l. |
| Description of the site | Description is supposed to help identify the site. Location and features of terrain should be described. Give area of the site.<br>Forests of the Oleśnica State Forest District located in Czeszowska Plain, among the towns of Ludgierzowice, Białe Błoto, Złotów, Czeszów, Pęciszów and Zawonia. Study surface area is 56.94 km$^2$. |
| Profile of the habitat of the species at the site | Give range of the potential habitat (whole forest complex or only its part, how big); describe conditions in the habitat: species structure of the stand (dominating tree species, share of deciduous historic stand), presence of rivers and water bodies, land-use pattern; describe direct surroundings of the studies site (e.g. connections with other forest complexes, proximity of roads and other factors that could be of significance for bats)<br>The pine is the main species the forests are composed of. Deciduous forests, preferred by the species, cover the area of 1230.11 ha, including historic deciduous stands of 232.01 ha. The number of dying and dead trees was 0-3 trees/40m$^2$. Only small rivers flow through this area, some of them have their springs here. Water bodies are located in western and north-western part of the studied area. The forests in the whole area are managed. The study area has numerous connections with other forest areas: with forests covering the Trzebnickie Hills, those located in the valley of the Barycz River or the ones located as far as behind Twardogóra, among others. |
| Information on the species at the site | Synthetic data on the presence of the species at the site (presence of lactating females or juveniles, recording echolocation signals of barbastelles, presence of a maternity colony in the study area or in its surroundings) research completed until now and other relevant facts; results of evaluations of previous years, especially those relating to reproduction of barbastelles<br>Reproduction of barbastelles was found in the area in 2003, when dispersion of barbastelles from the colony was observed (about dozen of bats). In 2011 three nights of catches were conducted (23.07, 25.07, 29.07) in the selected area, during which recording of echolocation signals of the bats was done (during first 4 hours after the sunset). One lactating female was caught, which is a confirmation of reproduction of this species in the area. The number of recorded signals was 4.2 flights/1 hour. However, on the assigned date of the study the weather got cooler. Unfavorable weather conditions (decrease in temperature, showers and wind) could influence the result by understating it. |
| Is monitoring in the following years required? | Write yes/no; in case of "no" justify why resignation from this site is suggested<br>Yes, as presence of barbastelles has been recorded in the study area for the last few years. The area of study can be extended in the future, to the north, for example, where larger fragments of forests with beech prevailing are located, as this type of stand is preferred by the species. |
| Observer | Name/surname of monitoring contractor at the site Iwona Gottfried |
| Dates of observations | Dates or the date the control was conducted in the season that the report concerned 23.07.2011; 25.07.2011; 29.07.2011; 17.08.2011; 18.08.2011 |

| Species protection status at the site | | | | |
|---|---|---|---|---|
| **Parameter/**Indices | | **Index value and comment** | **Evaluation** | |
| **Population** | Reproduction of the species | Complete with the number of caught lactating females (e.g. 2 f) or juveniles (e.g. 4 juv.) or the number of bats in the maternity colony<br>1f | FV | U1 |
| | Activity of the species | Complete with the number of recorded signals /hour. 4.2 flights/hour | U1 | |
| **Habitat** | Forested area | Complete with surface area in ha<br>7184.99 ha | XX | U1 |
| | Surface area of deciduous forests | Complete with surface area in ha<br>1230.11 ha | XX | |
| | Surface area of historic stands | Complete with surface area in ha<br>1077.97 ha | XX | |
| | Surface area of deciduous historic stands | Complete with surface area in ha<br>232.01 ha. Current status was evaluated as Unsatisfactory. | XX | |
| | Number of dying and dead trees | Complete with the number of dying and dead trees with the diameter at breast height of >25 cm (median and min. - max. spread of 30 squares)<br>0 (0-3) | U2 | |
| | Diameter of live trees that ensure potential day roosts | Complete with the diameter in cm (median and min. - max. spread of 30 squares) of all the trees with the diameter at breast height of >25 cm<br>43 cm (26-112 cm) | FV | |
| **Conservation prospects** | | Brief forecast of population and habitat status of the species at the site in the next 10-15 years in the context of their current status and observed evolution, considering all actions and plans that may impact the species and its habitat<br>Reproduction of barbastelles was found in the area in 2007. The studies in 2011 confirmed current presence of this species at the site. If the strategy of management of the area is continued, it seems that the population status will be maintained during the next 10-15 years, but because no data from previous years are available, it is hard to assess the species conservation prospects in the given area. | XX | |
| **Overall assessment** | | | **U1** | |

A list of the most important current and predictable impacts (threats) on the species and its habitat in the studied environment (including current use, planned investments, planned changes in management and use); coding of impacts/threats as in Annex E to the Standard Data Form for Natura 2000 areas; effect of the impact: “+” - positive, “-” - negative, “0” - neutral; intensity of the impact:A - high, B - moderate, C - low.

If the proper code is lacking - only description in the table “Other information” in the field “Other remarks”.

| Current impacts | | | | |
|---|---|---|---|---|
| **Code** | **Name of activity** | **Intensity A/B/C** | **Impact +/0/-** | **Synthetic description** |
| 164 | Logging | B | - | Logging that is the cause of loss of roosts and feeding grounds. Also stand rehabilitation through clearcut logging. |
| 948 | Fire (natural) | A | - | Threat for the existence of a forest. |
| 166 | Removal of dead and dying trees | B | - | Loss of roosts. |
| 502 | Roads, highways | B | - | Habitat fragmentation. Increase in mortality as a result of collision with vehicles. |

| Current impacts | | | | |
|---|---|---|---|---|
| **Threats (future, anticipated impacts)** | | | | |
| 164 | Logging | B | - | Logging that is the cause of loss of roosts and feeding grounds. Also stand rehabilitation through clearcut logging. |
| 948 | Fire (natural) | A | - | Threat for the existence of a forest. |
| 166 | Removal of dead and dying trees | B | - | Loss of roosts. |
| 167 | Exploitation of forest without restoration | B | - | Logging that is the cause of loss of roosts and feeding grounds. |
| 419 | Other industry and commercial areas | B | - | Location of wind farms 1 km away from the edge of the forest. |
| 502 | Roads, highways | B | - | Habitat fragmentation. Increase in mortality as a result of collision with vehicles. |

| Other information | |
|---|---|
| Other natural values | Other animal and plant species from the annexes of Habitats and Bird Directives, observed during monitoring operations: endangered and rare species (Redbook), protected species (cite abundance in scale: abundant, average, scarce). One should also cite here information on abundance of other species of bats using the habitat in the summer (if known).<br>During catches also other species of bats were caught:<br>Noctule bat Nyctalus noctula - 6 bats<br>Serotine bat Eptesicus serotinus - 6 bats<br>Natterer's bat Myotis nattereri - 1 bat<br>Whiskered bat Myotis mystacinus - 1 bat |
| Alien and invasive species | Observed alien and invasive species Not observed. |
| Other remarks | Any information useful when interpreting the results; also remarks concerning methodology<br>Coordinates of the places where the catches and detector listenings were performed:<br>N 51°XX'XX" E 17° XX'XXX"<br>N 51°XX'XX" E 17° XX'XXX"<br>N 51oXX'XX" E 17o XX'XXX"<br>3-5 nets were positioned on forest trails, in the places where underbrush on both sides of the trail was dense. If it was possible, the net was positioned in places where branches of the trees growing on both sides of the trail connected. In this way the underbrush and the branches overhanging the trail formed a "tunnel". Positioning nets in places like that increases the chances of catching bats. Catches should be performed in the best weather conditions possible (warm nights, without any rainfalls and wind). Catches should be performed in the period between 15.07-15.08 (up to 30.07 at best) and the nets should be checked every 10-15 minutes. During the catches detector listening activities should be performed. A detector should be positioned at the height of 1.5 m above the ground. Listening activities should be performed during the first 4 hours after the sunset. |
| Photographic and cartographic documentation | Annexes to database (electronic version):<br>At least 3 photos per site (species, microhabitat and macrohabitat), site boundaries marked on a proper cartographic base. |

## HIBERNATION ROOSTS

An observation sheet for the barbastelle hibernation sites is, in general, the same as observation sheets for hibernation sites of other species of bats hibernating in underground roosts. A template of such a sheet can be found in the chapter "Methodology of bat monitoring in hibernation roosts".
Apart from the standard sheet with the results of the monitoring of the species at the site, it is recommended to complete an additional, simplified data record sheet for the data collected in the area of hibernation sites that contains collective data for all the bats found during monitoring activities in the given environment (a template can be found in the chapter "Methodology of bat monitoring in hibernation roosts").

## 5. Species with similar ecological requirements for which the designed methodology can be adapted

### MONITORING OF SUMMER ROOSTS

Monitoring of the barbastelle summer roosts is conducted only for this species. Some elements (e.g. methodology of catches, evaluation of some characteristics of the forest environment) may be applied to other bats, which in Poland start their maternity colonies mainly in tree hollows and feed in forests. It concerns mainly the following species:

- mouse-eared bat *Myotis bechsteinii*,
- Natterer's bat *Myotis nattereri*
- brown long-eared bat *Plecotus auritus*.

### MONITORING OF HIBERNATION SITES

As a part of winter monitoring of the bats species using underground objects as hibernacula, the same methodology as the presented below for the barbastelle is applied. In the undergrounds used by the barbastelle for hibernation sites, 13 other bats species can be found: the lesser horseshoe bat *Rhinolophus hipposideros*, greater mouse-eared bat *Myotis myotis*, Bechstein's bat *Myotis bechsteinii*, Natterer's bat *Myotis nattereri*, Geoffroy's bat *Myotis emarginatus*, whiskered bat *Myotis mystacinus*, Brandt's bat *Myotis brandtii*, pond bat *Myotis dasycneme*, Daubenton's bat *Myotis daubentonii*, northern bat *Eptesicus nilssonii*, serotine bat *Eptesicus serotinus*, brown long-eared bat *Plecotus auritus*, grey long-eared bat *Plecotus austriacus*. For their hibernation sites, barbastelles select objects with good air circulation, cool with low humidity, where the temperature in winter oscillates around 0°C: between -1°C and 6°C (Rydell, Bogdanowicz 1997). Such conditions are too harsh for many bat species, especially of the horseshoe bat *Rhinolophus* and the mouse-eared bat genera *Myotis*. That is why in big objects that are hibernation sites for the barbastelle, only individual bats of other genera can hibernate. Thus when planning winter bat monitoring activities and selecting the sites, one should carefully analyze situation of each genus separately.

## 6. Protection of the species

The barbastelle is a species which is vulnerable. It is one of the least common bats in Western Europe. In most of the countries it has a threatened species status. In Holland it got extinct in the late 1990's and in Denmark and Belgium it is on the verge of extinction. In Germany and France it is relatively rare. In Norway it was observed over 50 years ago, and now it is considered to be an extinct species. In the last decades a decrease in the barbastelle's abundance in hibernation sites in Western Europe was observed. In Central Europe (Poland, the Czech Republic, Slovakia) it is more common than in the West and its population seems to be stable (Rydell et al. 1996, Rydell and Bogdanowicz 1997, Russo et al. 2004, Sachanowicz and Ciechanowski 2005). In Poland, despite being relatively common, the barbastelle was entered in the Red List of the Threatened Species in Poland in the category of species with unrecognized status (DD category; Głowaciński 2002).

Although the barbastelle is one of the most common bats in hibernation sites in the whole lowland part of Poland, little is known about biology of this species outside the winter season. The knowledge of the barbastelle in the period following the hibernation period, i.e. of its migrations, summer roosts and mating, is based only on a few studies. The lack of knowledge on life

requirements causes difficulties in undertaking successful protective measures aiming at conservation of the species.

The barbastelle is considered by some authors to be a sedentary species, i.e. its winter roosts are most often located up to a dozen kilometers from its summer roosts (Roer 1995, Steffens et al. 2004), and by others by the species that may migrate (Gaisler et al. 2003, Rydell, Bogdanowicz 1997). So, assuming that the barbastelle is a medium-distance migrant, it seems that determining the species population status in the biogeographical continental region on the basis of abundance status in the selected hibernation sites is justified and indicative (the same bats that use the area in winter season probably feed and mate in it). On the basis of the research conducted within the national barbastelle monitoring scheme in 2011, it is estimated that the Polish barbastelle population is as large as 6000-7000 bats.

Unsatisfactory status of the barbastelle habitat, determined during the monitoring activities in 2011, may lead to a decrease in the species status over the next few years. It may be prevented by application of protective measures. In the nearest future it is necessary to:

- secure the largest barbastelle hibernation sites and minimize pressure on the species, which is the result of increased uncontrolled visiting of underground sites during the bat hibernation period;
- monitor microclimate conditions in underground sites;
- educate and, if possible, make the underground sites available for visiting only in summer season;
- adopt measures aimed at changing forest management activities, so that a greater number of dying and dead trees is left in forests, and, where possible, also to change composition of stands that would lead to increase in the share of deciduous stands, especially deciduous historic stands with plenty of oak and beech, which are preferred by the species;
- carry out tree felling in the period between 15.10-30.03;
- in forests, where the number of dying and dead trees with the diameter at breast height of more than 25 cm which offer roosts is insufficient for the species, some boards, protected at the top, may be attached to trees at the height of about 5-7 m. They imitate crevices (2-4 cm), cracks and flaking bark, which are the roosts preferred by the species;
- try to limit or stop the use of chemical insect control in forests;
- prevent fragmentation of woodlands and isolation of population; especially alleys and woodlots should be protected, as they constitute bat migration routes;
- prevent construction of wind farms within the radius of 3 km from big hibernation sites of the species or of maternity colonies sites.

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Compiled by: **Iwona Gottfried**

# 4026 ***Rhysodes sulcatus*** (Fabricius, 1787)


Photo 7 Body profile of Rhysodes sulcatus: a) view from above; b) side view; c) view from below (© A. Mądra)

## I. INFORMATION CONCERNING THE SPECIES

### 1. Systematic classification

Order: *Coleoptera* beetle

Family: *Rhysodidae*

### 2. Legal status and threat to species

**International Law**

Habitats Directive - Annex II

**Domestic Law**

Species protection - strict protection (species that require active protection)

IUCN Threat Category

IUCN - EN Red List

Polish Red Book of Animals. Invertebrates (2004) - EN

Red List for the Carpathians (2003) - not included

Species considered a relic of primeval forests, very sensitive to disturbances to forest ecosystems. Present throughout Europe in the past, now extinct in many European countries.

### 3. Description of the species

Rhysodes sulcatus is a small beetle; the size of adults reaches 6.5 to 8.2 mm. Chestnut-coloured, shiny body. Beetles of longitudinal shape, ensiform and visibly furrowed, hairless (Fig. 1). A triangular

head with 11-member, beady tentacles. Head surface with two deep hollows. A bell-shaped protergum with three deep furrows running along. Side furrows at protergum base are notably widened. Bottom of furrows strongly lined, hence a matt appearance. Fine rotten wood often lies in furrows (protergum looks dirt-covered). Protergum between furrows is notably protuberant and shiny (roll-shaped forms). Scutellum nearly invisible. Ensiform covers, rounded at edges. Every cover contains 7 furrows, the bottom of which is thickly accentuated by a single row of points. Ribs on covers are smooth, wider than furrows, and shiny. Membranous wings under covers - flying beetle. Massive, relatively long legs with five-member feet.

A grown larva is ca. 9 mm long and 1.5 mm wide (head up to 1.0 mm). Cream-white colour with brownish, chitinised (hardened) elements. A pupa is ca. 6.5 mm long. Pre-imago stages described in detail by Burakowski (1975). They are not used for monitoring.

Adult form of Rhysodes sulcatus cannot be mistaken for other indigenous insect species (provided the individual is carefully looked at, applying a 5-fold magnitude at the least).

Photo 8 Rhysodes sulcatus on an exposed patch of moss growing on a decaying log (© L. Buchholz, W. Różański)

## 4. Biology of the species

The most detailed description of the growth of Rhysodes sulcatus is in Burakowski's work (1975). A new generation of beetles appears already in late July and early August. At this time the Rhysodes lives mainly in hiding, in decaying deadwood. It has also been found under loose bark, in tree cracks, galleries used by xylophagous beetles (among others, such species as Ceruchus chrysomelinus, horned stag beetle Sinodendron cylindricum). Copulation occurs after overwintering, in spring (in laboratories - even until September). Females place eggs in decayed, lying, sometimes standing stumps or logs, on which larvae feed later. Larvae drill a network of galleries (1.2-2.0 mm in diameter) parallel to the log axis, thriving on decaying remnants of wood. Hence the importance of proper humidity in places of growth and advanced stage of wood tissue decay. Larvae have been

observed in stumps decomposed by fungi that produce white and red decay (the author has noticed that for coniferous trees - mostly in stumps decomposed by red decay, while for broadleaf trees - mainly in stumps with white decay). Larvae growth probably lasts two years (younger and older stages have been observed simultaneously). Afterwards, the larva builds a pupa cradle of short, thin wood fibers; then it pupates. Pupation occurs in July; this stage of growth lasts about 2-3 weeks. Swarming occurs in May and early June of the next year, while the *Rhysodes* has been seen flying into barrier traps until the end of June. During its mating flights, *Rhysodes* often selects well-exposed places and sits on bright surfaces (for example, on a sunlit spot on decayed stump, on a sheet of paper, etc. - Photo 2). It has been observed to thrive in beech Fagus spp., oak *Quercus* spp., poplar *Populus* spp. as well as fir *Abies* spp., and spruce *Picea* spp. In the course of monitoring, and on basis of literature, beech and fir have been singled out as the preferred host plants for *Rhysodes sulcatus* (Kryzhanovskiy 1983, Kubisz 2004, Sienkiewicz 2004). Also, beetles have been observed feeding on birch Betula spp. (Plewa, Niemiec 2010).

## 5. Habitat requirements

*Rhysodes sulcatus* preferably thrives in old, primeval and natural forests (Fig. 3), that have a diversified species structure (both in terms of age and species, adapted to local biogeographic conditions), rich in various forms of deadwood (with a high share of large timber) in different stages of decomposition (ca. 5% stand volume as a minimum, optimum share of deadwood above 15%). This beetle is obligatory saproxylic, an actual primeval forest relic (not found in forests excessively altered by silviculture, even those with proper habitats for growth; only nearly-extinct populations may be found in forests that have been relatively recently transformed - to a rather minor extent). In such forests, mainly microhabitats composed of deeply decayed and humid (mainly lying) stumps with diameters of over 20 cm are colonised. Colonisation of primarily large timber (stumps with a diameter of over 40 cm), regardless of the age of decaying tree, has been observed.

Photo 9 *Rhysodes sulcatus*' habitat: fir forest (left), beech forest (right) (© Z. Maciejewski)

After the swarming period (mid-June to mid-July) adult beetles are observed under the loose bark of, e.g. firs (chunks and lying logs) in between the II and III decomposition stages (see methodology). But, this is not where *Rhysodes* thrives; this is where it seeks shelter.

*Rhysodes sulcatus* is found in lowlands, highlands and low mountainous areas, in broadleaf and mixed forests (throughout Europe in the past). As regards the association with habitat types of the I Habitats Directive, *Rhysodes sulcatus* lives in Central Europe's mountain beech forests with sycamore

(habitat code 9140), highland mixed fir forest (91P0), acidic mountain and high-mountain spruce forests (9410).

## 6. Species distribution

Apart from lists of wrinkled bark bettle positions drawn for the needs of the Polish Redbook of Animals, and the monitoring of selected invertebrates in the Białowieża Forest (European Natural Forest centre of the Forest Research Institute), no planned research on the current distribution of this species has been carried out in Poland.

According to the available information, *Rhysodes sulcatus* currently lives in the Białowieża Forest, Roztocze National Park, Lublin region, Holy Cross (Świętokrzyskie) mountains, probably in the Low Beskids (Jaśliska Sanctuary), Upper Silesia, Knyszyn Forest, and in the area of Hrubieszów (Kubisz 2004, Plewa, Niemiec 2010, Sienkiewicz 2004) (Fig. 1). In the past it used to live in the Upper Silesia, the area of Warsaw, Jarosław and in many positions near Przemyśl. Numerous positions of *Rhysodes* were found in 2010 in the Bircza Forest District (Buchholz et al., 2011), in the Przemyśl Foothills, in remnants of natural forests, some of which had already been thinned out (possibly due to unawareness of the contemporary presence of *Rhysodes* in the region).

In order to determine the current distribution of *Rhysodes sulcatus* in Poland, inventories should be carried out covering old positions and sites where, according to current data, proper habitat conditions still exist.

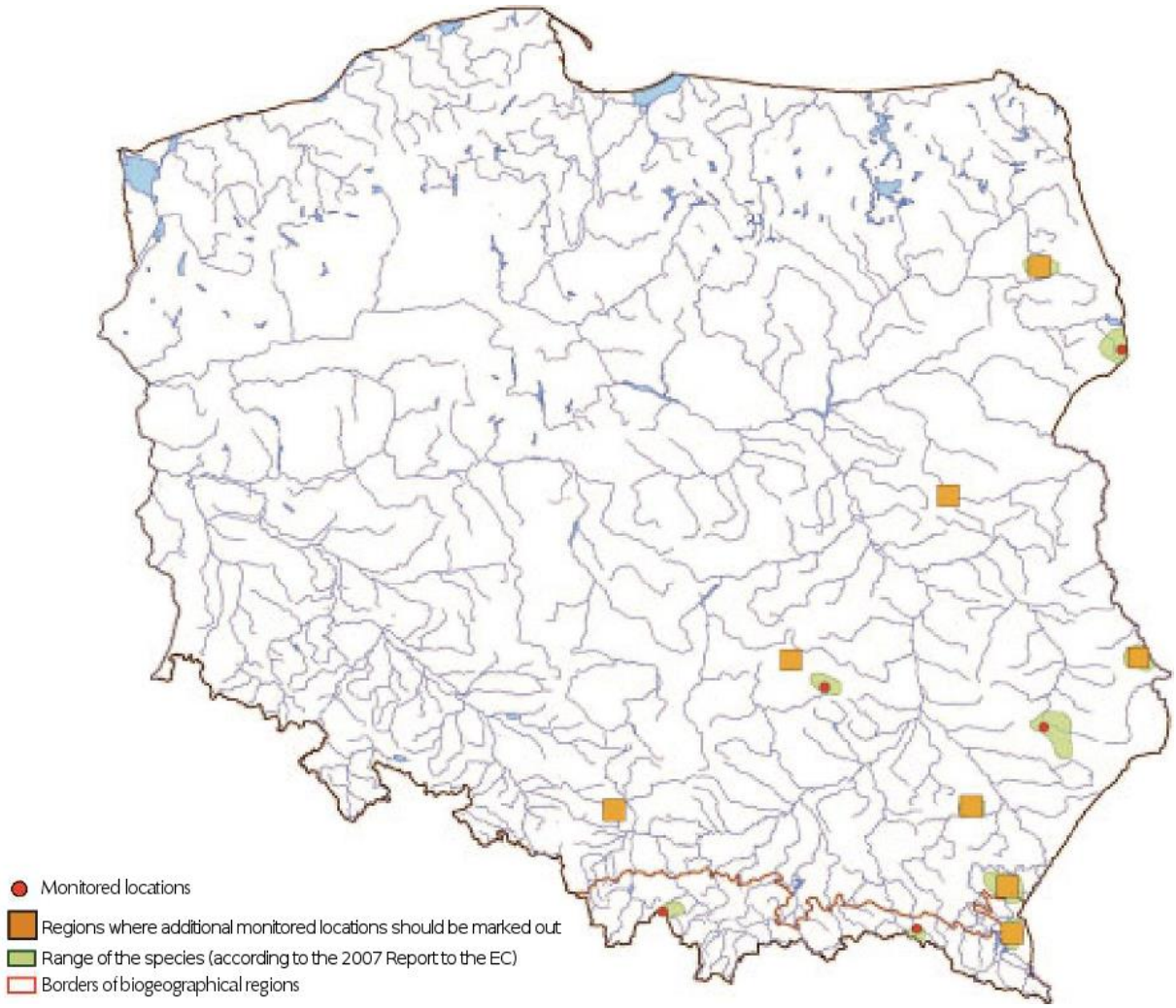


Fig. 3 Distribution of the positions of *Rhysodes sulcatus* in Poland in the context of its geographical range

# II. METHODOLOGY

## 1. Concept of monitoring of the species

The concept of monitoring the *Rhysodes sulcatus* is based on author's experience and available literature. Due to its low numbers, endangered status and hiding lifestyle, it is not possible to determine its relative abundance at the site. The population status may only be determined by the presence of *Rhysodes* and the number of detected individuals. Due to the sensitivity of the *Rhysodes sulcatus* to changes in its life environment, the method of screen (barrier) traps to catch imagines is recommended as the basic way to detect its presence. Beetles caught live should be returned to the environment. Only if this method fails, imagines should be searched for at sites where they thrive, meaning rotten logs of host trees. The methodology does not provide for seeking larvae. They live in hiding and are easy to overlook in deadwood or be mistaken for the larvae of other insects of similar shapes.

In addition to the population of *Rhysodes sulcatus*, key habitat factors are also monitored, the value of which determine the survival of a population at the given site. The indicators selected and described above apply to the microenvironment where larvae thrive and *Rhysodes* is present (deadwood in proper stage of decomposition) and the entire forest macroenvironment (mainly, the

natural feature of forest at the site and in its environs), the quality of which, together with the quality of microhabitat, determines the prospect of preserving the *Rhysodes sulcatus* population. Already completed observations show that altering the remnants of primeval and natural forests has contributed to the extinction of the *Rhysodes* population, e.g. in the Warsaw or Przemyśl regions (Gutowski, Bucholz 2000, Sienkiewicz 2004).

In the future, the suggested methodology may be tailored to the experience of successive phases of monitoring operations and independent research on the species.

## 2. Indicators and assessment of the species conservation status

### Indicators of population and habitat status

| Indicator | Measure | Measurement / determination method |
|---|---|---|
| **Population** | | |
| Presence of imagines | Number of individuals | Hanging screen traps of ca. 1 sq. m. or searching the deadwood by monitoring contractor |
| **Habitat** | | |
| Forest natural status | Descriptive indicator | Determining the degree of the natural state of forest, considering the conformity of actual species composition of stand with the potential composition adequate for the habitat, intensity of use in the past, stand origins and stand structure |
| Natural status of surrounding forests | Descriptive indicator | Determining the degree of the natural state of forest, considering the conformity of actual species composition of stand with the potential composition adequate for the habitat, intensity of use in the past, stand origins and stand structure |
| Species structure of stand at the site | Number of species | Counting the species considered the main host plants for Rhysodes sulcatus (beech, fir, spruce, in the I and II forest floors) and other host species in lower floors (oak, poplar, birch) |
| Stand species structure in area surrounding the site | Number of species | Counting the species considered the main host plants for Rhysodes sulcatus (beech, fir, spruce, in the I and II forest floors), and other host species in lower floors (oak, poplar, birch) |
| Age of trees in stand | Descriptive indicator | Determining the share of trees in 3 age classes - on-site expert assessment completed with data from the forest valuation report (or protection plan) |
| Volume of deadwood | Number of lying stumps with a diameter >40cm/100 m | Counting the lying stumps with a diameter above 40 cm on a transect that is 100 m long |
| Quality of deadwood | Wood decomposition classes (I, II, III, IV)[4] | Identifying the wood decomposition classes represented by lying stumps with a diameter >40 cm on a transect that is 100 m long |

[4] I - healthy wood and phloem, II - hard wood, phloem decomposed, III - initial stage of wood decomposition, IV - advanced wood decomposition

| Indicator/ Assessment[5] | FV | U1 | U2 |
|---|---|---|---|
| **Population** | | | |
| Presence of imagines | Observing or catching 4 individuals as a minimum | Observing or catching 1 individual as a minimum | No imagines observed despite good habitats and previous statements of the species at the site |
| **Habitat** | | | |
| Forest natural status | Natural or nearly natural forests, species structure consistent with potential plant community, produced by natural decomposing and renewal processes, with no evident traces of human activity (individual trees logged at most), complex stand structure | Forests of stand structure consistent with plant community, created by natural decomposing and renewal processes, or natural renewal associated with silviculture, extensively used for economic purposes ("thinning"), complex stand structure | Economic forests, intensely used, of species structure consistent with potential plant community, created by artificial renewal, stand structure usually simple |
| Natural status of surrounding forests | Natural or nearly natural forests, species structure consistent with potential plant community, produced by natural decomposing and renewal processes, with no evident traces of human activity (individual trees logged at most), complex stand structure | Forests of stand structure consistent with plant community, created by natural decomposing and renewal processes, or natural renewal associated with silviculture, extensively used for economic purposes ("thinning"), complex stand structure | Economic forests, intensely used, of species structure consistent with potential plant community, created by artificial renewal, stand structure usually simple |
| Species structure of stand at the site | Presence of at least one of the main host plants for Rhysodes sulcatus that are the main components of stand in I and II forest floors, and one species of main host plants in lower floors (beech Fagus sp., fir Abies alba, spruce Picea sp.) | Presence of at least one of the main host plants for Rhysodes sulcatus that are the main components of stand in I and II forest floors, and of one of other host plants in lower forest floors (oak Quercus sp., poplar Populus sp., birch Betula sp.) | No presence of any species of host plants as main component of stand in I and II forest floors |
| Stand species structure in area surrounding the site | Presence of at least one of the main host plants for Rhysodes sulcatus that are the main components of stand in I and II forest floors, and one species of main host plants in lower floors (beech Fagus sp., fir Abies alba, spruce Picea sp.) | Presence of at least one of the main host plants for Rhysodes sulcatus that are the main components of stand in I and II forest floors, and of one of other host plants in lower forest floors (oak Quercus sp., poplar Populus sp., birch Betula sp.) | No presence of any species of host plants as main component of stand in I and II forest floors |
| Age of trees in stand | Ancient forest with numerous (ca. 10%) trees above 150 years | Ancient forest composed of 100/150 years-old trees | Stand composed of trees younger than 100 years |
| Volume of deadwood | > 5 complete laying stumps | 3-4 complete laying stumps | 0-2 complete laying stumps |
| Quality of deadwood | All 4 classes present, or II, III and IV as a minimum | Classes II and IV present, or IV as a minimum | Classes I and/or II present, or no deadwood in place |

Remark: At a higher number of measurement points at the monitored location on which we mark the transects we calculate the average, applying the rules of mathematics at rounding the results up to unity (see description of monitoring research).

## Cardinal indicators

- forest natural status at the site
- volume of deadwood
- quality of deadwood

[5] FV - proper state, U1 - unsatisfactory, U2 - negative

### Assessment of population status

The indicator assessment is equivalent to an estimate of population

### Assessment of habitat status

To assess the habitat status, we attribute a determined point score to the assessments of individual indicators: FV - 2, U1 - 1, U2 - 0. Then we sum up the points and perform a complex assessment of habitat status, according to the following rule:

- ≥ 10 points - FV, provided all cardinal indicators are assessed as FV, and none of other indicators is assessed as U2;
- ≥ 7 points - U1, provided at least 2 cardinal indicators are assessed as FV, the third not less than U1 and no more than two of the other indicators are assessed as U2; < 5 points for cardinal indicators - U2.

### Conservation prospects

Assessment of the prospects of preserving the *Rhysodes sulcatus* is an attempt to anticipate its protection status over the next 10-15 years by the contractor of monitoring operations (expert assessment). If this perspective offers the chance to preserve the proper status or improve the inadequate status, then the preserving prospects should be assessed as adequate (FV). If we expect the adequate status to deteriorate or the inadequate status to continue, then the preserving prospects should be assessed as unsatisfactory (U1). If we expect the current unsatisfactory status to deteriorate or the bad status to continue, then we assess the prospects as negative (U2). When assessing the prospects, the state of isolation of the population subject to monitoring, the status of forest environment and the way it is used should be considered. The way the forest is used is relevant for the prospects of preserving the species. The populations that are still surviving within the area heavily impacted by silviculture will most probably gradually disappear.

### Overall assessment

The lowest assessment of one parameter is decisive for the assessment of the overall species protection status at the site.

## 3. Description of monitoring studies

### Selection of monitoring areas and their suggested size

The monitored location of the species is any section of the forest environment where the presence of *Rhysodes sulcatus* has been observed in recent years, or where it used to be observed, and an adequate habitat is still in place. The said section should not be divided into smaller fragments in any manner, to avoid complicating the dispersion of species within the monitored location. Monitoring locations may significantly differ in terms of area. They should be as extensive as possible, thus stable in environmental terms; optimal area above 100 ha. For larger monitored locations, the monitoring of population status and habitat indicators assessed on transects should be performed on several monitoring plots. Proposed density of such plots - not less than 1 per 50 ha of forest.

All currently detected locations of *Rhysodes sulcatus* should be monitored, meaning the ones located in the Knyszyn, Białowieża, Suchedniów Forests, the Strzelecki Forests, in Roztocze, Upper

Silesia, Sandomierz Forest, Przemyśl Foothills, Babia Góra National Park, the Low Beskids (cf. Fig. 1) and (in the initial phase of monitoring at least) also the historical positions where habitats adequate for the species still exist and the presence of populations not yet extinct may be expected (e.g. Pieniny Mountains, Janów Forests). Also, it is worthy to try to find the *Rhysodes* in the Magury National Park and Bieszczady National Park, where habitats adequate for the species could have been preserved. Locations for monitoring have been proposed on the basis of literature and author's personal observations.

## Study method

The method of observing individual indicators on-site is set out below. To effectively perform on-site operations, the attached diary may be used (Tab. 3).

## Determining population status indicators

The sole indicator of the population status of a species as rare and sensitive as *Rhysodes sulcatus* is the presence of imagines, considering the number of individuals observed. In order to determine it, two procedures are proposed:

- basic - catch using screen traps (e.g. IBL-2 type),
- complementary - search penetrating the life/growth environment with a solid knife or hatchet.

### Catch into screen traps

For the catch, available screen traps of the IBL-2 type or other may be used. It is important that the collection container into which the insects fall is provided with a drain strainer in the bottom and have a capacity of even up to 2 litres. We insert sawdust mixed with moss into the container. The purpose is to boost the chance of survival of Rhysodes in the trap, because the found individuals shall be released to the environment. Such traps should be controlled every 2-3 days and after every major rainfall. On this occasion also the filling should be replaced, if it is excessively soaked. The use of 3 screen traps per 50 ha is recommended. Traps should be exposed from mid-May to mid-June (4 weeks) or even to the end of June (depending on weather conditions). We conclude the catch by traps when 4 *Rhysodes sulcatus* individuals are stated, thus giving the highest assessment of the population status (Tab. 2). If after 4 weeks of exposing the trap a lower number of individuals is stated, then we remain at the U1 assessment of population status. The hanging of 3 traps on each plot of the position would be advantageous, in various places with abundant deadwood (the species - as most insects - will be distributed in concentrations, thus we reduce the risk of its strongly invasive detecting).

### Searching the environments where it lives and thrives

The method consists in actively penetrating deadwood of IV decomposition class. Therefore, it is a highly invasive method that affects the microhabitat of *Rhysodes* (that is why we apply it when the beetle is not detected by catching into traps). The tools needed to apply this method include a solid knife (sheath) or hatchet to break the logs of deadwood, which are then penetrated to state the presence of *Rhysodes*. Up to 10 lying logs should be penetrated, preferably of fir and beech, of IV decomposition class. Logs lying by or on a transect, 100 m long, should be selected and penetrated during the assessment of the habitat status (description below). The best time for research is from mid-August even until October. The rot is penetrated until 4 *Rhysodes sulcatus* individuals are found or 10 logs analysed.

Rot should be analysed carefully to avoid destroying the whole log, which represents the environment where *Rhysodes* lives and thrives. Penetrating of perimeter fragments of a log every 3 m is recommended.

## Determining habitat status indicators

The selected habitat status indicators that are crucial for the quality of the life environment of the *Rhysodes sulcatus* are set in tables 2 and 3 and stated below. To determine them, expert knowledge, access to statements of management and a measure to determine the transect are needed.

**Forest natural status.** This indicator determines the scope of forest deformation against its primeval form, which is the proper place where the monitored species thrives. It is an expert assessment based on field observations and data from the forest valuation report. Special attention should be dedicated to the consistency of actual stand species structure with the potential structure proper to the habitat, intensity of use in the past, origins of stand (natural renewal and decomposition processes, natural renewal prompted by silviculture, artificial plantings) and stand structure (complexity of spatial distribution of plants). When assessing this parameter, the work by Kucharczyk (2008) may be useful, as it sets the described components of natural forest status assessment in the form of a table. On the other hand, the concept of "stand structure" needs explanation. It should be understood as the spatial and age distribution of trees growing at monitored location of *Rhysodes*. We also perform a preliminary (visual) assessment of deadwood resources. This element will be assessed in more detail according to the below stated indicators. We may single out the complex and simple stand structure.

Complex stand structure - trees of all age classes, floor-structured, irregularly distributed on the plot (due to environmental conditions); multi-species stand (not all species must be represented in the highest floor of the stand). We observe many lying and standing dead trees (e.g. we always have several such trees within our viewing range - deadwood quite regularly lies on forest bottom, sometimes in major concentrations).

Simple stand structure - trees grow as in a typical economic forest. No trees of the top age classes, lower forest floors less represented or often missing, trees mostly distributed on the plot in regular shapes due to planned planting, the main (productive) stand dominated by one or two species of trees. We observe laying and standing dead trees only sporadically or not at all.

**Natural status of surrounding forests.** Indicator description as above. The forest deformation status in the area around the location is another important element of assessment of the survival prospects of the *Rhysodes sulcatus* at the site as such, the more so when the position is relatively small (up to ca 300 ha).

**Stand species structure at the site.** Current experience shows that the most important tree species in which *Rhysodes* thrives are fir Abies alba and beech Fagus sylvatica, while in north-eastern Poland - spruce *Picea abies*. To determine the value of the indicator, the presence of main species of host trees should be detected and it is necessary to determine how many of them are the main components of the stand (mainly of ancient forest, but also the forest II floor) and how many main and other species of host trees are in lower floors. Other host trees: poplar, oak and birch.

**Stand species structure in area surrounding the site.** As above. The "area around" is a stretch of forest around the site, 500 m wide. This indicator is also useful to assess the prospects of preserving the *Rhysodes sulcatus* at the site. It is more important at smaller locations.

**Age of trees in stand.** This indicator allows assessing how well the "primeval" form of the forest has been preserved, which also translates into the chances of preserving the *Rhysodes* population at

the location. The share of many old trees (ca. 10%), aged above 150 years, is the status that should be pursued in forests where the species lives. The age of trees in the stand is determined by an expert assessment and on basis of data from the forest valuation report.

**Volume of deadwood (number of laying stumps of diameter above 40 cm).** This indicator is determined by the transect method (5 randomly chosen transects per 100 ha). Along the route that is 100 m long and 10 m wide we count the stumps with diameters of above 40 cm that lie on the forest bottom (due to the plot size or other field conditions, the transect may be composed of sections 100 m long in total). The volume of dead trees (number of lying logs) compared to its quality is the main indicator that applies directly to places where *Rhysodes* thrives and the prospects of preserving these microbiotops at the site.

**Quality of deadwood (decomposition classes I, II, III, IV).** We observe the quality of deadwood on transect when determining the volumes of deadwood. The best habitat condition occurs when all decomposition classes are in place. It guarantees the continuous existence of the microhabitat the *Rhysodes sulcatus* needs to thrive (deadwood of IV class of decomposition). Decomposition classes (Gutowski et al. 2004):

I healthy wood and phloem;
II thick wood, decomposed phloem;
III initial stage of wood decomposition;
IV wood heavily decomposed.

Apart from the above indicators, in order to fully identify the living conditions of the *Rhysodes sulcatus* the type of decay in which it was found should be observed as well as the state of rot humidity. We also record all information on the species of trees where the presence of *Rhysodes* has been ascertained. We record this information in the field diary that should be attached to the monitoring documentation.

A diary to be filled during field operations

| | | | |
|---|---|---|---|
| Location: | | | |
| Position no./transect no.: | | | |
| Area [ha]: | | Stand age: | Continuity of forest presence YES/NO |
| GPS: | N | | |
| | E | | |
| Filling date: | | Filled by: | |
| **POPULATION** | | | |
| Number of *Rhysodes sulcatus* individuals | In traps: | In logs: | |
| | 1. | 1. | 6. |
| | 2. | 2. | 7. |
| | 3. | 3. | 8. |
| | 4. | 4. | 9. |
| | | 5. | 10. |
| **HABITAT** | | | |
| **Natural status of stand:** | **At the site:** | **In the surrounding area:** | REMARKS: [e.g.: tree species where *Rhysodes* is found, threats, impact of surroundings, number of documenting photo, alien species, protected species and rare accompanying species] |
| a) a natural or nearly natural forest, species structure consistent with potential plant community, created by natural decomposition and renewal processes, without evident traces of human activity (individual trees logged at most), complex stand structure | | | |
| b) a forest with the species structure consistent with potential plant community, created by natural decomposition and renewal processes or natural renewal associated with silviculture, extensively used ("thinning") for economic purposes, complex stand structure | | | |
| c) an economic forest that is intensely used, of species structure consistent with potential plant community created by artificial renewal, stand structure usually simple | | | |
| **Species structure:** | **At the site:** | **In the surrounding area:** | |
| a) 1 main species in I and II floor, 1 main species in lower floors - as a minimum | | | |
| b) Only one of the identified host species represents the main component of the stand (I and II floors) | | | |
| c) None of the host species represent the main component of stand (I and II floor) | | | |
| Age of trees in the stand at the site: | | Volume of deadwood [> 40 cm] | |
| a) Numerous trees (ca 10%) aged above 150 | | a) ≥ 5 stumps | |
| b) Trees aged 100-150 | | b) 3-4 stumps | |
| c) Trees under 100 years | | c) 0-2 stumps | |
| **Quality of deadwood:** | | **Additional observations:** | |
| a) All 4 classes present or II, III and IV at least | | Type of rot where species is found: | a) Brown |
| b) Classes II and IV present or IV at least | | | b) White |
| c) Classes I and/or II present or no deadwood in place | | Humidity of decay where the species is found: | a) Wet |
| | | | b) Humid |
| | | | c) Dry |

## Time and frequency of studies

Monitoring operations should be performed in spring, from May to June (start depending on phenologic situation) and from August even to November (possibly penetrating the deadwood when the trap method fails).

During the first 12 years of species monitoring the assessment of population status is recommended to be performed every 3 years. In the later period, this should be performed every 6

years at the best assessed sites and still every 3 years at the sites subject to the renewal of habitat conditions. We return to 3-year periods of populations monitoring when we see negative changes in habitats or when the assessment of population status is much worse than in the previous phase of operations (e.g. with FV or U1 on U2). It is proposed to assess the habitat conditions every 3 years, even at positive assessments, to rapidly detect the negative trends. For positions subject to strict protection - every 6 years.

### Equipment and materials used in the studies

- barrier traps, e.g. IBL-2 or IBL2-bis type;
- measuring tape;
- magnifying glass (5x zoom as a minimum);
- knife (sheath) or hatchet;
- GPS receiver;
- photo camera with macro mode;
- topographic map scale 1: 5000;
- field diary and observation records, notebook.

## 4. An example of a filled-in species observation sheet for a monitored location

| Species observation sheet for a monitored location | |
|---|---|
| Code and name of species | Code of the species as in the Habitats Directive, Polish and Latin names, author, as in the current terminology<br>4026 zagłębek bruzdkowany Rhysodes sulcatus (Fabricius, 1787) |
| Name of the site | Name of the monitored location<br>..... |
| Type of the site | Reference/research<br>Reference |
| Protected areas where the site is located | Natura 2000, nature reserves, national and landscape parks, sites of ecological interest, documentation sites, etc.<br>Świętokrzyski National Park, PLH260002 Łysogóry |
| Geographic coordinates | State the geographic coordinates of position (GPS)<br>N XX°XX'XX.X"; E XX°XX'XX.X" |
| Elevation a.s.l. | State elevation a.s.l. of the site or range from... to...<br>320-612 m a.s.l. |
| Area of the site | State in ha, a, $m^2$<br>3721 ha |
| Description of the site | Description is supposed to help identify the site. Describe the location and features of terrain and access route to the site.<br>The site is composed of the following elements located within and in the vicinity of strictly protected areas: "Łysica", "Święty Krzyż", Świętokrzyski National Park forest.<br>The site includes 3 points of species monitoring by the barrier traps method: Święta Katarzyna, unit ..... (XXoXX'XX''N - XXoXX'XX''E), Dębno, unit …….<br>(XXoXX'XX'''N - XXoXX'XX''E) and Święty Krzyż, unit ……. (XXoXX'XX''N - XXoXX'XX''E). Points are located outside strictly protected areas, but no protection operations have been performed over the last several years in the area of their location (passive protection is applied). |
| Profile of species habitat at the site | Brief description of species habitat at the site<br>Main plant communities represented therein include: Carpathian beech forest (Dentario glandulosae-Fagetum) with large share of fir in the stand and fertile mixed fir forest, known as the Polish fir forest (Abietetum polonicum). Forests at the site are highly natural, currently in the phase of spontaneous renewal of the ecological structure that is typical for such forests of this ecological structure (differing ages and species of trees, abundance of the so-called deadwood in various forms and phases of decomposition, etc.). Renaturalisation processes seem to be significantly stimulated by the vicinity of extensive, strictly protected areas of several hundred hectares that had been given such status already in the 1920s. ("Łysica", "Święty Krzyż") constitute a refuge of, among others, entomofaunas of highly natural forests.<br>Within the site, the forest communities mentioned in the description are present, with tree stands mostly above 100 years old and more or less numerous firs, beeches and individual pines, sometimes as old as about 150-250 years. The forest features a certain number of dying and dead trees, including old trees of large sizes (both standing and chunks or windthrows), the number varies in different sections of the site and it is the highest in strictly protected areas and their direct vicinity. Abundance of the so-called deadwood (volume of above-ground large timber with a diameter > 15 cm [excluding stumps of cut trees and underground parts of dead trees, even of windthrows]) in units where species monitoring points are located (as at the end of 2009), range as follows: unit ..... - 0.5-10 $m^3$/ha, unit ..... - 10-20 $m^3$/ha, unit ..... - 20-30 $m^3$/ha (data from an unpublished study by W. Świątkowski: Opracowanie wyników inwentaryzacji posuszu, złomów i wywrotów wykonanych na obszarze ochrony czynnej więtokrzyskiego Parku Narodowego w latach 2007 i 2008. Bodzentyn, 2009). |

| Species observation sheet for a monitored location | |
|---|---|
| Information on the species at the site | Synthetic data on the presence of the species at the site (last observed in particular), research completed until now and other relevant facts; results of assessments of previous years<br>Rhysodes sulcatus was first stated at the site Pasmo Łysogórskie (Łysogóry Range) by P. Sienkiewicz (2004: Polish Red Book of Animals. Invertebrates: 91-92) based on the information from L. Buchholz and D. Kubisz on observing this species within the "Święty Krzyż" strictly protected area in 2002. M. Bidas and L. Buchholz (2007: Wiad. Entomol., 24, 4: 289-291) give other observation locations of the species at the site, found in strictly protected areas "Święty Krzyż" and "Łysica" - observations apply to numerous individuals seen in the years 1990-2007. During the observations performed in 2008 and 2009, also using barrier traps, the species was found in numerous places at the Pasmo Łysogórskie (Łysogóry Range) site.<br>In 2008 two individuals were observed in the Dąbrowa protection zone (unit ..... ) In 2009 40 individuals were observed in total: 8 in protection zone Dębno (unit ..... ), 8 in protection zone Święta Katarzyna (unit ..... ), 23 in protection zone Święty Krzyż (unit ..... ), 1 in protection zone Jastrzębi Dół (unit ..... ). Species last observed at the site on 10 June 2010. |
| Observer | Name/surname of monitoring contractor Lech Buchholz PhD, Eng. |
| Dates of observations | Dates of all observations<br>02.05.2010; 06.05.2010; 11.05.2010; 14.05.2010;<br>20.05.2010; 23.05.2010; 01.06.2010; 04.06.2010 |

| Species protection status at the site | | | |
|---|---|---|---|
| **Parameter/**indicators | **Indicator value and comment** | **Assessment** | |
| **Population** | | | |
| Presence of imagines | >10 indiv.<br>Various observations of the species at the site prove that its large population is surviving here. More than 10 individuals have been caught into screen traps. | FV | FV |
| **Habitat** | | | |
| Forest natural status | Forest more or less natural, but with unnatural stand age structure (outside strictly protected areas). | FV | FV |
| Natural status of surrounding forests | Most of the site borders with non-forest (arable) areas, whereas in the Świętokrzyski National Park, the stand structure of forests adjacent to the position is similar to the site, meaning it is almost natural, except for the economic stands of Łagów Forest District (adjacent to the site in the south-east), the structure of which is significantly altered. | U1 | |
| Species structure of stand at the site | Stands have high shares of both main host trees - fir and beech.<br>Stands diverse in terms of species structure, proper for fertile beech forests with a high share of fir, Polish fir and some other forest communities. The admixture also features other tree species, such as rowan Sorbus aucuparia, sycamore Acer pseudoplatanus and Scots pine Pinus sylvestris. | FV | |
| Stand species structure in area surrounding the site | Stands have high shares of both main host trees - fir and beech. | FV | |
| Age of trees in stand | A significant part of the site (mainly in strictly protected areas) features numerous very old trees (approaching the age of physiologic death). In certain places the age of oldest trees in stands is too low (in many areas of the site outside strictly protected areas those trees are 100-150 years old). | FV | |
| Volume of deadwood | 3-7 / 100 m<br>3-7 dead trees (felled) on 100-m-long transects close to monitoring points, of which ca. 30% are of higher dimension (diameter above 50 cm) | FV | |
| Quality of deadwood | Trees in all decomposition phases present | FV | |
| **Conservation prospects** | Brief forecast of population and habitat status of the species in the site in the next 10-15 years in the context of their current status and observed evolution, considering all actions and plans that may impact the species and its habitat. Thanks to the strategy of protecting the habitat within the site, currently followed by the Świętokrzyski National Park, prospects of preserving the species are good. | FV | |
| **Overall assessment** | | | **FV** |

A list of the most important current and predictable impacts (threats) on the species and its habitat in the studied site (including current use, planned investments, planned changes in management and use); coding of impacts/threats as in Annex E to the Standard Data Form for Natura

2000 areas; effect of the impact: "+" - positive, "-" - negative, "0" - neutral; intensity of the impact:A - high, B - moderate, C - low.

| Current impacts | | | | |
|---|---|---|---|---|
| **Code** | **Name of activity** | **Intensity** | **Impact** | **Synthetic description** |
| 166 | Removal of dead and dying trees | C | - | Currently, impacts mainly due to wood theft (of dying trees, chunks and windthrows) |
| 501 | Paths, pedestrian and bicycle trails | C | - | Damaging the dying and dead trees (also chunks and windthrows) along trails by tourists (ripping bark off such trees); easier access for collectors and insect traders |
| 790 | Other types of pollution or human impacts | C | - | Dumping trash in forests (also pesticide packaging), polluting air and soil by local emissions from chimneys of farms located close to the site |
| 990 | Other natural processes | A | + | Spontaneous revival of the natural ecological forest structure, due to expanding range of passive protection |

| Threats (foreseeable future impacts) | | | | |
|---|---|---|---|---|
| **Code** | **Name** | **Intensity** | **Impact** | **Synthetic description** |
| 166 | Removal of dead and dying trees | C | - | Threat mainly due to wood theft (of dying trees, chunks and windthrows) |
| 501 | Paths, pedestrian and bicycle trails | C | - | Damaging dying and dead trees (also chunks and windthrows) along trails by tourists (ripping bark off such trees) |
| 790 | Other types of pollution or human impacts | C | - | Dumping trash in forests (also pesticide packaging), polluting air and soil by local emissions from chimneys of farms located close to the site |

| Other information | |
|---|---|
| Other natural values | Other animal and plant species from the annexes of Habitats and Bird Directives, observed during monitoring operations: endangered and rare species (Redbook), protected species (cite abundance in scale: abundant, average, scarce).<br>During the research, the presence of many interesting species of beetles has been certified at the site. The following have been observed, among others: blue ground beetle Carabus intricatus, Ceruchus chrysomelinus, Ampedus melanurus, Peltis grossa, Cucujus cinnaberinus. |
| Alien and invasive species | Observed alien and invasive species (cite abundance in scale: low numbers, average numbers, high numbers)<br>Not observed. |
| Implemented protection measures | E.g. strict protection, mowing, rising the water level, pasturage, other renaturing operations<br>Increasing the resources of lying deadwood in the habitat |
| Proposed protection measures | As above<br>Leaving old trees and all forms of deadwood |
| Methodological remarks | Information relevant for further planning of monitoring (procedure of operations, indicators that should be assessed in monitoring and their indexation, regionally optimal timing of research, etc.)<br>None |
| Other remarks | All information that helps to interpret the results, e.g. weather anomalies No remarks |
| Photographic documentation | Attached to database (electronic version):<br>At least 3 photos per site (species, microhabitat and macrohabitat), site boundaries marked on a proper cartographic base |

## 5. Species protection

*Rhysodes sulcatus* is strictly protected in Poland, with the provision that protection should be active (Journal of Laws 2011.237.1419). The exact measures of this protection are not specified. Due to the character of biocenoses inhabited by this species, strict passive protection may be the only effective measure that should also improve the habitat conditions. Most of the current positions of *Rhysodes* are located in national parks and nature reserves, where populations are apparently well protected. It is the particular case of the healthiest populations in Roztocze and Świętokrzyski National Parks, and of not so healthy but stable populations of the Białowieża National Park. Nature reserve protection should also be planned in the area of the Bircza Forest District, which features the

third largest population of this beetle on many sites that are still under assessment. The presence of *Rhysodes* in the Babia Góra National Park and Natura 2000 Jaśliska Sanctuary (monitoring results in 2010 were negative) still needs to be confirmed. In the latter case, from the places where the species had been observed 11 years ago most of the lying fir and beech stumps that used to host the *Rhysodes sulcatus* have been removed. Therefore, specific silviculture procedures in areas where the species lives, which are not subject to strict protection, determine its survival. Hence the importance of silviculture that is "friendly" for the species at the sites of *Rhysodes* in economic forests, which means discontinuing all operations associated with economy. This is due to the sensitivity of *Rhysodes* to changes in the forest environment. In the current phase of identifying the biology and ecology of *Rhysodes sulcatus*, it should be assumed that only eliminating the silviculture from positions inhabited by *Rhysodes*, and reducing tourist traffic (excessive tourism alters the habitat structure, reducing the chances of preserving the population), will stop further extinction of this species in Poland (Burakowski 1975, Gutowski et al. 2000, Gutowski, Buchholz 2002, Nubisz 2004, Sienkiewicz 2004). What is more, the areas that comprise the positions of *Rhysodes* should be protected as extensively as possible (not smaller than 100 hectares of forest adequate in terms of species around an individual certification). It will allow, among others, protecting adequate numbers of microhabitats the beetle needs to thrive and its population to expand and stabilise (in terms of abundance and genetic diversity). The perfect solution would consist in creating "saproxylic corridors" to connect isolated populations, at least locally for a start.

As *Rhysodes sulcatus* may become the object of illegal trade on entomologic markets, the areas where it lives should be patrolled more intensely. Also, an education programme addressed to a broad target group should be developed, providing information on the extent of threat to saproxylic organisms. *Rhysodes* should be used as a case study to explain the role of this beetle as an umbrella species and a bioindicator for ecologically well preserved remnants of ancient wilderness.

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Compiled by: **Paweł Sienkiewicz**

# 4066 **Ladder spleenwort** *Asplenium adulterinum* Milde

Photo 10 A ladder spleenwort at a site on the Kiełczyńskie Hills (© L. Żołnierz)

## I. INFORMATION CONCERNING THE SPECIES

### 1. Systematic position

Family: spleenworts *Aspleniaceae*

### 2. Status

#### International law

Habitats Directive - Annex II

#### National law

Protection of the species - strict protection since 2004

Zonal protection – requires establishment of a protection zone within the radius of 30 m from the boundaries of the site.

**Threat category**

IUCN Red List – not taken into account
Polish Red Book of Plants (2001) – EN
Endangered vascular plant of the Sudetes (2002) – EN
Red List of Lower Silesia (2003) – CR
Red List of vascular plants in Poland (2016) – EN
Red Book of the Czech Republic and Slovakia (1999) – CR

## 3. Description of the species

The ladder spleenwort is an allotetraploid (2n = 144) derived from a combination of sets of chromosomes derived from two different ancestral species of diploid spleenworts (2n = 72): maidenhair spleenwort *Asplenium trichomanes* and green spleenwort *A. viride* (Lovis and Reichstein 1968).

Clusters of ladder spleenwort usually consist of between a few and a dozen or so or sometimes twenty odd fronds growing from the top of a short rhizome. Sporadically, one can encounter overgrown clusters of old specimens consisting of as many as over fifty fronds. 1-pinnate fronds reach the length of between several and twenty (25) cm and contain up to 20-30 (40) pairs of pinnae. These leaflets are ovate to rhombic to ovate-oblong, slightly convex, with shallowly crenate margins. Their tapered base narrows into a short petiole. On the underside, elongated sori are placed along the end sections of veins. The numbers of sori are as follows: (3) – 6-8 (-9). They are protected by light brown indusia with somewhat frayed edges. Bean-shaped spores are covered by narrow exosporia. The petiole, which is shorter than the pinna blade, and the basal section of the frond are of chestnut brown colour.

The main feature which makes it possible to distinguish the ladder spleenwort from its ancestral species is the green colour of the top of the basal section between 1/10 and sometimes even (approximately) the middle of the length of the frond. The species are easily confused with one of hybrid forms of maidenhair spleenwort *Asplenium trichomanes*, in which the ends of basal sections are green shortly after fronds appear and they only become brown some time later. There is also a hybrid species with features closely resembling *A. viride* (Křisa 1997), whose entire fronds are green. It probably comes from the territory of the Czech Republic.

## 4. Biology of the species

The species is a hemicryptophyte. It multiplies through spores, which ripen from July to August. Its small prothallia reach a width of up to 7 mm. Their development lasts approximately three months, culminating with the production of the archegonium (Karpowicz 1963).

In 2010, Bucharová and other researchers carried out studies of demographic populations of *Asplenium adulterinum* using stochastic matrix models. They came to the conclusion that even very small populations consisting of up to ten specimens are very unlikely to become extinct over the period of 50 years. According to the authors' calculations, the average lifespan of one specimen is 34 years.

## 5. Environmental requirements

Most ladder spleenworts grow in rock crevices, but they can also be found on rubble deposits on rock shelves. The species prefers semi-shade, avoiding both too shady and sunlit places. It grows well in the latter only in sufficiently humid conditions.

The ecological indicator values are as follows:

| Indicator | According to Zarzycki et al. (2002) | According to Ellenberg et al. (1992) |
|---|---|---|
| light L | 4 | 5 |
| thermal T | 4-3 | 4 |
| of continentalism C | 2 | 4 |
| soil moisture M (F) | 3 | 5 |
| of trophism Tr (N) | 2 | 1 |
| of soil acidity R | 4 | 6 |

The ladder spleenwort *Asplenium adulterinum* grows almost exclusively on serpentine rocks or on peridotites, dunites, magnesites and other rocks that are closely related to serpentine rocks in terms of their genesis and properties. Serpentinite habitats are characterised by shallow, poorly developed soils with a specific composition and specific quantitative relations between elements. As a general rule, these soils contain very few essential nutrients – nitrogen, phosphorus and potassium. In comparison with soils derived from other rocks, they contain high concentrations of magnesium and low concentrations of calcium. In addition, they contain high levels of heavy metals: nickel, chromium and cobalt. The set of these habitat factors, referred to as the “serpentine complex”, forces plants to adapt and determines the uptake and specific proportional representation of elements in their tissues.

The ladder spleenwort belongs to rock fissure communities from the *Asplenietea trichomanis* class and is a characteristic species of the *Androsacetalia vandellii* order. Together with the serpentine spleenwort *Asplenium cuneifolium* and the black spleenwort *A. adiantum-nigrum*, which can only be found on serpentinites in Poland now, the ladder spleenwort is a representative species of habitat 8220-1 “Rock fissure communities of serpentine ferns” (Świerkosz et al 2004).

At some sites, ladder spleenworts faces strong competition from co-existing expansive species, such as the bushgrass, blackberries, raspberries and other species. It seems that this phenomenon is on the increase, as habitats are becoming more fertile because of atmospheric precipitation polluted with nitrogen compounds.

Photo 11 A ladder spleenwort at a site near Janowice Wielkie (© L. Żołnierz)

## 6. Distribution in Poland

In Poland, the ladder spleenwort grows exclusively on serpentinites, hence its sites are limited to the only region in the country where these rocks occur, i.e. in the Sudetes and the tectonic foreland of the Sudetes, in the mountain ranges of Ślęża and Grochowa. At present, there are twelve known sites of this species. The westernmost site is situated on the Popiel Hill near Janowice Wielkie. Seven sites are located on the Kiełczyńskie Hills in the western part of the mountain range of Ślęża. Two sites are situated in the Owl Mountains – in Kamionki and near Przygórze – and one on the Żmijowiec Mountain in the mountain range of Śnieżnik. Recently (2011, Żołnierz, unpublished data), another site has been discovered in the mountain range of Grochowa. It consists of 19 specimens. The site was known from historical records (Fiek 1881, Schube 1903), but its existence in the post-war period has not been confirmed before. The site on the Żmijowiec Mountain has the highest altitude (1150 m above sea level), whereas the altitudes of the other sites range between 300 (Kiełczyńskie Hills) and 540 m above sea level (Przygórze). During the observations conducted in 2009 at all sites, with the exception of the above-mentioned site in the mountain range of Grochowa, it was found that the number of specimens (clusters) of *Asplenium adulterinum* totalled 640, including 510 (80%) clusters growing on the Kiełczyńskie Hills. The populations inhabiting the Kiełczyńskie Hills include two populations that are the most numerous, one with 250 specimens and the other with 104 specimens. Based on the comparison of the monitoring results with data from previous observations, it can be seen that the number of specimens in most populations has risen in the last decade.

There are historical records suggesting that ladder spleenworts used to grow on walls in Witoszów and on the ruins of a fortress in Świdnica; however, their existence there has not been confirmed in the post-war period. In the 1960s, ladder spleenworts were still present on the Radunia Mountain in the mountain range of Ślęża (J. Fabiszewski, oral information). In 2004, the author (Żołnierz) reported

that ladder spleenworts had been found there again. Unfortunately, it was a mistake. The discovered specimens proved to be a hybrid form of the maidenhair spleenwort *Asplenium trichomanes*, which is very similar to A. adulterinum in spring just after the leaves appear. Maidenhair spleenworts can also be encountered on the ruins of a fortress in Świdnica. Therefore, the historical reports of the presence of ladder spleenworts there were presumably erroneous too.

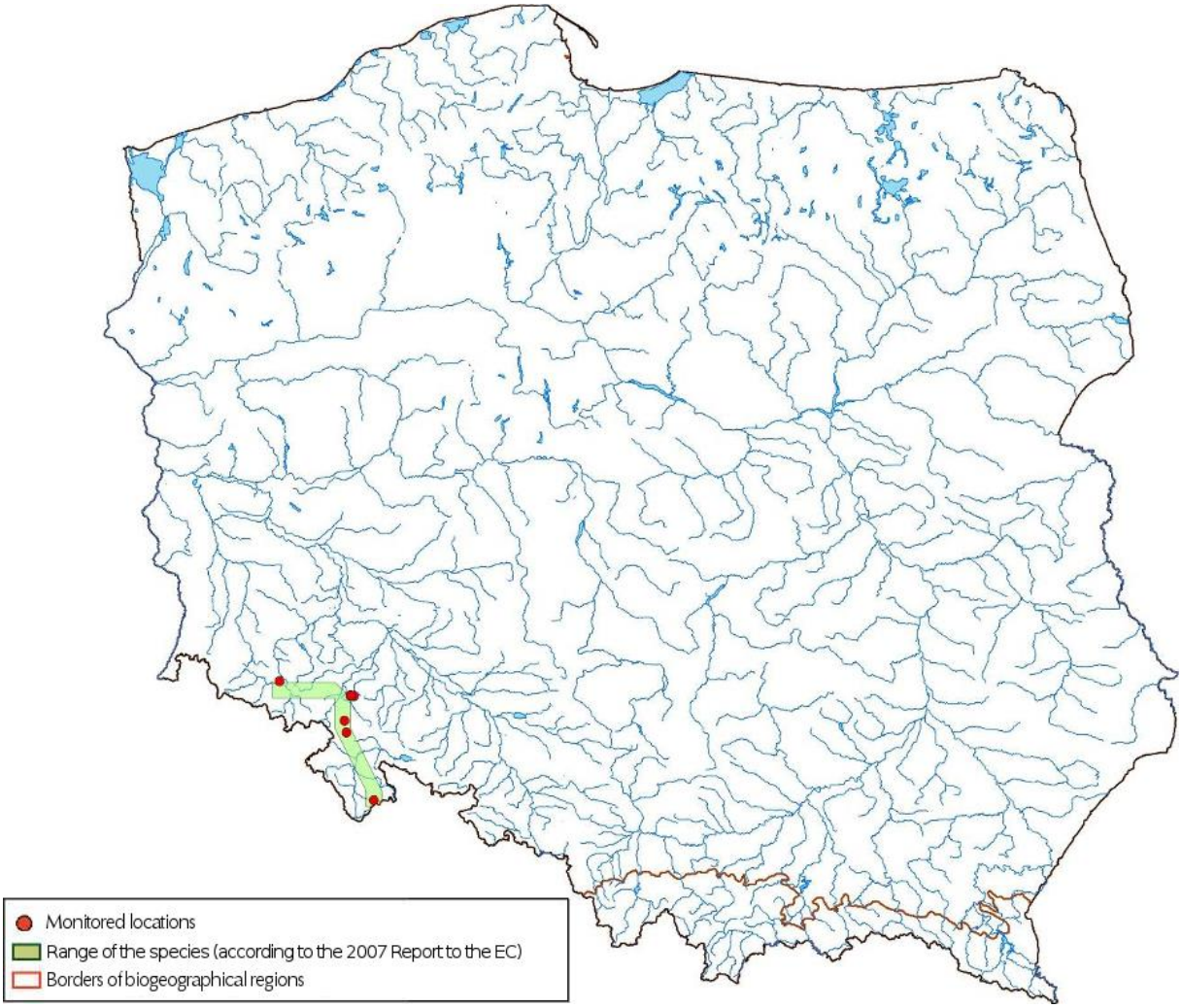


Fig. 4 The distribution of the monitoring locations compared with the geographical range of the species

# II METHODOLOGY

## 1. Description of monitoring studies

### Selection of monitoring locations

It is suggested that all the known twelve sites of this species should be covered by regular monitoring due to its high natural value at the European level and its significance for the specific flora composition of Lower Silesia, all the more so because the species is highly endangered and most of its populations have been declining in the last twenty years.

The site here is understood as a separate area with exposed serpentinite rocks or a group of serpentine rocks and clusters of ladder spleenworts, separated from other areas of the same type by a space of at least 50 m.

The area of the habitat at the site is the area of a polygon whose vertices are formed by the outermost specimens of the population. The area covered by the population: the total area (projection onto the horizontal plane) covered by clusters of ladder spleenworts at the site.

## Time and frequency of studies

The best time for carrying out studies is mid-September, i.e. after most spores have been dispersed and before fronds dry out naturally. At that time, it is possible to carry out precise measurements of the sporulation performance and to minimize the risk of damage to plants as a result of any of the fronds having been torn off during counting or measurements. At sites with thinned-out tree stands, overexposed to sunlight, such an observation period also makes it possible to notice any signs of premature drying of fronds before the end of the growing season.

It is also advisable to carry out annual inspections of the most endangered sites, as well as periodic monitoring activities with measurements of all indicators, at intervals of three to five years.

## Equipment used in studies

A GPS device will be helpful in establishing the location of sites. Other useful items include a measuring tape and metal rods ("pins") for delineating baselines (grids) during measurements of the area of sites performed with a laser target marker. A folding carpenter's ruler with a zero point placed at the edge is used for measuring the length of fronds and rock crevices. A digital camera will make it possible to document the condition of habitats and specimens or their assemblages. A camera with wide-angle lens will help to estimate the density of crowns of trees.

Table 5 The method of measuring the indicators used for assessing the condition of the population and the habitat

| Index | Unit | Measurement method |
|---|---|---|
| **Population** | | |
| Quantity | Number of specimens (pcs) | Calculation of clusters |
| Percentage of juvenile specimens | The number (pcs) % in the population | Counting; value as compared with the overall size of the population (%; a juvenile specimen is understood as a sporophyte with one, sometimes two fronds with a length of up to approximately 3 cm, with no remnants of petioles from the previous season |
| Health condition | Percentage of damaged specimens | Estimation of the percentage of damaged specimens (%) – observation and supplementation of the description of symptoms such as chloroses, death of clusters, poor sporulation performance, premature drying of leaves before the end of the growing season, bite marks left by herbivores, etc. |
| The number of fronds in the cluster | The average number of fronds per specimen | Counted for 20-30 randomly selected specimens or for all specimens in the case of less numerous populations. |
| The length of 5 longest fronds in the cluster | The average length of fronds | Measurements for 20-30 randomly selected specimens or for all specimens in the case of less numerous populations. |

| Index | Unit | Measurement method |
|---|---|---|
| **Habitat** | | |
| Habitat area at the site | Area ($m^2$) | Measurement of the polygon comprising the outermost sites where particular specimens occur, using a laser target marker, with coordinates of contour points of the site in relation to the established baseline. |
| Area occupied by the population | Area ($m^2$) | Measurement (or estimation in inaccessible places) of the area covered by clusters of ladder spleenworts at the site. |
| Potential habitat area | Area ($m^2$) | Measurement (or estimation in inaccessible places) of the area of the site with microhabitats which would be suitable for ladder spleenworts to grow. |
| Overshadowing by trees and bushes | Estimation (%) of the density of crowns of trees and bushes. | It relates to the entire patch of the habitat where the species may potentially occur; Identify tree species occurring at the site (Polish and Latin names). Specify the average density on the basis of observations or on the basis of an analysis of photographs of the forest canopy taken in different parts of the site. |
| Intensity of competition | In a 3-step scale | In the microhabitat where the ladder spleenwort occurs, identify species competing with it (Polish and Latin names). Evaluate the intensity of competition using a three-step scale: no competition or competition of low intensity - 0, competition of medium intensity - 1, competition of high intensity - 2) |
| Invasive species | In a 3-step scale | In the patch where the ladder spleenwort occurs, identify present alien species (Polish and Latin names). Evaluate their impact using a 3-step scale: non-existent -0, medium - 1, strong - 2 |

## 2. Assessment of population and habitat condition indicators

The usefulness of pre-assessed indicators presented in this paper will be verified after the next monitoring period.

Table 6 Assessment of population and habitat condition indicators

| Index | FV<br>favourable | U1<br>unsatisfactory | U2<br>bad |
|---|---|---|---|
| **Population** | | | |
| Quantity | At least the same as in the previous monitoring period or >50 specimens. | Up to 10% smaller than in the previous monitoring period or 25-50 specimens | More than 10% smaller than in the previous monitoring period or <25 specimens |
| Percentage of juvenile specimens | >5% | 1-5% | <1% |
| Health condition | <5% | 5-20% | >20% |
| The average number of fronds in the cluster | No statistically significant differences or an increase | A statistically significant decrease of up to 20% | A statistically significant decrease of >20% |
| The average length of 5 longest fronds in the cluster | No statistically significant differences or an increase | A statistically significant decrease of up to 20% | A statistically significant decrease of >20% |
| **Habitat** | | | |
| Habitat area at the site | The same or larger in the next monitoring period | Smaller by up to 10% in the next monitoring period | Smaller by >10% in the next monitoring period |
| Area occupied by the population | The same or larger in the next monitoring period | Smaller by up to 10% in the next monitoring period | Smaller by >10% in the next monitoring period |
| Potential habitat area | The same or larger in the next monitoring period | Smaller by up to 10% in the next monitoring period | Smaller by >10% in the next monitoring period |
| Overshadowing by trees and bushes | 50-90% | 40-49% or 90-95% | <40% or >95% |
| Intensity of competition | 0 | 1 | 2 |
| Invasive species | 0 | 1 | 2 |

### Cardinal indicators

- Number
- Overshadowing by trees and bushes
- Intensity of competition

## 3. An example of a filled-in species observation sheet for a monitored location

Template of a filled-in species observation sheet for a monitored location with instructions for filling in particular fields

| A species observation sheet for a monitored location | |
|---|---|
| Code of the species | 4066 Asplenium adulterinum (ladder spleenwort) |
| Code and name of the area | Name of the monitored Natura 2000 site<br>PLH020037 Góry i Pogórze Kaczawskie |
| Other forms of protection of the area within which the site is situated | Nature reserves, national and landscape parks,<br>sites of ecological interest, documentation sites, etc.<br>Rudawski Park Krajobrazowy |
| Name of the site | Name of the monitored location<br>Janowice Wielkie |
| Site type | Reference/research<br>research |
| Description of the site | Provide a description identifying the site in the area<br>Anthropogenic site. A small rock wall facing south-east in an abandoned stone quarry overshadowed by a cluster of Quercus robur oak-trees and Betula pendula birch-trees. A part of the quarry situated in the direct vicinity of rocks with ferns is a popular location for organizing picnics and fun activities. |
| Area of the site | Area (in ha, a, $m^2$)<br>Approximately 10 $m^2$ |
| Geographical coordinates | Specify the geographical coordinates (GPS) of the site<br>15°56'...E 50°53'...N |
| Elevation a.s.l. | elevation of the site a.s.l. – or an elevation range – from... to...<br>450 m a.s.l. |
| The characteristics of the species' habitat at the site | general character of the area: e.g. meadow, warm grassland, a fragment of a forest, brushwood<br>natural habitat type (natural habitat code/plant community/plant association)<br>composition and age of tree stand/s (in the case of forest habitats)<br>habitats in the vicinity of the site<br>In the vicinity, there are fragments of thermophilous vegetation with sticky catchfly Viscaria vulgaris and bladder campion Silene vulgaris. Direct competitors of the ladder spleenwort include grasses: reed grass Calamagrostis arundinacea and wavy hair-grass Deschampsia flexuosa. In one of the rock crevices inhabited by the ladder spleenwort, there is also one specimen of the black spleenwort A. adiantum-nigrum. A population of that species overgrows the neighbouring rocks.<br>Natural habitats:<br>8220 Rock walls and siliceous rocky slopes with vegetation of alliances Androsacion vandelii.<br>8220-1 Rock fissure communities of serpentine ferns. |
| Information about the species at the site | Synthetic information about the occurrence of the species at the site, research to date and other essential facts. Results of monitoring activities from previous years<br>Ferns cover several rock crevices densely, some specimens grow on rubble deposits covering the sloping part of the rock. After strong fluctuations in the previous decades, a considerable increase in the size of the population has been observed in the last decade. |
| Observer | First name and surname of the local expert responsible for the site (as specified in the agreement).<br>Ludwik Żołnierz |
| Dates of observations | Dates of all observations (as specified in partial forms)<br>19.08.2009 |

The description should be based on field observations. A proposal of an expert summary of observations carried out at the site as part of the project in the current year is presented below; the summary can be supplemented with one's own data collected previously at the site under analysis.
Evaluation of particular parameters: satisfactory (FV) / unsatisfactory (U1) / bad (U2) / unknown (XX).

| Species protection status at the site | | | | |
|---|---|---|---|---|
| **Parameter/ indicators** | | **Value of the indicator and comments** | **Assess-ment** | |
| **Population** | Quantity | the number or density of specimens<br>53 | FV | FV |
| | Percentage of juvenile specimens | The number of juvenile specimens<br>9 (17% of the population) | FV | |
| | Health condition | Health condition<br><5% of specimens in the population with signs of deterioration of health condition. All other specimens sporulate intensively with the exception of juvenile species. | FV | |
| | The average number of fronds in the cluster | The number of fronds in the cluster<br>16.37 ±2.14<br>A statistically significant (t-Student test, p =0,03) and almost twofold increase in value as compared with the last observation (based on observation results from 2004) | FV | |
| | The average length of 5 longest fronds in the cluster | The length of 5 longest fronds in the cluster<br>12.26 ±1.19<br>No differences as compared to the previous observation.<br>(based on observation results from 2004) | FV | |
| **Habitat** | Habitat area at the site | Area (in ha, a, $m^2$)<br>3 $m^2$ | FV | FV |
| | Area occupied by the population | Area (in ha, a, $m^2$)<br>Approximately 0.5 $m^2$ | FV | |
| | Potential habitat area | Area (in ha, a, $m^2$)<br>Approximately 7 $m^2$ | FV | |
| | Overshadowing by trees and bushes | % or assessment in a 3-step scale in comparison with the patch where the species occurs (acreage occupied by the population)<br>40-60%<br>Common oak Quercus robur, warty birch Betula pendula, scots pine Pinus sylvestris | FV | |
| | Intensity of competition | Species (Polish and Latin name) and % coverage in the patch where the species occurs<br>Reed grass Calamagrostis arundinacea, Wavy hair grass Deschampsia flexuosa<br>1 – 2 from moderate to considerable | U2 | |
| | Invasive species | 0 - none | FV | |
| **Conservation prospects** | | site in the context of the sustainability of the population, availability of an appropriate habitat, existing and potential risks, as well as other information, e.g. own previous data)<br>Species sustainability prospects<br>In the last decade, the size of the population has increased considerably, even though significant fluctuations were observed in the previous decades. The main risk factors for the population are as follows:<br>1. Unfavourable random events associated with permanent and intensive human activity.<br>2. Strong competitive pressure from co-occurring species, mostly grasses. | FV | |
| **Active protection measures and their effectiveness** | | Specify visible signs of protective measures, possibly relying on previous knowledge obtained in the past (protection plans, etc.)<br>In the last 20 or so years, irregular attempts have been made to remove grasses competing with ferns and to remove plant debris from sites where fern spores could germinate. In the last decade, the size of the population has increased considerably, however, there is no evidence that there is a causal relationship between this increase and the performed procedures, as no detailed observations were carried out. | | |
| **Overall assessment** | | | **FV** | |

The list of the most significant impacts affecting the species and its habitat at the monitored location (including its use). Impacts should be coded in accordance with Appendix E to the Standard Data Form for Natura 2000 sites.

| Current impacts | | | | |
|---|---|---|---|---|
| **Code** | **Operation** | **Intensity** | **Impact** | **Synthetic description** |
| 690 | Other possible impacts of recreational and sports activities | A | - | The area adjacent to the site is a popular location for organizing picnics and fun activities. |
| 971 | Competition | A | - | A part of the population is strongly affected by competition from reed grass Calamagrostis arundinacea and wavy hair-grass Deschampsia flexuosa. |

A list of factors that may pose a threat to the species and/or its habitat over a longer term (future, anticipated impacts, such as for example planned investments, changes in management and use, urban sprawl pressure). Threats should be coded in accordance with Appendix E to the Standard Data Form for Natura 2000 sites If there is no proper code - only a description should be provided in the table "Other information" in the field "Other comments".

| Threats (foreseeable future impacts) | | | | |
|---|---|---|---|---|
| **Code** | **Name** | **Intensity** | **Impact** | **Synthetic description** |
| 250 | Harvesting / removal of plants - in general | C | - | There is a potential risk that some specimens may be removed by collectors. |
| 690 | Other possible impacts of recreational and sports activities | A | - | The area adjacent to the site is a popular location for organizing picnics and fun activities. |
| 950 | Biocenotic evolution | B | - | In the course of succession by plants growing on the rubble deposits covering rock crevices, ferns may be forced out from this part of the site. |
| 971 | Competition | A | - | Pressure from competitors may become stronger due to contaminated precipitation eutrophying the habitat - the scale of this phenomenon is unknown. |

| Other information | |
|---|---|
| Other natural values | Other observed animal and plant species listed in the Annexes to the Habitats and Bird Directives: endangered (Red Book) and rare species/ protected species (their numbers should be classified as follows: abundant, average, rare); other exceptional qualities of the area<br>On the rocks in the vicinity of the population of ladder spleenworts, there is a population of black spleenworts A. adiantum-nigrum, consisting of 34 specimens. It is a species protected by law, included in the Red Book. |
| Other observations | All information that helps to interpret the results, e.g. weather anomalies<br>None |
| Methodological remarks | Any other comments associated with performed work. Most of all, information relevant for further planning of monitoring (work methodology, indicators to be used for monitoring purposes, the optimal time for carrying out research in this region, etc.)<br>The area of the potential habitat can be wrongly estimated due the subjectivity of the observer. It seems that estimations should be limited to microhabitats closely resembling (in terms of their properties) the ones used by ladder spleenworts, but occupied by competitive species, rock crevices filled with leaves fallen from trees, etc. |

A drawing of the site can be enclosed, containing:

- distribution of the species within the site (assemblages)
- marked locations where phytosociological relevés were taken.

Photographs to be enclosed: (specify the titles/number and authors of all photographs, in an electronic format, attached to the site observation forms – at least 2 photographs per stand – preferably a general view and the structure of the plant community comprising the monitored species.

## 4. Species with similar ecological requirements

The habitats occupied by ladder spleenworts *Asplenium adulterinum* are likewise used by serpentine spleenworts *A. cuneifolium* and black spleenworts *A. adiantum-nigrum*. Apart from "serpentinite spleenworts", other components of the vegetation at the sites of *A. adulterinum* include maidenhair spleenwort *A. trichomanes*, northern spleenwort *A. septentrionale* and the common polypody *Polypodium vulgare*. The proposed methodology can be adopted for the purpose of monitoring the above-mentioned species.

## 5. Protection of the species

The ladder spleenwort together with other species of the so-called "serpentinite ferns" has been protected as a species since 2004. Under Regulation of the Minister of the Environment, it is required to delineate a protection zone with a width of 30 cm from the edges of its sites. Active protection measures must be undertaken too.

The proposed active protection measures (Żołnierz 1993, 1997, 2001, 2004, Szczęśniak 2006, Świerkosz et al 2007, Żołnierz et al 2008) at sites occupied by *Asplenium adulterinum* include:

- modification of tree stands within sites and in their surroundings in order to ensure optimum shading and other micro-climate parameters;
- removal of expansive competitors (with utmost care to avoid any damage to ferns);
- at some sites, it seems advisable to clean some rock crevices in order to transform them into suitable micro-habitats for ferns;
- securing an ex situ population in the event of adverse events which may jeopardize the survival of the species. The developed method of cultivation and multiplication of *Asplenium adulterinum* (Marszał et al 1999, Kromer et al 2006) makes it possible to secure all populations in the facilities of the Tissue Culture Laboratory of the Botanical Garden of the University of Wrocław.

Up to now, the only procedure out of the ones mentioned above which has been performed, although irregularly, is the removal of competitors at some sites where their pressure was particularly strong. The ex situ cultivation of the species is only conducted on an experimental scale. Promising results have been obtained after experimental cleaning of selected micro-habitats (crevices and soil at the foot of rocks) at one of the sites, where juvenile specimens were discovered in the following year (Żołnierz, unpublished data).

Three out of the eleven sites of the species are protected as sites of ecological interest (Żołnierz 1997). It seems appropriate to establish such a form of protection for other sites too. The site in Kamionki is the only one which is occupied by all the three species of "serpentinite ferns". There, the population of black spleenworts *Asplenium adiantum-nigrum* is the largest in Poland. Therefore, it deserves the status of a flora reserve.

As can be concluded from field observations, it is necessary to provide training for employees of the forest districts where populations of the ladder spleenwort occur, to make sure that they exercise proper care when performing forestry tasks in the vicinity of sites and intervene on an ongoing basis if any adverse phenomena take place.

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Compiled by: **Ludwik Żołnierz**

# 4068 **Lady bells** *Adenophora liliifolia* (L.) Besser

Photo 12 Lady bell *Adenophora liliifolia* in "Dąbrowa koło Zaklikowa" special area of conservation (© A. Rapa)

## I. INFORMATION C0NCERNING THE SPECIES

### 1. Systematic position

Family: bellflower *Campanulaceae*

### 2. Status

#### International law

Habitats Directive - Annex II and IV
Berne Convention – not included

#### National law

Protection of the species - strict protection since 2001

#### Threat category

IUCN Red List – not included
Polish Red Book of Plants (2014) – CR
Red List of vascular plants in Poland (2016) – CR

## 3. Description of the species

The lady bell is a perennial plant with a beetroot-shaped root. One specimen (cluster) consists of a variable number of shoots – from one to a dozen or so. The stem is between a dozen or so and 160 cm long, with an alternate arrangement of leaves. Basal leaves, roundish and heart-shaped, petiolated, dry out early. Stem leaves are the largest in the middle and bottom sections of the stem. They are egg-shaped and lanceolate, short-petioled or non-petioled, with serrated edges, slightly wrinkled. The underside of leaves is covered with short and stiff hairs, especially on the veins.

Initially, the inflorescence has the form of a raceme, which later turns into a loose panicle. The calyx consists of 5 lanceolate-triangular sepals; the sepals are about 2 times shorter than the corolla. The corolla consists of white or pale blue bell-shaped flowers. It is naked and is 1.5–2 cm long. The lobes of the corolla are shorter than the tube.

There are 5 stamens with elongated anthers. At the base, filaments are flattened and clearly ciliated. There is just one pistil. The neck of the pistil is 2 times longer than the corolla, thickened in the upper part, covered with papillose hairs, ending with three flat stigmas; the base of the neck is surrounded by the honey ring (Korzeniak, Nobis 2004). Fragrant flowers.

Fruits are pear-shaped capsules, which open with three holes at the base part (Piękoś Mirkowa, Mirek 2008). The seeds are flattened, egg-shaped, of brown colour, with narrow wings on one side. They reach a length of up to 1.7 mm. The number of chromosomes 2n = 34 (Wcisło 1983).

During the flowering stage, they are easily confused with other species. In the barren stage, they can be mistaken for other bellflowers, especially young specimens.

## 4. Biology of the species

The lady bell is a perennial plant with overwintering buds located at the soil surface (hemicryptophyte).

Flowering lasts from the second decade of July to the second half of August. Individual shoots from one cluster may flower at slightly different times, thus prolonging the flowering period (Rapa, unpublished data). The lady bell is pollinated by numerous species of insects. The seeds ripen and are dispersed in late August and throughout September. The plant can also reproduce vegetatively from fragmented roots (Korzeniak, Nobis 2004).

From year to year, the number of shoots in a cluster changes only slightly. The number of clusters, on the other hand, remains constant over the years (Rapa A., unpublished data from a multi-year observation of a site with *Adenophora liliifolia* in the special area of conservation “Dąbrowa koło Zaklikowa”). The length of shoots depends not only on the development stage of an individual lady bell, but also on habitat conditions. The longest shoots and the largest number of flowers and fruits can be found in places with favourable light conditions. In too shady conditions, however, shoots are short and barren or long and sometimes generative. In the latter case, plants try to break through a layer of, for example, low bushes to places with better light conditions (Rapa A - unpublished data).

## 5. Environmental requirements

The lady bells are a photophilous species, requiring soils rich in calcium carbonate. In Poland, they occur mainly in oak forests *Potentillo albae-Quercetum petraeae*. In addition, they can be encountered in subcontinental oak-hornbeam forest *Tilio cordatae – Carpinetum* and mixed pine and oak forest *Querco roboris-Pinetum*. In the past, they were also reported to be present in xerothermic

grasslands of the *Festucetalia valesiacae* order (*Festuco-Brometea* class), in xerothermic scrubs of the *Prunetalia* order (*Rhamno-Prunetea* class) and on dry meadows (Korzeniak, Nobis 2004).

The ecological indicator values are as follows:

| Indicator | According to Zarzycki et al. (2002) | According to Ellenberg et al. (1992) |
|---|---|---|
| light L | 3 | 7 |
| thermal T | 4-5 | 6 |
| of continentalism C | 4 | 6 |
| soil moisture M (F) | 3 | 6 |
| of trophism Tr (N) | 3 | 8 |
| of soil acidity R | 4 | 2 |

Photo 13 *Potentillo albae-Quercetum petraeae* oak forests in the special area of conservation "Wierzchowiska" (© A. Rapa)

## 6. Distribution in Poland

In Poland, lady bells have been reported to occur on about 100 sites (according to the data collected since the end of the 19th century until 2010), mainly in central and north-eastern Poland, but also in upland areas. The north-western limit of the species' distribution ran through Pomerania, Greater Poland and Silesia. In most sites, the species has become extinct or its presence has not been confirmed recently, for example in Subcarpathia (Piękoś-Mirkowa, Mirek 2008), Eastern Pomerania, Western Pomerania, Greater Poland (Żukowski, Jackowiak 1995) and in Lower Silesia (Kącki 2003).

Today, *Adenophora liliifolia* occurs in upland areas (Roztocze, Lublin Upland, Volhynian Upland, Lesser Poland Upland and Silesian-Cracow Upland), in Central Polish Lowlands (Central Masovian Lowland, South Masovian Heights, South Podlachian Lowland), North Podlachian Lowland and in the Masurian Lake District.

Depending on the site, the number of specimens (clusters) in a population varies, ranging from several to over 1000 specimens. The largest population of lady bells in Poland can currently be found in the Special Area of Conservation "Dzwonecznik w Kisielanach" (Ciosek 1998, 2006).

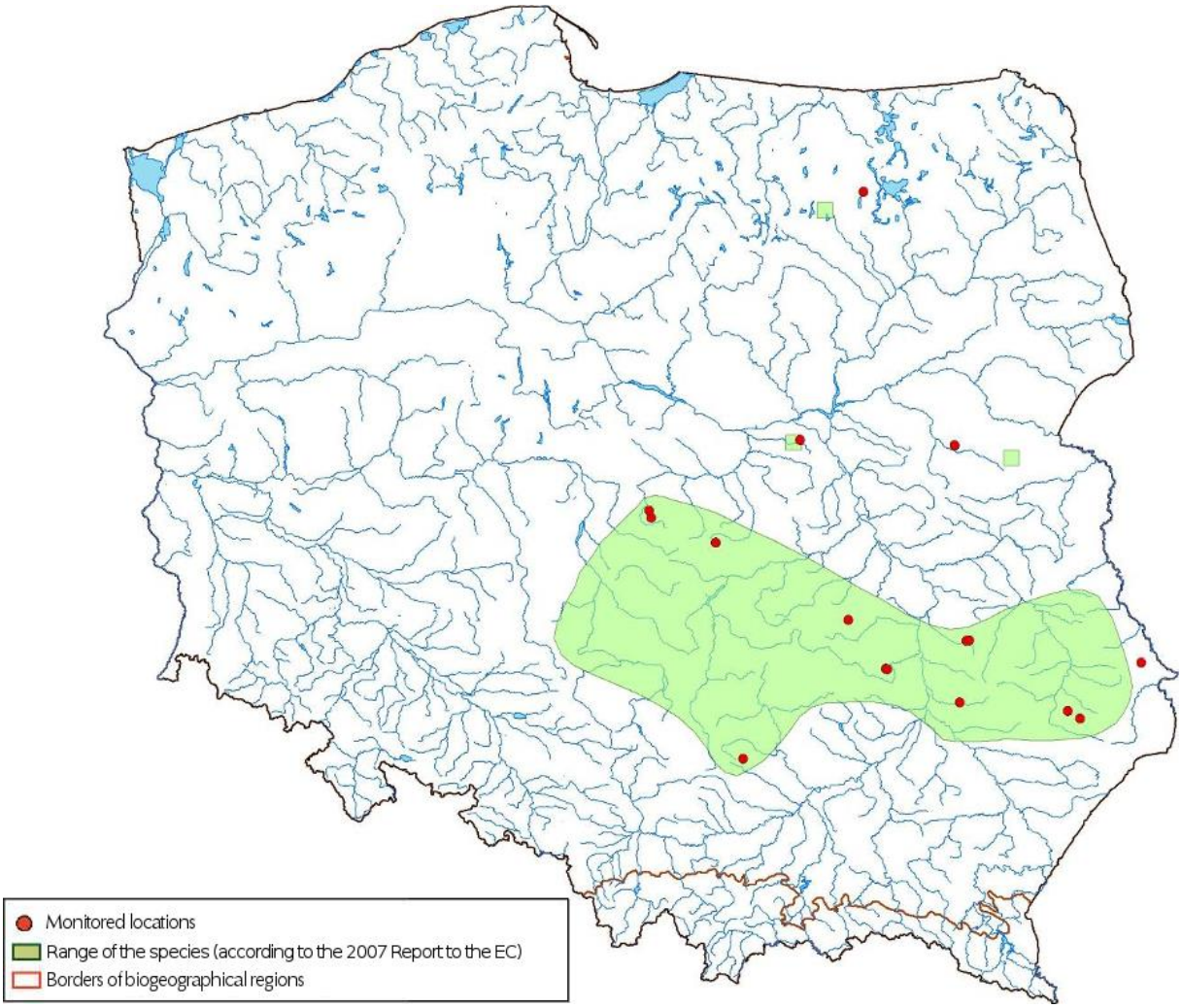


Fig. 5 The distribution of the monitoring locations compared with the geographical range of the species

# II METHODOLOGY

## 1. Description of monitoring studies

### Selection of monitoring areas and their suggested size

The sites should be selected in such a way so as to take into account populations of different sizes (small populations consisting of several specimens, medium-sized populations – a dozen or so clusters, as well as large ones, consisting of several dozen or over 100 specimens).

In the case of small and medium-sized populations, the monitoring area should cover the whole acreage of this population, whereas in the case of large populations a representative research area of about 0.5 ha should be selected.

Lady bells should be monitored at about 10 sites situated in the main areas of its occurrence, within the limits of their range.

In addition, the analysis of the conservation status of the species in Poland should take into account the results of monitoring activities conducted in national parks (all analyses should be performed using the same methodology).

## Study method

The cluster is used as a calculation unit. Single shoots growing on their own should be treated as clusters.

Table 7 The method of measuring the indicators used for assessing the condition of the population and the habitat

| Indicator | Measure | Measurement method |
|---|---|---|
| **Population** | | |
| Quantity | Number of specimens (pcs) | Counting of pieces – clusters and shoots growing on their own |
| The number of generative specimens | The number of clusters (pcs) | Counting of blooming clusters (containing at least 1 generative shoot) as a proportion of all clusters |
| The number of shoots in a cluster | The number of shoots (pcs) | Counting of shoots in particular clusters as well as the minimum, maximum and average number |
| The height of plants | In cm | Measurement of the height of shoots (all shoots in small populations and in large ones – of 30 specimens), together with the maximum, minimum and the average height. |
| Health condition | Identified diseases, parasites, mechanical damage, etc. | Observation of shoots and flowers for the presence of parasites and traces of their feeding, bite marks left by herbivores and other mechanical damage |
| **Habitat** | | |
| Potential habitat area | Area (in: ha, a) | Estimation of the area of the whole habitat of the species at a given site |
| The area of the covered habitat | Area (in: a, $m^2$) | Specify the acreage covered by the population, i.e. a convex polygon encompassing all places where particular specimens occur; in the case when the acreage is small, its evaluation can be based on measurements |
| Density of trees | % of coverage | Evaluate the average coverage (%) by particular species of trees (separately for each species) in the area of the habitat occupied by lady bells |
| Density of bushes | % of coverage | Evaluate the average coverage (%) by particular species of bushes (separately for each species) in the area of the habitat occupied by lady bells |
| Density of undergrowth | % of coverage | Evaluate the average coverage (in % or in percentage ranges) within the limits of the habitat concerned |
| Expansive, competitive species | Species and % of coverage | In the patch where the species occurs: Identify species present in the patch which are already forcing lady bells out or which have a strong competitive potential, e.g. bushgrass Calamagrostis epigejos, blackberries etc. and assess the area covered by them. |
| The height of undergrowth | In cm; | The average from 20 measurements of the main vegetation mass |
| Dead organic matter (non-decomposed plant debris, litterfall) | Thickness in cm | The average from 20 measurements performed in the patch (measurement sites should be selected in such a way so as to take into account the maximum, the minimum and the average thickness, e.g. 0-5 cm, with the mean value of 3 cm) |
| Germination sites | Specify in %; | The area and frequency of gaps (exposed soil) |
| Alien, invasive species | % of coverage by particular species | In the patch where the species occurs: Identify alien and invasive species that are present in the patch and measure the area covered by them. |

## Time and frequency of studies

The best period for studying lady bells is the first half of August, because at that time most specimens have flowers and it is easier to find them within the site. It is also easier to establish the number of generative specimens. The condition of plant communities where *Adenophora liliifolia* grows, especially of *Potentillo albae-Quercetum petraeae* oak forest communities, provides a basis for evaluating essential parameters of the habitat and making a phytosociological relevé. The

monitoring activities should be repeated every 6 years, whereas on smaller sites, situated at the edges of the range and strongly endangered - every 3 years.

In addition, it is suggested that several representative sites are selected all over Poland for multi-year population studies. Lady bells are a perennial plant, therefore correct conclusions as to their population dynamics can only be drawn after a series of long-term observations.

### Equipment used in studies

The studies do not require any specialized equipment. Useful equipment includes a measuring tape – for measuring the size of the patch, a ruler – for measuring the thickness of non-decomposed plant debris and the height of forest floor vegetation, a notebook, a satellite GPS receiver for establishing the exact location of the site and a digital camera.

## 2. Evaluation of population and habitat condition indicators

Suggested indicators to be evaluated: The height of forest floor vegetation, non-decomposed plant debris (dead organic matter), germination sites, the number of shoots in a cluster and the height of plants can only be evaluated after a series of long-term observations and, possibly, after the species ecology having been researched.

Table 8 Evaluation of population and habitat condition indicators

| Indicator | FV<br>favourable | U1<br>unsatisfactory | U2<br>bad |
|---|---|---|---|
| **Population** | | | |
| Number of specimens (clusters) | At least the same as in the previous monitoring period; however, there may be no fewer than 50 specimens | Up to 10% smaller than in the previous monitoring period; however, there may be no fewer than 20 specimens | More than 10% smaller compared with the previous monitoring period, or fewer than 20 specimens |
| The number of generative specimens (% of the population) | >60% | 30%-60% | < 30% |
| The number of shoots in a cluster (minimum, average, maximum)[6] | XX | XX | XX |
| The height of plants[6] | XX | XX | XX |
| Health condition | None | Single attacked specimens or shoots | More than 20% of specimens with signs of necrosis |

[6] It is suggested that this indicator should be used at the end of studies. There are no field data for its evaluation.

| Indicator | FV<br>favourable | U1<br>unsatisfactory | U2<br>bad |
|---|---|---|---|
| **Habitat** | | | |
| Potential habitat area | A multiple of the area occupied by lady bells | No more than several times larger than the one occupied by lady bells | Not much larger than the one occupied by lady bells |
| The area of the covered habitat | The same or larger, but not smaller than 0.5 ha | Smaller but by no more than 10%, not smaller than 0.25 ha | Smaller by more than 10%, or smaller than 0.25 ha |
| Density of trees | ≤70% | 71%-80% | >80% |
| Density of bushes | ≤70% | 71%-90% | >90% |
| Density of undergrowth[7] | <85% | 85-95% | >95% |
| Expansive species | <10% of the area of the patch | 10%-40% | >40% of the area of the patch |
| Height of undergrowth[8] | XX | XX | XX |
| Non-decomposed plant debris (dead organic matter)[7] | 0-2 cm | 2-5 cm | >5 cm |
| Germination sites[7] | >5% | 3-5% | <3% |
| Alien, invasive species | None | Single specimens of 1 species | More than 1 species or more than 10% of the area covered |

### Cardinal indicators

- Number of individuals
- Expansive species

## 3. An example of a filled-in species observation sheet for a monitored location

Template of a filled-in species observation sheet for a monitored location with instructions for filling in particular fields

[7] The values given are purely indicative and may be modified following further studies.
[8] The species thrives in monitored locations within the height range of the undergrowth of between 25 and 170 cm. Current knowledge does not suggest that this indicator can be linked with the evaluation of the habitat.

| A species observation sheet for the site "Dąbrowa koło Zaklikowa" | |
|---|---|
| Code and name of the species | 4068 Lady bell Adenophora liliifolia |
| Code and name of the area | Name of the monitored Natura 2000 site<br>PLH180019 Dąbrowa koło Zaklikowa |
| Other forms of protection of the area within which the site is situated | Nature reserves, national and landscape parks,<br>sites of ecological interest, documentation sites, etc.<br>None |
| Site name | Name of the monitored location<br>Dąbrowa koło Zaklikowa |
| Type of site | Reference/research<br>Research |
| Site description | A description which makes it possible to identify the site in the area<br>The site covers a limestone hill in the village of Dąbrowa (municipality of Zaklików, district of Stalowa Wola) |
| Site area | Area (in ha, a)<br>2a |
| Geographical coordinates | Geographical coordinates of the site<br>N 50°45'..., E 22°08'... |
| Elevation a.s.l. | Site elevation (or elevation range) a.s.l.<br>191 - 200 m a.s.l. |
| The characteristics of the species' habitat at the site | General character of the area: e.g. meadow, warm grassland, a fragment of a forest, brushwood<br>natural habitat type (natural habitat code/plant community/plant association)<br>composition and age of tree stands (in the case of forest habitats)<br>habitats in the vicinity of the site<br>The site covers a limestone hill in the village of Dąbrowa (municipality of Zaklików, district of Stalowa Wola). The forms present include: Potentillo albae-Quercetum petraeae oak forest, subcontinental oak-hornbeam forest and some forms in-between. Apart from the acreage covered by lady bells Adenophora liliifolia, the hill is also occupied by substitutional communities with pine and birch trees. In the vicinity, there are also arable fields, underwoods and buildings belonging to the residents of the village of Dąbrowa. The site is a private property of the residents of Dąbrowa.<br>Natural habitats:<br>91I0 – Warmth-loving oak forests (Quercetalia pubescenti-petraeae)<br>9170 – Central European and subcontinental oak-hornbeam forest (Galio-Carpinetum, Tilio-Carpinetum)<br>8210 – Limestone rock walls with Potentilletalia caulescentis communities |
| Information about the species at the site | Synthetic information about the occurrence of the species at the site, research to date and other essential facts. Results of monitoring activities from previous years.<br>The presence of lady bells Adenophora liliifolia was first reported in 2005 (Rapa A. - unpublished materials). Most lady bells (more than 60 specimens) grow in the westernmost part of the hill in the best preserved patch of Potentillo albae-Quercetum. |
| Observer | First name and surname of the local expert responsible for the site (as specified in the agreement)<br>Adam Rapa |
| Dates of observations | Dates of all observations (as specified in partial forms)<br>11 – 20 August 2009 |

The description should be based on studies/field observations. A proposal of an expert summary of studies/observations carried out at the site as part of the project in the current year is presented below; the summary can be supplemented with one's own data collected previously at the site under analysis.

Evaluation of particular parameters: satisfactory (FV) / unsatisfactory (U1) / bad (U2) / unknown (XX)

| Species protection status at the site | | | | |
|---|---|---|---|---|
| **Parameter/**indicators | | **Indicator value and comment** | **Assessment** | |
| **Population** | Quantity | the number or density of specimens<br>77 clusters. | FV | FV |
| | | type of distribution (dispersed, with assemblages)<br>Dispersed | | |
| | Number of generative specimens (% of population) | the number of generative specimens<br>56 clusters (72%) | FV | |
| | Number of shoots in a cluster | the number of shoots in a cluster (minimum, average, maximum)<br>min: 0 (1 live leaf), average 2.0, max: 17 | XX | |
| | Presence of seedlings | number of seedlings<br>No seedlings were found | U2 | |
| | Height of plants | The height of plants (average, max, min)<br>average: 92.5 cm, max: 160 cm, min: 25 cm | XX | |
| | Health condition | Identified diseases, parasites, etc.<br>Some specimens were found to have deformed leaves, probably due to a viral disease. It is unlikely to pose a direct threat to the species. | FV | |
| **Habitat** | Potential habitat area | Area (in ha, a, $m^2$)<br>At present, about 2 ha in habitat 91I0<br>If long-term and intensive active protection measures are taken, the potential range of the habitat will be extended to include most of the planned special area of conservation – over 4 ha. | FV | U1 |
| | The area of the covered habitat | Area (in ha, a, $m^2$)<br>About 1.5 ha | FV | |
| | Density of trees | Coverage (%) of trees at the site, species name<br>70% mainly oak Quercus petraea, Quercus robur<br>in admixture: silver birch Betula pendula, scots pine Pinus silvestris | U1 | |
| | Density of bushes | Coverage (%) of bushes at the site, species name<br>50-60% mainly common hazel Corylus avellana, spindle tree Euonymus verrucosus<br>in admixture: hornbeam Carpinus betulus | U1 | |
| | Density of undergrowth | Coverage (%) at the site, dominant species name<br>70-80% blueberry Vaccinium myrtillus, lily of the valley Convallaria majalis, Brachypodium pinnatum | FV | |
| | Expansive species | Species, coverage (%)<br>Common hazel Corylus avellana 40%, spindle tree Euonymus verrucosus 10% | U1 | |
| | The height of undergrowth | 30 cm (the average). Max 50 cm, minim. 10 cm, | FV? | |
| | Non-decomposed plant debris and litterfall (dead organic matter) | 0-2 cm | FV | |
| | | Density: specify the % of the area of the patch covered by non-decomposed plant debris and litterfall<br>> 90% | | |
| | Germination sites | Specify in %; the area and frequency of gaps (exposed soil) in the patch or possibly in its direct vicinity<br>1 – 2% | FV? | |
| | Alien/invasive species | None found at the site occupied by lady bells. | FV | |
| **Conservation prospects** | | The species sustainability prospects are good only if active protection measures are taken at the site – the cutting of underbrush. The population is quite numerous; however, it may be reduced and eventually become extinct due to progressive succession processes. | U1 | |
| **Active protection measures and their effectiveness** | | Specify visible signs of protective measures, possibly relying on the knowledge obtained in the past (protection plans, etc.)<br>There are no planned protective measures. The periodic cutting of bushes by owners makes it easier for the population of lady bells to survive. However, activities of this type should be planned and conducted on a larger scale. In the past, the area could have been used as a | | |
| **Overall assessment** | | | **U1** | |

The list of the most significant impacts affecting the species and its habitat at the monitored location (including its use). Impacts should be coded in accordance with Appendix E to the Standard Data Form for Natura 2000 sites

| Current impacts | | | | |
|---|---|---|---|---|
| **Code** | **Operation** | **Intensity** | **Impact** | **Synthetic description** |
| 950 | Biocenotic evolution | A | - | Progressive succession processes - the undergrowth is increasingly overshadowed by bushes – mainly by hazel. The habitat is becoming more and more fertile. At the site with the main part of the population of Adenophora liliifolia – succession processes take place at an alarmingly fast rate. |
| 165 | The cutting of underbrush | C | + | The cutting of bushes is not performed on a sufficient scale. |
| 250 | Harvesting of plants | C | 0 | The picking of forest fruit and mushrooms does not have a major impact on Adenophora liliifolia. |
| 164 | Forest (tree) cutting | C | - | In oak forests Potentillo albae-Quercetum petraeae, oak trees are occasionally cut outside the sites occupied by lady bells. It results in an expansion of the underbrush, leading to degeneration of Potentillo albae-Quercetum petraeae oak forests because of excessive overshadowing of the stratum. Over the years the area of Potentillo albae-Quercetum petraeae oak forests and potential acreage for Adenophora liliifolia are decreasing. |

A list of factors which may pose a threat to the species and/or its habitat over a longer term (future, anticipated impacts, such as for example planned investments, changes in management and use, urban sprawl pressure). Threats should be coded in accordance with Appendix E to the Standard Data Form for Natura 2000 sites. If there is no proper code - only a description should be provided in the table “Other information” in the field “Other comments”.

| Threats (foreseeable future impacts) | | | | |
|---|---|---|---|---|
| **Code** | **Name** | **Intensity** | **Impact** | **Synthetic description** |
| 164 | Forest (tree) cutting | B | - | Due to the small acreage of lady bells, the cutting of even a few trees may result in excessive exposure of the forest floor and too fast an expansion of the underbrush, mostly hazel. |
| 990 | Other natural processes | X | - | Due to its small size, the population may be affected by unfavourable genetic factors. |
| 300 | Excavation of sand and gravel | C | - | The extraction of limestone contained in the bedrock used to have a negative impact on Potentillo albae-Quercetum petraeae oak forests and lady bells and this may continue in future. |

| Other information | |
|---|---|
| Other natural values | The site is situated in Potentillo albae-Quercetum petraeae oak forests (91I0), which are of great natural value and are highly representative. They are inhabited by a number of rare and protected plants, for example: Cimicifuga europaea, Lilium martagon. |
| Other observations | All information that helps to interpret the results, e.g. weather anomalies |
| Methodological remarks | It is best to observe lady bells when they are in full bloom – from the end of July to the second decade of August. Most specimens bloom in the first decade of August. |

Photographs to be enclosed: (specify the titles/number and authors of all photographs, in an electronic format, attached to the site observation forms – at least 2 photographs per stand – preferably a general view and the structure of the plant community with the monitored species.

Phytosociological relevés taken on an area of approximately 100 $m^2$ (no more than 200 $m^2$), using the Braun-Blanquet method, in the habitat patch where the site of the species is situated, should be enclosed too. In justified cases, the area of the phytosociological relevé may be different.

## 4. Protection of the species

Lady bells are protected as a species. Passive protection measures are undertaken in protected areas: national parks and reserves, including the Kampinoski National Park and the "Dąbrowa Grotnicka" Reserve.

To ensure effective protection of lady bells, active protection measures should be taken at most sites. The most important measure is to reduce the density of underbrush (and possibly of trees). If bushes and trees grow back again after having been cut, the cutting should be repeated at specific intervals. It may be a good idea to consider litterfall raking in the vicinity of lady bells in order to reduce the quantity of organic matter covering the soil and to limit the eutrophication of *Potentillo albae-Quercetum petraeae* oak forests. The raking of leaves and the use of forests as a pasture for farm animals was a common practice in the past, which may have contributed to the development and survival of *Potentillo albae-Quercetum petraeae* oak forests in Poland (Jakubowska Gabara 1993).

It is necessary to secure a gene pool of native populations of Adenophora liliifolia ex situ by collecting seeds from wild populations. Thus derived plants should be grown in botanical gardens. In the case of sites with small-sized populations (consisting of several specimens), it must be done urgently, as they may disappear completely in the coming years.

At small sites, especially those situated at the edges of the range, e.g. at "Kwiatówka" site, the population of lady bells must be enhanced by ex situ cultivation of specimens from seeds sourced from local populations.

To ensure more effective protection of lady bells in the context of forest management, it is proposed to introduce zonal protection - inclusion of lady bells in Appendix no. 4 "Wild plant species requiring the establishment of special areas of conservation or sites" to the Regulation of the Minister of the Environment of 5 January 2012 (2012 Regulation).

It is necessary to implement forest and environment programmes (following the example of agricultural and environmental programmes) with a package of protective measures for plants listed in Annex II to the Habitats Directive.

At the same time, research must be conducted on the species ecology, focusing in particular on the type of seed bank in the soil, germination biology and the population dynamics.

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Compiled by: **Adam Rapa**

# 4030 **Dry heath communities** *Calluno-Genistion, Pohlio-Callunion, Calluno-Arctostaphylion*

Photo 14 Heathland in the "Diabelskie Pustacie" Reserve in Western Pomerania (© P. Pawlaczyk)

## I. INFORMATION CONCERNING THE NATURAL HABITAT

### 1. Phytosociological identifiers

Class: *Nardo-Callunetea* vegetation of heathlands and species-poor mat-grass swards

Order: *Calluno-Ulicetalia* sub-Atlantic and subcontinental inland dry heathlands

Alliance: *Calluno-Genistion* Dry genista heaths

*Genisto germanicae-Callunetum genista* heath

*Genisto pilosae-Callunetum genista* heath

Alliance: *Pohlio-Callunion* dry heaths

*Pohlio-Callunetum* heath with nodding thread-moss

Alliance: *Calluno-Arctostaphylion* dry bearberry heaths

*Calluno-Arctostaphylion* bearberry heath

*Scabioso canescentis-Genistetum* flowery genista heaths

## 2. Description of the natural habitat

Heaths usually have the form of low bush communities with diverse vascular flora and a rich flora of cryptogams and lichens. Seemingly simple and monotonous, the habitat exhibits a considerable internal diversity. The most commonly occurring type is a heath community with prevailing *Calluna vulgaris* heath and a moss-grown layer dominated by nodding thread-moss *Pohlia nutans*. Such heaths are common in coniferous forest landscapes and they may also cover large areas on former and existing military training grounds.

Less common and very interesting forms of this habitat include:

- bearberry heaths with prevalent kinnikinnick *Arctostaphylos uva-ursi*: most of them can be found in central and eastern Poland, they are much less frequent than typical forms of heaths;
- wet heaths with peat mosses Sphagnum spp., round-leaved sundew *Drosera rotundifolia*, bog blueberry *Vaccinium uliginosum*, are very rare in Poland; they have only been found in the "Diabelskie Pustacie" Reserve on the heathland of Borne Sulinowo – they could even be classified as a natural habitat code 4010, were it not for the lack of cross-leaved heath Erica tetralix;
- *Genisto-Callunetum* heaths and "flowery heaths" representing the *Scabioso canescentis–Genistetum* plant association, originating from western Poland, occur rarely.

Heaths come in a wide variety of forms – from natural heaths, usually growing in small patches in clearings in pine forests, semi-natural, taking the form of small strips and patches on the outskirts of pine forests and species-poor oak forests, through to anthropogenic vast heaths on military training grounds.

Photo 15 Heaths on the military training grounds near Drawsko Pomorskie (© P. Pawlaczyk)

Photo 16 The former military training grounds near Borne-Sulinowo is gradually being overgrown by trees (© P. Pawlaczyk)

## 3. Ecological conditions

Heaths develop in poor, oligotrophic locations, exclusively on a sandy stratum, often in dune areas. They usually grow on poor and acidic podzolised soils with pH of between 4.0 – 5.0, composed of loose sands or slightly loamy sands. Heaths occupy different areas, including: sandy plains and depressions, hill-sides, mountain sides, tops of dunes or entire extensive areas of dune landscape. The above-described habitats are most often, but not always, dry. They may also grow near the groundwater level and on soils with a distinct gleyic pattern: in such conditions, heaths are known to be accompanied by different hygrophilous species.

Habitat conditions are important for the distribution of heaths; however, there is a "causal agent" which seems to affect these predominantly semi-natural ecosystems even more. An example of such an agent is the use of military training grounds (giving rise to the following factors: maintenance of these grounds as non-forested areas, removal of self-sown trees and bushes, occasional disturbance of soil and destruction of heaths by military vehicles and sporadic fires). Heaths persist on active military training grounds, being a characteristic landscape component of most of them. When the use of military training grounds is discontinued, heaths are usually recolonised by trees, unless active measures are undertaken to protect them.

Heaths may also appear in dune, oligotrophic landscapes where forest vegetation has been destroyed by fires – of course unless forest-ravaged areas have been afforested again (and where afforestation attempts have not been unsuccessful). For example, such is the genesis of the

bearberry heaths on the Lucynowsko-Mostowieckie Dunes in Mazovia and of some heaths in the Kampinos Forest.

In the case of heaths covering smaller areas in coniferous forest landscapes, the causal agent is usually the existence and maintenance of treeless strips along the sides of forest roads and under power lines, as well as maintenance of wide fire breaks, etc. and forest management involving timber logging, where microhabitats are constantly created at the edges of wood-cleared and cultivated areas.

Another factor that may sometimes contribute to the maintenance of heaths is extensive grazing. For example, the heathland in the Natura 2000 site "Wrzosowisko w Orzechowie" in the Region of Lublin covers a dune formerly used as a pasture, owned by a rural community. The area has not been used for agricultural purposes for many years; however, at the turn of the 1980s and 1990s it was subjected to quite heavy grazing, with up to 5 heads of cattle per hectare. At present, the heathland is affected by slow but noticeable secondary succession and is being recolonised by trees.

In a natural coniferous forest landscape, small and scattered patches of heath would normally appear at sites of disruptions – in clearings and forests thinned out following the death of trees or as a result of small- and large-area fires.

Heaths are a frequent component of a dynamic mosaic of entire plant landscapes, including in particular:

- heaths with nodding thread-moss, and in eastern Poland also bearberry heaths, are a natural element of the oligotrophic landscape of pine forests, even though the heaths cover small areas and are scattered;
- heaths on former or present military training grounds are usually a component of a mosaic with sand grasslands (particularly on dunes), different types of grassy vegetation (including areas overgrown with reed grass), fragments of forest or different stages of succession towards a forest;
- bearberry heaths, e.g. on the Lucynowsko-Mostowieckie Dunes, form a mosaic with dune grasses and fragments of forests;
- flowery, stenothermal heaths can form a mosaic with xerothermic grasses and stenothermal bushes;
- wet heaths have been found to form a mosaic with purple moor-grasses *Molinia caerulea* and patches of moor grass forest.

Locally, heaths can serve as very important mainstays and habitats of precious species of plants and animals – e.g. unique invertebrate species. In various parts of Poland, heaths are inhabited by very rare species: mantis *Mantis religiosa* (Sandomierz Wilderness) and *Eresus cinnaberinus* spider (Oder River Valley, Tuchola Forest). Heaths provide an important habitat for birds, including: wood-lark *Lullula arborea*, tawny pipit *Anthus campestris*, black grouse *Tetrao tetrix*, amphibians and reptiles (natterjack toad *Bufo calamita*, common European adder *Vipera berus*).

Photo 17 The Niepust heathland in the Kampinos Forest is being recolonised by trees (© A. Kębłowska)

Photo 18 Heaths in the forest complex known as the Red Wood (Czerwony Bór) near Łomża – former military training grounds (© U. Biereznoj)

Photo 19 A bearberry heath on the Lucynowsko-Mostowieckie Dunes (© A. Kębłowska)

Photo 20 Bearberry heath undergrowth (© A. Kębłowska)

## 4. Typical plant species

The most common heaths with nodding thread-moss (*Pohlio-Callunetum*) usually take the form of a shrub community, characterized by the absolute dominance of common heather *Calluna vulgaris*. In terms of its structure, the association consists of two predominant layers. The first layer with the dominant common heather *Calluna vulgaris*, determines the characteristic physiognomy of these heaths. The second layer is composed of low plants such as the mouse-ear hawkweed *Hieracium pilosella*, common bent *Agrostis capillaris* and sand sedge *Carex arenaria*. Stag's-horn clubmoss *Lycopodium clavatum* can sometimes be found there, too. There are also numerous mosses and lichens.

Due to the stratum with a wide amplitude of humidity, heaths with nodding thread-moss incorporate moist patches composed of purple moor-grass *Molinia coerulea*, sometimes also with bog blueberry *Vaccinium uliginosum*.

Bearberry heaths *Arctostaphylo-Callunetum* have a characteristic physiognomy dominated by *Calluna vulgaris* heath and patches of kinnikinnick *Arctostaphylos uva-ursi* with creeping sprouts. The shrub layer is composed of heath and kinnikinnick, filling free spaces between clumps of heather. The second layer comprises low plants such as the mouse-ear hawkweed *Hieracium pilosella* and sheep fescue *Festuca ovina*.

Genista heaths, which are rare in Poland, are composed of German greenweed *Genista germanica* and common heather *Calluna vulgaris*). The second layer consists of low plants, often taking the form

of creeping undergrowth, incorporating slender eyebright *Euphrasia micrantha*, heath speedwell Veronica officinalis and heath dog-violet *Viola canina*.

In all types of heaths, there may be single and scattered species of trees and bushes, mostly Scots pine *Pinus sylvestris*, warty birch *Betula pendula* and common broom *Sarothamnusscoparius*. If these species are present in larger quantities, it is a sign that a heathland is turning into a woodland.

Photo 21 "Flowery heath" undergrowth in the Oder River valley near Krajnik (© K. Barańska)

Photo 22 Wet heath undergrowth with purple moor-grass *Molinia coerulea* and bog blueberry *Vaccinium uliginosum* in the "Diabelskie Pustacie" Reserve in Western Pomerania (© P. Pawlaczyk)

Photo 23 Common heather *Calluna vulgaris* regenerating on the heathland after having been mown. "Diabelskie Pustacie" Reserve in Western Pomerania (© P. Pawlaczyk)

Photo 24 Heath undergrowth regenerating after having been mown. "Diabelskie Pustacie" Reserve in Western Pomerania (© P. Pawlaczyk)

## 5. Distribution in Poland

The distribution of these heaths in Poland has not been sufficiently studied. Therefore, the range specified in this paper is purely indicative.

This habitat occurs throughout lowland Poland, exclusively in the continental region. Patches of vegetation with heaths that occur in the Carpathian Mountains (in the Alpine region) should be classified as Nardus grasslands with heaths (habitat 6230) rather than heaths themselves.

Small patches of heaths appear in pine forest complexes, on verges of forest roads, under power lines, etc. Large-area dry heaths, with an area of up to several thousand hectares, have developed on military training grounds as a result of military training activities. Their occurrence in Poland is nearly exclusively connected with either active or abandoned military training grounds.

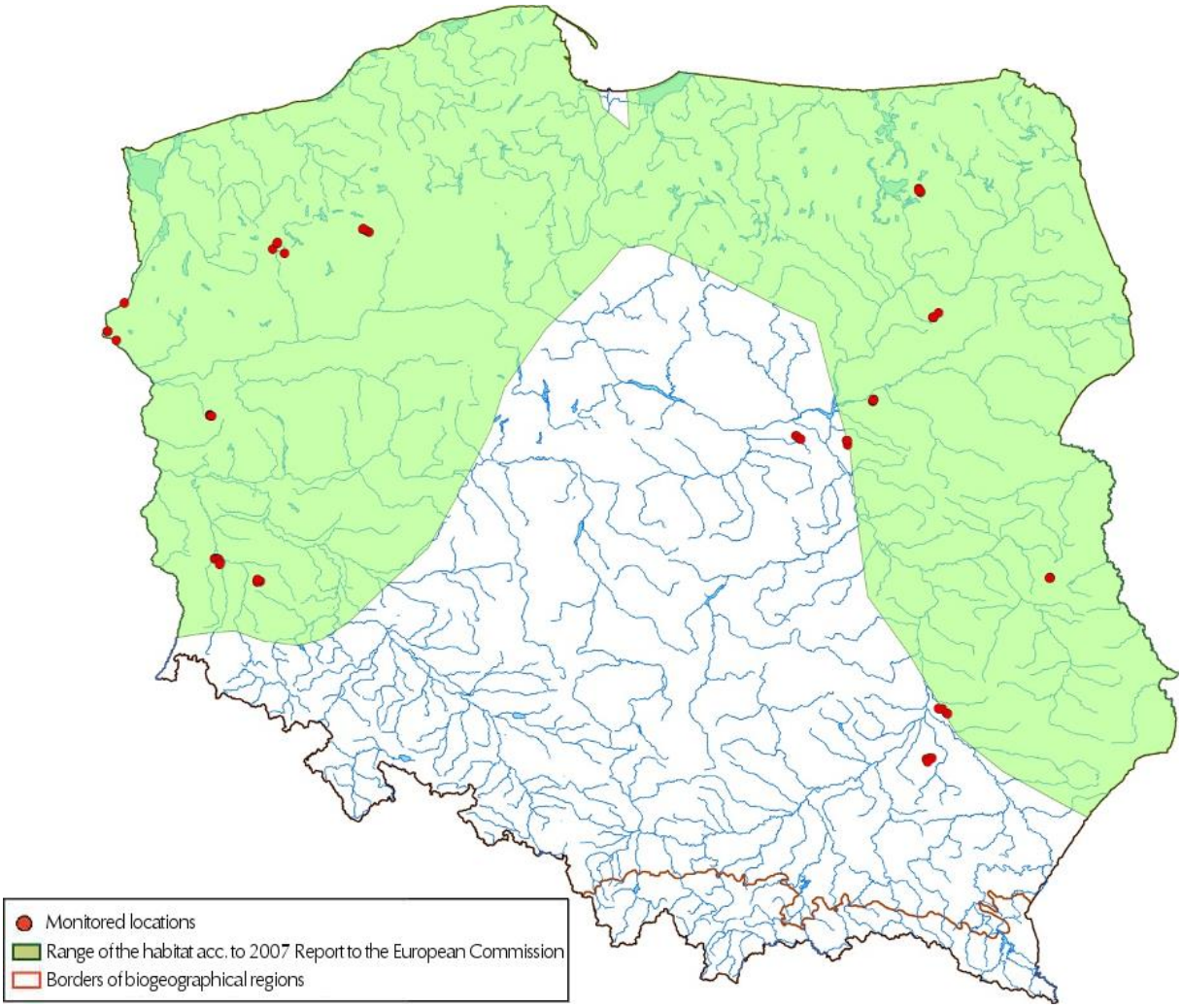


Fig. 6 Distribution of monitored locations in the context of the geographical range of the habitat

# II. METHODOLOGY

## 1. Methodology of monitoring studies

### Selection of monitoring locations

The monitoring should include the entire diversity of the habitat in the area concerned - taking into account such aspects as the diversity of types of heaths, their spatial forms and the state of their conservation. A set of monitored locations should be selected in such a way so that it is representative for habitat resources in a given area.

Before monitoring can be undertaken at an area level (Natura 2000 site, national park, landscape park), it is necessary to identify a "spatial pattern" and to evaluate the diversity of heaths at a given site. Most of all, it must be found out if heaths grow on large areas or in small scattered patches in a coniferous forest landscape, because it will determine their monitoring methodology.

### Study method

In the case of large-area heaths, the most suitable monitoring area is a transect with a length of 200 m and a width of 10 m. Within this transect, 3 phytosociological relevés must be performed, each with an area of 100 $m^2$, and monitoring indices must be described with respect to the entire

area of the transect. If the transect does not fit into the habitat patch, its dimensions should be modified without altering its area. In the case of patches of heath with an area of >10 ha, more than one transect can be established there. The location of the site must obligatorily be identified with its GPS-tracked geographical coordinates and entered onto a 1:10000 topographic map, a forest economic overview map or a photo-map of the same scale, with the to-be-researched biochore of habitat 4030 being marked on such a map.

In the case of small-area heaths, the monitoring must concern:

- occurrence of patches of heaths in the landscape; e.g. in the form of a map of their distribution in a test area of about 100 ha (the size of patches should be mapped with dots, with field survey mapping of larger patches);
- the characteristics of selected patches using a single phytosociological relevé and a description based on monitoring indices at the point under examination.

To analyse habitat resources in larger areas (e.g. Natura 2000 site), field studies must be carried out. To facilitate preliminary identification of heaths, photointerpretation data can be used (in the case of heaths, colour photographs are especially useful because it is hard to distinguish the photophone of heaths from the photophone of grass communities on a black and white photograph), together with forest inventory data of the State Forests. It must be noted, however, that they are especially useful for finding large-area heaths. In addition, each piece of information from these sources must be verified in field conditions. To identify small-area heaths, field work is usually required; however, even a general field survey is sufficient for establishing if a given fragment of the forest abounds with small patches of heath or not.

### Time and frequency of studies

July, August and September are the best months for studying heaths. One observation per year is sufficient. Habitat conservation status can usually be assessed in other seasons too; however, there is a risk that the phytosociological documentation will contain erroneous assessments of area coverage by certain species and that it will not be possible to identify some of them at all. Studies at monitoring sites should be carried out at least once every 5-6 years, preferably every 3 years.

### Equipment used in studies

No specialized equipment is required for carrying out observations of heaths. The necessary equipment includes a notebook (a form to be filled in), a GPS device, a measuring tape and a camera.

## 2. Assessment of parameters of the conservation status of a natural habitat and the indicators of its specific structure and functions

Table 9 Description of indicators of specific structure and function of the natural habitat, as well as 'conservation prospects' for natural habitat 4030 – dry heaths

| **Parameter/** Indicator | **Description** |
|---|---|
| **Specific structure and functions** | |
| Coverage by common heather Calluna vulgaris or in the case of bearberry heaths - joint coverage by heather and kinnikinnick Arctostaphylos uva-ursi | The indicator determining the structure of the habitat and its classification as a "heath". The measure is the coverage of the area by a species (multiple species) expressed as %.<br>It should be treated as a cardinal indicator. For assessing the conservation status of an area as satisfactory, it should be required that at least 75% of sites have a satisfactory conservation status. |
| Coverage by grasses | A negative indicator, indicative of the most common type of degeneration of heaths. The measure is the total coverage of the area by grass species, expressed as % rounded up to full tens, as understood by phytosociologists.<br>It should be an auxiliary indicator. To assess the conservation status of an area as satisfactory, it should be required that at least 50% of sites have a satisfactory conservation status. |
| Incursion of trees | A n indicator which shows the main risk and a factor contributing to the degeneration of heaths - recolonisation by trees. The measure is the coverage of the area by trees expressed as %. Both self-sown seedlings and trees planted in afforestation projects are taken into account.<br>It should be treated as a cardinal indicator. For assessing the conservation status of an area as satisfactory, it should be required that at least 75% of sites have a satisfactory conservation status. If some fragments of a heathland are so strongly overgrown by trees that the habitat may disappear, it should also have an effect on the evaluation of such parameters as the "area" and "conservation prospects". |
| Geographically alien species | Most common: wild black cherry Padus serotina, Canadian fleabane Conyza canadensis, large-leaved lupine Lupinus polyphyllus, late goldenrod Solidago gigantea; sometimes other species as well.<br>A negative indicator suggesting the likely presence of invasive alien species (neophytes). To evaluate this indicator, a list of all such species (all geographically alien and locally invasive species) should be given together with their percentage share in the coverage of the transect.<br>It should be treated as a cardinal indicator. For assessing the conservation status of an area as satisfactory, it should be required that at least 90% of sites have a satisfactory conservation status. |
| Expansive native species (apophytes) | The most common: bushgrass Calamagrostis epigejos, blackberries Rubus spp., ruderal species – although in flowery heaths even the white swallow-wort Vincetoxicum hirundinaria was observed to act as an apophyte.<br>A negative indicator suggestive of possible apophytization. To evaluate this indicator, a list of all such species should be given together with their percentage share in the coverage of the transect.<br>It should be treated as an auxiliary indicator. For assessing the conservation status of an area as satisfactory, it should be required that at least 75% of sites have a satisfactory conservation status. |
| The population structure of key species | For the purposes of this indicator, "key species" include common heather and, on bearberry heaths - heather and kinnikinnick Arctostaphylos uva-ursi.<br>It is an indicator which shows the "completeness" of age and development stages of key structure-forming species, evaluated on the basis of an expert's opinion – a satisfactory state is defined as a state in which all age and development stages are present (juvenile, mature, generatively reproducing and senile specimens) and the structure of the population is indicative of its continuity over time; an unsatisfactory state is a state in which different age and development stages are present, but not to the extent evidencing the full sustainability of the population and its renewal processes; bad state – dominance of senile stages only, with no renewal of key species.<br>It should be treated as an auxiliary indicator. The conservation status of the area can be assessed as satisfactory when the conservation status of at least 50% of sites is satisfactory. |

| **Parameter/** Indicator | **Description** |
|---|---|
| The condition of locally typical species which are of key importance for the biodiversity of the habitat (optional indicator, to be used only when appropriate data are available) | An optional indicator for evaluating an additional aspect of the conservation status of a habitat – its ability to sustain locally typical species that are important for its biodiversity (protected, endangered, rare species). The selection of species that are to be taken into account will depend on the specific characteristics of the local area. Such species may include, for example: stag's-horn clubmoss Lycopodium clavatum, wood-lark Lullula arborea, tawny pipit Anthus campestris, black grouse Tetrao tetrix, mantis Mantis religiosa, ladybird spider Eresus cinnaberinus and other unique invertebrates locally associated with heaths. This indicator should only be used when appropriate data are available. It should be treated as an auxiliary indicator. |
| Other distortions | E.g. contamination with litter, sand harvesting, etc. This indicator makes it possible to take into account non-specific but sometimes occurring distortions. Heath sustaining factors (such as traces of local fires on military training grounds) should not be treated as distortions. If distortions are identified, assessments should be downgraded to U1 or U2 (depending on their scale, extent and intensity).<br>It should be treated as an auxiliary indicator. For assessing the conservation status of an area as satisfactory, it should be required that at least 90% of sites have a satisfactory conservation status. |
| Conservation prospects | Evaluating “future conservation prospects of the habitat”, one should pay attention to the following aspects:<br>continuous existence of heath sustaining factors (e.g. active military training grounds, grazing, recurrent occasional fires) or factors giving rise to their dynamic emergence (fires, forest management involving the harvesting of wood);<br>undertaken protective measures;<br>presence of afforested areas whose extension inevitably leads to heaths being overgrown by trees;<br>succession processes, expansion of trees;<br>the structure of heath populations and the presence of heath “renewal” processes;<br>inclusion of heaths in the forest management plan and the nature conservation plan (do they include any planned afforestation or cultivation activities that may affect heaths? Do they envisage active protection measures for heaths if such protection is required?)<br>the risk of neophytisation;<br>other anticipated forms of pressure |

Table 10 Assessment of status parameters and indicators of specific structure and functions for natural habitat 4030 – dry heaths

| **Parameter/** Indicators | **Favourable FV** | **Unsatisfactory U1** | **Bad U2** |
|---|---|---|---|
| **Area of the habitat at the monitored location** | Is not decreasing, is not anthropogenically fragmented | Is showing a slow downward trend or is anthropogenically fragmented | Is showing a fast downward trend or is strongly anthropogenically fragmented |
| **Specific structure and functions** | | | |
| Coverage by common heather Calluna vulgaris (or jointly by common heather and kinnikinnick Arctostaphylos uva-ursi) | >50% | 30-50% | <30% |
| Coverage by grasses | <10% | 10-30% | >30% |
| Incursion of trees | <10% | 10-30% | >30% |
| Geographically alien species | None | Single species, <10% | >10% |
| Expansive native species (apophytes) | None | Single species, <10% | >10% |
| The population structure of key species (common heather Calluna vulgaris / common heather and kinnikinnick Arctostaphylos uva-ursi) | All development stages are present in large numbers – juvenile, generative and senile specimens | All development stages are present, but juvenile specimens are poorly represented | Absence of juvenile specimens and the population appears to be aging with no renewal |
| The condition of locally typical species which are of key importance for the biodiversity of the habitat (optional indicator, to be used only when appropriate data are available), e.g. stag's-horn clubmoss Lycopodium clavatum, wood-lark Lullula arborea, tawny pipit Anthus campestris). | All species evaluated as being in a satisfactory (FV) condition | Some species evaluated as being in an unsatisfactory (U1) condition | Some species evaluated as being in a bad (U2) condition |
| Other distortions (litter, sand harvesting, etc.) | none | occurring but insignificant | strong |
| **General structure and functions** | All cardinal indicators evaluated as FV, other indicators evaluated at least as U1 | All cardinal indicators evaluated at least as U1 | One or more cardinal indicators evaluated as U2 |
| **Conservation prospects** | There are no risks or negative trends. It is almost certain that the habitat will be preserved in a non-deteriorated condition for 10-20 years | Preservation of the habitat in a non-deteriorated condition in the next 10-20 years is not certain, but likely, as long as the existing risks are eliminated | Preservation of the habitat in a non-deteriorated condition in the next 10-20 years is very difficult: advanced recession processes, strong negative trends or considerable risks |
| **Overall assessment** | **All three parameters evaluated as FV** | **At least one of the three parameters evaluated as U1, no U2 assessments** | **One or more of the three parameters evaluated as U2** |

## Cardinal indicators

- Coverage by common heather Calluna vulgaris (or jointly by common heather and kinnikinnick Arctostaphylos uva-ursi),
- Expansion of trees,
- Geographically alien species

## 3. An example of a filled-in habitat observation sheet for a monitored location

| Habitat observation sheet for the monitored location | |
|---|---|
| **Monitored location – basic information** | |
| Code and name of the natural habitat | 4030 Dry heaths (Calluno-Genistion, Pohlio-Callunion, Calluno-Arctostaphylion) |
| Site name | Duchny Młode I |
| Type of the monitored location | reference |
| Plant communities | Subcontinental variation of Calluno-Genistetum |
| Description of the habitat at the monitored location | The site is situated on former military training grounds. The habitat area is quite large, however, a considerable part of the forest management unit is affected by secondary succession, whereas the remaining part has been afforested (mainly with pine and birch trees). The area is clearly undulating, with a changing direction of exposure. Within the site, there are single elevations - dunes, mostly overgrown with trees and bushes. The community is homogeneous, but in some places there may be one-species assemblages of bushgrass Calamagrostis epigejos or the community may be dominated by sheep fescue Festuca ovina, with a large area covered by Rumex acetosella (outside the transect). The site visit coincided with common heather Calluna vulgaris entering into a full blooming stage. German greenweed Genista germanica has not been found, but dyer's greenweed Genista tinctoria has been found to be present.<br>Structure of the layer (c) visibly two-layer, height (c): 10-50 cm. The upper layer is formed by greenweed, common broom and heather, whereas the lower layer consists of plants such as: red sorrel Rumex acetosella, heath dog-violet Viola canina, heath speedwell Veronica officinalis and rare spring sedge Carex ericetorum. The moss layer, moderately developed, is dominated by red-stemmed feathermoss Pleurozium scherberi. |
| The area of habitat patches | 0.8 ha |
| Protected areas where the site is located | PLH200018 Czerwony Bór |
| Manager of the area | State Forests, Forest District of Łomża |
| Geographical coordinates | Beginning of the transect: 22º 02' 54.2''E 52º 59' 48.4''N<br>Centre of the transect: 22º 02' 54.8''E 52º 59' 44.9''N<br>End of the transect: 22º 02' 54.5''E 52º 59' 41.5''N |
| Dimensions of the transect | 10 m * 200 m |
| Elevation a.s.l. | Minimum elevation a.s.l. 138 m<br>Maximum elevation a.s.l. 141 m |
| Name of the area | Czerwony Bór |
| **Annual report – basic information** | |
| Year | 2011 |
| Monitoring type | General |
| Coordinator | Biereżnoj Urszula |
| Additional coordinators | |
| Threats | secondary succession and vegetation artificially planted by the managing entity (State Forests). |
| Other natural values | not observed |
| Is monitoring required? | Yes |
| Justification | The patch of habitat 4030 is well developed and fairly varied in terms of species; monitoring is advisable also to make sure that appropriate protective measures are taken to prevent excessive expansion of tree and bush species. |
| Protective measures taken | not observed, in most cases there are none |
| Proposed protective measures | removal of self-sown trees and bushes at intervals of several or a dozen or so years; controlled small-area burning |
| Date of monitoring | 26.08.2011 |
| Comments | new artificial plantings should be discontinued; a large part of the former military training grounds is now being afforested |

| Habitat observation sheet for the monitored location | |
|---|---|
| **Conservation status of the natural habitat at the monitored location** | |
| **Phytosociological relevé I** | |
| Geographical coordinates of the centre, elevation a.s.l., Area of the relevé, inclination, exposure, Density of layers a, b, c, d Height of layers a, b, c, d Phytosociological unit | Geographical coordinates: 22º 02' 54.2''E 52º 59' 48.4''N<br>141 m above sea level<br>Area of the relevé: 25 $m^2$, Inclination: 0, Exposure:<br>Density of layers: C – 75%, D – 5%<br>Height of layers: C – 50 cm, D – 2 cm<br>Phytosociological unit: Calluno-Genistetum<br>Layer C: Arctostaphyllos uva-ursi +, Calluna vulgaris 4, Danthonia decumbens r, Festuca ovina +, Genista tinctoria +, Hieracium pilosella +, Hypericum perforatum +, Juniperus communis r, Rumex acetosella +, Sarothamnus scoparius +, Solidago virgaurea +, Thymus serpyllum +, Viola canina +<br>Layer D: Pleurozium schreberi 1 |
| **Phytosociological relevé II** | |
| Geographical coordinates of the centre, elevation a.s.l., Area of the relevé, inclination, exposure, Density of layers a, b, c, d Height of layers a, b, c, d Phytosociological unit | Geographical coordinates: 22º 02' 54.8''E 52º 59' 44.9''N<br>140 m above sea level<br>Area of the relevé: 25 $m^2$, Inclination: 0, Exposure: 0<br>Density of layers: B – 1%, C – 85%, D – 5%<br>Height of layers: B – 1.5 m, C – 50 cm, D – 2 cm<br>Phytosociological unit: Calluno-Genistetum<br>Layer B: Pinus sylvestris r<br>Layer C: Calluna vulgaris 5, Carex ericetorum +, Festuca ovina +, Genista tinctoria +, Jasione montana r, Rumex acetosella +, Sarothamnus scoparius 1, Viola canina +<br>Layer D: Pleurozium schreberi 1 |
| **Phytosociological relevé III** | |
| Geographical coordinates of the centre, elevation a.s.l., Area of the relevé, inclination, exposure, Density of layers a, b, c, d Height of layers a, b, c, d Phytosociological unit | Geographical coordinates: 22º 02' 54.5''E 52º 59' 41.5''N<br>139 m above sea level<br>Area of the relevé: 25 $m^2$, Inclination: 1, Exposure: NW<br>Density of layers: C – 80%, D – 5%<br>Height of layers: C – 50 cm, D – 2 cm<br>Phytosociological unit: Calluno-Genistetum<br>Layer C: Agrostis capillaris +, Betula pendula r, Calamagrostis epigejos r, Calluna vulgaris 4, Festuca ovina 1, Genista tinctoria +, Jasione montana r, Pinus sylvestris+, Rumex acetosella +, Sarothamnus scoparius 1, Solidago virgaurea r, Vaccinium myrtillus +, V. vitis-idaea +, Veronica officinalis +<br>Layer D: Pleurozium schreberi 1 |

| TRANSECT | | | | |
|---|---|---|---|---|
| **Parameters/** Indicators | **Description of the indicator** | **Value of the parameter/ indicator** | | **Evaluation of the parameter /indicator** |
| **Surface area of the habitat** | | The potential surface area of the habitat is much larger. The range of habitat 4030 has been limited by artificial plantings, mainly of birch trees and pine trees. A smaller part of the area became recolonised by trees when it ceased to be used for military training purposes. | | U1 |
| **Specific structure and functions** | | | | FV |
| Coverage by common heather Calluna vulgaris (or jointly by common heather and kinnikinnick Arctostaphylos uva-ursi) | Proportion of the area covered by common heather Calluna vulgaris (or jointly by common heather and kinnikinnick Arctostaphylos uva-ursi) in the transect | common heather covers 75-80% of the transect and kinnikinnick covers 2% | | FV |
| Coverage by grasses | Percentage share of the area covered by particular grass species in the transect | Festuca ovina 5%, Agrostis capillaris 0.5%, Calamagrostis epigejos 2-3% | | FV |
| Incursion of trees | Percentage share of the area occupied by particular tree species in the transect | Pinus sylvestris 3%, height of 1.5-2.5 m; Betula pendula 2%, height of 5-8 m | | FV |
| Geographically alien species | List of invasive and geographically alien species (Polish and Latin name); specify the percentage share of the area occupied by every species in the transect (with accuracy of up to 10%) | no geographically alien species have been found | | FV |
| Expansive native species (apophytes) | List of native expansive species (Polish and Latin name); specify the percentage share of the area occupied by every species in the transect (with accuracy of up to 10%) | bushgrass Calamagrostis epigejos is present, but in small quantities and it currently does not pose any threat to the monitored habitat | | FV |
| The population structure of key species (common heather Calluna vulgaris / common heather and kinnikinnick Arctostaphylos uva-ursi) | Development stages of the population of common heather Calluna vulgaris and kinnikinnick Arctostaphylos uva-ursi | all development stages of heather and kinnikinnick are present and numerous; the population is in a stable condition | | FV |
| The condition of locally typical species that are of key importance for the biodiversity of the habitat (optional indicator, to be used only when appropriate data are available), e.g. stag's-horn clubmoss Lycopodium clavatum, wood-lark Lullula arborea, tawny pipit Anthus campestris. | Optional indicator, to be used only when appropriate data are available, e.g. stag's-horn clubmoss Lycopodium clavatum, wood-lark Lullula arborea, tawny pipit Anthus campestris. | No data | | XX |
| **Conservation prospects** | | progressive secondary succession; if no actions are taken, habitat 4030 will be degraded over a longer-term period | | U1 |
| **Overall assessment** The percentage share of areas representing different conservation status in the entire area of the monitored location (in comparison with the total habitat area in that location) shall also be provided | | FV | - | U1 |
| | | U1 | 100% | |
| | | U2 | - | |

| Human activities | | | | |
|---|---|---|---|---|
| **Code** | **Name of activity** | **Intensity** | **Impact** | **Description** |
| 100 | Cultivation | B | - | artificial plantings on former military training grounds |
| 161 | Afforestation | B | - | large areas of the former military training grounds have already been afforested |
| 950 | Biocenotic evolution | A | - | secondary succession |

## 4. Habitats of similar ecological characteristics

Most methodology components (in particular the indicators relating to the structure and functions) can be adapted for the purpose of monitoring wet heaths (4010).

## 5. Protection of the habitat

Heaths on active military training grounds are in a good condition and do not require active protection measures. It is more difficult to protect heaths on former military training grounds where military practice activities have been discontinued. Without any doubt, trees overgrowing those heaths must be removed. It is a procedure which must be periodically repeated. The removal of trees itself is usually insufficient for sustaining heaths, which also need – at least on a long-term basis – a factor stimulating periodic "rejuvenation" of the heath population. Protective measures in this respect are still undertaken on an experimental basis. On the heaths of the former military training ground in Borne-Sulinowo, common heather *Calluna vulgaris* has been experimentally mown in a quarter-based system. As a result, the population of heaths is "rejuvenated" and sustained, but this method should not be used too often, because it temporarily reduces the diversity of species. It seems that the mowing of the same area should be repeated at intervals of about 7-10 years; however, it still needs to be verified by experiments.

Other proposed methods include extensive sheep grazing (e.g. on flowery heaths near Krajnik) or cattle grazing (heaths in Orzechowo in the Region of Lublin). Such method of sustaining heaths by means of extensive grazing is quite commonly used in Western Europe and a lot of the relevant experience has been gained there.

In Scotland, Ireland and Norway, different types of heaths are traditionally maintained by means of quarter-based burning of areas of 6-15 acres, each year a different one (the same area is burnt every 8-10 years). Therefore, the heaths covering the slopes of the Scottish mountains have a characteristic "patchy" appearance. Mosaic burning has also proved to be an effective method of active protection of heaths in Holland, Denmark and Germany (e.g. in the Zschornoer Heide Reserve near the border with Poland), despite quite different climatic conditions. Perhaps this method should be considered and tested in Polish heath areas too.

Another problem which still needs to be solved is how to stop the expansion of bushgrass *Calamagrostis epigejos* (some protection plans suggest frequent mowing of bushgrass – at least 4 times per annum for 3 years).

The protection of heaths may also be hindered by deposition of nitrogen compounds contained in atmospheric pollutants, due to which initially oligotrophic habitats are becoming more fertile. In Holland, Denmark and Great Britain, some disappearing heaths have been restored by removing the top layer of fertilized soil.

Attempts are made to combine active protection measures (e.g. eradication of self-sown trees) with the use of heaths as a "bee pasture" (beekeepers are allowed to place their beehives on heaths

on condition that they perform some protection-related tasks there). One example of such areas is the Heath of Przemków, where heath honey is produced as an important regional product. In the same area, the protection of heathland has been combined with the harvesting of heath as a roofing material.

Of course, every heath should be scrupulously and effectively protected against devastation, such as excavation of sand or dumping of waste.

Heaths occurring as small-area patches in a coniferous forest landscape usually do not require any special activities, as long as the factors that determine this landscape continue to exist.

The protection of heaths should take into account their biodiversity, especially the unique species associated with them – such as, for example, interesting species of invertebrates or birds (e.g. in Great Britain detailed rules have been developed for the "maintenance of heaths for the purpose of sustaining invertebrate fauna associated with them"). However, protection of the biotope itself and ensuring its structural diversity (presence of sites with naked soil, mixed-aged population of heath, including senile clusters, presence of single trees and bushes, preservation of flora diversity), as well as avoidance of activities which might be harmful for particular species (e.g. mowing heath in the breeding season of birds nesting on the ground) should also contribute to the protection of habitat-related diversity.

The protection of heaths should focus on large-area patches. One should be aware that active protection may be necessary. In Polish conditions, effective protection methods must be developed or the existing ones should at least be clarified. The protection measures undertaken thus far still have an experimental character and their specific results must be monitored. The protection measures should imitate, to the largest possible extent, the factors which determine the development of heaths.

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# 91E0 **Willow, poplar, alder and ash riparian forests** *Salicetum albae*, *Populetum albae*, *Alnenion glutinoso-incanae*, spring alder forests

Photo 25 A typical riparian alder forest – Polnica valley in Pomerania (© P. Pawlaczyk)

## I. INFORMATION CONCERNING THE NATURAL HABITAT

### 1. Phytosociological identifiers

class: *Salicetea purpureae* - willow riparian forests and willow bushes
- order: *Salicetalia purpureae*
  - alliance: *Salicion albae* - willow riparian forests
    - *Salicetum albae* - willow riparian forest
    - *Populetum albae* - poplar riparian forest

class: *Querco-Fagetea* - deciduous forests
- order: *Fagetalia sylvaticae* - mesotrophic and eutrophic deciduous forests
  - alliance: *Alno-Ulmion* - alder riparian forests
  - sub-alliance: *Alnenion glutinoso-incanae*
    - *Fraxino-Alnetum* - lowland ash-alder riparian forest
    - *Stellario nemorum-Alnetum glutinosae* – stitchwort riparian forest
    - *Carici remotae-Fraxinetum* - submontane ash riparian forest
    - *Alnetum incanae* - riverside montane alder forest
    - *Caltho-Alnetum* - montane alder swamp forest

In addition, habitat 91E0 comprises alder forests in spring areas – irrespective of their phytosociological classification. Some of them have the form of streamside alder-ash forests Fraxino-Alnetun and some resemble alder forests ("spring alder forests"- "Cardamino-Alnetum").

## 2. Description of the natural habitat

A natural habitat of this type includes riverside forests: alder, ash, white willow, brittle willow, silver poplar and black poplar. They grow in all parts of Poland, but in specific locations they are represented by different subtypes.

The above-mentioned forests develop on soils flooded by river water, with a high level of groundwater, classified mainly as post-bog soils or floodplain alluvial soils. In accordance with its definition, this habitat comprises several quite different subtypes of tree stands, including: ash-alder stands in spring areas and the related water courses, alder stands in valleys of fast flowing rivers, alder forests growing along slowly flowing streams, montane grey alder forests and riverside willow and poplar forests on the banks of large rivers.

Periodic flooding is a typical but not necessary feature of riparian forests: patches of riparian forests also develop in non-flooded areas under the influence of moving groundwater.

The definition of habitat 91E0 includes almost precisely:

- Riparian forests of the *Querco-Fagetea* class, *Fagetalia sylvaticae* order, *Alno-Ulmion* alliance and *Alnenion glutinoso-incanae* sub-alliance (stands of *Ulmenion minoris* sub-alliance are classified as a separate entity with code 91F0)
- Riparian forests of the *Salicetea purpureae* class, *Salicetalia purpureae* order and *Salicion albae* alliance.

Lowland alder forests from spring areas are also included here, even though from a syntaxonomic point of view they do not constitute a homogeneous group and some of their forms should be classified as communities of the *Alnetea glutinosae* class, because alder species prevail over riparian forests of the *Querco-Fagetea* class. Irrespective of their systematics, such a classification is justified by the ecological relationships of these ecosystems with flowing water and river valleys.

The natural habitat 91E0 does not include riparian forests from the Baltic region described as the *Pruno-Fraxinetum* association from the *Alno-Ulmion* alliance and *Alnenion glutinoso-incanae* sub-alliance. It seems that the ecology of these tree stands is mostly determined by factors associated with their seaside location, including the dynamics of dunes. Forests of this type qualify as natural habitat 2180.

The typology of forest habitats may be confusing: habitat 91E0 is not only associated with habitat type Ł, but mostly with habitat type OlJ and Ol.

Photo 26 A riparian alder forest with ostrich ferns in the Forest District of Lubsko in the Lower Silesian Wilderness (© A. Jermaczek)

Photo 27 A spring riparian forest (© P. Pawlaczyk)

Photo 28 A spring riparian forest in the Karwickie Springs Reserve in Pomerania (© J. Kujawa-Pawlaczyk)

Photo 29 A riparian alder forest (91E0) with blackcurrants growing in spring areas in the Beech Forest Wilderness near Szczecin (© P. Pawlaczyk)

## 3. Ecological conditions

The main ecological factor that determines the specific character of riparian forests is water conditions – in particular those connected with the vertical and horizontal movement of water. The specific character of particular subtypes of this habitat depend on the frequency and duration of floods and on the movements of groundwater, such as soaking in and flowing out.

Most subtypes of the habitat are characterized by periodic flooding. Willow and poplar riparian forests are typical for larger river valleys. Willow riparian forests are usually flooded every year, the poplar ones – every several years. However, they are also known to grow in non-typical locations, for example, on the shores of lakes.

Alder and alder-ash riparian forests are typical for valleys of smaller water courses. They may be flooded periodically or may not be flooded at all – in the latter case, however, they are affected by groundwater movements. In some places, water may tend to stagnate and the habitat may turn into a boggy swamp, which is a common feature of alder forests and alder swamps. Alder riparian forests too may occur in atypical locations unconnected with water courses, for example, on the shores of lakes.

In the mountains, the ecological equivalent of riparian alder forests growing on the banks of rivers is grey alder forests.

Habitat 91E0 also comprises swamp alder forests in mountain areas, which are mostly influenced by vertical groundwater movements and stagnant water.

Submontane ash riparian forests usually remain non-flooded, but they are affected by moving groundwater. They can be encountered not only in the mountains, but also in isolated lowland locations.

Spring alder forests, sometimes of a riparian-alder character, develop in places where underground water soaks through or flows out – e.g. on copulas of soligenic bogs and in wellspring circuses.

Photo 30 A submontane ash riparian forest (91E0) in lowlands - in the Beech Forest Wilderness near Szczecin. It forms narrow strips along water courses, among beech forests (9130). (© P. Pawlaczyk)

Photo 31 A montane alder forest (© W. Mróz)

Photo 32 Swamp alder wood (Caltho-Alnetum) in Gorce. (© Jan Loch)

Photo 33 A montane riparian forest with grey alders and brittle willows (91E0) at the Jasiołka River Gorge. (© M. Węgrzyn)

## 4. Typical plant species

91E0 riparian forests are ecologically and geographically very diverse. As a result, the “natural” species composition of their undergrowth is very diverse too. There are virtually no species demonstrating fidelity to riparian forests and there are no riparian forest species that could serve as

a universal indicator of the conservation status of habitat 91E0. It is difficult to rely on the concept of characteristic species in a phytosociological sense, because they do not, as a general rule, demonstrate fidelity to well-preserved riparian forests and they are not common for different subtypes, forms and varieties (ecological or regional / local) of natural habitat 91E0.

The tree species regarded to be typical for this habitat include: black alder *Alnus glutinosa*, European ash *Fraxinus excelsior*, white willow *Salix alba*, brittle willow *Salix fragilis*, silver poplar *Populus alba* and black poplar *Populus nigra*.

The undergrowth species (often together with bushes) which are most often encountered in this habitat include: ground elder *Aegopodium podagraria*, yellow wood anemone *Anemone ranunculoides*, common lady-fern *Athyrium filix-femina*, hedge bindweed *Calystegia sepium*, elongated sedge *Carex elongata*, beaked sedge *Carex rostrata*, hairy chervil *Chaerophyllum hirsutum*, alternate-leaved golden-saxifrage *Chrysosplenium alternifolium*, Alpine enchanter's nightshade *Circaea alpina*, broad-leaved enchanter's nightshade *Circaea lutetiana*, common hazel *Corylus avellana*, hemp-agrimony *Eupatorium cannabinum*, giant fescue *Festuca gigantea*, lesser celandine *Ficaria verna*, alder buckthorn *Frangula alnus*, cleavers *Galium aparine*, common marsh bedstraw *Galium palustre*, water avens *Geum rivale*, common hop *Humulus lupulus*, touch-me-not balsam *Impatiens noli tangere*, yellow iris *Iris pseudacorus*, yellow archangel *Lamiastrum galeobdolon*, gypsywort *Lycopus europaeus*, garden loosestrife *Lysimachia vulgaris*, purple loosestrife *Lythrum salicaria*, bird cherry *Padus avium*, reed canary grass *Phalaris arundinacea*, blackcurrant *Ribes nigrum*, European dewberry *Rubus caesius*, glutinous sage *Salvia glutinosa*, common skullcap *Scutellaria galericulata*, bittersweet nightshade *Solanum dulcamara*, hedge woundwort *Stachys silvatica*, wood stitchwort *Stellaria nemorum*, common comfrey *Symphytum officinale* and common nettle *Urtica dioica*.

However, the above-mentioned species are not suitable as indicators of the conservation status of riparian forests. In the case of natural habitat 91E0, the concept of “phytosociologically characteristic” species as an indicator of the condition of the entire habitat does not work very well – instead, one should rely on a comprehensive assessment of how typical the flora composition is, and on the selection of “species locally typical for the habitat (taking into account the specific characteristic of a given location) which are of key importance for its biodiversity” (plant species and animal species alike).

## 5. Distribution in Poland

The habitat occurs all over Poland and is one of the most common Natura 2000 habitats. This applies in particular to ash-alder riparian forests, and in the mountains – to montane alder forests. Other subtypes of the habitat (willow and poplar riparian forests, submontane ash riparian forests, spring alder forests and swamp alder forests in the mountains) are not distributed evenly and may be rare.

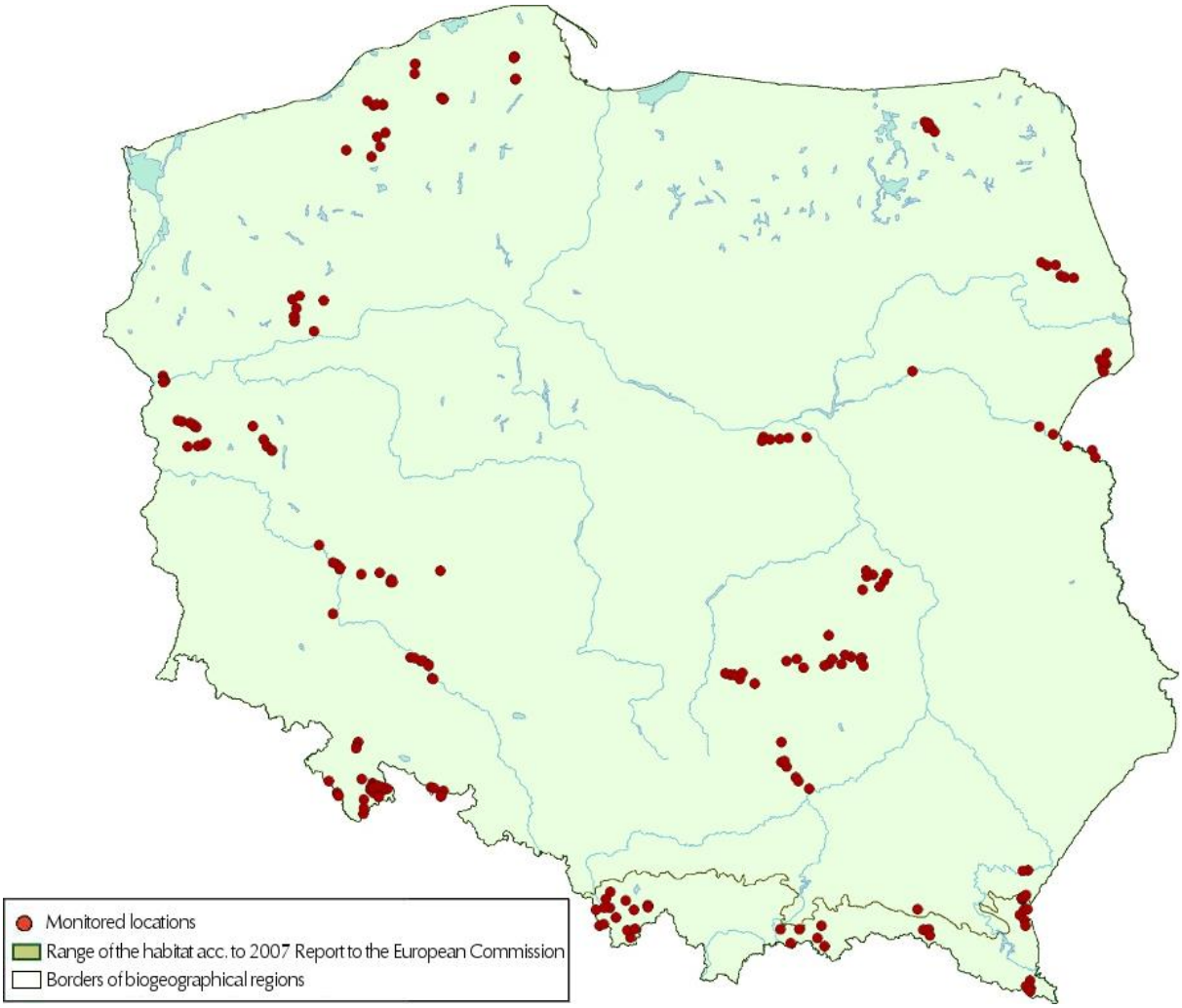


Fig. 7 Distribution of the habitat sites in Poland (revised to take into account the monitoring data from 2006-2008)

# II. METHODOLOGY

## 1. Methodology of monitoring studies

### Selection of monitored locations

Monitoring at an area level (Natura 2000 site, national park, and landscape park) must cover the habitat in its entire diversity, both in terms of plant alliances and conservation status. Efforts should be made to establish sites in patches representing at least 20-50% of the total acreage of the habitat in the area, with the lower limit mostly relating to areas where riparian forests are very numerous. A site should be understood as a habitat patch which is relatively homogeneous in terms of the plant association, water regime and the degree of distortion. The set of sites should be selected in such a way so that it is representative for habitat resources in a given area.

### Study method

The most suitable monitoring area is a transect with a length of 200 m and a width of 10 m. Within this transect, 3 phytosociological relevés must be performed, each with an area of 100 $m^2$. If the transect does not fit into the habitat patch, its dimensions should be modified without altering its area.

The location of the site should be presented on a 1:10000 topographic map, a forest economic overview map or a 1:5000 orthophotomap, with delineated boundaries of the area classified as habitat 91E0.

### Time and frequency of studies

The best time for studying riparian forests depends on their specific local character. It usually covers the period from mid-May to September. An additional observation of floodings in the period of high water levels in spring can be very useful too. In general, it is best to perform studies in late spring and early summer (if the area is accessible). Alder forests in the mountains, on the other hand, can be monitored throughout summer or even in autumn until mid-October. Studies at monitoring sites should be carried out at least once every 5-6 years, preferably every 3 years.

### Equipment used in studies

In order to obtain reliable and valuable data concerning water conditions, monitoring activities should be accompanied by simultaneous recording of the level of water in the ground / flooding level. An alternative method is to register the level of the water course sustaining a given riparian forest, provided that a relation between that level and the pattern of riparian forest floodings is established on the basis of at least several flooding episodes. One can also rely on the data of a water gauging station, if there is one nearby. In other cases, it is recommended to install a limnigraph on the water course, or to install in the ground a piezometer equipped with a device for automatic registration of the water level (e.g. the so-called MiniDiver with simultaneous measurement of both the level and the temperature of water - with any frequency in a period of about 10 years, with measurement storage capacity of up to 24 thousand – all one has to do then is to collect the readings during the next monitoring observation). In addition, an atmospheric pressure sensor is also required (one is usually sufficient for the entire Natura 2000 site). It should be installed in a nearby forester's lodge, house, etc.

## 2. Assessment of parameters of the conservation status of a natural habitat and the indicators of its specific structure and functions

Table 11 Description of the specific structure and functions of the natural habitat and of the parameter "conservation prospects" for natural habitat 91E0 - willow, poplar, alder and ash riparian forests

| **Parameter** Indicator | **Description** |
|---|---|
| **Surface area of the habitat** | An assessment should be carried out of trends of changes in the surface area of the habitat and its anthropogenic fragmentation (caused, for example, by agricultural use of a part of the potential biochore of riparian forests) due to wood cutting, division of the habitat by dykes, roads, etc. A situation in which patches of riparian forests are divided by a river-bed, river-beds or oxbow lakes should not be regarded as fragmentation. |

| Parameter<br>Indicator | Description |
|---|---|
| **Specific structure and functions** | |
| Characteristic species | The tree species which are usually mentioned as typical for this habitat include: black alder Alnus glutinosa, European ash Fraxinus excelsior, white willow Salix alba, brittle willow S. fragilis, silver poplar Populus alba and black poplar P. nigra.<br>The undergrowth species (often together with bushes) which are most often encountered in this habitat include: ground elder Aegopodium podagraria, yellow wood anemone Anemone ranunculoides, common lady-fern Athyrium filix-femina, hedge bindweed Calystegia sepium, elongated sedge Carex elongata, beaked sedge C. rostrata, hairy chervil Chaerophyllum hirsutum, alternate-leaved golden-saxifrage Chrysosplenium alternifolium, Alpine enchanter's nightshade Circaea alpina, broad-leaved enchanter's nightshade C. lutetiana, common hazel Corylus avellana, hemp-agrimony Eupatorium cannabinum, giant fescue Festuca gigantea, lesser celandine Ficaria verna, alder buckthorn Frangula alnus, cleavers Galium aparine, common marsh bedstraw G. palustre, water avens Geum rivale, common hop Humulus lupulus, touch-me-not balsam Impatiens noli tangere, yellow iris Iris pseudacorus, yellow archangel Lamiastrum galeobdolon, gypsywort Lycopus europaeus, garden loosestrife Lysimachia vulgaris, purple loosestrife Lythrum salicaria, bird cherry Padus avium, reed canary grass Phalaris arundinacea, blackcurrant Ribes nigrum, European dewberry Rubus caesius, glutinous sage Salvia glutinosa, common skullcap Scutellaria galericulata, bittersweet nightshade Solanum dulcamara, hedge woundwort Stachys silvatica, wood stitchwort Stellaria nemorum, common comfrey Symphytum officinale and common nettle Urtica dioica.<br>Evaluating the characteristic flora combination, one should take into account the phytosociological diversity of this type and analyse separate sets of species for particular subtypes of the natural habitat (on the basis of Herbich et al. 2004):<br>**Riverside willow riparian forest Salicetum albae**<br>Apart from white willow Salix alba and brittle willow S. fragilis, other relatively constant components of the riparian forest include: hedge bindweed Calystegia sepium, cleavers Galium aparine, garden loosestrife Lysimachia vulgaris, reed canary grass Phalaris arundinacea, great yellowcress Rorippa amphibia, creeping buttercup Ranunculus repens, European dewberry Rubus caesius, almond-leaved willow Salix triandra, comfrey Symphytum officinale and common nettle Urtica dioica. Only nettles and blackberries form facies assemblages.<br>**Riverside poplar riparian forest Populetum albae**<br>The structure of fully natural Populetum albae phytocoenoses, which are at the optimum stage of development of the forest ecosystem, is unknown, making it difficult to specify representative species. Such representative species most certainly include the white poplar Populus alba, black poplar P. nigra and grey poplar Populus x canescens. Other representative species may include relatively constant components of the undergrowth: couch grass Agropyron repens, mugwort Artemisia vulgaris, creeping thistle Cirsium arvense, field horsetail Equisetum arvense, common hemp-nettle Galeopsis tetrahit, cleavers Galium aparine, ground-ivy Glechoma hederacea, European dewberry Rubus caesius and common nettle Urtica dioica.<br>**Alder-ash riparian forest**<br>Black alder Alnus glutinosa, European ash Fraxinus excelsior, bird cherry Padus avium, touch-me-not balsam Impatiens noli-tangere, common nettle Urtica dioica, yellow archangel Galeobdolon luteum, wood stitchwort Stellaria nemorum, alternate-leaved golden-saxifrage Chrysosplenium alternifolium, broad-leaved enchanter's nightshade Circaea lutetiana, common lady-fern Athyrium filix-femina, garden loosestrife Lysimachia vulgaris.<br>**Spring alder forests in lowlands**<br>Black alder (Alnus glutinosa), large bitter-cress (Cardamine amara), dog's mercury (Mercurialis perennis), alternate-leaved golden-saxifrage (Chrysosplenium alternifolium).<br>**Submontane ash riparian forest**<br>European ash Fraxinus excelsior, grey alder Alnus incana, wood ragwort Senecio Fuchsii, hedge woundwort Stachys sylvatica, common nettle Urtica dioica, hairy chervil Chaerophyllum hirsutum lub touch-me-not balsam Impatiens noli-tangere. Frequently occurring species include great masterwort Astrantia major, European meadow sedge Carex remota, upland enchanter's nightshade Ciracea intermedia, great horsetail Equisetum telmateia, ornamental sorrel Rumex sanguineus, asarabacca Asarum europaeum, wood anemone Anemone nemorosa, woolly buttercup Ranunculus lanuginosus, giant fescue Fagus sylvatica, dog's mercury Mercurialis perennis, ground elder Aegopodium podagraria and wood speedwell Veronica montana.<br>**Riverside montane alder forest Alnetum incanae**<br>• Characteristic species: dusky crane's-bill Geranium phaeum, grey alder Alnus incana (regionally in the Sudetes, in tiers at the foothills of the Carpathian Mountains).<br>• Species of high fidelity but with a limited range: ostrich fern Matteucia struthiopteris, spring snowflake Leucoium vernum. |

| Parameter<br>Indicator | Description |
|---|---|
| | • Characteristic species, in tiers (in lower locations): great marsh thistle Carduus personata, greater meadow-rue Thalictrum aquilegifolium.<br>• Distinctive species in the Carpathian Mountains: shining chervil Anthriscus nitida, stinking woodsalad Aposeris foetida (both in Bieszczady), wood spurge Euphorbia amygdaloides, glabrous butterbur Petasites kablikianus, butterbur P. hybridus, glutinous sage Salvia glutinosa, heart-shaped comfrey Symphytum cordatum, coltsfoot Tussilago farfara, heartleaf oxeye Telekia speciosa (Bieszczady).<br>• Other frequently occurring species: ground elder Aegopodium podagraria, hairy chervil Chaerophyllum hirsutum, cabbage thistle Cirsium oleraceum, marsh hawk's-beard Crepis paludosa, mead wort Filipendula ulmaria, water avens Geum rivale, touch-me-not balsam Impatiens noli-tangere, yellow pimpernel Lysimachia nemorum, wood bluegrass Poa nemoralis, wood stitchwort Stellaria nemorum, common nettle Urtica dioica.<br>**Montane alder swamp forest**<br>Grey alder Alnus incana, montane marsh-marigold Caltha laeta subsp. laeta, hairy chervil Chaerophullum hirsutum, yellow pimpernel Lysimachia nemorum, Carpathian valerian Valeriana simplicifolia, wood club-rush Scirpus sylvaticus, marsh hawk's-beard Crepis paludosa, water forget-me-not Myosotis palustris, white butterbur Petasites album.<br>This indicator should be treated as cardinal; however, it is not as much the number of characteristic and typical species that should be assessed, but the character of the whole flora composition, by comparing it to the composition of the best preserved riparian forests in the area. For assessing the conservation status of an area as satisfactory, it should be required that at least 25% of sites have a satisfactory conservation status. |
| Dominant species | Depending on the specific plant community, it is proposed to assume that each patch must be dominated by species which are typical for a given habitat-variant (i.e. for a given plant community) in order to be classified as having a satisfactory conservation status). In the case of riparian forests, it should be treated as a cardinal indicator. For assessing the conservation status of an area as satisfactory, it should be required that at least 75% of sites have a satisfactory conservation status. |
| Geographically alien species in the tree stand | All species outside their natural range should be treated as geographically alien species, taking into account the present state of knowledge. During the observations carried out in riparian forests thus far the following geographically alien species were discovered: Euro-American poplars, green ash, spruce (in Pomerania) and, in higher mountains – black alder (derived from plantings). The assessment of the indicator should be downgraded if the presence of an alien species is more than sporadic, especially when its generational replacement occurs. The presence of 1-2 specimens of an alien species is acceptable even in a patch assessed as FV.<br>This indicator should have an auxiliary character. For assessing the conservation status of an area as satisfactory, it should be required that at least 90% of sites have a satisfactory conservation status. |
| Invasive alien species in the underbrush and forest floor vegetation | The riparian forest ecosystems are highly susceptible to neophytisation; therefore the problem of invasive alien species is significant and quite often mentioned in records. The species mentioned there include: small-flowered touch-me-not Impatiens parviflora, kiss-me-on-the-mountain Impatiens glandulifera, devil's beggarticks Bidens frondosa, wild cucumber Echinocystis lobata, late goldenrod Solidago gigantea, five-leaved ivy Parthenocissus quinquefolia, Asian knotweed Reynoutria japonica, giant knotweed Reynoutria sachalinensis. In most areas, this indicator was assessed as "unsatisfactory" and in a few areas even as bad. Every geographically alien species in the undergrowth must be recorded in the observation sheet, but its assessment can only be downgraded when such a species is invasive locally. It is proposed to assume that the site must be free from invasive alien species in the undergrowth in order to be classified as having a satisfactory conservation status. This indicator should be treated as cardinal. For assessing the conservation status of an area as satisfactory, it should be required that at least 90% of sites have a satisfactory conservation status. |
| Native expansive species of herbaceous plants | The species of expansive apophytes that occur in riparian forests include, for example: blackberries, tufted hairgrass, nettles and ground elder. The assessment is downgraded when there is clear expansion of one of the species which are atypical for well-preserved patches of the habitat (so strong that it limits the development of other undergrowth species). The expansion (if any) of neophytes (geographically alien species) should not be taken into account here, because it is measured with a different indicator.<br>It is proposed to assume that the site must be free from expansive apophytes in the undergrowth in order to be classified as having a satisfactory conservation status. This indicator should have an auxiliary character. For assessing the conservation status of an area as satisfactory, it should be required that at least 75% of sites have a satisfactory conservation status. |

| **Parameter** Indicator | **Description** |
|---|---|
| Deadwood | This indicator is used for assessing the stocks of decaying wood in the ecosystem. According to contemporary knowledge of ecology, it is an element of the structure of the forest ecosystem which is of key importance for biodiversity (however, the quality characteristics of the stocks of decaying wood must also be taken into account; the latter can at least partially be measured with the indicator "standing and of lying deadwood" of a length of >3m and thickness of >50 cm).<br>The calculation must include deadwood and parts of lying and standing trees with the diameter at the thinner end of at least 7 cm; tree stump are excluded.<br>During the monitoring conducted in the years 2006-2011 and during nature inventorying carried out in State Forests in 2007, the volume of deadwood was estimated visually as the proportion of the "volume of deadwood compared with the volume of live trees", using percentage intervals (required to be assessed as U1) and 10% (required to be assessed as FV). In future monitoring activities, the above measurement method is to be replaced by measurement of the absolute quantity of decaying wood performed on the surface of the transect (usually 0.2 ha) by counting and adding the volumes of its particular fragments, expressed in $m^3$/ha.<br>This indicator is to be calibrated as in most other types of forest ecosystems. The suggestions and experience of other European countries have also been taken into account (compare a problem analysis in Muller and Butler 2010), as well as the fact that most forests forming the natural habitat concerned are commercial forests. The threshold volume considered to be "satisfactory" (20$m^3$ of deadwood per ha of forest) is still about 2 times lower than the stocks of deadwood which is scientifically known to be necessary for undisturbed development of communities of xylobiotic organisms in European lowland deciduous forests. Therefore, in protected areas (national parks, nature reserve) or in specially established preserves of biodiversity in State Forests (reference areas, refuge areas for xylobiotic species) dead and dying trees should not be removed even when this threshold value is considerably exceeded.<br>In riparian forests – just as in most other forest ecosystems – it will serve as an auxiliary indicator. In order for the conservation status to be assessed as satisfactory, the average value in patches of the natural habitat should exceed the threshold for acceptable results (evaluation can be performed using the data collected during forest planning, in accordance with the forest planning instructions which have been in force since 2011; the instructions comprise the method for measuring the volume of deadwood).<br>At sites identified as subtypes 91E0-6 and 91E0-7, it is an auxiliary indicator, i.e. it should be evaluated, but without being taken into account in the evaluation of the parameter "specific structure and functions". |
| Large-size deadwood | Irrespective of the total stocks of decomposing wood, it is very important to establish their quality. In most forest ecosystems, there is a shortage of large-dimension wood. Xylobiotic species connected with thick decomposing logs belong to the most endangered species. Therefore, it was decided that the quantity of thick, decomposing wood should be evaluated as a separate indicator.<br>The indicator measures the thickness of logs and standing tree trunks – an indispensable microhabitat for the most demanding xylobiotic organisms. It takes into account logs and standing tree trunks with a length of >3m and thickness of >50 cm, measured as a diameter at breast height, if measuring is possible, or at the thicker end of the log. If in a given patch of the habitat trees do not grow to such large sizes due to natural causes, the thickness threshold is reduced to 30 cm. A given area should be measured using a counting method.<br>In riparian forests – just as in most other forest ecosystems – it will serve as a cardinal indicator. For assessing the conservation status of an area as satisfactory, it should be required that at least 25% of sites have a satisfactory conservation status.<br>At sites identified as subtypes 91E0-6 and 91E0-7, it is an auxiliary indicator, i.e. it should be evaluated, but without being taken into account in the evaluation of the parameter "specific structure and functions". |
| Natural character of the river-bed (to be used only for riparian forests associated with water courses) | This indicator is used only for riparian forests associated with natural water courses. The indicator relates to traces of an anthropogenic transformation of the basin of such a water-course system. This indicator should have an auxiliary character. For assessing the conservation status of an area as satisfactory, it should be required that at least 75% of sites have a satisfactory conservation status. |

| **Parameter** Indicator | **Description** |
|---|---|
| Water regime (including the rhythm of floods, if exists) | riparian forests and it should be treated as a cardinal indicator. What is essential to remember, however, is that particular types of riparian forests differ with their "natural flooding rhythm", whereas the surface of some of them (swamp alder forests in the mountains, spring riparian forests, some forms of ash-alder riparian forests) is not flooded at all, as they rely instead on groundwater movements. Such forests are affected by over-saturation of their stratum with water rather than by surface floodings. Therefore, this indicator should not be evaluated against the absolute frequency of floodings, but against the frequency and rhythm of floodings which are "normal" for a given plant community.<br>This indicator should be treated as cardinal. For assessing the conservation status of an area as satisfactory, it should be required that at least 75% of sites have a satisfactory conservation status. |
| The age of tree stands | This indicator expresses the "maturity" of the phytocoenosis, measured, in a simplified way, with the age of trees constituting a given stand.<br>This indicator should have an auxiliary character. For assessing the conservation status of an area as satisfactory, it should be required that at least 25% of sites have a satisfactory conservation status.<br>At sites identified as subtypes 91E0-6 and 91E0-7, it is an auxiliary indicator, i.e. it should be evaluated, but without being taken into account in the evaluation of the parameter "specific structure and functions" |
| Vertical structure of the vegetation | An assessment should be "satisfactory" when the stand has a multi-generational structure, i.e. it is diverse in terms of age of particular trees. The assessment should be downgraded if the age structure of the tree stand is not diverse enough.<br>Note: a layer and spatial structure of the tree stand (evaluated jointly) would probably be a more appropriate indicator (than merely a vertical structure). This indicator should have an auxiliary character. For assessing the conservation status of an area as satisfactory, it should be required that at least 50% of sites have a satisfactory conservation status. |
| Natural renewal of the tree stand | This indicator takes into account the total rate of renewal of all tree species that occur naturally in the tree stand. This indicator should have an auxiliary character. Non-renewal can be only temporary and should not automatically lead to a lower assessment of the "conservation status of the structure and functions". For assessing the conservation status of an area as satisfactory, it should be required that at least 25% of sites have a satisfactory conservation status. |
| Damage to the undergrowth and soil as a result of wood harvesting | It should be checked whether wood is harvested or not and if there are any tree stumps. Do the undergrowth and the surface of the soil exhibit any signs of damage? Young trees, the underbrush and stocks of deadwood, etc. should be checked too.<br>The indicator should have an auxiliary character, i.e. it should not automatically lead to a lower assessment of the "specific structure and functions". For assessing the conservation status of an area as satisfactory, it should be required that at least 75% of sites have a satisfactory conservation status. |
| Other distortions | E.g.: damage caused by vehicles and pedestrians, contamination with litter.<br>This indicator should have an auxiliary character. For assessing the conservation status of an area as satisfactory, it should be required that at least 90% of sites have a satisfactory conservation status. |
| The condition of locally typical species which are of key importance for the biodiversity of the habitat (optional indicator, to be used only when appropriate data are available) | An optional indicator for evaluating an additional aspect of the conservation status of a habitat – its ability to sustain locally typical species which are important for its biodiversity (protected, endangered, rare species). The selection of species that are to be taken into account will depend on the specific characteristics of the local area. Such species may include, for example: white-backed woodpecker Dendrocopos leucotos, collared flycatcher Ficedula albicolis, middle spotted woodpecker Dendrocopos medium, beetles from the Cucujidaes family, scarab beetle Protaetia aeruginosa, lesser stag beetle Dorcus parallelipipedus, hermit beetle Osmoderma spp., scarce fritillary Euphydryas maturna and other species.<br>This indicator should only be used when appropriate data are available. |

| Parameter<br>Indicator | Description |
|---|---|
| **Conservation prospects** | Evaluating "future conservation prospects of the habitat", attention should be paid to the following issues:<br>• are patches of the habitat formally regarded as a "forest" or an "afforested area" and under whose management?<br>• is there a risk that riparian forests will be cut down, e.g. as an anti-flood measure?<br>• in the case when the riparian forest is formally regarded as a "forest", how is it managed and what provisions does the forest management plan contain with respect to particular patches of the habitat?<br>• in areas where nature inventorying has been performed (including State Forests), it should be checked if the habitat has been identified correctly – it may be important for its protection in future.<br>Any plans of possible hydro-technical investments are also very important for assessing the future conservation prospects of the habitat. |

Table 12 Assessment of parameters of the conservation status and the indicators of its specific structure and functions of the natural habitat 91E0 - willow, poplar, alder and ash riparian forests

| Parameter<br>Indicator | Favourable<br>FV | Unsatisfactory<br>U1 | Bad<br>U2 |
|---|---|---|---|
| **Area of the habitat at the site** | Is not decreasing, is not anthropogenically fragmented | Is showing a slow downward trend (decreases caused by deliberate reforestation of peat bogs should not be taken into account!) or is anthropogenically fragmented | Is showing a fast downward trend (decreases caused by deliberate reforestation of peat bogs should not be taken into account!) or is strongly anthropogenically fragmented |
| **Specific structure and functions** | | | |
| Characteristic species | The flora combination typical for a riparian forest | The flora combination is impoverished but based on species typical for a riparian forest | The flora combination is dominated not by riparian forest species but by meadow or ruderal species |
| Dominant species | all layers are dominated by species typical for the habitat and quantitative relations between them are natural (with no domination at the facies-level) | all layers are dominated by species typical for the habitat but quantitative relations between them are disrupted (domination at the facies-level) | one or more layers are dominated by a species which is alien for the natural plant community |
| Geographically alien species in the tree stand | <1% and not renewing themselves | <10% and not renewing themselves | >10% or spontaneously renewing themselves, irrespective of their proportion |
| Invasive alien species in the underbrush and forest floor vegetation | no more than 1 species present, not numerous-sporadic | more than 1 species or even 1 numerous species | domination of an alien species at the facies-level |
| Native expansive species of herbaceous plants | Not very strongly expansive | Strongly expansive but without limiting the diversity of the undergrowth | Dominating at the facies-level in a way which limits the diversity of the undergrowth |
| Native expansive species of herbaceous plants | Not very strongly expansive | Strongly expansive but without limiting the diversity of the undergrowth | Dominating at the facies-level in a way which limits the diversity of the undergrowth |
| Deadwood | >20m$^3$/ha | 10-20 m$^3$/ha | <10 m$^3$/ha |
| Large-size deadwood | >5 pcs/ha | 3-5 pcs/ha | <3 pcs/ha |
| Naturalness of the river-bed | The water course is not regulated or it has been restored to its natural state after previous regulation; | The water course has been regulated using "soft" methods, with its hydro-morphological features having been preserved | Regulation changing the rhythm of floodings or regulation completely changing the line of the water course. Existence of damming devices which change the water-course regime |

| **Parameter**<br>Indicator | **Favourable**<br>**FV** | **Unsatisfactory**<br>**U1** | **Bad**<br>**U2** |
|---|---|---|---|
| Water regime (including the rhythm of floodings, if exists) | The dynamics of floodings and over-saturation of the stratum with water is normal from the point of view of a given ecosystem / plant community | The dynamics of floodings and over-saturation of the stratum with water is below normal | There are no floodings or the stratum is completely dry |
| The age of tree stands | trees older than 100 years account for >20% of the total volume of trees | trees older than 100 years account for <20% of the total volume of trees, but trees older than 50 years account for >50% of the total volume of trees | trees older than 100 years account for <20% of the total volume of trees, whereas trees older than 50 years account for <50% of the total volume of trees |
| Vertical structure of the vegetation | natural, varied | changed anthropogenically, but varied | anthropogenically unified |
| Natural renewal of the tree stand | Yes, abundant | Yes, on an individual basis | None |
| Damage to the undergrowth and soil as a result of wood harvesting | None | Few traces, with <1% of the area/of the number of trees having been damaged | Considerable, affecting >1% of the area, of the number of trees, etc. |
| Other distortions | None | Occurring but insignificant | Strong |
| The condition of locally typical species which are of key importance for the biodiversity of the habitat (optional indicator, to be used only when appropriate data are available) | All such species evaluated as being in a satisfactory (FV) condition | Some species evaluated as being in an unsatisfactory (U1) condition | Some of such species evaluated as being in a bad (U2) condition |
| **General structure and functions** | All cardinal indicators evaluated as FV, other indicators evaluated at least as U1 | All cardinal indicators evaluated at least as U1 | One or more cardinal indicators evaluated as U2 |
| **Conservation prospects** | There are no risks or negative trends. It is almost certain that the habitat will be preserved in a non-deteriorated condition for 10-20 years. | Preservation of the habitat in a non-deteriorated condition in the next 10-20 years is not certain, but it is likely, as long as the existing risks can be eliminated. | Preservation of the habitat in a non-deteriorated condition in the next 10-20 years is very difficult: advanced recession processes, strong negative trends or considerable risks. |
| **Overall assessment** | **All parameters evaluated as FV** | **One or more parameters evaluated as U1, no U2** | **One or more parameters evaluated as U2** |

## Cardinal indicators:

- characteristic species
- dominant species
- alien invasive species
- deadwood
- large-size deadwood
- water regime

## 3. An example of a filled-in habitat observation sheet for a monitored location

| Habitat observation sheet for the monitored location | |
|---|---|
| **Monitored location – basic information** | |
| Code and name of the natural habitat | 91EO willow, poplar and alder riparian forests |
| 91EO-S submontane ash riparian forest | |
| Site name | Tomasówka Górna |
| Site type | Research |
| Plant communities | It is difficult to unambiguously classify this habitat as one of the plant communities which have thus far been identified in the Sudetes. On the one hand, it has many features of a submontane ash riparian forest Carici remotae-Fraxinetum. On the other hand, its species composition is somewhat similar to communities from the Tilio-Acerion alliance, especially to adjacent Mercuriali-Fraxinetum communities. |
| Description of the habitat at the monitored location | Ash and sycamore forest in the upstream part of the Tomaszówka stream (Tomaszewski Stream).<br>It develops as a narrow strip on a very stony stratum along the banks of a river. It is adjacent to grasslands and spruce monocultures planted on the steep slopes of the valley, formerly occupied by Tilio-Acerion forests of slopes, screes and ravines. |
| The area of habitat patches | 0.25-0.3 ha |
| Natura 2000 site | PLH020019 Krowiarki Range |
| Other protected areas where the site is located | None |
| Manager of the area | State Forests, Forest District of Tomaszówka |
| Geographical coordinates | N 50"16' ... "; E 16°48' ..." |
| Dimensions of the transect | 10 x 200 m |
| Altitude above sea level | 595 – 61O m |
| **Annual report – basic information** | |
| Year | 2008 |
| Monitoring type | Detailed |
| Coordinator | Jan Kowalski |
| Additional coordinators | |
| Threats | Planned forest management, penetration of alien species due to a large contact area, dieback of ash trees due to insect plagues |
| Other natural values | No data |
| Is monitoring required? | Yes |
| Justification | The habitat has an unusual flora composition (species characteristic for 91 EO and 9180). It is advisable to monitor the dynamic tendencies of the habitat. |
| Protective measures taken | No |
| Proposed protective measures | Exclusion from forest management as a water- and soil-protection forest continuous scientific monitoring |
| Date of monitoring | 22.07.2008 |
| Comments | - |

| Habitat observation sheet for the monitored location | |
|---|---|
| **Conservation status of the natural habitat at the monitored location** | |
| **Phytosociological relevé I** | |
| Geographical coordinates of the centre, elevation a.s.l.,<br>Area of the relevé, inclination, exposure<br>Density of layers a, b, c, d<br>Height of layers a, b, c, d<br>Phytosociological unit | Coordinates: N 50"16' ... "; E 16°48' ... ", 595 m a.s.l.<br>Area of the relevé: 100 m$^2$, Inclination and exposition: none<br>Density of layers: A – 55%, B – 20%, C – 80%<br>Height of layers: A - 20 m, B - 4 m, C - 0.8 m<br>Species: layer a: Acer pseudoplatanus 2, Fraxinus excelsior 3;<br>layer b: Acer pseudoplatanus l, Corylus avellana 2, Lonicera xylosteum l, Rosa pendulina 2;<br>layer c: Acer platanoides r, Aegopodium podagraria 2, Asarum europaeum 2, Athyrium iilix-femina +, Carex sylvatica r, Chaerophyllum hirsutum l, Chrysos- plenium alternifolium +, Corylus avellana +, Crepis paludosa +, Deschampsia caespitosa r, Dryopteris carthusiana r, Dryopteris filix-mas 1, Epilobium montanum -ł-, Filipendula ulmaria r, Fraxinus excelsior l, Geleobdolon luteum 2, Galium aparine +, Geranium robertianum l, Impatiens noli-tangere 2, Impatiens parviflora l, Mycelis muralis r, Oxalis acetosella 2, Paris quadrifolia +, Petasites albus +, Picea abies r, Poa trivialis l, Polygonatum verticil- latum +, Ranunculus lanuginosus l, Ribes uva-crispa +, Rubus idaeus +, Senecio nemorensis 2, Stellaria nemorum 2, Thalictrum aquilegiifolium +, Urtica dioica +, Veratrum lobelianum r |
| **Phytosociological relevé II** | |
| Geographical coordinates of the centre, elevation a.s.l.,<br>Area of the relevé, inclination, exposure<br>Density of layers a, b, c, d<br>Height of layers a, b, c, d<br>Phytosociological unit | Coordinates: N 50"16' ... "; E 16°48' ... ", 600 m a.s.l.<br>Area of the relevé: 100 m$^2$, Inclination: 0, Exposure: 0<br>Density of layers: A – 65%, B – 55%, C – 85%<br>Species: layer a: Acer pseudoplatanus 2, Fraxinus excelsior 4;<br>layer b: Acer pseudoplatanus, Corylus avellana 3, Rosa pendulina 3, Ulmus glabra r;<br>layer c: Acer platanoides +, Acer pseudoplatanus + Entoloma pleopodium;a 2, Asarum europaeum 2, Athyrium filix-femma l, Campanula trachelium +, Chaerophyllum hirsutum l, Chrysosplenium alternifolium +, Cirsium oleraceum +, Crepis paludosa r, Deschampsia caespitosa +, Dryopteris filix-mas l, Filipendula ulmaria +, Galeobdolon luteum 2, Galium aparine +, Impatiens noli-tangere l, Lonicera xylosteum +, Mercurialis perennis 2, Mycelis muralis +, Oxalis acetosella l, Paris Juadrifolia r, Petasites albus 2, Phyteuma spicatum +, Poa nemoralis +, Poa remota +, Ranunculus anuginosus l, Ribes uva-crispa l, Senecio nemorensis 2, Stellaria nemorum l, Thalictrum aquilegiifolium +, Ulmus glabra +, Urtica dioica +, Veratrum lobelianum 1 |
| **Phytosociological relevé III** | |
| Geographical coordinates of the centre, elevation a.s.l.,<br>Area of the relevé, inclination, exposure<br>Density of layers a, b, c, d<br>Height of layers a, b, c, d<br>Phytosociological unit | Coordinates: N 50"16' ... "; E 16°48' ... ", 610 m a.s.l.<br>Area of the relevé: 100 m$^2$, Inclination: 10°, Exposure: E<br>Density of layers: A – 55%, B – 45%, C – 85%,<br>Species: layer a: Acer pseudoplatanus 3, Fraxinus excelsior 3, Picea abies 1;<br>layer b: Acer pseudoplatanus 2, Corylus avellana 2, Rosa pendulina 3;<br>layer c: Acer pseudoplatanus 1, Aegopodium podagraria 2, Asarum europaeum 2, Carex sylvatica +, Chrysosplenium alternifolium +, Cirsium oleraceum r, Deschampsia caespitosa r, Dryopteris carthusiana +, Dryopteris filix-mas 1, Epilobium montanum r, Euphorbia dulcis +, Fraxinus excelsior 1, Galeobdolon luteum 2, Galium aparine +, Geum urbanum 1, Heracleum sphondylium r, Impatiens noli-tangere 1, Impatiens parviflora 1, Maianthemum bifolium r, Oxalis acetosella 2, Paris quadrifolia +, Petasites albus 2, Poa remota +, Polygonatum verticillatum 1, Primule elatior r, Ranunculus lanuginosus +, Ribes uva-crispa +, Rubus idaeus 1, Senecio fuchsii 2, Sorbus aucuparia +, Stellaria nemorum 1, Thalictrum aquilegiifolium 2, Urtica dioica 1, Viola reichenbachiana + |

| TRANSECT | | | |
|---|---|---|---|
| **Parameters** Indicators | **Description of the indicator** | **Value of the parameter/ indicator** | **Evaluation of the parameter/ indicator** |
| **Surface area of the habitat** | | 0.25-0.3 ha<br>Limited fragmentation with spruce tree plantations | U1 |
| **Specific structure and functions** | | | U1 |
| Characteristic species | List of characteristic species (Polish and Latin name); specify the proportion of the area covered by each species on the transect (with accuracy of up to 10) | Stellaria nemorum 3-5<br>Petasites albus 15-20<br>Crepis paludosa <1<br>Aegopodium podagraria 5-10<br>Urtica dioica 1<br>Galium aparine <1<br>Thalictrum aquilegifolium 1<br>Chaerophyllum hirsutum 1.<br>The number of characteristic undergrowth species and the areas covered by them relatively low in comparison with typical patches of Carici remotae-Fraxinetum. In addition, there are no typical swampy species which constitute a permanent component of boggy patches of the submontane ash riparian forest in the Sudetes such as Carex remota, Gyceria spp., Veronica beccabunga, vetonice montana | U1 |
| Dominant species | A list of dominant species on the transect (Polish and Latin name); specify the proportion of the area covered by each species on the transect (with accuracy of up to 10); specify only species with coverage of 2:10 | a: Acer pseudoplatanus 15-20, Fraxinus excelsior 45-50;<br>b: Corylus avellana 20-30, Rosa pendulina 20-30;<br>c: Asarum europaeum 15-20, Petasites albus 15-20, Mercurialis perennis 15-20 | FV |
| Geographically alien species | A list and percentage of geographically alien species | None | FV |
| Alien invasive species in the undergrowth and underbrush | A list of invasive and geographically alien species (Polish and Latin name); specify the proportion of the area covered by each species on the transect (with an accuracy of up to 10%) | Invasive: Impatiens parviflora <1<br>Other: none | FV |
| Expansive native species (apophytes) | A list of species (Polish and Latin name); specify the proportion of the area covered by each species on the transect (with an accuracy of up to 10 % | The dynamic tendencies of undergrowth species are hard to establish | XX |
| Deadwood | Visual estimation of the quantity of deadwood in comparison with live wood. Description of elements of existing deadwood and of its species. | About 5 different thicknesses of live wood<br>Dead trees, standing and lying, mainly spruce, branches of deciduous trees. | U1 |
| Large-size deadwood | Estimation of the number of such fragments on 1 ha | Approximately 3 pcs on 1 ha | U1 |

| | | | |
|---|---|---|---|
| The naturalness of the river bed (to be used only in the case when the development of the riparian forest is connected with a water course) | Description | No signs of regulation | FV |
| Water regime (including the rhythm of floodings if they occur) | Description | Normal, there are no anthropogenic distortions of the water regime | |
| Age structure of tree stands | Trees of the same age, proportion of trees > 100 years; proportion of trees >50 years | Tree stands of different age, but without old trees. The number of trees > 100 years: 0. The number of trees >50 years: 60. | U1 |
| Vertical vegetation | Description | Natural, diverse | FV |
| Natural renewal of tree stands | The proportion of transect coverage by natural renewal (if there are different species, specify the proportion for every species) | Acer pseudoplatanus <1<br>Fraxinus excelsior 1-2 | FV |
| Damage to the undergrowth and soil caused by picking forest fruit | Describe and evaluate the intensity | Damage to the undergrowth as a result of log-rolling | U1 |
| Other distortions | Description | None | U1 |
| The condition of locally typical species that are of key importance for the biodiversity of the habitat (optional indicator, to be used only when appropriate data are available) | List of species and description of their conservation status. | No data | XX |
| **Conservation prospects** | | As envisaged in the forest management plan, the tree stand is to be covered by forest management activities. There are no plans to interfere with the water course. Natural processes should gradually restore the naturalness of the structure. | FV |
| **Overall assessment**<br>The percentage share of areas representing different conservation status in the entire area of the monitored location (in comparison with the total habitat area in that location) shall also be provided | | FV<br>U1<br>U2 | -<br>100%<br>- | U1 |

| Human activities | | | | |
|---|---|---|---|---|
| **Code** | **Name of activity** | **Intensity** | **Impact** | **Description** |
| 160 | Forest management | B | - | Habitat fragmentation by cultivation and maintenance of spruce tree plantations on a part of the potential patch of the habitat |

## 4. Habitats of similar ecological characteristics

Most methodology components (in particular the indicators relating to the structure and functions) can be adapted for the purpose of monitoring other forest natural habitats. However, the indicators specific for riparian forests – associated with the water course accompanying them and water conditions (including river water floodings), will not be applicable then.

## 5. Protection of the habitat

The key to the protection of riparian forests is the preservation of natural water conditions in which these ecosystems have developed. Different subtypes of the habitat differ with their flooding regime – the aim of protection measures is to preserve or recreate the regime in which the relevant community has developed. The postulate to restore the naturalness of proper water relations for riparian forests tends to be purely theoretical, because there are no examples of natural protection projects known to have put this postulate into effect.

The construction of small retention dams on artificial ditches may improve the condition of riparian forest habitats. The conservation status of riparian forests may also improve, in an indirect way, if the water courses associated with them regain their natural character.

In most cases, passive protection is the best method of protecting riparian forests, provided that there are proper water conditions. It is the most effective method of optimizing the condition of the natural habitat and enhancing its role in the protection of biodiversity.

Riparian forests can function successfully without human assistance and are in the best condition when they are not put to any use. And this is often the case – in many forest districts, small patches of riparian forests are left unused and are not subjected to any forest management activities. In some patches of riparian forests outside State-owned forests, wood is harvested in an unplanned fashion – trees are plundered and cut illegally by local residents or entire patches of riparian forests are cleared within the framework of anti-flood measures. The scale of this phenomenon is sometimes larger than that of the forest cutting performed as part of planned forest management activities in forest districts.

Sustainable and planned forest management in riparian forests is acceptable, as long as it does not have a major negative impact on the state of the natural habitat and on condition that clear cutting is ruled out and only partial cutting or gradual cutting is allowed there, and on further condition that no ecologically and geographically alien tree species are introduced and that there is no decrease – even temporary – in the proportion of old trees, fragments of tree stands and stocks of deadwood. The reversion of riparian forests to their natural state usually consists in “making them older” and restoring the stocks of dead and decomposing wood. These elements have a key significance for anthrophobic species which are an essential element of the biodiversity associated with riparian forests.

It should be emphasized, however, that in the case when riparian forests and brushwood occur in small patches over water courses – it is vitally important to reduce forest management activities.

Riparian forests containing a proportion of ash trees have recently been affected by ash dieback, occurring all over Poland. An effective method of preventing ash dieback has not been found yet. There is no evidence that the removal of dying ash trees slows down the progression of that disease, although of course it seems rational from the point of view of the utilization of wood raw material.

Active protection measures, such as eradication of invasive alien species, may need to be taken in patches of riparian forests invaded by neophytes – and habitat 91E0 is highly susceptible to such invasions and strongly endangered by them. Thus far, there have been no examples of effective eradication of invasive alien species from riparian forests.

The protection of riparian forests should focus on the maintenance or restoration of the natural water regime – and on this basis, a rational compromise should be achieved between the optimum passive protection of the ecosystem and the needs associated with its economic use. Such a

compromise can be attained by excluding from use a certain part of riparian forests in the area and "giving it back to nature".

It is suggested that the following rules should be adopted:

- The most valuable and best-preserved natural habitats should be excluded from use and protected as "reference areas" or, possibly, they should be protected as nature reserves. Such an example of "riparian forests developing naturally", with an area of at least approximately 30-50 ha, should gradually be established in every forest district.
- Forest use involving clear cutting should not be allowed (I).
- In other patches, a complex system of cutting may be introduced; however, more care should be taken to maintain and restore stocks of decomposing wood and to preserve fragments of old tree stands in their original state. In every clearfelling, 5% of the tree stand (in the form of a compact fragment) should be left as a future generation, with an area of no less than 0.5 ha. Dying and dead trees should be left to ensure stocks of decomposing wood equal to at least 10% of mature tree stands. Old birch, aspen, alder and hornbeam trees should not be removed ("bird hollow" species).
- Clear cutting should be planned in such a way so as to prevent any negative impact on the "conservation status structure" of riparian forests in the entire forest district. It must be made sure that the proportion of tree stands which are more than 100 years old is not reduced.
- If there are ash, elm and oak trees in the forest stand, it should be made sure that these species are also present in forest renewals.
- Species of alien origin (e.g. Canadian poplar) should be eliminated. It also relates to the layer of bushes.
- Areas which turn into a swamp due to natural causes should be tolerated. The activity of beavers should be tolerated, too.
- In the case of spring riparian forests, it is necessary to exclude them from use. In addition, no clear cutting should be performed in adjacent tree stands within a distance 2 times longer than the height of the stand from the edge of the spring riparian forest.

The needs associated with the conservation of riparian forests must be taken into account in flood prevention plans.

Natural disruptions (flood damage, erosion caused by a river, activity of beavers) should not be assessed as something negative from the point of view of the conservation status of riparian forests, even when they cause local damage to tree stands or phytocoenoses. Usually, they do not require any countermeasures.

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