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Nature monitoring: a tool for the evaluation of the preservation of synanthropic habitats

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Abstract: The article presents the results of nature monitoring in synanthropic habitats. It shows the organizational aspects of monitoring, a survey procedure, including its assessment for use in synanthropic habitats, and the key findings of the research, including the evaluation of the conservation status of habitats covered by the monitoring and influencing factors' effects. Observations of segetal and ruderal habitats were carried out in 2013 within the Kampinos National Park, according to the recommendations specified in the State Environmental Monitoring Programme, with specific adjustment to the monitored habitats. We used, for example, modified indices for specific structures and functions, e.g., by introducing the index of "archaeophytes", which was also adopted as a cardinal index for synanthropic habitats. The obtained results show the detailed information, collected during monitoring, on the current status of synanthropic habitats. They allowed to evaluate conservation status, threats and conservation prospects for these habitats. This is the first proposal for the standardized monitoring of synanthropic habitats in Poland.

Key words: biodiversity monitoring, conservation management, methodological framework, low-intensity agriculture, protected area, rural areas, synanthropic communities, Kampinos National Park

1. Introduction

Monitoring can be defined as the collection and analysis of repetitive observations or measurements of a specified set of variables over an extended period of time to evaluate the changes in habitat condition and progress towards meeting a management objective (Elzinga *et al*. 1998). One important kind of monitoring is nature monitoring, i.e., regular observations and measurements of selected biotic elements of nature (species, habitats, ecosystems), conducted to obtain information on changes occurring in them at a specific time, and on the directions and rates of these changes (Vaughan *et al*. 2001; Yoccoz *et al*. 2001). The monitoring of nature is an integral part of efforts to stop the loss of biodiversity (Beever 2006; Pereira & Cooper 2006). The evaluation of nature elements provides guidelines for making decisions on how to maintain biological diversity, especially for planning efficient conservation activities (Niemelä 2000; Buckland *et al*. 2005; Stem *et al*. 2005; Nichols & Williams 2006; Henry *et al*. 2008). The monitoring of a biological system is needed before active management, to improve the biological understanding on which such management can be based (Nichols & Williams 2006). This results in different conceptual frameworks and recommendations for the development and maintenance of effective ecological monitoring programmes (e.g. Vos *et al*. 2000; Yoccoz *et al*. 2001; Parr *et al*. 2002; Weber *et al*. 2004; Green *et al*. 2005; Legg & Nagy 2006; Teder *et al*. 2007). However, monitoring programmes are more than just data collection. They also involve all other activities needed to present the results, including, e.g., analysis and interpretation of data (Vos *et al*. 2000; Yoccoz *et al*. 2001).

The obligation to implement nature monitoring is imposed by international conventions, in particular the Convention on Biodiversity (CBD 1992). Pursuant to Article 7b, countries contracted to the Convention are obliged to identify and monitor their biodiversity. Tasks implemented under nature monitoring also result from the European Union directives, mainly Council Directive 92/43/EEC on the conservation of natural

habitats and wild fauna and flora (Habitats Directive), especially Annex II, species requiring designation of Special Areas of Conservation (Council of the European Communities 1992), and Council Directive 2009/147/EC on the conservation of wild birds (Birds Directive; European Commission 1979). International legislation compels national governments to implement monitoring programmes for biological diversity (e.g. Critchley *et al*. 2003; Weber *et al*. 2004; Lengyel *et al*. 2008; Cierlik 2010).

In Poland the obligation to carry out nature monitoring is imposed by the Nature Conservation Act (Journal of Laws of 2004, No. 92, item 880 with later amendments). Nature monitoring is a part of The State Environmental Monitoring Programme, established pursuant to the Act of 20 June 1991 on Inspection for Environmental Protection (Journal of Laws of 2007 No. 44, item 287, as amended).

Because of the requirements under EU law, the monitoring should, above all, enable the assessment of the nature conservation status of natural habitats and species of European Community importance, and help to evaluate the effectiveness of measures applied to protect them (Ostermann 1998). In keeping with this, since 2006, under The State Environmental Monitoring Programme, the task "Monitoring of natural habitats and species with particular attention to special areas of conservation of habitats of the Natura 2000" has been accomplished. The aim of this programme is to provide information enabling the evaluation of the conservation status of habitats and species at the national level (Natura 2000 sites), to indicate conservation measures, and to assess the efficiency of these measures (Cierlik 2010). Methodological and organizational principles for the monitoring of species and natural habitats were established, and monitoring was carried out for all types of natural habitats occurring in Poland, listed in Annex I to the Habitats Directive (81 types), and species listed in Annexes II, IV and V of the Habitats Directive, including 140 animal species and 54 taxa of plants (Makomaska-Juchiewicz 2010; Makomaska-Juchiewicz & Baran 2012a, 2012b; Mróz 2010, 2012a, 2012b; Perzanowska 2010, 2012a, 2012b).

From the viewpoint of the needs of nature protection in Poland, the scope of monitoring should be broader and also cover other habitats and species that are endangered but not listed in the annexes to the Habitats Directive. This concerns such habitats as synanthropic communities and species, which are today undergoing rapid and irreversible changes due to human activity (Ratyńska & Boratyński 2000; Brzeg & Wojterska 2001; Stoate *et al*. 2001; Bomanowska 2010; Siciński & Sieradzki 2010; Storkey *et al*. 2012; Zając & Zając 2014). So far, monitoring has not been carried out in such habitats due to their specific, highly anthropogenic character and, associated with this, the common perception of their low value for nature, as well as due to their location on private land and, thus, limited access, as researchers need owners' permission each time to enter the property.

An opportunity to implement this in practice emerged in 2013, when the Kampinos National Park (KNP) commissioned the development of methodology and monitoring of two types of synanthropic habitats within the park's area, i.e. segetal and ruderal communities. A multifaceted environmental monitoring in national parks is a necessary element of effective management of natural resources and their conservation, but is also a tool for the analysis of changes that occur in these parks. This is why it should cover all types of habitats within a given national park (e.g. Andrzejewska 2003; Karwowski 2003; Knapik & Raj 2014).

The article presents the scope and organizational aspects of nature monitoring in the synanthropic habitats of KNP, a research procedure, including its assessment for use in synanthropic habitats, and the key findings from the carried out monitoring, including the evaluation of the conservation status of habitats covered by the monitoring, and evaluation of influencing factors' effects.

2. Material and methods

2.1. Study area

The Kampinos National Park (52°19′0″N, 20°34′0″E) was established in 1959 to protect the natural values and historic and cultural heritage of Kampinos Forest. The park covers an area of 38 544.33 ha and is located in Central Poland, in the south-western part of the Warsaw Basin mesoregion, between the left bank of the Vistula and Bzura, just off the north-western outskirts of Warsaw (Fig. 1a). The aim of nature protection is to preserve a complex of glacial valley inland dunes and swamps unique in Poland and Europe, with their biological and landscape diversity (Andrzejewska 2003). Due to their natural and cultural significance, in 2000, the KNP and its buffer zone were designated the "Kampinos Forest" Biosphere Reserve by UNESCO. Since 2004, the KNP has also been a NATURA 2000 site (code PLC 140001), because of the abundance of bird species and the diversity of plant communities.

A specific feature of KNP is its developed network of settlements and the presence of agricultural areas. They were established in clearings within the forest complex as a result of settlement in the 18th-20th centuries (Kębłowska 2009). Settlements and agricultural land cover in total 7762 ha, which is 20.1% of the park's surface area. Rural areas and agricultural land are linked with two types of synanthropic vegetation: segetal – weed communities associated with cereals or root crops,

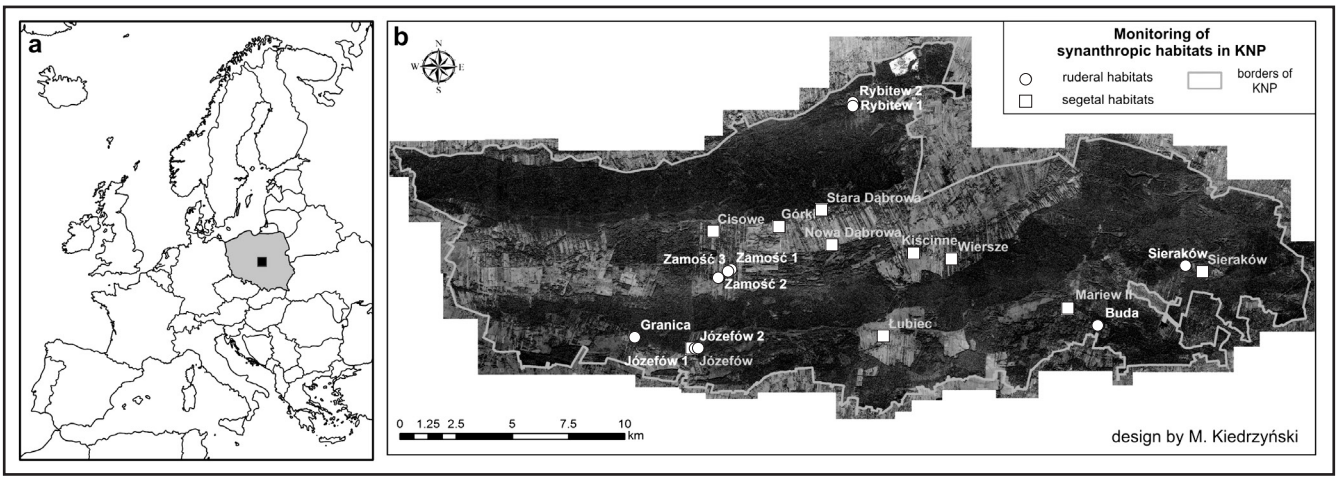

Fig. 1. Location of the Kampinos National Park (a), the monitoring locations for synanthropic habitats (b)
Explanations: gray dots – ruderal sites, gray squares – segetal sites

and ruderal – plant communities near houses and fences, on roadsides, cottage yards, rubbish heaps, developed land and in abandoned homesteads, etc. The persistence of synanthropic habitats is determined by continuous, moderate anthropogenic pressure. However, since the establishment of KNP, the abandonment of fields and the depopulation of villages continues, while former farm buildings are demolished and arable fields afforested or left to undergo secondary succession (Markowski 2009). Because of these processes, synanthropic habitats are disappearing from the landscape of Kampinos Forest, along with many valuable and rare plant species (Kirpluk 2005, 2009, 2011; Bomanowska 2006, 2009; Kirpluk & Bomanowska 2008).

2.2. Selection and description of monitoring locations

Based on orthophoto maps, maps of actual vegetation, analyses of source materials, but above all based on field pilot research, 10 sites were chosen for each of the two types of synanthropic habitats, where in 2013, monitoring plots were established and observations carried out (Fig. 1b). Selection criteria included local edaphic diversity and a good reflection of the ecological transformations that occurred in the habitat.

Monitoring locations were relatively uniform areas of the examined habitat, clearly demarcated and easy to describe in the field (Mróz 2010, 2012a, 2012b). For segetal habitats the demarcation of a monitoring location was easy because weed communities are closely linked with crops and limited to a specific arable field. Thus, a monitoring location was defined as a single arable field with a specific crop. The site of a ruderal habitat was defined as a group of well-distinguished patches covering, for example, the yard of a single farm, land near a house or fence on a single farm, or a roadside in a single village. The surface area of the habitat on a given site was the sum of the patches' area (3 patches as standard), where phytosociological relevé samples were taken. The size of the monitoring locations was diverse.

2.3. Methods of monitoring research

The carried out monitoring of synanthropic habitats was a part of the task entitled "The monitoring of plant communities", conducted by the KNP under the programme "Inventory and monitoring of biotic natural resources in KNP, including natural habitats and species covered by Natura 2000" (contract with National Fund for Environmental Protection and Water Management no. 453/2011/Wn-50/OP-IN/D).

The described habitat includes the communities of arable weeds from *Stellarietea mediae* class and communities of ruderal weeds from *Sisymbrietalia* order (*Stellarietea mediae* class) and *Artemisienea* subclass (*Artemisietea* class; Matuszkiewicz 2008). The habitat is not listed in "The guides of the Natura 2000 habitats and species conservation, a methodological textbook", but when preparing research methodology we followed the principles of the State Environmental Monitoring Programme (SEMP) contained in these guides (see Mróz 2010, 2012a, 2012b). The report on the carried out monitoring was also prepared based on the guidelines presented in these textbooks. Collected documentation material was systematized according to the Matuszkiewicz (2008) classification. Species nomenclature followed Mirek *et al*. (2002).

Observations were carried out according to the recommendations specified in the SEMP, with specific adjustment to the monitored habitats. Because of the specific character of the studied habitats, we did not demarcate the transect, but instead established 3 subsequent phytosociological relevés randomly or arbitrarily

on each monitoring site. On segetal habitats, whenever possible, we maintained a linear arrangement of relevés and established them at the beginning, in the middle, and at the end of an arable field. In the case of ruderal

Table 1. Description and evaluation of parameters and indices of the specific structure of the habitat, as well as "conservation prospects" for segetal habitats in the Kampinos National Park (according to Bomanowska 2013a, amended)

Parameter/Index	Description	Status		
		Favourable (FV)	Unfavourable, inadequate (U1)	Unfavourable, bad (U2)
Parameter "Surface area of the habitat"	An assessment of the changes in surface area (stable, increases, decreases) occupied by the habitat and its dynamics is required	Does not change or increases	A slight decrease in the habitat area in comparison with previous studies or cited in references	An evident decrease in the habitat area in comparison with previous studies or cited in references
Parameter "Specific structure and functions"				
Percentage proportion of the habitat in the location	Percentage of surface area occupied by habitat on the location determined with an accuracy of 10%. This index defines indirectly the spatial structure and the degree of fragmentation of the habitat in the monitored location	80% and more	50-80%	Up to max. 50%
*Typical species	This index describes the specific richness of species composition in plant communities in the monitored location. The typical species show great variability depending on syntaxonomic and ecological diversity of the habitat. The list of typical species for the habitat includes characteristic and distinguishing species for the *Centauretalia cyani* order, *Aperion spicae-venti* alliance and its lower syntaxonomic units (communities of cereal weeds), and characteristic and distinguishing species for *Polygono-Chenopodietalia* order, *Panico-Setarion* and *Polygono-Chenopodion* alliances and their lower syntaxonomic units (communities of root crop weeds). A list of typical species with their approximate percentage of coverage (with an accuracy of 10%) in the location should be given	Numerous species (more than 5) and with significant coverage (3 or more on the Braun-Blanquet scale)	Less than 5 species and with low coverage	No typical species or one of them with insignificant coverage
Dominant species	This index describes the structure of plant communities in the monitored location, as well as their conservation status (or possibly the degree of their deformation). It answers the question of whether the species characteristic of the habitat dominate in the monitored location. The index describes the presence of co-dominant and dominant species (score 3 or more on the Braun-Blanquet scale). The assessment of the indicator is complex, and depends on the nature of the dominants and the level of the domination, because a high domination ratio is usually connected with low species diversity. The presence of dominant species (score 4-5 on the Braun-Blanquet scale), even those typical to the community, results from negative changes in the community and should decrease the index value. A list of species dominating in the location and their approximate percentage coverage (with an accuracy of 10%) should be given. Only species with the highest coverage in the location (≥ 10%) should be replaced	No species with coverage >50%, co-dominance of species typical for habitat	Dominant species are present (with coverage >50%), dominance of segetal species characteristic for *Stellarietea mediae* class	Among the dominants (with coverage >50%) expansive species or ecologically alien for habitat species are present
*Archaeophytes	Index describes the share of archaeophtes, e.g., alien species established in Polish flora, which arrived in "ancient" times (prior to 1492). Typically formed segetal communities are characterised by a significant share of species from this group. A reduced number of archaeophytes indicates the degeneration of the community and reduces the index value. A list of archaeophytes and their approximate percentage coverage (with an accuracy of 10%) should be given	Numerous (≥10)	Several (5-10)	Few (≤5)

Alien invasive species	This index describes the degree of deformation of the habitat and share of geographically alien species considered as invasive in Poland. Invasive species that, at the same time, are species characteristic for associations and higher phytosociological units representing the habitat should not be considered unless their coverage is significant (more than 50%). The presence of even single individuals ("+" on the Braun-Blanquet scale) representing invasive species in a patch, with some exceptions specified earlier) should be associated with reduced index value. A list of invasive alien species should be given together with their percentage proportions (with an accuracy of 10%)	No invasive species and/ or the total coverage of characteristic (invasive) species <50%	Single individuals of invasive species with a total coverage <5% or coverage of characteristic (invasive) species <50%	Coverage of invasive species ≥5% and/or total coverage of characteristic (invasive) species ≥50%
*Expansive species of herbaceous plants	List of native expansive herb species spreading in the habitat, which can pose a threat to the habitat. For the described habitat most of these species are typical, and, thus, they pose a risk only if species coverage is ≥ 2 on the Braun-Blanquet scale. The index value should be reduced in such a case. A list of expansive species in the location should be given together with their percentage proportions (with an accuracy of 10%)	Lack or expansive species with low coverage (<10%)	Average number of expansive species with coverage up to 30%	Numerous expansive species, with a considerable coverage (>50%)
*Anthropogenic pressure (level of agricultural technology)	The index describes effects of the carried out agrotechnical activities (techniques and intensity of soil preparation and cultivation, including the use of nitrogen fertilizers and chemical plant protection measures, use of qualified seed material, mechanisation of field work) that affect the state of the habitat. The index value is decreased because of the use of nitrogen fertilizers and herbicides, because they disturb the biocenotic balance, leading to changes in species composition and structure of communities established during traditional management. Index values are also reduced because of strongly limited agrotechnical activities, e.g., simplified or abandoned crop rotation	Adequate (traditional, extensive methods of cultivation)	Inadequate (faulty, inferior methods of cultivation)	Inadequate (modern techniques of cultivation; intensive use of mineral fertilizers and herbicides)
Assessment of Parameter "Specific structure and functions"		All cardinal indices evaluated as FV, remaining indices as at least U1	One or more cardinal indices evaluated as U1	One or more cardinal indices evaluated as U2
Parameter "Conservation prospects of the habitat"	Assessment of realistic possibility for the maintenance of the habitat in an appropriate state, its current conservation status and factors that can affect it in the near future are taken into account. For segetal habitat it is particularly important to assess the possibility of further agricultural use	Conservation prospects for the habitat are good or excellent, no significant impact of threatening factors predicted	The real possibilities of the impact of threatening factors	Conservation prospects for the habitat are bad, strong impact of threatening factors observed, no survival of the habitat can be guaranteed in the longer perspective
Overall assessment		All parameters evaluated as FV	One or more parameters evaluated as U1, no U2 evaluations	One or more parameters evaluated as U2

Explanations: *cardinal index

habitats, which form a mosaic with other habitats, marking a transect of the envisaged dimensions was not possible in a single patch of the habitat, so the places for phytosociological relevés were chosen arbitrarily.

On each chosen site, we took 3 phytosociological relevé samples based on the classical Braun-Blanquet method (Dzwonko 2007) on the standard for nature monitoring plot sizes of 5m x 5m (Mróz 2010, 2012a,

2012b), or smaller, if the habitat covered a small area of the site or its size precluded making a standard phytosociological relevé.

The collected data were recorded on standard forms used for the monitoring of natural habitats (Mróz 2010, 2012a, 2012b). The form consisted of several parts: a natural habitat observation sheet for the monitored location, assessment of the habitat conservation status at the site, a list of current impacts and threats (and future foreseeable impacts), and other information (Bomanowska 2013a, 2013b; Kirpluk 2013a, 2013b).

2.4. Parameters and indices of conservation status

The current conservation status ("condition") of the monitored habitats was assessed on the basis of three groups of parameters: (*i*) surface area of the habitat within the conservation area, (*ii*) specific structure and functions, (*iii*) conservation prospects of the habitat. Each of the parameters presents a synthetic description of a group of the characteristics of monitored habitats, as well as factors affecting them (Tables 1-2). Parameters adopted for synanthropic habitats conform to the recommendations in the SEMP and the scale of evaluation was the same as that used in the monitoring of natural habitats: FV – favourable status; U1 – unfavourable, inadequate; U2 – unfavourable, bad (Mróz 2010, 2012a, 2012b).

The way of evaluating the "surface area" and "conservation prospects" parameters is the same for all natural habitats. The "specific structure and functions" parameter describes these features which distinguish a given habitat and decide about its unique nature. Therefore, the indicators included in this parameter were matched individually. The scope and methods of measuring the indices are given in tables (Tables 1-2). Two new indices were introduced, i.e. "archaeophytes" and "anthropogenic pressure". Almost all typical synanthropic communities are formed by archaeophytes, which are often dominant in species composition (Matuszkiewicz 2008; Balcerkiewicz & Pawlak 2010). A decrease in the share of this group of species may indicate the degeneration of a plant community. The index "anthropogenic pressure" defines the effects of human activity (techniques and intensity of soil cultivation and modes of crop cultivation, level of agro-chemical inputs, and other anthropogenic impact factors) that enable the maintenance of that habitat. A more detailed definition of "alien invasive species" was established because alien species, including invasive ones, are an integral component of synanthropic communities and some of them are characteristic or distinguishing species for syntaxonomic units, such as: *Anthoxanthum aristatum*, *Echinochloa crus-galli*, *Galinsoga ciliata*, *G. parviflora*, *Setaria viridis*, *S. glauca* and *Veronica persica* (Matuszkiewicz 2008). These are also species considered as invasive in Poland (Tokarska-Guzik *et al*. 2012). Because of their diagnostic value, their presence in the described communities was not considered as a decrease in the community's value, unless they reached a considerable (over 50%) cover rate in the monitored location. For segetal habitats, we did not use the commonly used for non-forest habitats index "expansion of shrubs and underwood", because this index provides information on succession in phytocenoses, which in agricultural phytocenoses occurs after farming was abandoned, i.e., when the major factor determining their existence was eliminated.

The following cardinal indices with particular significance for the assessment of the conservation status of discussed habitats were established after the analysis of collected data: typical species, archaeophytes, native expansive species of herbaceous plants (only segetal habitats), anthropogenic pressure (Bomanowska 2013a; Kirpluk 2013a). The values of the used indices for the status of monitored habitats, expressed numerically or descriptively, were evaluated similarly as parameters of the conservation status, on a three-level scale (FV, U1, U2; Tables 1-2).

Because of the adopted methodology (no transect was established) parameters and indices were used for the evaluation of the whole habitat on the site.

Methodological records, with a detailed description of research procedure and reports on the carried out monitoring, including reporting forms for individual sites, maps of monitoring locations prepared in ArcGIS and photographic records, were submitted to the Monitoring Department of Kampinos National Park.

3. Results

3.1. Phytosociological identifiers of monitored habitats

During field research carried out in the segetal habitats under a monitoring project, we identified six plant communities: two associations and two communities of cereal weeds from the *Centauretalia cyani* order in winter cereals (rye and triticale), i.e., *Arnoserido-Scleranthetum*, *Spergulo-Veronicetum dillenii*, community from *Aperion spicae-venti* alliance, transitional community *Arnoserido-Scleranthetum – Papaveretum argemones*, and two associations of root crop weeds from the *Polygono-Chenopodietalia* order formed in potato fields and in garden plants, i.e., *Echinochloo-Setarietum* and *Galinsogo-Setarietum*.

In the ruderal habitats, five plant communities were identified: two associations of annual and biennial ruderal weeds from the *Sisymbrietalia* order: *Sisymbrietum sophiae* and *Urtico-Malvetum neglectae*, and three associations of perennial nitrophilous weeds from the *Artemisienea* subclass: *Berteroëtum incanae*,

Table 2. Description and evaluation of parameters and indices of the specific structure of the habitat, as well as "conservation prospects" for ruderal habitats in the Kampinos National Park (according to Kirpluk 2013a, amended)

Parameter/Index	Description	Status		
		Favourable (FV)	Unfavourable, inadequate (U1)	Unfavourable, bad (U2)
Parameter "Surface area of the habitat"	An assessment of the changes in surface area (stable, increases or decreases) occupied by the habitat and its dynamics is required	Does not change or increases	A slight decrease in the habitat area in comparison with previous studies or cited in references	An evident decrease in the habitat area in comparison with previous studies or cited in references
Parameter "Specific structure and functions"				
Spatial structure of the habitat patches	Determination of the habitat fragmentation level (high, medium or low) in the ordering scale and quoting the areas of particular habitat patches in the location. The indicator shows the patchiness of the habitat. The well-preserved ruderal habitat is relatively slightly fragmented, although the presence of patches is always determined by local development, presence of roads, etc. Fragmentation of this habitat in KNP mainly results from the dynamics of vegetation associated with change in use, less often with change in edaphic factors, e.g., land overdrying, formation of brushwoods during succession, etc. Only in cases when high fragmentation is associated with the use of area, it can be considered adequate	Lacking or slight fragmentation	Average fragmentation level	High fragmentation level
*Typical species	List of typical species for the habitat includes characteristic and distinguishing species for *Artemisienea* subclass and its lower syntaxonomic units and for *Sisymbrietalia* order, *Sisymbrion officinalis* alliance and their lower syntaxonomic units. A list of typical species with their approximate percentage of coverage (with an accuracy of 10%) in the location should be given	Numerous species and with significant coverage (3 or more on the Braun-Blanquet scale)	Clear reduction in the quantity and coverage of typical species	No typical species or one of them with insignificant coverage
Dominant species	This index describes the structure of plant communities in the monitored location, as well as their conservation status (or, possibly, the degree of their deformation). It answers the question of whether the species characteristic of the habitat dominate in the monitored location. The index describes the presence of co-dominant and dominant species (score 3 or more on the Braun-Blanquet scale). If dominant species are species typical for the habitat, the index is evaluated as adequate. However, if invasive species, trees or shrubs are dominant, the index value is decreased. A list of species dominating in the location and their approximate percentage coverage (with an accuracy of 10%) should be given. Only species with the highest coverage in the location (≥ 10%) should be replaced	Species characteristic of the habitat dominate, or no dominant present	Clear reduction in the quantity and coverage of typical species	Among dominants, expansive species or species alien to the habitat in ecological terms are present
*Archaeophytes	Index describes the share of archaeophtes, e.g. alien species established in Polish flora, which arrived in "ancient" times (prior to 1492). Typically formed ruderal communities are characterised by a significant share of species from this group. A reduced number of archaeophytes indicates the degeneration of the community and reduces the index value. A list of archaeophytes and their approximate percentage coverage (with an accuracy of 10%) should be given	Numerous (≥5)	Several (2-5)	One sp. or none

Parameter/Index	Description	Status		
		Favourable (FV)	Unfavourable, inadequate (U1)	Unfavourable, bad (U2)
Alien invasive species	This index describes the degree of deformation of the habitat and share of geographically alien species considered as invasive in Poland. The presence of even single individuals ("+" for quantity on the Braun-Blanquet scale) should be associated with a decreased index value. Ruderal communities, despite being formed largely by alien species, are not characterised by the presence of invasive species. An exception to this case are phytocenoses of the *Sisymbrietalia* order, where alien invasive species are present. In this case, these species should not be taken into consideration unless their coverage is significant (more than 50%). A list of invasive alien species should be given together with their percentage proportions (with an accuracy of 10%)	No invasive species and/ or the total coverage of invasive species characteristic for *Sisymbrietalia* <50%	Single individuals of invasive species with a total coverage <5% or coverage of invasive species characteristic for *Sisymbrietalia* <50%	Coverage of invasive species ≥5% and/or total coverage of invasive species characteristic for *Sisymbrietalia* ≥50%
Expansion of shrubs and under growth	This parameter characterises the threat that the habitat will be overgrown by shrub formations and forest communities. The indicator is described by the total coverage of shrubs and underwood in the location. The described habitat is found in mosaic systems with other anthropogenic communities, not considered in the study, and next to overgrowing meadows and forest communities, so the encroachment of shrubs and trees is a natural process. However, if this process is combined with less intensive agricultural use and even anthropogenic pressure causing changes, the habitat becomes strongly or completely degraded. A list of tree and shrub species occurring in the location should be given together with the approximate percentage coverage (with an accuracy of 10%) by each species and the total coverage by all trees and shrubs	Total coverage in the location <1%	Total coverage in the location 1-5%	Total cover in the location >5%
*Anthropogenic pressure	This index describes the effect of human activity (management and other anthropogenic factors affecting ruderal habitats) that allow for the preservation of the habitat	Adequate (extensive methods of management)	Decreased extensive management or increased effect of other anthropogenic factors	Lack of extensive management or other strong anthropogenic pressure
Habitat surface area of variable preservation status on the site	The index describes the surface area of habitat patches with a well-preserved species composition. The percentage share of well-preserved patches should be specified with respect to those transient, atypical, degraded, including expansive species, etc. Typical patches are identified with consideration of the share of species typical for the plant community	Well-preserved patches cover ≥50% of the site surface area	Well-preserved patches cover <50% of the site surface area or generally patches are not very typical, but there are no poorly preserved patches	Well-preserved patches cover <50% of the site surface area and poorly preserved patches are present
Assessment of Parameter "Specific structure and functions"		All cardinal indices evaluated as FV, remaining indices as at least U1	One or more cardinal indices evaluated as U1	One or more cardinal indices evaluated as U2

Parameter "Conservation prospects of the habitat"	Assessment of realistic possibility for the maintenance of the habitat in an appropriate state, its current conservation status and factors that can affect it in the near future are taken into account. For ruderal habitats it is particularly important to assess the possibility of further extensive use	Conservation prospects for the habitat are good or excellent, no significant impact of threatening factors predicted	The real possibilities of impact of threatening factors	Conservation prospects for the habitat are bad, strong impact of threatening factors observed, no survival of the habitat can be guaranteed in longer time perspective
Overall assessment		All parameters evaluated as FV	One or more parameters evaluated as U1, no U2 evaluations	One or more parameters evaluated as U2

Explanations: *cardinal index

Leonuro-Ballotetum nigrae and *Arctio-Artemisietum vulgaris*.

3.2. Evaluation of the preservation status of plant communities

The parametric evaluation of the monitored sites provided variable results (Tables 3-4). A reference segetal location was not indicated. Phytocenoses best reflecting the monitored habitat included those of the *Arnoserido-Scleranthetum* association on the Mariew II site, formed in winter rye, the community from the *Aperion spicae-venti* alliance identified in household winter rye and triticale on a Józefów site, the *Galinsogo-Setarietum* association, formed in

Table 3. Evaluation of the conservation status of segetal habitats in the Kampinos National Park

Monitored location	Assessment of the parameter			
	Area of the habitat	Specific structure and function	Conservation prospects	Overall assessment
Cisowe (*Echinochloo-Setarietum*; household potato cultivation)	FV	FV	FV	FV
Górki (*Echinochloo-Setarietum*; potato cultivation)	FV	U1	FV	U1
Józefów (community from *Aperion spicae-venti* alliance; household winter rye and triticale cultivation)	FV	FV	FV	FV
Kiścinne (*Spergulo-Veronicetum dillenii*; winter rye cultivation)	FV	U1	FV	U1
Łubiec (*Arnoserido-Scleranthetum*; triticale cultivation)	FV	U1	FV	U1
Mariew II (*Arnoserido-Scleranthetum*; household winter rye cultivation)	FV	FV	FV	FV
Nowa Dąbrowa (*Echinochloo-Setarietum;* household winter rye cultivation)	FV	U1	FV	U1
Sieraków (*Galinsogo-Setarietum*; household vegetable cultivation)	FV	U1	FV	U1
Stara Dąbrowa (*Galinsogo-Setarietum*; household potato and vegetable cultivation)	FV	FV	FV	FV
Wiersze (*Arnoserido-Scleranthetum–Papaveretum argemones* community; household winter rye cultivation)	FV	U1	FV	U1
Total	FV – 10 U1 – 0 U2 – 0	FV – 4 U1 – 6 U2 – 0	FV – 10 U1 – 0 U2 – 0	FV – 4 U1 – 6 U2 – 0

Explanations: in parentheses – the identified phytosociological unit and the type of segetal habitat (type of crop); the values of the parameters for the status of monitored habitats, FV – favourable status, U1 – unfavourable, inadequate, U2 – unfavourable, bad

Table 4. Evaluation of the conservation status of ruderal habitats in the Kampinos National Park

Monitored location	Assessment of the parameter			
	Area of the habitat	Specific structure and function	Conservation prospects	Overall assessment
Buda (*Leonuro-Ballotetum nigrae*) near cottage and building foundations	FV	U1	U1	U1
Granica (*Leonuro-Ballotetum nigrae; Urtico-Malvetum neglectae*) cottage yard: near cottage and fence	U1	U1	U1	U1
Józefów I (*Arctio-Artemisietum vulgaris*) cottage yard: near cottage and fence	FV	FV	FV	FV
Józefów II (*Sisymbrietum sophiae; Urtico-Malvetum neglectae*) cottage yard: near fence	U1	U1	U1	U1
Rybitew I (*Arctio-Artemisietum vulgaris, Leonuro-Ballotetum nigrae*) cottage yard: near cottage	FV	FV	U1	U1
Rybitew II (*Arctio-Artemisietum vulgaris*) roadside	U1	U1	U1	U1
Sieraków (*Urtico-Malvetum neglectae*) cottage yard: near cottage	U1	FV	FV	U1
Zamość I (*Leonuro-Ballotetum nigrae*) near cottage	U1	FV	FV	U1
Zamość II (*Leonuro-Ballotetum nigrae*) cottage yard: near cottage	U1	U1	U1	U1
Zamość III (*Berteroetum incanae*) roadside	U1	U1	U1	U1
Total	FV – 3 U1 – 7 U2 – 0	FV – 7 U1 – 3 U2 – 0	FV – 4 U1 – 6 U2 – 0	FV – 1 U1 – 9 U2 – 0

Explanations: in parentheses – the identified phytosociological unit and the type of ruderal habitat; parameter values for the status of monitored habitats, FV – favourable status, U1 – unfavourable, inadequate, U2 – unfavourable, bad

household vegetable and potato cultivation on a site in Stara Dąbrowa, and the *Echinochloo-Setarietum* association in household potato cultivation on a site in Cisowe (Table 3). In all these sites, all the indices describing the plant community indicated its favourable status. On the other six sites, the overall evaluation was unfavourable (Table 3). Lower scores of the evaluation in three cases (sites: Górki, Nowa Dąbrowa and Sieraków) were attributed to the presence of invasive species, inadequate value of a parameter regarding "specific structure and functions", reduced by incorrect agricultural technique on two monitored sites (Kiścinne and Wiersze), and the presence of both these factors on one site (Łubiec).

For ruderal habitats, all the indices describing plant communities were evaluated positively only in one case and only one reference ruderal site, i.e. the *Arctio-Artemisietum vulgaris* association on the Józefów I site was indicated. Other well-preserved communities were the *Urtico-Malvetum neglectae* association on a site in Sieraków and the *Leonuro-Ballotetum nigrae* association on the Zamość I site (Table 4). On the other eight sites, the parametric evaluation of the habitat provided variable results and the status of ruderal communities was inadequate. This evaluation of preservation status for ruderal habitats in the villages of Kampinos region was mostly affected by two indices: surface area of the habitat and spatial structure of vegetation patches (in most cases evaluated as U1 unfavourable, inadequate). The patches of well-preserved ruderal habitats are difficult to distinguish and have very small surface areas, because cottages and their surroundings are no longer typical farms and are owned by private owners, so access to them is restricted. The evaluation was negatively affected by the index 'invasive species', which only in one case (Sieraków site) was evaluated as adequate.

3.3. Evaluation of influencing factors

We indicated the major factors influencing communities which are important today and may potentially pose a threat to the survival of the monitored habitats. The analysis of data collected during the monitoring revealed that the main threats to synanthropic habitats in KNP are: cessation of use – cessation of farming initiates secondary succession on segetal habitats, depopulation

of households and demolition of buildings, followed by ploughing, which destroys ruderal habitats irreversibly. One serious threat to segetal habitats is the replacement of organic fertilizers with mineral ones (mostly artificial nitrogen fertilizers) and the increased use of chemicals for plant protection (authors' personal observations and information obtained from the owners during the monitoring studies), which causes the degradation of agricultural habitats.

The persistence of ruderal communities near cottages, fences, rubbish heaps, etc., is threatened by changes in the use of cottages and the lack of typical rural yards. Most cottage yards are very neat, surrounded with concrete or metal fencing, often paved, and the owners of cottages do not keep farm animals anymore, even chickens or other poultry that could walk around the property. In many places organic waste is not dumped anymore, or rubbish heaps no longer exist. This limits the supply of nutrients, particularly nitrogen, to the soil, which disables the persistence of nitrophilous ruderal communities. On the roadsides, ruderal communities are often threatened by frequent mowing, which leads to the dominance of grasses in ruderal habitats and the withdrawal of some other species (authors' personal observations).

The invasion of alien species is a negative factor for both types of communities. This mainly refers to *Acer negundo*, *Echinocystis lobata*, *Robinia pseudoacacia* and *Solidago gigantea*.

4. Discussion

4.1. Benefits and limitations of the implemented monitoring

As shown above, with the use of methodology compliant with the recommendations of SEMP, we were able to obtain detailed information on the current status of synanthropic habitats allowing the evaluation of their conservation status, threats and conservation prospects. The collected data allow counteracting the observed negative changes and taking up specific conservation measures.

The focus on detailed aspects during the monitoring study also allowed us to evaluate the preservation status of individual synanthropic species, including the identification of new sites of species endangered in Poland, such as *Asperugo procumbens* (E; Zarzycki & Szeląg 2006), and species valuable for the area of KNP, such as: *Arnoseris minima* and *Malva pusilla* (Kirpluk & Bomanowska 2008).

Developing and applying a uniform organisational-methodological system of monitoring for the discussed habitats enables us to link the monitoring of the conservation status of synanthropic habitats with the monitoring of natural habitats in KNP.

The appropriate interpretation of results requires additional information about synanthropic habitats, regarding, for example, carried out agrotechnical practices – their intensity and type, weed control methods, use of chemicals for the protection of crops, fertilization of arable fields, and also potential changes in the type of use on the monitored sites in the future. Such additional information could be obtained from land owners in direct conversation, or based on a brief interview using a short questionnaire.

However, the most important factor distinguishing this type of nature monitoring from the monitoring of natural habitats, and at the same time limiting the actual possibility of carrying out field research, was the fact that almost all synanthropic habitats are located on privately owned land. Owners' permission is always required to carry out research, and it cannot be obtained in all cases. Therefore, it is important to arrange the study site with a local forester, who might provide great assistance in searching for suitable sites, and in negotiations with local people. Research was carried out in selected places, agreed with the land owners and indicated by the Forestry Service of Kampinos National Park. This, beyond any doubt, affects the value of the monitored habitats.

The locations chosen for monitoring should be suitable for repeated research on the same sites (Mróz 2010, 2012a, 2012b). Monitoring means maintaining regular surveillance by making measurements at regular time intervals over an indefinite, usually long, period of time. The length of time is fundamental to the design and purpose of all nature monitoring programmes (Vaughan *et al*. 2001; Legg & Nagy 2006; Lindenmayer & Likens 2009). For this reason, in some cases, despite available permission for observations, the monitoring was abandoned because land owners provided information about the changes in habitat use or plans for its total destruction in the near future. Therefore, our choice was focused on the places where segetal and ruderal habitats in KNP are still identifiable and where there is a chance for their preservation.

Monitoring was carried out in all potentially accessible locations of the habitat because of its limited acreage in the KNP, high dynamics, and threats posed by natural (secondary succession) and anthropogenic factors (change in land use, including purposeful actions of the park administration). Therefore, pilot field research was necessary, after which locations best representing the preservation status of the habitat in this area were chosen.

Unfortunately, because the monitoring sites are located on privately owned arable fields, it is very difficult to limit the negative effects of the factors we identified, similarly like the implementation and enforcement of the active methods of protection.

4.2. Recommendations and prospects

Despite the existing limitations, the evaluation of the conservation status of synanthropic habitats based on the results of monitoring of the sites should be continued in the future in the area of KNP, and, whenever possible, implemented in other protected areas. It can be implemented in national parks where, as in KNP, synanthropic habitats are a permanent element of nature and landscape (e.g., Wielkopolska NP or Narew NP).

The developed and implemented methodology designed according to SEMP are useful for synanthropic habitats, although the guidelines should not be applied automatically, but instead treated as a 'conceptual framework', and the planning of conservation for such habitats should also involve other concepts.

Ruderal and segetal habitats cannot be analysed jointly, as these habitats differ in terms of characteristic species. Because of the significant threats to habitat status, and the rapid changes that are taking place in KNP, monitoring research should be repeated in a 2-3-year cycle.

Importantly, this is the first proposal for the standardized monitoring of synanthropic habitats, and, thus, it will be revised in future in line with further experience and new findings.

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