

2nd modified edition

XI. HABITAT MAPPING



**National
Biodiversity monitoring
System**

NATIONAL BIODIVERSITY MONITORING SYSTEM XI.

Habitat mapping
2nd modified edition

Edited by Gábor Takács & Zsolt Molnár

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Table of Contents

I. Application of Habitat Mapping in Biodiversity Monitoring.....	7
I.1. Conceptions and Aims of Vegetation Mapping	7
I.1.1. Description of Areas	7
I.1.2. Comparison of Areas.....	8
I.1.3. Monitoring, Repeated Mapping	8
I.2. Competence and Ability Required, Phases of Work	10
I.2.1. Competence and Ability Required	10
I.2.2. Phases of Work	10
I.3. Preparations for Habitat Mapping	10
I.3.1. Technical Requirements.....	10
I.3.1.1. Topographic Maps.....	10
I.3.1.2. Orthophotos (Aerial Photos)	12
I.3.1.3. Satellite Images	14
I.3.2. Historical and Other Background Materials.....	16
I.3.2.1. Sources of Data	16
I.3.2.2. Overview of Former Habitat Mapping(s).....	17
I.3.3. Work Map of Habitat Mapping	17
I.3.3.1. Characteristics of Work Maps.....	17
I.3.3.2. Technical Devices of Work Map Production	18
I.3.3.3. Plotting of the Work Map.....	18
I.3.4. Survey Route Plan.....	18
I.4. Field Work of Habitat Mapping	20
I.4.1.1. Preparations of Field Work	20
I.4.2. Field Work	21
I.4.2.1. Field Survey	21
I.4.2.2. Delineation of Patches.....	21
I.4.2.3. Habitat Classification	21
I.4.2.4. Classification of Patches	21
I.4.2.5. Comments on each Habitat Patch.....	22
I.4.2.6. Habitat Photos	25
I.4.2.7. Record of Route on a Separate Map.....	25
I.4.3. Posterior Field Survey	25
I.4.4. Documentation of Habitat Pattern and Habitat Quality Change	25
I.5. Processing and Archiving of Materials Produced by Field Work	27
I.5.1. Preparation for Archiving and Processing.....	27
I.5.2. Processing	27
I.5.2.1. Documentation of Habitat Mapping.....	27
I.5.2.2. Processing Habitat Mapping Data	28
II. GIS Processing of Former Mappings.....	35
III. Nature Conservation Information System (NCIS).....	36
III.1. Introduction	36
III.2. Goals and tasks of the Nature Conservation Information System (NCIS).....	36
III.2.1. Goals of NCIS	36
III.2.2. Tasks of NCIS	36
III.2.3. Conditions of proper functioning.....	36
IV. References Used and Recommended	37

PREFACE

This monitoring manual is the completely revised second edition of the book with the same title published in 1999. During the development and elaboration of the methodology of National Biodiversity Monitoring System we could rely on the results of test habitat mapping performed at Tiszabercel in 1996, repeated later in 2000, the habitat mapping made in Duna-Tisza-köze (Biró 2006) and also monitoring experience of the last 10 years (more than 100 maps). By today within the scope of the National Biodiversity Monitoring System nearly 3 % of Hungary was mapped at the scale of 1: 25 000. Since each map was quality controlled by experts we have a comprehensive view of the possibilities and limitations of this mapping method.

Why was there a need for the revised second edition? In one respect remote sensing and GIS, supporting the mapping, have developed significantly (the spread of georeferenced aerial photos and high resolution satellite images, development of softwares), in other respects the number of vegetation maps has been multiplied, thus a lot of new mapping experience has been accumulated. Remapping requires certain methodological changes precisely because of the repetition.

The primary aims and main products of biodiversity monitoring based on habitat mapping have not changed in the past 10 years therefore neither has the chapter structure of the book. The composition of the volume is the same as the order of working phases.

Parallel with textual description of tasks we also present the maps and summary tables prepared as the result of certain phases during habitat mapping. In some cases we publish data (contact and collection address), that are true at present but might obviously change in the future.

Since the development of mapping, remote sensing and GIS will not stop in the future, further update and revision of the material will certainly be necessary. Any comments are welcome.

The editors

Introduction

The Hungarian National Biodiversity Monitoring System was launched by a series of manuals ten years ago. These manuals can not only be used by professionals, but any other people interested in nature. The manuals are professional books containing both the theoretical and practical aspects of biodiversity monitoring. Biodiversity monitoring focuses on populations, communities, habitats and habitat complexes. The Hungarian National Biodiversity Monitoring System provides data for the Nature Conservation Information System (NCIS) on the state and change of the living world at different levels of organization to help nature conservation policy and practice. To monitor and protect nature is a common task of many people, and the increase of biodiversity loss demands detailed documentation of the survived biological heritage.

Monitoring needs precise, and long-term data collection and analysis to monitor the changes at the different organizational levels and at different spatial and time scales. The landscape scale is of prime importance, hence the habitat mapping has great emphasis in the Monitoring System. In the last 10 years cca. 3% of the country was already mapped in 5*5 km large quadrats, that will be repeated in the next 10 years. This monitoring will be a part of the new Natura 2000 habitat monitoring system.

Methodological experiences and technical improvements forced the up-dating of the 10 year old habitat mapping protocol. We hope that this new protocol will further improve the efficiency and quality of habitat mapping monitoring in Hungary!

Vácrátót, 2008. február 11.

Edit Kovácsné Láng
the leader of the NBmR Board of Experts

I. Application of Habitat Mapping in Biodiversity Monitoring

Prior to every monitoring the fundamental question should be: what is the exact aim of the survey? This knowledge is the most important precondition to design sampling, to choose and use the method. However we cannot generally foresee the future directions and extent of vegetation changes. The aim of monitoring is often to understand the studied system better by observation of changes that cannot be accurately predicted and by this means e.g. to improve the effectiveness of nature conservation.

If the purpose of monitoring is to track the vegetation changes at landscape level then we often choose some sort of mapping method. In many cases, however, a more accurate result can be expected e.g. by point sampling, recording vegetation features along transects, by taking aerial photos or document photos, than by mapping. The first problem to study: is really mapping the most appropriate method in the specific situation? Can we map the relevant feature of the vegetation? Mapping of the relevant features is often limited or of restricted accuracy. Why is then mapping used so widely for monitoring?

Mapping, if it is performed really consequently makes the parallel documentation of several vegetation characteristics possible, the result is a spatially detailed multilayered GIS database. Even if the future changes are unforeseen, this multilayered database could provide a reference to analyse vegetation changes over decades.

During the habitat mapping program of the Duna-Tisza-köze (Biró et al. 2006), a new method was developed. Although the legend of the mapping method is defined (the so-called Á-NÉR1997 and Á-NÉR2007 habitat classification systems has to be used, see National Habitat Classification System, Fekete et al. 1997, Bölöni et al. 2003, 2007), but at the patch level all possible category combinations can be used, hence a wide variety of cases can be classified. The common legend increases comparability. As a novelty, for each vegetation patch, a short textual description has been prepared accompanied by a short list of species. All habitats of the mapped area has to be described on the pre-prepared data sheets, a mapping route has to be drawn, the landscape has to be documented in a structured way (for other details see chapters II.4. and II.5.). Though mapping always remains a subjective method, this complexity of documentation helps the subsequent mappers not only to imagine the past vegetation pattern, but also to have some information on the previous mappers' botanical knowledge, concepts, practice. This information transfer will increase the comparability of the maps.

I.1. Conceptions and Aims of Vegetation Mapping

There are three types of vegetation mapping considering the conception and aim:

- for the description of a selected area,
- for the comparison of areas
- mapping executed in a certain area for comparison of states in different times.

We analyse the differences of these aims below.

I.1.1. Description of Areas

Most vegetation maps prepared formerly and even today are only for description and presentation. Since most mapper generally has exact conception about the purpose of mapping, they choose description oriented and/or locality specific legend and mapping methods.

Mapping works of the famous mapping generation of the 1950ies were description oriented (Fekete 1980, 1998). The main aim at this period was to describe the static states of vegetation units on maps. Plant associations were mapped with special emphasis on zonal vegetation. Legend was specific for the specific mountain at first, later the list of plant associations described less or more accurately became the legend at national level. Later the evaluation and mapping of the natural value of the vegetation became an important aim (see e.g. Seregélyes and Csomós 1995). Seregélyes also created 'value' maps by using a five grade scale (for the system see Németh and Seregélyes 1989). Phytosociologists (e.g. Bagi 1991, 1997) elaborated legends based on a fine classification of plant associations and subassociations, which could have been used for the classification of vegetation patches at different dynamic states. In the last few years maps based on landscape and land-use history oriented legends were published (e.g. Biró et al. 2006).

The great advantage of the locality specific legend is that the consideration of local characteristics is possible thus patch classification is probably not so 'forced'. Almost all plant association based vegetation maps were like this at first. The aim was then to describe local units. Later vegetation maps often became only illustrations.

Nowadays maps with locality specific legend are drawn first of all because the vegetation pattern of a specific landscape is the most important aim to document. It is achieved by searching the most important attribute of local vegetation then a local legend is elaborated. The great advantage of this method is that the aim of classification is generally not the description of new syntaxons and there is no pressure like e.g. searching

character species.

The Á-NÉR habitat classification is usually not suitable as a legend for local, specific descriptive purposes. It is a multipotent (that is 'without purpose') and rather coarse legend.

The great advantage of purpose oriented and locality specific maps is that they accurately and properly document the vegetation pattern of a specific landscape, their great disadvantage on the other hand is that they can only be used for comparisons with restrictions. In the past few years more and more experience – though unpublished - have been accumulated about what restrictions traditional plant association maps (with descriptive purpose) have as an historic reference of vegetation change.

I.1.2. Comparison of Areas

Qualitative comparison of vegetation pattern of different areas is an old tradition in Hungarian botany. However quantitative comparative analyses of patterns is rather rare, where we are eager to know the differences in patch size, neighbourhood, heterogeneity, fragmentation etc. of landscapes (e.g. Fekete and Fekete 1998).

Precondition of comparison is that the legends of maps must have the same meaning and mapping should be done by the same conception (scale, the decision algorithm of patch delineation, etc.) This can almost only be realized if the maps are prepared by the same person, not forgetting that they are drawn for comparison.

By reason of these above, the task to compare the maps – often made for various purposes - of various persons is very difficult and requires the greatest possible care.

In recent years vegetation database of MÉTA project, documenting the vegetation heritage of Hungary, has been created (Molnár et al. 2007). Since 200 botanists participated in the mapping, the map of Hungary might be considered as vegetation maps of various mappers placed side by side. In order to be able to compare and summarize these unique maps at national level a standardized methodology must have been elaborated (legend, grid net, fixed and textual documentation of mapping algorithm, same remote sensing background materials, data sheets, methodology tested by many experts on field) and this methodology must have been taught to mappers, quality control and homogenization must have been run on the results. The results so far show that maps drawn by various mappers are not completely made by the same methodology in spite of these preparations, so the database is not homogeneous. The experiences of MÉTA show that vegetation mapping can only be standardized to some degree, some elements can be standardized more, others less.

I.1.3. Monitoring, Repeated Mapping

We mentioned in the subchapter above what difficulties might there be at the comparison of vegetation pattern of different areas. It is even more difficult to analyse several vegetation maps of a certain area from different dates (not only 2, but 5-10), namely vegetation monitoring.

We are aware that standardized methodology is needed for mapping for monitoring. We also know that mapping always remains subjective, and there will never be a habitat classification system, that is easily applicable to any vegetation patch in the country.

Hereafter the question has arisen if it is possible to have the same legend in each dates. It seems obtainable, but according to experiences the same legend is interpreted differently by various experts. It often occurs that mappers do not exactly know what should be meant by each category. The reason for this generally is that the documentation of former mappings are incomplete, scientific literature is deficient or out-of-date, the knowledge of scientific literature and also the knowledge about the diversity of the vegetation types in the landscape are insufficient. Á-NÉR habitat classification with its long textual descriptions is intended to reduce this problem, but it could only reduce it. It helps a lot if every mapper reads the category descriptions of former mappers and tries to draw the new map according to their conception.

If the key they use is very defined and not flexible, then forced classification into categories is the main problem. Transitions, degraded stands are difficult to manage like this. Although the keys of Á-NÉR habitat classification system are defined but they can be adapted flexibly during mapping, that is why they can be suitable for monitoring. Variances of types, local characteristics can be given easily in patch descriptions. Category combinations can also be given, what makes the management of diversity possible without increasing category numbers endlessly.

Another solution might be the 'fuzzy' classification. In this case each patch is described compared to several 'types', eg. percentage of meadow and forest character. But it is also a problem how mappers interpret the type and how they 'measures' the distance from the type.

Another important question is if it is possible to standardize the drawing of patch borders. In the 1950ies, when zonality, neighbourhood, abiotic factors were the aims to study, the exact boundary was not so important (suitable base maps were not available because the fine scale topographic maps were secret). Nowadays – first of all influenced by nature conservation, but it is also more emphasized in basic researches – the aim is to draw exact

patch borders. It is also a difficult task to standardize. The solution seems even more difficult in this case than patch classification. The problem apparently can be evaded by producing raster maps. Then dominant type or an 'important' feature of the vegetation is given in each specific grid cell. This mapping method shows the patch boundary not as a line, but displays in compliance with the resolution of the specific grid. Another advantage of the method, that it describes intra-patch heterogeneity more accurately. The advantage of raster maps is a disadvantage at the same time, since we might lose the possibility for accurate patch delineation and significant information loss might we have if we do not choose the appropriate grid size. Mapping based on field work with extreme small grid size, however, might demand significant additional work.

Comparison of maps with monitoring purposes made in different dates is greatly helped if the present mapper knows and acknowledges the vegetation concept of the predecessor(s) and prepares the new map by the thorough knowledge of the former documentations. Thus we can significantly improve the accuracy and reliability of time analyses. As it can be seen later, analyses are not only done by GIS but the actual mapper is asked to document the spatial and biological changes.

As a summary we must emphasize that mapping with Á-NÉR categories and with the habitat mapping method described in this book seems to be the most suitable for documentation of vegetation pattern of bigger areas for monitoring changes.

I.2. Competence and Ability Required, Phases of Work

I.2.1. Competence and Ability Required

To execute habitat mapping, experts with suitable competence and ability are required. The good mapper should know these:

- The knowledge of Hungarian flora at a level that identification of even the most questionable taxon (grass, sedge) is not a problem, also to know the indicator values, plant association preference of species (see Horváth et al. 1996, Simon 2000, Borhidi 2003). Profound knowledge of Á-NÉR category system (see Fekete et al. 1997, Bölöni et al. 2003, 2007) is also essential, this is acquired by reading it several times, field practice, learning habitat classification by participation on course and collective mapping practice.
- Experience in interpretation of aerial and satellite images and the knowledge of relevant scientific literature.
- Cartographic basic knowledge (cartography manuals): legend, map reading, generalization experience, map drawing knowledge
- Fitness for field work, orientation ability, conscientiousness, enthusiasm, reliability as the conditions of accurate work
- Good organizing ability.

I.2.2. Phases of Work

The work is practically divided into phases below, which follow each other in order and cannot generally be changed. Description of work phases corresponds to the chapters of this manual. The phases are the following:

- Preparation: maps, photos, obtain literature data, establish technical requirements, preparatory work done at home (especially 'studying' the methodology and Á-NÉR).
- Precursory field survey: gathering information on local relations (e.g. approachability, closed areas), checking the usefulness of maps and aerial photos.
- Field work: preparation of field work, approaching the area, mapping, documentation of the route.
- Data processing: digitizing habitat maps, data sorting into standardized database, preparation of a so-called change map, assembling the report.
- Posterior field survey: supply lacks arisen during processing, checking maps, making the final report.
- Optional analyses: special, appropriate GIS processing, making derived maps, etc.

I.3. Preparations for Habitat Mapping

I.3.1. Technical Requirements

The task of preparation phase is to set up the technical conditions and obtain required raw material of mapping. This means the purchase of maps, aerial and satellite images. If the date (year) of mapping is known, it is practical to start preparations in the previous year. During preparation the following material should be obtained:

- topographic map at scale 1:10 000 (compulsory)
- current, digital orthophoto-map or current big resolution satellite image (compulsory)
- orthophoto-map made from archive aerial photos (at least one is compulsory, the others are optional)
- historical maps in paper or digital format (compulsory)

I.3.1.1. Topographic Maps

Topographic maps are the most widely used maps since they represent the artificial and natural features of the landscape with accurate details, they have high geodetical and projection accuracy. Their scales are between 1:10 000 and 1:1 000 000. By decreasing scale generalization is increasing. Bigger scale topographic maps (1:10 000 and perhaps 1:25 000) are drawn by direct surveys while smaller scale ones are prepared cartographically by simplification and generalisation of original surveys. (Sárközi: http://www.agt.bme.hu/tutor_h/terinfor/tbev.htm; Kaszai, 1995).

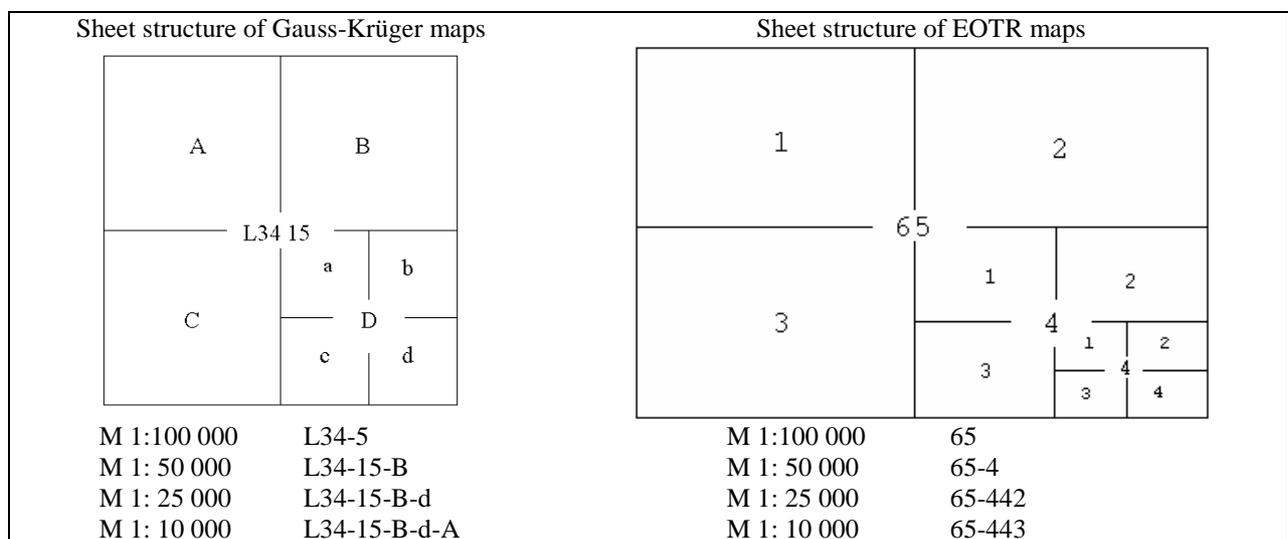
Topographic maps use shifted plotting and symbols. It means if objects have too small basic areas, they are not drawn in size on the plan, they are drawn with a much bigger symbol size than their size would be on the

map. It might result in hiding other objects or their symbols. To avoid this kind of covering the topographically less important object is shifted. It should also be considered, that there are also artificial distortions on the maps, but there is no information about their positions.

In the course of habitat mapping the use of topographic maps with the highest resolution available is practical, from which two different projection and sheet types of detailed topographic map series are at disposal. Both of them have a map series in 1:10 000 scale, which covers the total area of the country, but the date of the last mapping might be very different. The maps of EOTR (Hungarian National Map System) are mainly for public use while the maps with Gauss-Krüger projection system are for military purposes. Following the political transformation in 1989 both became available for public use too.

EOTR (Hungarian National Map System) is a map system of large scale (Cadastral) and topographic maps in EOV (Unified National Projection System). At this projection the projection plane is divided by straight lines - that are parallel to the axis of the coordinate system - into 48 000 m wide columns and 32 000 wide layers. Rectangles, obtained this way, present the area of 1:100 000 scale sheet each, sheets in larger scales represent one sheet series within it. Serial dividing of sheets into four parts 1:50 000 scale sheets can be obtained first from a 1:100 000 scale sheet, then 1:25 000 scale sheets, and 1:10 000 scale sheets at the end.

Figure 1. Sheet structure of Gauss-Krüger and EOTR maps (Source: Magyarai 2007)



Gauss-Krüger projection map sheets are based on the grid system of the international world map at scale 1:1 000 000. The surface of the Krassowski ellipsoid is divided into zones six degrees wide by meridians and zones 4 degrees wide by parallel circles. The borders of the zones are not parallel to the axes of the coordinate system, but they are the images of the lines of the the grid system, thus they are curved lines theoretically. Zones North and South to the Equator are marked by letters of the alphabet (A, B, C), meridional zones are marked by numbers from 1 to 60 proceeding towards East, starting with the meridian opposite to Greenwich. The sign of a 4° x 6° size ellipsoid square is a big letter and a number. Four 1:1 000 000 scale sheets cover the area of Hungary: L-33, L-34, M-33, M-34. The improvement of 1:10 000 scale Gauss-Krüger projection maps has been stopped, so their possible use in habitat mapping will be more and more limited in the future.

Legend can be obtained to each map series, which helps the interpretations of rare and special symbols. For expert use of maps a basic cartographic knowledge and map reading practice is expedient.

The above mentioned maps can be purchased here:

- Ministry of Defence Mapping Company – Map shop address: 14. Fillér utca, Budapest, II. H-1024 (www.mhtehi.gov.hu)
- Institute of Geodesy, Cartography and Remote Sensing (FÖMI) - 5. Bosnyák tér, Budapest H-1149 (<http://fomi.hu>)

1.3.1.2. Orthophotos (Aerial Photos)

Aerial photos and orthophoto maps¹ are essentially used in habitat mapping. Accurate habitat-maps for large areas cannot be made without their use. At the second mapping period of National Biodiversity Monitoring System the use of digital orthophotos is a base requirement.

Aerial photo is a fundamental type of raw data gained by optical way of remote sensing. There are different types of aerial photos depending on the height of the shot, the film type, the focal length of the objective used and also the position of the optical axis of the camera compared to the horizontal plane. The most important parameter for habitat mapping is the height of shot (which influences the details of the photo) and the film type.

There are three main categories depending on the height, the boundary, however, between these categories are not clear-cut:

- small scale photograph (high fly), the film scale is between 1:30 000 and 1:60 000,
- medium scale photograph, the film scale is between 1:10 000 and 1:30 000,
- large scale photograph (low fly), the film scale is 1:5000 or bigger.

Medium scale photos are suggested to use in habitat mapping, since their cost is acceptable, the information content is highly adequate for the task. Low fly photos are sometimes useful for detailed vegetation maps of smaller areas especially for extremely mosaic landscapes.

There are four types respecting the raw material:

- films sensitive in the visible light range ($\lambda=0,35-0,73$ mm):
 - black and white (panchromatic)
 - true colour
- films also sensitive in near infrared range
 - black and white (between $\lambda=0,35-0,5$ mm and $\lambda=0,65-0,85$ mm),
 - false colour ($\lambda=0,5-0,85$ mm).

Photos recently taken are mostly true colour ones, rarely false colour (infra) pictures. Black and white images have not been taken in the past years, while we can find a lot among archive pictures.

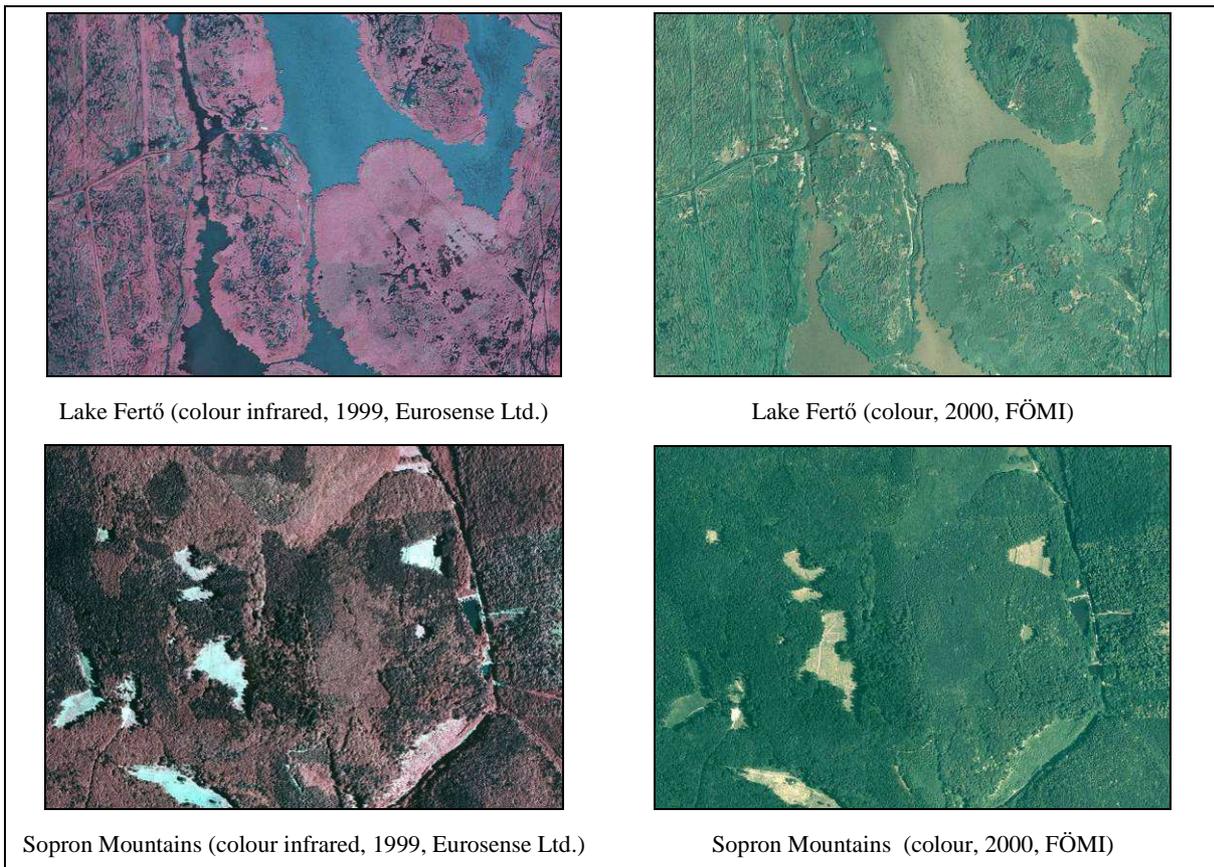
The types of aerial photos are determined by first of all the size of the area intended to map and sources available. The use of infrared images is more expedient in most cases since wet and dry areas, deciduous or coniferous woods and also grassland habitats, which cannot be separated on true colour images, can be separated well on them.

Current colour or false colour (infra) image series in digital format is necessary to obtain for habitat mapping. Pictures taken mainly in the last five years are considered current, however our aim is always to get the latest raw material. In certain areas (e.g. saline steppes or suburban areas) we might need a picture from the year of mapping. There are several companies in Hungary taking up aerial photography, the most well-known ones and their addresses are presented here:

- **Institute of Geodesy, Cartography and Remote Sensing (FÖMI):** Aerial photos taken by aerial topographic cameras in normal colour and colour infrared films, orthophotos. Address: 1st floor, 5. Bosnyák tér, Budapest H-1149 Phone: (+36 1) 3636670, website: <http://fomi.hu>
- **Hungarian Army Mapping Company:** Aerial photos taken by aerial topographic cameras in normal colour and colour infrared films, orthophotos. Address: 7-9. Erzsébet Szilágyi fasor, Budapest, II. H-1024 (+36-1) 2120807, Website: www.mhtehi.gov.hu.
- **Eurosense Kft. :** Aerial photos taken by aerial topographic cameras in normal colour and colour infrared films, orthophotos. Address: 200. Üllői út, Budapest XIX. Phone: (+36-1) 2822019. Website: www.eurosense.com.
- **Telecopter Kft.** Aerial photos taken by aerial topographic cameras in normal colour and colour infrared films, orthophotos. Address: 36. Kőberki u. Budapest, XI., Phone: (+36-1) 2120807, Website: www.telecopter.hu
- **VITUKI Rt., ARGOS Remote Sensing and Filmstudio:** Aerial photos taken by non-aerial topographic cameras in normal colour and colour infrared stereo films, termovisual images, digital photo- and thematic maps. Address: 1. J. Kvassay u. Budapest, IX. Phone: (+36 1) 2158160/23-71, Fax: (+36 1) 2161514.

¹ Photos of remote sensing are made by central projection. The map and the most of the projection systems used in geoinformatics are orthogonal projection of the surface. Relying upon these, the transformation of the central projection photo to the perpendicular one, the concept of ortho rectification or photo correction is next: the perspective photo or digital photo gained by remote sensing is transformed to a photo or digital photo without perspective distortions. Distortion free perspective photos are called orthophotos, digital photos are called digital orthophotos. If parallel to transformation alignment into a projection system is also done then we talk about orthophoto map or digital orthophoto map (Source: Kornél Czímber: Geoinformatics).

Figure 2. Colour and infrared colour aerial photos of wet and wooded areas



Orthophotos derived from the 2005 fly, produced by FÖMI will be useful in the second period of mapping (2008-2017). The images can be ordered at 1:10 000 scale of EOV sheets. 0,5 m resolution, 24 bit colour depth, in “.tif” format files are suggested to be obtained for habitat mapping.

FÖMI is supposed to fly the whole country in every five years, thus the continuous collection of uniform orthophoto series is ensured for mapping.

For historical research archive images should also be purchased. These can be ordered in analogue and digital formats at two Hungarian companies (FÖMI, Ministry of Defence Mapping Company) which own the largest collection of archive pictures. Digital images are of better quality, if the film is scanned directly, thus ordering the paper format picture and scanning them at home is not suggested. Both companies have equipment and experts for digitizing. When we order the images we should ask for the biggest resolution and colour depth available at scanning. Just remember the fact that it is always easier to produce worse quality data from better quality ones while the process cannot be reversed. Big resolution and big colour depth take a considerable amount of hard disk storage capacity, thus for delivering data of a bigger area a portable hard disk might be needed. If the ordered digital aerial photo is not an orthophoto map, picture correction and projection transformation should be done by a GIS expert.

In case if independent fly, the selection of the proper time for the flight is very important, that can only be chosen according to the area proposed to be mapped. Most of the images are acquired in July and August, because characteristic features of the vegetation can be separated well and fly circumstances (cloud cover) can be considered adequate. In Euhydrophyte habitats Euhydrophyte patches can be seen the best on August and September pictures, but by this time we should get ready to repeat flights due to the clouds. We should choose earlier dates for flights, e.g. in April or May for inland watered areas or where it is important to confine the periodically water covered areas.

The use of aerial photos has several advantages, but this technique has also its limits. The advantages are as follows:

- easy to survey the total area,
- helps in drawing the exact borders of patches,

- information can be gained about areas which are difficult to access,
- areas, that are no use going in, can be excluded (e.g. inside an arable land and *Populus x euramericana* plantation),
- helps to recognize a “hidden” habitats (e.g. a small patch of grassland in a corn field or a Black Locust patch in an oak forest can be seen well on a colour infrared photo),
- helps in mapping the pattern where types can be recognized in the field but their patches are too complex (e.g. limestone scrub forest, alkali mosaic),
- helps to see traces of extinct waterflows, locality of former spring inland waters,
- a great help in plotting the borders of inner-city area, urban area and industrial estates, considering that topographic maps are out-of-date (they might be 5-15 years old),
- comparing them to older aerial photos we can get exact information about the vegetation dynamics:
 - about the areal change of a woodland, spontaneous afforestation in some areas or forest plantations, clearings in other places,
 - the change in closure of the canopy: we can observe how the formerly open woodland have closed by now or the opposite,
 - old solitary trees also can be tracked which is particularly informative in wooded pastures,
 - about different silvicultural interventions, especially bigger scale clear-cuts or often about,
 - we can trace other human impacts e.g. approximate time of abandonment of arable fields and grazing, or the plough of grasslands.

Difficulties and limits can be classified as below:

- aerial photos record a temporary condition (e.g. mowing, grazing, flood might be disturbingly present)
- classification problems: grasslands and open black locust forests run into each other on a low contrast black and white aerial photo, while they can be differentiated well on a colour infrared photo: open sand grasslands are light blue, black locust forests are orange)
- small patches are often difficult to observe (e.g. patches of steppe grasslands on loess cannot be recognized on alkali steppes),
- especially on black and white aerial photos clouds, near surface haze layers and their shadows might be very inconvenient,
- in forest skirts, and in open woodlands the shadows of bigger trees can be inconvenient,
- it cannot “see” under the closed canopy thus it cannot be used in the case of forest habitats.

Luckily most problems connected to aerial photos can be solved by field surveys, and vegetation and habitat maps are prepared by field studies so far.

1.3.1.3. Satellite Images

During the first period of NBmR habitat mapping the resolution of satellite images (SPOT4, Landsat TM and Landsat ETM) commercially available, did not make their use in field mapping possible. Great developments of the last 10 years in remote sensing resulted in high resolution satellite images (ICONOS, QuickBird, SPOT, (2,5 m) etc.). The resolution of these images are completely suitable for the requirements of habitat mapping, they are at reasonable price and more spectral bands give several possibilities for habitat mapping.

Images can be bought in panchromatic (0,61 m), multispectral (2,44 m) and pan-sharpened multispectral (0,61 m) formats in most cases.

Quick Bird images are offered by Hungarian distributors at two formats: basic and standard images. From basic images a geoinformatic expert can easily produce ortho-photo maps for mapping, which is more exact, than standard images that are pre-processed products with 14 m mean error. Despite of their higher total costs we suggest the acquisition of the basic images.

The advantage of high resolution, multispectral images compared to aerial photos is that their 4 bands can be variously combined thus we gain more details than just using a true or false (infra) colour aerial photos.

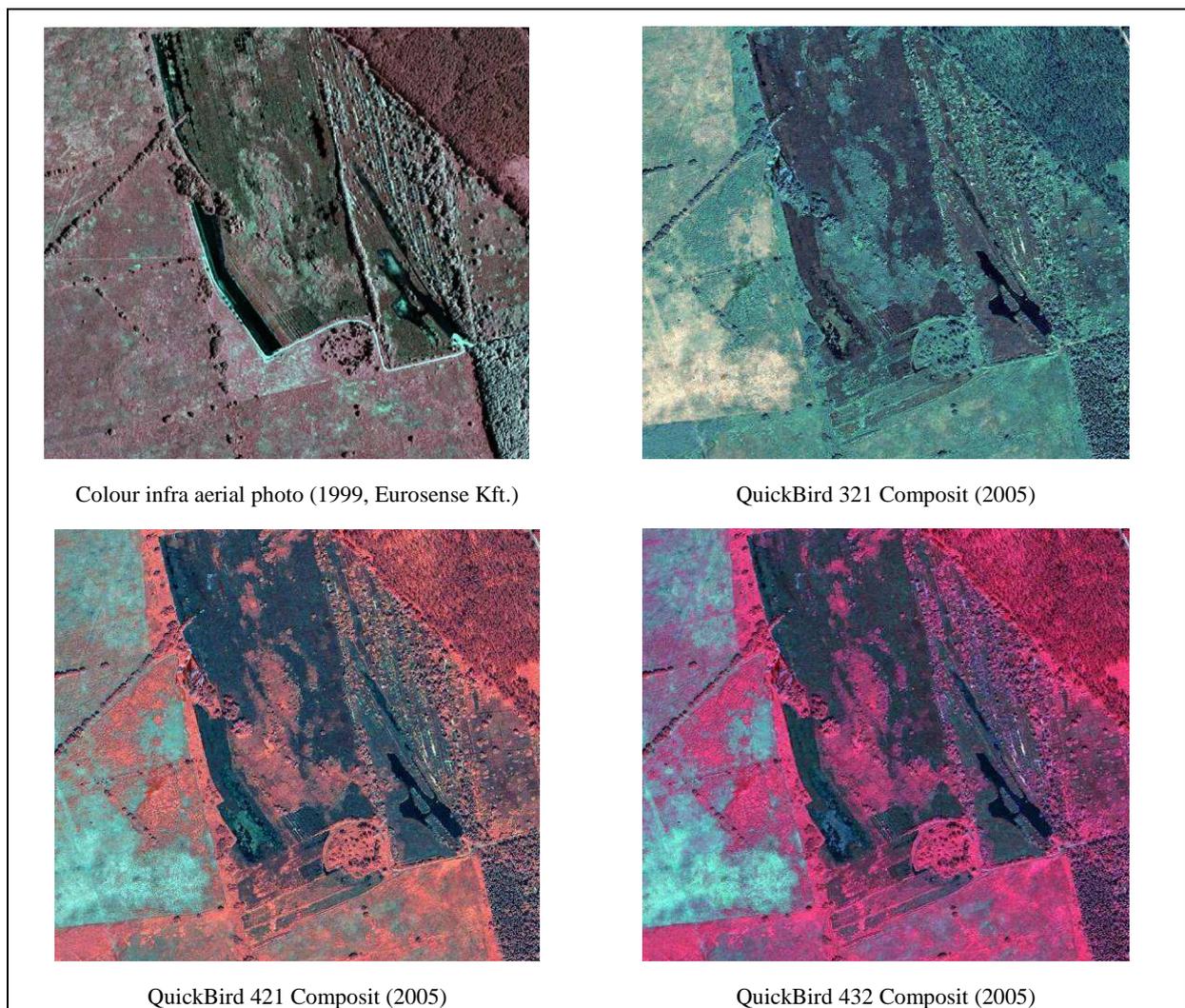
The biggest problem with high resolution multispectral satellite images is that the cloud cover which is considered acceptable even up to 20 % by producers, what have troublesome consequences for customers. Application is not restricted but costs are affected by minimum order limit (64 km² for Quick Birds), that is bigger than the sample 25 km² area of NBmR habitat mapping.

It should also be mentioned that SPOT4 and Landsat (MSS, TM, ETM) images cannot be used directly in habitat mapping while indirectly (e.g. in landscape historical studies) they are very useful. Time series can be fit together for several areas, thus we can gain information about the landscape change of the mapping area. Some of the images are available at FÖMI Archive, while other are published for free on the Internet (Earth Data Science Interface - <http://glcfapp.umiacs.umd.edu:8080/esdi/index.jsp>) where you can download Landsat images acquired till 2000. Special literature is available about satellite images and their processing with further details.

Table 1. Major details of high resolution satellite images

Name of Satellite	ICONOS	QuickBird
Launch Date	24 th September 1999.	18 th October 2001.
Orbit	Near polar, circular, sun-synchronous orbit	Near polar, circular, sun-synchronous orbit
Height of orbit	680 km	450 km
Max. geometric resolution	1 m (11 km swath width)	0,61 m
Spectral Band	1 panchromatic, 4 multispectral	1 panchromatic, 4 multispectral
Orbital Period	98 minutes	93,5 minutes
Revisit Rate	5 days	
Inclination	98°	97,2°
Panchromatic Spatial Resolution	1m	0,61 m – 0,72 m
Panchromatic Spectral Resolution	0,45-0,90 nm	0,45-0,9 nm
Multispectral Spatial Resolution	4 m	2,44 m – 2,88 m
B1 (blue)	0,45-0,53 nm	0,45-0,52 nm
B2 (green)	0,52-0,61 nm	0,52-0,60 nm
B3 (red)	0,64-0,72 nm	0,63-0,69 nm
B4 (near infrared)	0,77-0,88 nm	0,76-0,90 nm
Owner	Space Imaging Europe (SIE)	Eurimage
Hungarian Distributor	FÖMI	FÖMI Bekes Kft.

Figure 3. A wet area on an infra aerial photo and different colour composites of high resolution satellite images



I.3.2. Historical and Other Background Materials

Specified processing of historical and background material, particularly the habitat maps of former monitoring have stressed significance in habitat mapping, because they help understand landscape dynamics, first of all the long-term changes and past human land use. Hereby habitat maps become more reliable, their effectiveness in monitoring increase significantly. Cognition of past contributes to the prediction of future changes, thus consciousness of monitoring can be increased.

I.3.2.1. Sources of Data

Data of former habitat monitoring. All the material from former habitat mapping concerning the specific area should be collected from National Biodiversity Monitoring System meta-database. The significance of this data source will considerably increase during the progress of monitoring. (Data source is compulsory to process)

Historical maps. Historical topographic maps give us the easiest overview about the past of an area. The following order is practical in collecting and processing maps: Military Survey I. (1763-1787), II. (1806-1869) és III. (1869-1887), then the V. so called New Survey (1953-58). Maps can be obtained at Military History Institute (Hadtörténeti Intézet) Collection of Maps, or on DVDs published by Arcanum (www.arcanum.hu). Georeferenced maps can be exported to EOVI projection in a viewer software, thus they can be used by GIS softwares. On hilly areas the use of Military Survey II. is essential, namely the maps of Military Survey I. are not accurate enough. (Military Survey I., II., III., IV. compulsory to evaluate)

Historical aerial photos. Aerial photos taken in the last 50 years give a more detailed image about the past of an area, in time and space, than maps. It is practical to obtain all the photos available. Acquiring the possible oldest aerial photo is of primal importance. It is worth trying to start first at Hungarian Army Mapping Company where there are photos from the 1950-ies, and later go to FÖMI, where the photos are from the 1970-ies. Aerial photos can be processed by visual interpretation but we can also use digital image processing. (At least one photo is compulsory, others are optional.)

Historical satellite images. The use of satellite image series for botanical purposes has just started in Hungary, but this type of data source will become more important in the future. For the time being visual interpretation is the reasonable aim. (Evaluation is optional.)

Historical botanical data. This is a very important data source. Detailed landscape descriptions, flora lists, phytosociological data, vegetation maps, etc. are available mainly about “well-known” areas. Finer vegetation changes can be occasionally reconstructed fairly well from them. Nevertheless, at the judgement of their accuracy we should consider the technical and social limits of the era when they were produced. (Evaluation is optional.)

Forest management plans. Data can be purchased at Hungarian Forest Management. Important details by forest compartments are in them e.g. about tree species, mixture ratio, age, origin. Current data of Natura 2000 areas and nature conservation areas can be obtained at National Park Directorates. The possible oldest and the first management plan or map of management plan just after the World War II should be collected, but it is also practical to get all the earlier (before the 1960-ies) ones. From old management plans we obtain some details about at least the approximate changes in tree species of the specific area during the last 50-100 (-150) years. We might also find lots of useful information (with a piece of luck) about former way of agriculture, as well as rough or finer human interventions. (Evaluation is optional.)

Nature conservation data. In the case of protected areas it is worth collecting the proposals and decisions of protection declaration, former and current management plans, etc. The quality and availability of these materials are varying, but both factors are improving rapidly. (Evaluation is optional.)

Geographical (geological) data. The knowledge of abiotic background is also essential in the development of habitat patterns (base rock, habitat, hydrography, etc.), therefore the soil, geological and hydrological maps are very useful. It is also useful to study the general geographic description of the area. Landscape monographies and the maps of the Hungarian National Atlas are also important sources. (Evaluation is optional.)

Geographic names. The collection of geographic names is also practical (from present and historical maps) in several respects: helps in orientation, to localize data and the interpretation of historical data. (Evaluation is optional.)

Regional historical and land-use data. Land-use in the past is generally a very important factor of landscape change. Reconstruction requires detailed research in most cases, therefore only the more relevant sources should be gathered. Such are county monographies and settlement history studies. These can be found in city councils and local libraries usually in 1-2 days and the most important parts may be photocopied. Several old descriptions are available in digital form too (eg. Monumenta Hungarica) by Arcanum Kiadó and National Széchenyi Library. (Evaluation is optional.)

Verbal information. Detailed description about the events of the past 40-60 years can be gathered from landscape managers, forest rangers, agronomists, herdsman, farmers, etc. For the recognition of the most important events 1-2 days of "interviewing" is usually enough. The information obtained this way makes mapping easier, collection of data helps at the same time to establish a positive relation to the locals. (Evaluation is optional.)

1.3.2.2. Overview of Former Habitat Mapping(s)

Thorough study of formerly prepared habitat map(s) is the most important part of preparations. In one respect, we should compare the results of our current mapping to these maps, on the other hand they make the cognition of a landscape possible before the mapping or we can revive our field experience if the preceding map(s) were prepared by us.

Proposed main steps of overview:

- study the quality control data sheet of the report (the quality of field work and report compilation)
- read the introduction chapters and habitat descriptions of the report
- joint study of habitat maps and patch descriptions, comparing them with historical maps and aerial photos
- compare the aerial photos used in current mapping and former habitat map(s)
- examine the differences of habitat classification used for former map(s) and current method eg. Á-NÉR1997, Á-NÉR2003 and Á-NÉR2007)

Do not forget: the so-called change map will be the most important product of the current mapping, on which we should compare the present state of the landscape to the former mapping(s). For this reason we also should take the most important data of former monitoring with us to the field.

1.3.3. Work Map of Habitat Mapping

At the first monitoring period of the National Biodiversity Monitoring System habitat mapping, the production of field work maps was difficult due to the insufficient development of technology and hard availability of basic data. The development of the past 10 years luckily made the work with photocopier and transilluminate tables unnecessary.

The goal of the habitat mapping work maps is to provide the necessary information for delineation of habitat patches and for orientation.

1.3.3.1. Characteristics of Work Maps

It is practical to produce and take paper maps with us to use for field work, which contain at least three different thematic sets of the available information. The scale of work maps is at least 1:10000 but for certain areas they might be at scale 1:5000. Thus we can draw the smallest (50 m diameter) patches relatively easily on the work maps. These are 5 mm in diameter on maps of 1:10000 scale, and 10 mm on 1:5000.

The following thematic maps we suggest to prepare:

- 1.) If the patch pattern of the former habitat map is drawn by orthophoto-map, then:
 - the current aerial photo (or topographic map) of the quadrat and the patch pattern of the former mapping (we draw on this, so this is our work map)
 - topographic map of the quadrat (for orientation)
 - aerial photo of the quadrat (if we could not see something on the work map)
- 2.) If the patch pattern of the former habitat map is not drawn by orthophoto-map, then:
 - current aerial photo of the quadrat (we draw on this, so this is our work map)
 - patch pattern of former habitat mapping and aerial photo used at former mapping
 - topographic map of the quadrat (for orientation)

Development of technology is rather rapid nowadays, so it is feasible that at the second period of mapping the researcher might take a palmtop computer to the field and confine the habitat patches on the spot (digitizing) by hand or by the help of GPS.

1.3.3.2. Technical Devices of Work Map Production

Work maps can be produced by any GIS softwares. There are professional and often very expensive ones (eg. ArcGIS ArcView, MapInfo, Digiterra) and also freewares (eg. Grass, QGIS), or even Linux versions. National park managements that distribute the task, make the preparations and postprocessing, have ArcGIS ArcView.

A computer with 1,6 GHz processor and 512 MB memory is required to execute these softwares. Colour ink-jet or laser printer at A/3 size is practical for printing the prepared maps. Maps printed by ink-jet printers are suggested to be laminated in order not to ruin the whole day work by rain or wet hand. They are also available at every national park directorates.

1.3.3.3. Plotting of the Work Map

If the prepararions of the work are appropriate, we have the following material for the area to be mapped:

- digital topographic map at scale 1:10 000
- actual digital orthophoto-map
- digital borders of patches of former mapping.

Selected areas of NBmR habitat monitoirng cover four 2,5x2,5 km UTM squares. Enframing squares of UTM squares are approximately 2,7x2,7 km size, thus we can only print a quarter of the area at scale 1:10 000 on a A/3 sheet. It is advisable to display on the work maps the identity number of the quadrat, the number of the UTM square (Dévai et al. 1997) and a graphic scale for possible measurements.

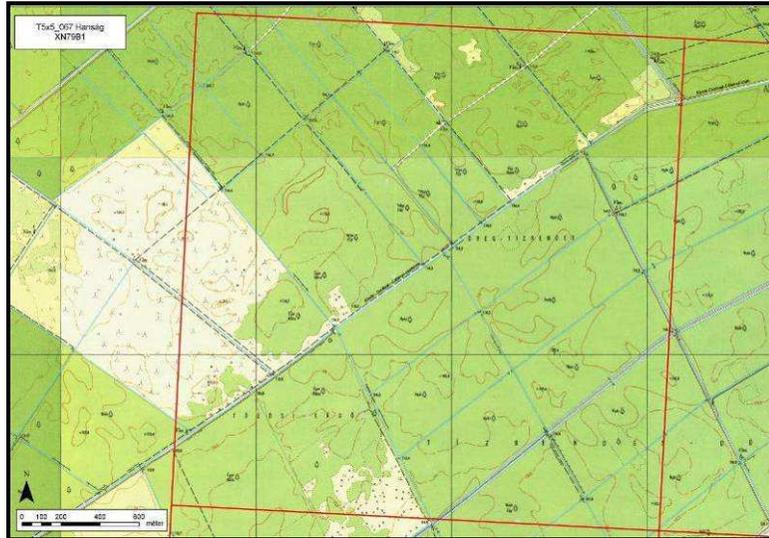
If the quality of the digitized files of the first mapping are not appropriate considering the map accuracy in case of some quadrats, there is no use to print patch borders on work maps. Inappropriate quality might be derived from many things. Methods used at earlier methodology (eg. enlargement by photocopier, drawing on a transilluminating table, the use of not ortho corrected aerial photos) in certain cases, especially on hilly and mountainous areas might result in big shifts at drawing, and if they were not corrected at the time of digitization, significant shifts migt be found at re-mapping, although there was no habitat change in the area. In this case it is worth drawing a new patch map, on an orthophoto, and indicate real vegetation changes on a change map. Later these not ortho corrected, former habitat maps should be corrected before GIS evaluation.

1.3.4. Survey Route Plan

The purpose the make a route plan is to optimise the field survey in order to explore the area in the shortest route. Heterogenous areas and ones with uncertain classification should be confined by the use of aerial photos, topographic maps, historical and background data and work maps. A main principle to make a route plan is to increase the survey density as the heterogeneity and uncertainty grows. Routes for cars, walking and routes that can be surveyed quickly or slowly should be planned separately. Route plan might change during mapping. Interpretation of aerial photos often become easier after surveying a part of the area, thus route can be significantly shortened. It is advisable to survey areas as tests where the classification is considered sure. If interpretation is proved incorrect during the test we should also alter the route plan.

If a former (real) route plan exists it should also be regarded at comparison. If e.g. a big patch (that really can be classified as one patch) is viewed from two opposite ends, there might be a big “difference”, what is not real.

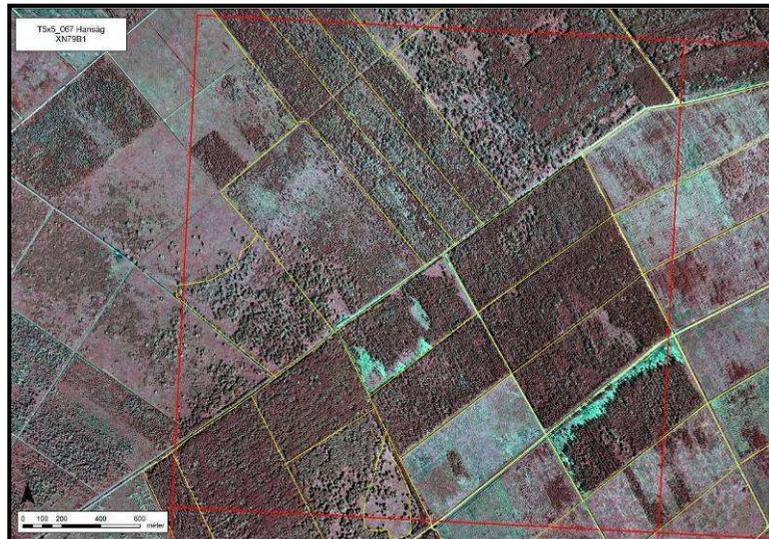
Figure 4. Field maps prepared for habitat mapping



Topographic maps



Aerial photo of the first mapping



Aerial photo of the first mapping with patch borders



Work map

I.4. Field Work of Habitat Mapping

I.4.1.1. Preparations of Field Work

I.4.1.1.1 Precursory Field Survey

During precursory field survey we gather information that is absolutely important to accurately estimate the tool, time, labour and expert demand of the task to be done.

We check the optimal approach and route possibilities of the area to be mapped. The aim is to have an overall view about the vegetation of the area, the problems that might arise during habitat classification and mapping, and the possible ways of their acceptable solution. During precursory field survey, we should visit bigger patches identified on the aerial photo, check how they can be approached, try to pre-identify the patches of main habitat types. Thus we might prepare for the classification of difficult cases occurring in almost always and in all areas before the start of mapping field work.

During precursory field survey we check the usefulness of the aerial photo we have for the actual work. One of the most important question at this point is how and how much the patch pattern seen on aerial photo corresponds to the patches and patterns of the habitat type we see in the field.

The suggested date for this precursory survey is spring, possibly March-April, time demand is not more than 1-2 days. Maps, aerial photos, we already have, and habitat identification handbook must be taken with us. We should get information about the authority (e.g. military, highly protected areas) or the owner (e.g. of a preserve) who gives the admission to closed areas, for research purposes. We might also use the opportunity for preliminary inquiry chats with local inhabitants. We also can gather information about accommodation possibilities.

I.4.1.1.2 Planning of Field Work and Preparation for Mapping

The money and time spent on preparations is refunded many times during mapping and processing. The thorough theoretical and practical preparation lays the foundation for the successfulness of mapping and makes it more effective.

The Habitat Guide descriptions of those habitats must be read, that occur or probably occur in the area (the former mappings and MÉTA database might help in it).

The probable time needed for a mapping depends greatly on the scale, the length of the route where we can only walk over, how the area can be seen over, how fine is the patch pattern of habitats. It is suggested to plan carefully, so mapping can be finished even supposing some loss of time due to unexpected difficulties, adverse weather or technical problems. The optimum period for mapping is the middle of the growing season, in May or June. Naturally certain habitats show the most characteristic vegetation in different times (e.g. geophyte aspect of oak-hornbeam woodlands, Euhydrophyte communities, plants of salt lakes), these should be visited several times during the year.

A convenient vehicle should also be provided. In a landscape with mostly plough-lands we should possibly use a jeep, because it greatly increases the time we can spend on real mapping work. Walking to farther areas might demand significant amount of working time and energy. A car is also useful to protect maps, aerial photos, identification handbooks and plant collections.

Accommodation should be booked in advance if possible, in order not to spend the working time of mapping for this. A local colleague might help a lot, who does not necessarily have to be an expert. The local guide might tell us about the passable or non-passable roads, closed areas, might help in collecting historical data or even can help to treat the distrust of inhabitants or occasionally unfriendly attitude.

We should ascertain that nothing would hinder in our movement in the field at the certain time. It might happen that the area is temporarily closed owing to certain occasions (live-fire exercise, hunting) or natural factors (e.g. flood) might temporarily prevent us to approach the area.

We should ascertain in time if all the documents are obtained what we need. The materials should accurately be assembled one or two days before field work. For longer field trips we should take not just those maps and aerial photo copies with us what were prepared for field mapping but their digital or paper copies too.

We also should check the batteries of electric equipments (camera, GPS), buy supplementary batteries.

It is worth making field data sheets. Thus we can see at the documentation of each patch if every data type is recorded.

I.4.2. Field Work

In the course of repeated habitat mapping the field work is basically unchanged comparing to first mapping (although the data we collect are more structured), but mapping in the field should be done with continuous studying and using the materials of former mapping.

I.4.2.1. Field Survey

For moving over bigger distances a car should possibly be used. The survey should be done according to the route plan. During the survey we should walk around as much patches as possible. Internal areas of bigger patches should also be surveyed, in order to check their pattern and homogeneity. Attention should be paid not to omit patches incidentally, because it might take too much time later to visit them. Aerial photos, maps and data sheets are the best to keep on a clipboard (they are not scattered, it is easy to write on it and also protects against drizzle).

I.4.2.2. Delineation of Patches

The two most important phases of mapping are the delineation of patches and habitat classification.

The size of the smallest patch to be mapped depends on the scale of mapping. The smallest patch which can be mapped accurately on the map with 1:10 000 scale is 2 mm (that is 20 m in the field) in diameter. Smaller patches than this are generally not mapped (if they are important from some point of view - e.g. orientation, species occurrence – then they are plotted as point). If the patch is smaller than 20 m in width but longer than that, e.g. a tree line, it is drawn as a line. If we work on a good quality orthophoto or special patches are measured around by GPS, then smaller patches might also be drawn.

During field work we draw the borders of vegetation patches. If the patch borders of former habitat mappings were delineated on ortho-corrected aerial photo then we should check former borders and draw the changes. There will be cases when although the vegetation has not changed, the current mapper would draw the borders of patches somewhere else. In this case this border is drawn on the habitat map but this change is not drawn on the change map since there is no change in the vegetation. If the patches of former habitat map were not delineated on ortho-corrected aerial photo, then we draw a completely new habitat map.

If the border cannot be identified accurately, then we have to choose the middle of the transitional zone. If the border of the patch is changing in time during the year (e.g. Euhydrophyte habitats), then the current or the most characteristic border is to be drawn (remember to document this decision in the patch description).

The question of borders and transitions is also arising at classification of habitat patches, since the number of categories or their possible combination is limited, we suggest the following: (1) if the size of a transitional zone approximates the minimum patch size, it is not drawn, but might be mentioned in patch description; (2) if the transitional zones can be drawn, then we should decide which habitats' transition it is and code it accordingly.

I.4.2.3. Habitat Classification

Habitats are encoded by Á-NÉR2007 categories. We must make an effort to find a category that clearly matches, if there is no such, then two or more categories have to be used. In the case of every unknown habitat type, we use Habitat Guide (Bölöni et al. 2007). We should consider both physiognomy and species composition in the course of classification. If any of them differs from the one in the description then we should search further before the final decision. We also should pay attention to 'Subunits' paragraph in the Habitat Guide at the final identification, because the lists of the most similar habitats can be found here, and we might change our opinion relying upon these.

If we find ourselves face to face with some classification problems, we do not have to be surprised. It is common and probable in most landscapes that we find only few clearly identifiable habitats. Transitional categories are often in majority.

The most important point is that we always map the current state. This means that we should not be influenced in our decision about the Á-NÉR category by some knowledge we learnt about the past of the area from historical maps, since we are just interested in the change of current state during monitoring.

I.4.2.4. Classification of Patches

Some patches of the habitat map cannot often be clearly classified into one definite habitat category. The cases and examples below show that habitat mosaics and transitions can also be displayed in a way that the number of habitat categories are limited.

Main cases:

- Basic situation: the patch can be clearly identified as one Á-NÉR category, e.g. A
- The vegetation of the patch is homogenous but the habitat is of transitional (hybrid) character between

two or more Á-NÉR habitats, e.g. AxBxC, if type A is the most characteristic and e.g. BxCxA if type B gives the main character.

- The habitat patch can be delineated but it is not homogenous, the habitats can be identified in it, but they change transitionally into each other:
 - the habitat characteristic within the patch changes continually, along a gradient: e.g. AxBxCg
 - two or more habitats are changing in mosaic: AxBm
 - habitats create a zonal complex: AxBz
- If we cannot assign any Á-NÉR category to the patch then the category considered the most fitting is written first and the possibilities are also listed in brackets subsequently, the degree of uncertainty is indicated by the number of brackets. E.g. A (B) ((C)).
- The above mentioned situations are sometimes combined, then it is expressed by marks (e.g. (AxB)xCm, that is habitats A and B are mosaicing with habitat C, but it is more useful to write a good detailed description about the patch instead of accumulating letters and brackets.

1.4.2.5. Comments on each Habitat Patch

The structured documentation of the patches provides the most important information in the habitat mapping documentation.

There are three compulsory and two non-compulsory parts:

- the naturalness of the patch according to the categories of Németh-Seregélyes (compulsory)
- textual description (compulsory)
- the list of plant species (compulsory)
- factors causing degradation or endangerment (non-compulsory)
- the occurrence of degradation (non-compulsory)

Naturalness

Naturalness should be given for every patch. Definitions specified in Habitat Guide and several hundred examples given for natural habitat types help in it. One category or two categories, in the case of transitional, mosaic situation, might be given. If there are very different habitat types considering the naturalness in the patch, this must be recorded in a textual comment, or if the size is appropriate it should be delineated as two separate patches.

The following system of naturalness-based habitat evaluation is to be used: (1) totally degraded state; (2) heavily degraded state; (3) moderately degraded state; (4) semi-natural state; (5) natural state (for definitions see: Németh & Seregélyes 1989). This system is more or less in accordance with the convences used in some other European countries.

Naturalness-based habitat quality has to be recorded separately for each habitat patch. The fact, that 10-25% of a particular patch belongs to a lower category of naturalness, is not documented (because it happens in almost any case). Selection of the proper category of naturalness-based habitat quality is supported by a large set of examples in the Habitat Guide.

Textual description

Textual description should contain those unique features of the patch that we consider characteristic, and later they can be the base for comparative judgement of unique features of the specific patch or the features of the specific habitat type in the current region. A textual description should be written for each patch. This can be only a few words in unambiguous cases but generally it is a longer or shorter sentence.

When we write the comments we should consider what details, observations would make it possible to describe vegetation changes at a specific locality in 10 years time at repeated mapping. The following vegetational characteristics must be mentioned:

- sub-type (listed in Habitat Guide or any other sub-type, e.g. classification into a plant association)
- physiognomy (e.g. second tree stratum, dead wood, half of the locust tree line stolen, on 30% of the clear-cut area there is no indigenous growth)
- pattern (e.g. patches, monodominant species)
- disturbance and its consequence (choose damaging factors from the list)
- land-use and its consequence (e.g. grazing animal type, mowing, overgrazing)

The list of species

Textual description is completed with the list of characteristic species: characteristic tree species, shrubs, dominant plant species, common invasive species, protected plant species, etc. A complete list of species is to be made, if possible, for 15% of the patches. In this case, the frequency of a species should also be given, as below:

- 5: dominant species
- 4: common species

- 3: scattered species
- 2: rare species
- 1: only some individuals

Factors causing degradation or endangerment (non-compulsory)

It is possible to record for each patch what factors are endangering that specific patch. The endangering factors are chosen from a code list (maximum three). The code list originally was published in the 3rd volume of National Biodiversity Monitoring System (Plant associations) (Kovács-Láng & Török 1997), but was revised and completed during the development of Nature Conservation Information System. The improved list is in Appendix 2.

The occurrence of degradation (non-compulsory)

If the patch is described as degraded (Naturalness by Németh-Seregélyes < 5) then we have the possibility to record the phenomenon of degradation (Kovács-Láng & Török 1997). If we record these values consistently during mapping (Appendix 3) then several statistics might be made during evaluation which can help the planning of nature conservation management.

Table 2. Exemplar comments on particular patches of a habitat map

Patch no.	Á-NÉR code	Naturalness value	Detailed description (sub-type, physiognomy, vegetation pattern, disturbance, land-use)	Species list with abundance values (dominant species, invasive species, protected species)
1.	S6	1	app. 20-year-old black locust stand, yet with trees of various age, spontaneously colonising an oldfield; only weeds are present in the herb layer	<i>Ailanthus altissima</i> 2
2.	F1a(xF1b)	4	overgrazed <i>Artemisia</i> salt steppe (slightly turning into an <i>Achillea</i> steppe) with the increasing abundance of <i>Festuca</i> , established on deeply cracked soil	<i>Festuca pseudovina</i> 5, <i>Artemisia santonicum</i> 2, <i>Gypsophila muralis</i> 3, <i>Trifolium angulatum</i> 3, <i>Trifolium retusum</i> 2, <i>Limonium gmelini</i> 2, <i>Bromus mollis</i> 4, <i>Lotus tenuis</i> 2, <i>Trifolium strictum</i> 1, <i>Cardaria draba</i> 2
3.	F1axF1bxF5xOCm	3-4	non-grazed, leaching salt steppe with minor patches of open saline surfaces, and featureless loess grasslands on the fine ridges	<i>Carduus acanthoides</i> 2, <i>Carduus nutans</i> 2, <i>Camphorosma annua</i> 1, <i>Matricaria chamomilla</i> 2, <i>Achillea setacea</i> 3, <i>Ventenata dubia</i> 3, <i>Artemisia santonicum</i> 1, <i>Limonium gmelini</i> 4, <i>Bromus mollis</i> 4
4.	S3xS6m	2	<i>Juglans nigra</i> plantation with dense <i>Amorpha</i> thickets where the walnut did not grow up; invaded by indigo bush and white poplar from the edges; the habitat is casually inundated.	<i>Alopecurus pratensis</i> 3, <i>Festuca gigantea</i> 2, <i>Leucosium aestivum</i> 1, <i>Amorpha fruticosa</i> 4, <i>Fraxinus pennsylvanica</i> 2, <i>Acer negundo</i> 1
5.	T1	1	sparse cornfield	<i>Tribulus terrestris</i> 2
6.	S7	1	mulberry tree line with featureless steppe-like herb layer, invaded by weeds	<i>Agropyron repens</i> 4, <i>Bromus inermis</i> 4, <i>Conium maculatum</i> 3, <i>Salvia nemorosa</i> 1
7.	GlXP2bXS6xH5b	4	sand grassland mosaic, spontaneously invaded by shrubs: in 1950 the habitat was covered by a grassland with scattered trees and shrubs; mature and juvenile <i>Populus alba</i> and <i>Crataegus</i> , also with root sprouts; black locust: principally mature trees (with few young saplings); juniper: only young bushes and trees; patches of grasslands are dominated by <i>Stipa borysthena</i> and <i>Stipa capillata</i> , though the remnant patches of the former mesic meadows (with <i>Molinia</i>) are also present, as well as those dominated by <i>Calamagrostis</i> and <i>Festuca wagneri</i>	<i>Festuca vaginata</i> 4, <i>Stipa borysthena</i> 5, <i>Festuca wagneri</i> 3, <i>Koeleria glauca</i> 3, <i>Salix purpurea</i> 1, <i>S. rosmarinifolia</i> 2, <i>Ailanthus altissima</i> 1, <i>Allium sphaerocephalum</i> 1, <i>Dianthus serotinus</i> 3, <i>Veronica dentata</i> 1, <i>Silene otites</i> 2, <i>Euphrasia kernerii</i> 1, <i>Cynoglossum officinale</i> 1
8.	OC	2	oldfield seriously invaded by weeds, resembling patch 113, mown in the last year	<i>Agropyron repens</i> 5, <i>Cirsium arvense</i> 3
9.	B6	5	homogenous <i>Bolboschoenus</i> bed, with 15-cm-deep water; several clumps are dead (high amount of feather and bird faeces)	<i>Bolboschoenus maritimus</i> 5, <i>Agrostis stolonifera</i> 3, <i>Lemna minor</i> 3, <i>Utricularia vulgaris</i> 2
10.	K2xL1	4	mixed stand composing of white oak, Turkey oak, common ash, broad-leaved lime app. in equal proportion, and also with infrequent hornbeam, manna ash and wild service tree in the canopy; the (semi-)dry/mesic herb layer consists of thermophilous species; large scattered remnant trees (mainly white oak and common ash) are also present	<i>Quercus pubescens</i> , <i>Q. cerris</i> , <i>Fraxinus excelsior</i> , <i>Tilia platyphyllos</i> , <i>Carpinus betulus</i> , <i>Fraxinus ornus</i> , <i>Sorbus torminalis</i> , <i>Glechoma hirsuta</i> 2, <i>Scutellaria columnae</i> 3, <i>Mercurialis perennis</i> 3, <i>Galium odoratum</i> 4, <i>Alliaria petiolata</i> 2, <i>Brachypodium sylvaticum</i> 3

I.4.2.6. Habitat Photos

Landscape and habitat photos must be taken about the most important particulars of the landscape, 30-60 for an average quadrat. The photos must be attached in digital format to the report, but also must be printed in at least quarter page size (photo appendix). During map digitization the spots of each photo must be recorded (manually or downloaded from GPS) and the direction of the shot (little eye) in a separate map. At least one sentence description must be written about each photo.

I.4.2.7. Record of Route on a Separate Map

The mapping route of the survey must be documented accurately. Remapping can be done more precisely by the help of it. The tour route is to be recorded manually or by loading the „track log” of GPS during map digitization.

I.4.3. Posterior Field Survey

During this, we can check the accuracy of the prepared maps. It is also useful to gather missing information and also to retrieve lacks arose during data processing.

Time demand is one day. The optimum date is the end of September or the beginning of October.

I.4.4. Documentation of Habitat Pattern and Habitat Quality Change

The observed changes must be documented by comparison to previous mapping:

- (1) the overall changes of the landscape is written in the landscape description chapter (see the details there);
- (2) the changes of each habitat is written in chapter describing habitat characteristics (see the details there);
- (3) the changes of each patch are plotted on a change map (see here)

The aim of the change map and the table attached to it is:

- to have an overall view about the changes of the quadrat without thoroughly reading the report
- to quickly summarize the changes of several quadrats (e.g. for NP directorates)
- changes arising from mapping or geo-coding errors and real biologic changes might be separated easier during subsequent GIS analyses
- more important former changes might be looked over more easily during repeated mapping

What changes do we document?

- the disappearance, appearance of a patch, the changes in the size and/or the location, habitat type change, the changes in naturalness by more than two values
- appearance of many patches (that are often in almost the same habitat type), the changes in their size and/or their location, habitat type change, the changes in naturalness by more than two values (e.g. in the case of wet years, drought, changed land use, nature conservation management)
- the changes in a major part of the quadrat (e.g. in the case of wet years, drought, changed land use)

How do we document the changes?

Those landscape parts are marked on the map that has changed, then we describe them each.

- the changed spatial location of a patch boundary is drawn on the patch map.
- each changed patch is coloured
- if just a part of the patch has changed (e.g. grassland plough, clear-cutting) then only this part is marked

The marks should be drawn manually with intense (e.g. red) colour on the polygon map printed in black and white, then the map is archived as a scanned image and a colour print. (Namely for the moment there is no need to record changes by georeferenced digitization. We can make an exception if the former mapping is available at georeferenced digital format.)

Every patch of the change map has an own data record according to the example below:

- the ordinal number of the patch on the change map
- the ordinal number of the patch on the former habitat map (implicitly one or more patches)
- the ordinal number of the patch on the current habitat map (one patch or a part of it)
- the former Á-NÉR code and naturalness value of the patch(es) (if later is available)
- the current Á-NÉR code and naturalness value of the patch
- one sentence textual description about what might be the possible reasons for the change
- a rough estimation about the area of changes (in hectare)

Table 3. An example for a table of the change map

The number of the patch on the change map	The number of the patch on the former habitat map	The number of the patch on the new habitat map	The Á-NÉR code and naturalness of the former patch	The Á-NÉR code and naturalness of the new patch	What changes happened for what actions?	The affected area (rough hectare estimation)
1.	69.	34.	J6/4	RC/1-2	deep plough of the clear-cutting in species rich hardwood woodlands, then renewed by Turkey oak	4
2.	43.	47.	H5a/3	T1/1	ploughed loess steppe part	0.2
3.	256., 257., 260.	12.	B2xB5/3	B2xB5xB1xB3/4-5	water conservancy reconstruction and regenerated steppe marshes as a result of wet years, in one part common Club-rush broke in	approx. 15
4.	187.	304	L2	L2a/2	it became a hunting game preserve, shrub stratum has disappeared	approx. 30-35
5.	122.	156.	T1	T10/1	it became an abandoned arable field	approx. 20
6.	256.	134.	D4/4	D34*S6/2	after floods, false indigo spread as a consequence of abandonment from mowing	5

Figure 5. Change map (sample)



I.5. Processing and Archiving of Materials Produced by Field Work

I.5.1. Preparation for Archiving and Processing

Materials produced during field work are useful to be photocopied, since the original documentation might be lost, damaged (e.g. during next field work). Working maps, aerial photos used in the field, other maps used during preparation (e.g. fine resolution supplementary maps), textual notes, species lists, etc. must be archived in any case.

After each day spent in the field, maps and notes must be reviewed. Errors must be corrected, and uncertainties must be recorded. This is principally necessary when a considerable time is passed between the field survey and the completion of the final report. As soon as possible we should finish the primary clarification of field notes. (We might forget the meaning of the temporarily created codes, we are not able to read the blurred writing, etc.)

We must pay special attention to archive the notes made by marker felts on aerial photos, since they might be faded by sunlight or during storage.

I.5.2. Processing

I.5.2.1. Documentation of Habitat Mapping

Documentation produced on specific sample areas (quadrats) in the course of National Biodiversity Monitoring System habitat mapping programme is consisted of two parts. The most important data is the digital database produced from data collected in the field, which will get into Nature Conservation Information System in the future. Digital database contain data in vector map data and descriptor data tables formats. The second part of the documentation is the report, made in a definite content and format (e.g. thematic maps, textual descriptions).

The report is to be done in a printed format too beside the digital one.

I.5.2.1.1 Data base

- delineation of the mapped area (vector, polygon coverage)
- habitat-map (vector, polygon coverage, with detailed data of each patch in the descriptor file)
- survey route (vector, line coverage)
- documentation photos taken in the course of mapping (photos, video shots, etc.)
- the location of photos (point coverage)
- descriptor data of attached images (table)

I.5.2.1.2 Report (compulsory items)

- theme data sheet (summary of the most important data)
- general description of the mapped area
- detailed description of each habitat
- printed patch descriptions (compulsory)
- thematic maps
 - overlook map -1:100 000
 - detailed topographic map of the sample area – 1: 25 000
 - aerial photo or high resolution satellite image – 1: 25 000
 - historical maps and archive aerial photos used for the elaboration of landscape history – 1: 25 000
- habitat map with identification numbers of the patches – 1: 25 000
- habitat map coloured by Á-NÉR codes and naturalness values of patches
- habitat map coloured by the first category with Á-NÉR codes of the patches
- the spots of photos taken at the field and attached to the report with the route on the patch map
- change map and its documentation

1.5.2.2. Processing Habitat Mapping Data

The following steps must be done during processing:

- delineate patches and record their descriptor data
- choose the photos and other multimedia materials to be attached
- record the spots of picture taking and record descriptor data of each attached image
- write textual files to be attached
- compile thematic maps needed for the report
- print the report

To standardize documentation, template and sample files were prepared for every compulsory material. National park management should provide them for the mapper or can be downloaded from NBmR homepage.

1.5.2.2.1 Delineation of patches and loading of textual descriptions of patches

During data processing, the first step is the digitization of patches we had recorded in the field and loading their describing textual data. This can be done by any GIS software but it is advised to use data recording software developed within the scope of Nature Conservation Information System.

We must remember two topological rules during the digitization of habitat patches. Overlappings and gaps must be avoided. Two digitization technologies are suggested to use. At the first method we draw first the area to be mapped, then patches are formed by cutting it. In the case of patches overhanging the quadrat boundary we create patches by “auto complete polygon”. At the second method we draw the first patch and all the others are appended to it. As a result we will have a patch map without overlaps and gaps.

After digitization or even at the same time we might record describing data of each patches with the following format:

Field group	Field	Description	PerGeoDatBas
	...		
	Code	Pay attention not to write the same number twice. In one theme 9999 patches can be recorded.	Automatic but can also be rewritten
	...		
Field documenting the conditions of the patch creation.	The day of creation	When was the patch drawn?	Automatic
	The creator	Who drew the patch?	Automatic
	What was the base for creation	Orthophoto Topographic map GPS etc.	From list
	The accuracy of patch	How accurate the delineation of the patch according to the opinion of the mapper. 1m, 5m, 10m, 20m	From list
Identification surveyors	Informant	It must be filled in implicitly. The person's code is supplied by the organization who gave the task.	Must be filled in
	Identification person		Must be filled in
	Collector 1		Must be filled in
	Collector 2		Optional
	Collector 3		Optional
Date of survey	Date (from)	The date of survey. If there is one date then only the 'to' column must be filled in, if the surveyor went back to the patch several times then the first and last date must be written. Inter-dates are to be written in notes column.	Optional
	Date (to)		Must be filled in
Indicate habitat code and naturalness	Vegetation code	Adequate Á-NÉR code or code combination.	Must be filled in
	Generalized vegetation code	If a code combination was written in the 'vegetation code' column then that only one code should be given here which is the most characteristic for the patch (generally the first member of the code combination).	Must be filled in
	Naturalness – the level of degradation	The evaluation of patch naturalness.	Must be filled in
	Generalized vegetation code (Á-NÉR)	In the case of habitat mapping it shouldn't be dealt with.	Automatic
	Note	Textual description of the patch and any	Must be filled in

Field group	Field	Description	PerGeoDatBas
		other note concerning the survey.	
Description of habitat patch endangerment	Endangerment	Can be chosen from a list. The surveyor can describe the endangerment of the habitat patch.	Optional, from list
	Threat 1	What threats are threatening the habitat. Can also be chosen from a list. Maximum four threats can be given, others are to be written in notes column.	Optional, from list
	Threat 2		Optional, from list
	Threat 3		Optional, from list
	Degradation occurrence 1	The consequences of degradation is given here (e.g. species richness, simple structure).	Optional, from list
	Degradation occurrence 2		Optional, from list
	Degradation occurrence 3		Optional, from list
	Degradation occurrence 4		Optional, from list
Degradation occurrence 5	Optional, from list		
Characterization of descriptive data accuracy	Not correct habitat	If the informant is not sure about any factor then number 1 must be written in the field.	Optional
	Not correct locality		Optional
	Not correct date		Optional
	Not correct collector		Optional

Nature Conservation Information System affords the possibility to record species list given at each habitat patch (species list or species list completed with mass data).

1.5.2.2.2 Selection of photos and other multimedia material to be attached

Several photos and recently videos are shot during field work. We can attach optional number of images to the documentation. Photos must be submitted in printed and digital format, too. We must copy the photos into 'Docufoto' directory which can be found in sample database. The names of attached images are given by ordinal numbers (e.g. 0001, 0012). This way 9999 photos or videos can be attached to mapping materials what is probably abundantly enough for mappers.

1.5.2.2.3 Record the spot of photos and describing data of each attached image

For multimedia materials attached to documentation, the exact spot of the shot must be given in every case. The spots of shots must be recorded in a point coverage. It is essential that several shots can be attached to one specific locality, thus there is no need to draw a new point for each shot.

Some more important parameters have to be given for the multimedia materials attached to documentation. These are mainly about the person who took the shot, the locality of the shot and the quality of the attached image.

1.5.2.2.4 Writing the word files to be attached

After data recording, the compilation of textual parts of the documentation can be started. Minimum three part-chapters should be drawn up for this.

Theme data sheet (meta-data of the report)

Theme data sheet serves for summarizing the meta-data of the report: quadrat number, surveyor, methods used, list of attachments.

General description of the mapped area

At the first phase of habitat monitoring this document has already been prepared once. At the course of second, third... mappings it has to be supervised and completed. Chapters are as follows:

- General landscape description: Climatic characteristics, geology, edaphic features, hydrological conditions, main vegetation types
- Landscape representation
 - Comparison of significantly differing landscapes within the quadrat
 - Summary of landscape history, the history of the quadrat based on historical data
 - The history of the most important habitats, habitat groups
- Emphasize the most important changes occurred since the last mapping

General landscape description

Description of geomorphological conditions, soil, hydrology, land use, main vegetation types etc. Extent: 5 lines – half page.

Comparison of significantly differing landscapes (vegetation mosaic) within the area

- (1) general/geographic differences (relief, hydrology, soils, etc.), e.g. saltier;
- (2) differences in their habitat/flora: common habitats: X, Y, only in landscape A: Y, M, N, in landscape B: L, K, J, habitat X is more like some or other;
- (3) important different plant species: only in landscape A/ only in landscape B;
- (4) differences in land use: in landscape A almost all pastures are grazed yet, in landscape B only on those that are on habitat Y, in landscape A there are more farms/canals;
- (5) other significant differences: landscape A is protected. Extent: 10 lines-half page.

Landscape representation

To what extent does the quadrat represent the 5-10 km environment of the area by the basis of field experience and satellite images?

- (1) the mosaic of habitats: it is represented completely/X, Y, Z habitats are only within the area / outside the area / the neighbourhood is absolutely different in the west, while in the east for at least 20 km it is similar.
- (2) each habitats: habitat Z is richer in species/more grazed to the south, mainly X subunit occurs in habitat Z to the east/ habitat X is more fragmented and characterless to the north;
- (3) other significant differences: the landscape is flatter to the east. Extent: 10 lines-1 page.

Short summary of landscape history

The complete history of the quadrat: The area at the time of Military Survey I. (18th century): only smaller groups of trees, marshes here and there, 5% is plough-land, two roads. The area at the time of Military Survey II. (19th century): the current road system exists by then, there are many farms, plough-land in 60%, some planted wood patches (3%). The area at the time of 1943 mapping: a village was established in the immediate vicinity of the quadrat, railway was built, a big wood was planted beside Y farm, Y canal was built by this time, marsh X is drawn as a smaller patch. The changes since the fifties: in the place of present poplar-juniper woodlands there are shifting sand dunes with a few trees (5%), the extent of marsh Y is five times bigger than now, there are 3 new canals built, marsh X disappeared, it is a plough-land at the present time, from 35 farms only 4 remained, the 40% of plough-lands are abandoned, 25% of meadows are ploughed, many tree lines has disappeared. The extent: half page-2 pages.

The short history of specific, more important habitats and habitat groups: dry deciduous forests: in the 18th century: some tree groups (15), the end of 19th century: 1 tree group remained (the area of it has increased) but there are two planted woodland patches too, the middle of the 20th century: the area of planted woodlands is 25%, mainly pine, the end of 20th century: two nice poplar-juniper woodlands, one of them can be traced from one of the 18th century patches, the other is younger than 100 years. Extent: half page-2 pages.

Vegetation changes in the quadrat since the last mapping

Here we document the changes occurred in the quadrat that are at the landscape level. We also give the supposed reasons and results for these changes.

E.g.:

- Marshes and meadows have been regenerated in the wet years (1999-2000). The influence of wet habitat reconstruction can also be felt. Species of dry habitats disappeared.
- A wild game preserve was established at the south-east quarter of the quadrat, therefore herb and shrub layer have been degraded. On the other hand sheep grazing has been stopped on the neighbouring pasture, there is more litter, thorn and Russian olive are expanding. Canals are cleared and tree-lines along dirt roads are cut.

Detailed description of each habitat

Beside the general description of the landscape, a detailed description of habitats is also necessary. They have important role in documenting the features that are difficult to record at the patch level and also useful for subsequent mappers who can see this way what we meant by habitat type in the mapped landscape. This descriptive work is practical to start in the field, complete them continuously during the survey and make it final and unified after the survey. The most important criteria of the description are given below. The extent of it is generally one page for each habitat, it is shorter for rare and not natural types. Chapters are as follows:

- General description
- Criticism of Á-NÉR description
- Subtypes, associations
- Description of dominant, indicator, cultivated, protected and invasive species
- Description of vegetation dynamics
- The last natural and present potential vegetation

- Nature conservation management proposals
- Changes occurred in the last 10 years and their possible reasons

General description

General description about the habitat in one or two sentences.

E.g.:

- Stands invaded by reed are gradually turning into reed beds (B1a), which can be characterized by vigorous growth of reed, but *Bolboschoenus* is still occurring.
- Black walnut and plane are not able to endure flood, thus their stands on lower areas are sparse, shrubs invade the open spaces.
- The soil of the habitat is sand soil, contains more or less humus, there is small relief difference.

The criticism of Á-NÉR description

The errors found in Habitat Guide is documented here, and also those features of the landscape, that could be built in the guide as e.g. a subtype.

E.g.:

- Since proportion of alien tree species exceeds 50% locally, strictly taken, does not fit into this category.
- I put white ash, plane, Box Elder woodlands here (in S3) and also mixed stands dominated by these species too, but older stands do not look like plantations.
- It corresponds to the description.
- The soil is not eroded contrary to the description.

Subtypes, associations

List of subtypes classified into one Á-NÉR category in the quadrat, indicating their ratio.

E.g.:

Subtypes, associations drawn together	%
Degraded <i>Succiso-Molinietum</i>	35
Degraded <i>Agrostio-Caricetum distantis</i>	50
Dried reed patches in a weedy meadow	10
Secondary stands in adobe pits	5
White willow riverine woodlands	25
White poplar riverine woodlands	75
<i>Bolboschoenetum maritimi typicum</i>	15
<i>Bolboschoenetum maritimi puccinellietosum</i>	5
<i>Bolboschoeno-Phragmitetum typicum</i>	50
<i>Bolboschoeno-Phragmitetum phragmitetosum</i>	25
<i>Bolboschoeno-Phragmitetum agropyretosum repentis</i>	5
<i>Brometum tectorum</i>	20
<i>Brometum tectorum</i> with <i>Asclepias</i>	20
Monodominant <i>Asclepias</i> field	60
Maize	70
Cereals	30

Description of dominant, indicator, cultivated, protected and invasive species

We must specify the characteristic dominant, indicator, protected and invasive species characteristic for the habitat. All of them must be described in short.

E.g.:

<i>Achillea ochroleuca</i>	in patches on humus-rich sand
<i>Aconitum vulparia</i>	occurs only at the summit and the bottom of the valley, on both places on rocky soil
<i>Bolboschoenus maritimus</i>	dominant in some places, elsewhere forms association with reed
<i>Bothriochloa ischaemum</i>	dominant species of degraded loess grasslands
<i>Clematis integrifolia</i>	in one patch with hundreds of shoots
<i>Convallaria majalis</i>	smaller patches, also in stands dominated by black walnut!
<i>Coronilla coronata</i>	it is characteristic in open woodland patches that were produced by fire, elsewhere it occurs scarcely
<i>Spiraea media</i>	there are four stands, but moufflon regularly chews them to their stems almost everywhere, several times during the year
<i>Amorpha fruticosa</i>	it is surprising but we only found three individuals on the meadows

Description of vegetation dynamics

Experience and observations related to vegetation dynamic of the habitat.

E.g.

- Expansion of vegetation around the artificial lakes, that were built formerly outside the quadrat, can already be observed, probably this can be expected in the case of newer lakes inside the quadrat.
- The tracks of cars remain for decades and secondary strips of vegetation (generally salt marshes) - different from the surroundings - develop in them.
- We do not know too much about the long term dynamics of old-fields covered by common milkweed. The fate of not treated, abandoned common milkweed fields cannot be predicted.
- Former pasture woodland has completely been overgrown mainly by shrubs: Rosa species, thornapple, blackthorn, but sporadically some young individuals of certain tree species are there in greater numbers: mainly turkey oak and wild pear, but in some places hornbeam and even beech too.
- In the place of clear cuts done 50 years ago, common ash is dominating today with a few beeches, mountain maples, common maples, hornbeams and turkey oaks.
- On steep hillsides burnt by fire several times, white oaks survived the fire with Cotinus thicket developing under them, it seems as if fire was expressly useful for them, but further studies are needed for this.
- Old oak stands are mosaicing in some places with old and young patches, in older gaps young sessile oaks are advancing towards the top tree stratum. Hornbeam here cannot grow so high anywhere, but their sprout origin might be the reason for it. Elsewhere flowering ash is growing into the gaps, creating a shrub stratum hardly penetrable.

Comments on last natural and current potential vegetation

Here we describe shortly the former natural and present potential vegetation of the area. It might help in understanding landscape changes and planning of nature conversation management.

E.g.:

- Originally it might have been a lowland mesotrophic meadow habitat varying with riverine willow shrublands, later it might approach to lowland marsh meadows, when they dry out, to weedy dry grasslands.
- Each stand of the habitat (degraded H5a) have developed after the drying-out of meadows, thus mesic meadows (or a mesotrophic woodland association) might have been here the last natural vegetation, the potential vegetation depends on the propagulum source and the success of colonization.
- Originally it might have been a closed deciduous woodland, the top layer of soil is so eroded by now that the stand can only form an open woodland.

Nature conservation management proposals

Drawing up some important nature conservation management proposals.

E.g.:

- Driving over by any type of vehicle would be necessary to stop.
- The woodland is isolated, so in the absence of propagulum source the colonization of natural species will be very slow.
- Probably by draining of spring inland waters, only restricted regeneration might be expected, since most „good” species became already extinct.
- Tree species selection should be stopped in any case and age-group structure should be improved.

Changes occurred in the last 10 years and their probable reason

We document here those changes, that have occurred since the previous mapping. E.g.:

- Grazing of loess grasslands has completely been stopped since then, litter is accumulating. Ranunculus illyricus, Potentilla arenaria and Sternbergia colchiciflora became scarce. Stands around sweep-pole wells have regenerated, stands are dominated by Gramineae. Sections around Nagy-kút (Big well) have been ploughed and Russian olive was planted at Bíbic-kút (Bíbic well).
- As the result of wetland restoration habitat reconstruction finished in 2000 and some rainy years, reeds have been regenerated, weed species of dry habitats have perished, Aster tripolium and Bolboschoenus maritimus expanded. Grey cattle grazing is prosperous for the opening of marshes. Greylag goose ate drastically some of the stands.
- This habitat was not touched by clear-cuts what is exceptional since they are characteristic for the quadrat, at the same time a new lookout was built on Vár-hegy (Castle hill), for this reason stands around it are degraded. Wildlife at the east part of the quadrat has increased, there is no stand that is not overgrazed.

Change map and its documentation

- Map
- Description of the patches of the change map

The number of the patch on the change map	The number of the patch on the former habitat map	The number of the patch on the new habitat map	The Á-NÉR code and naturalness of the former patch	The Á-NÉR code and naturalness of the new patch	What changes happened for what actions?	The affected area (rough hectare estimation)
1.	69.	34.	J6/4	RC/1-2	deep plough of the clear-cutting in species rich hardwood woodlands, then renewed by Turkey oak	4

1.5.2.2.5 Assembling thematic maps of the report

Thematic maps needed for the report can easily be compiled by any GIS softwares from the recorded data. Although there is no restrictions for the software to use, we propose ArcGIS ArcView, that is used commonly at national park directorates. The templates made for help, are also prepared for this software. During the use of templates only the hyperlinks and labels of built-in layers must be corrected and the map appendix is finished with this. We outline the form and content requirements of appendix below.

General form requirements:

Page: A/3, landscape

Margins: left 2,5, right 2,5, bottom 2, top 2 (cm)

Texts:

Title: Times New Roman, 14pt, Bold

Identity number and name of the quadrat: Times New Roman, 14pt, Bold Italic

Legend title: Times New Roman, 12pt, Bold

Every other text: Times New Roman, 10pt

Background: White

Frames: 1pt, continuous, black

Map: 24,7x24,7 cm

Grid: Times New Roman, 10pt, 0,5cm frame

The name, contact address and logo of National Park Directorates must be written on every map sheet and also the name and organization of the mapper. We should not forget to represent the copyright references of the base maps on map sheets.

Content requirements:

T101 Overview map (compulsory)

Scale: 1:100 000

Basemap: 1:100 000 EOTR raster

Layers: The border of the country, county, quadrat

Label: The identification number of the quadrat

T102 The topographic map of the quadrat (compulsory)

Scale: 1:25 000

Base map: 1:10 000 EOTR raster

Layers: The border of the country, county, quadrat

Label: there is no label

T103 Aerial photo (year) (compulsory)

Scale: 1:25 000

Base map: 1:10 000 EOTR raster

Layers: The border of the country, county, quadrat

Label: there is no label

T301 Habitat map with identification number of the patches – 1:25 000

Scale: 1:25 000

Base map: there is no base map

Layers: The border of the country, county, quadrat, the patches of the habitat map

Label: The identification number of habitat patches

T302 Habitat map with Á-NÉR codes of patches

Scale: 1:25 000

Base map: there is no base map

Layers: The border of the country, county, quadrat, the patches of the habitat map

Label: Á-NÉR code of habitat patches

T303 Habitat map with Á-NÉR code of the patches coloured by the first category

Scale: 1:25 000

Base map: there is no base map

Layers: The border of the country, county, quadrat, the patches of the habitat coloured by the template

Label: The Á-NÉR code of habitat patches

T304 The spots of photos attached and the survey route on the patch map

Scale: 1:25 000

Base map: there is no base map

Layers: The border of the country, county, quadrat, the patches of the habitat, the spots of photos

Label: The identification number of the spots where the photos were taken

1.5.2.2.6 Printing the report

Textual documents and thematic maps prepared from templates must be exported to PDF format (e.g. PDFCreator). Reports are to be printed in at least three copies and in two copies on CD. The CD should contain the following files:

- digitized habitat map (database)
- textual documents (MS Word or Open Office and in PDF format)
- thematic maps (in PDF format)
- photos

II. GIS Processing of Former Mappings

At the first monitoring period of National Biodiversity Monitoring System, habitat maps were mainly prepared on papers, but around the end of the course, there were also some data files produced by the use of some GIS method. In a national system it can be considered as an essential requirement to access written reports and data in a uniform format and quality. The most important task for years forthcoming is to process the materials of the first mapping.

During the processing of materials collected by former mappers, we should practically use the same tools and execute the same task what we would use for new mapping.

The first step of processing is the preparation, the most important task is to transform the aerial photo, we want to use, into orthophoto map. In certain cases we must obtain the original image again (if it was not bought in digital format at the first mapping) and orthophoto map is to be produced. An image with the best available resolution and colour depth must be ordered when we purchase the aerial photo. Habitat map, route plan map and also the map of the spots of shots are scanned and georeferenced during processing.

Subsequent the preparation, habitat patches, survey route and the spots of photos are to be digitized. Patches are delineated mainly on aerial photos during digitization, but we continuously check the drawn lines of the original habitat maps too. It is sound if that person does the digitization who originally drew the map, thus he or she can correct drawing errors and distortion errors. It might happen that the mapper did not draw the patch boundary as it could be seen on the aerial photo, in such a case, when it is possible, the mapper should be asked if it is a drawing error or the boundary was really not there. Patch boundaries, lines and points produced during digitization must be done according to data structure of Nature Conservation Information System.

After this, other documents enclosed to the report should be digitized, if these are not in digital format. If the photos of former report were taken by digital camera, we do not have to scan the printed ones but we should try to obtain the original pictures.

III. Nature Conservation Information System (NCIS)

Source: <http://www.termesztvedelem.hu>

III.1. Introduction

At the end of the 20th century the fundamental changes in information technology resulted in changes in public administration, especially in the field of efficiency. The unplanned and uncoordinated use of information technology and the databases, however, might cause particularization and inefficiency.

In the last years in Hungarian Nature Conservation (under the Ministry of Environment and Water) the need for a comprehensive information system to help professional decision making appeared. The increasing number of scientific results connected to nature conservation, the increasing area of sites under the management of the National Parks (with more and more tasks connected to property management), the detailed, up-to-date, quality controlled register of protected sites all needed a complex, well structured information system.

The Nature Conservation Information System (TIR) is a central, EU-compatible register of databases (e.g. geological, hidrological, botanical, zoological, landscape and cultural values, ecotouristical sites etc.) of the central and regional public administration of the Hungarian Nature Conservation.

III.2. Goals and tasks of the Nature Conservation Information System (NCIS)

III.2.1. Goals of NCIS

To provide

- complex information for strategic planning of nature conservation
- basic or synthetic data for decision making
- information for country reports and publications on the state of Nature in Hungary
- relevant information to analyse efficiency of nature conservation management and other factors affecting nature

III.2.2. Tasks of NCIS

- To collect and store locality-based data (e.g. geo-data of protected sites).
- Standardized data management (e.g. registers).
- Analysis (for administration, management, monitoring, research etc.)
- Publication (results, monitoring, PR)

III.2.3. Conditions of proper functioning

- Quality controlled data
- Complex query possibilities in space and time (sites, species, species groups, communities etc.)
- Compatibility with other databases (property register, forestry database)
- Easy management and accessibility for certified users
- Well structured, standardized database that is easy to develop and manage
- High potential for co-management of different data sources

The Map server of the NCIS Public Relations Module is available on : http://geo.kvvm.hu/tir_en

IV. References Used and Recommended

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Appendix 1.: National Habitat Classification system (Á-NÉR2007) (Nov. 2007)

Editors: J. Bölöni, Zs. Molnár, A. Kun and M. Biró

For a detailed description of the National Habitat Classification system (Á-NÉR) see

<http://www.novenyeterkep.hu/meta/en/index.shtml>

Appendix 2: Degradation factors and threats

Reference: Nature Conservation Information System (1st December, 2007)

Code	Denomination
Mining activity	
B00	Mining
B01	Opencast mining (but not the sand and gravel quarries, peat mines, salt pits, gas or oil wells)
B02	Mining under the surface (but not the sand and gravel quarries, peat mines, salt pits, gas or oil wells)
B03	Sand and gravel quarries
B04	Opencast sand and gravel quarries
B05	Exploitation of sand and gravel resources of the riverbanks
B06	Peat mining
B07	Mechanised peat mining
B08	Manual peat mining
B09	Prospecting for and exploitation of oil and natural gas resources
B10	Salt pits
B11	Illegal exploitation of mineral substance resources
B12	Depression of the karst water level
B13	Mechanical damage
B14	Disturbance
B15	Noise impact
Other human activities	
E00	Other human activities
E10	Gathering, capture/removal of wild animals (in general)
E11	Gathering of snails
E12	Antler gathering
E20	Gathering/removal of wild plants (in general)
E21	Gathering of medicinal herbs
E22	Gathering of wild flowers
E30	Build-in
E31	Change in the line of cultivation
E40	Open-air sports and free-time activities (in general)
E41	Car races
E42	Motocross, quad
E43	Water sports
E44	Hiking, horse riding and bicycling
E45	Excursion with motor vehicles
E46	Hill- and rock-climbing, caving
E47	Gliding, sailplaning, paragliding and ballooning
E48	Skiing on and outside of ski trails
E49	Cross-country running
E50	(Nature) photography and filming
E60	Vehicular traffic
E61	Air traffic
E62	Water traffic
E63	Salting of the roadways
E64	Trampling
E65	Reconstructing embankments
E66	Maintenance of the roadways
E70	Wind power turbines
E71	Hydroelectric power plants
E72	Uncovered wires
E80	Ownerless animals
E81	Direct human disturbance
E82	Excavation

Code	Denomination
E83	Mechanical damage
E84	Fire damage
E85	Spring catchments
E86	Lawn-mowing
Activities of the forestry	
F00	Sylviculture
F10	Afforestation/plantation
F11	Deforestation
F12	Artificial regeneration
F13	Natural regeneration
F14	Filling-in
F15	Final removal cutting
F16	Clear cutting
F17	Removal of the deadwood
F18	Sanitary cutting
F19	Preparatory cutting
F30	Removal of the shading stand
F31	Eradication of the shrubs
F32	Canopy replacement with non-native trees
F33	Canopy replacement with native trees
F50	Stockpiling
F51	Dragging of the felled timber
F52	Leaching
F53	Mechanical damage
F54	Soil erosion
F55	Complete preparation of the soil
F56	Use of chemicals
Agricultural activities	
M00	Agricultural activities
M01	Change in the line of agriculture
M10	Plough-in
M20	Cessation of grassland management
M30	Mowing
M31	Improper mowing
M32	Cessation of mowing
M40	Grazing
M41	Decreasing intensity or the cessation of grazing
M42	Overgrazing
M43	Undergrazing
M44	Establishment of water holes
M45	Establishment of stalls for the livestock
M50	Sowing over grasslands
M51	Loosing the structure of the grassland
M52	Burning
M53	Organic fertilisation
M54	Artificial fertilisation
M55	Terrestrial eutrophisation
M56	Soil erosion
M57	Mechanical damage
M58	Use of chemicals
Pollutions	
S00	Pollution
S01	Light pollution

Code	Denomination
S02	Noise pollution
S03	Air pollution
S04	Dumping of waste
S05	Storage of the sewage
S06	Organic pollution
S07	Inorganic pollution
S08	Mosquito-killing
S09	Soil pollution
S10	Use of chemicals
S11	Water eutrophisation
S12	Water pollution
Biological invasion	
I00	Biological invasion
I10	Spread of an invasive animal (in general)
I11	Spread of other invasive animal
I20	Spread of an invasive plant (in general)
I21	Spread of the black locust (<i>Robinia pseudoacacia</i>)
I22	Spread of the pokeweeds (<i>Phytolacca</i> sp.)
I23	Spread of the green ash (<i>Fraxinus pennsylvanica</i>)
I24	Spread of the goldenrods (<i>Solidago</i> spp.)
I25	Spread of the asters (<i>Aster</i> spp.)
I26	Spread of the tree-of-heaven (<i>Ailanthus altissima</i>)
I27	Spread of the peppervine (<i>Ampelopsis arborea</i>)
I28	Invasion of shrubs
I29	Spread of the Russian olive (<i>Elaeagnus angustifolia</i>)
I30	Spontaneous spread of conifers
I31	Spread of the indigobush (<i>Amorpha fruticosa</i>)
I32	Spread of the Japanese knotweeds (<i>Reynourtia</i> spp.)
I33	Spread of the black cherry (<i>Prunus serotina</i>)
I34	Spread of the coneflowers (<i>Rudbeckia</i> spp.)
I35	Spread of the touch-me-nots (<i>Impatiens</i> spp.)
I36	Spread of the ragweed (<i>Ambrosia artemisiifolia</i>)
I37	Spread of the common milkweed (<i>Asclepias syriaca</i>)
I38	Spread of the wild cucumber (<i>Echinocystis lobata</i>)
I39	Spread of the boxelder maple (<i>Acer negundo</i>)
I40	Spread of other invasive plants
Natural processes	
T00	Other natural processes
T10	Succession
T11	Invasion of shrubs
T12	Invasion of trees
T13	Erosion
T14	Mouldering
T15	Mud avalanche
T16	Invasion of the (river)bank by weeds
T17	Falling of the high (river)bank
T18	Eutrophisation
T19	Sedimentation
T20	Leaching
T21	Drying-out
T22	Depression
T30	Extreme weather conditions
T31	Stagnant water

Code	Denomination
T32	Low level of the groundwater
T33	High level of the groundwater
T34	Insufficient precipitation
T35	Poorly decaying litter
T40	Natural disasters
T41	Flood
T42	Avalanche
T43	Land- or rock-slide, soil creep
T44	Storm, cyclone
T45	Volcanic activity
T46	Earthquake
T47	Tidal wave
T48	(Natural) fire
T49	Other natural disasters
T60	Fragmentation of the population
T61	Isolation of the population
T62	Too small size of the population
T63	Overpopulation of the foxes
T64	Overpopulation of the game
T70	Interspecific relations between animals
T71	Competition (e.g. between gulls and terns)
T72	Parasitism
T73	Introduction of a disease
T74	Genetic pollution
T75	Predation
T76	Antagonism appeared due to the introduction or invasion of new species
T77	Antagonism against domestic animals
T78	Other or transitional types of competition between animals
T79	Presence of predators
T80	Interspecific relations between plants
T81	Competition
T82	Parasitism
T83	Introduction of a disease
T84	Genetic pollution
T85	Absence of the pollinator
T86	Damage caused by native plants
T87	Other or transitional types of competition between plants
Hunting/Fishing activity	
V10	Hunting
V11	Establishment of hunting facilities
V12	Dredgers' activity
V13	Overpopulation of the game
V14	Overpopulation of the foxes
V15	Damage caused by the game
V16	Rooting of wild boars
V17	Trampling
V20	Large-scale fishery
V21	Small-scale fishing
V22	Intense fishing pond
V23	Fertilisation
V24	Over-forage/Accumulation of the nutrients
V25	Overfishing
V26	Introduction of non-native fishes

Code	Denomination
V27	Boat/Ship traffic
Water management	
H00	Water management
H01	Sedimentation
H02	Deposition of the dredged material
H03	Dredging
H04	Removal of the floating timber
H05	Removal of the shading stand
H06	Drainage
H07	Drainage of the inland water
H08	Depression of the groundwater level
H09	Controlling the water level
H10	Stagnant water
H11	Inundation
H12	Damming
H13	Channel building
H14	Construction of dykes
H15	Protection of the shore
H16	Averting the riverbed
H17	Riverbed reconstruction
H18	Mechanical damage
H19	Use of chemicals
Military activities	
K00	Military activities
K01	Fire damage
K02	Soil damage caused by combat vehicles
K03	Soil damage caused by explosion
K04	Trampling

Appendix 3: Degradation phenomena

Reference: Nature Conservation Information System (1st December, 2007)

Code	Denomination
J01	Monodominance of a natural dominant species
J02	Monodominance of a natural sub-dominant species
J03	Invasion of weeds
J04	Dominance of weeds
J05	Dominance of a non-native species
J06	A previously cultivated species dominates the habitat
J07	Disappearance of the specialists
J08	Disappearance of the protected species
J09	Disappearance of or the increased threat against an important rare species
J10	Few species of the original vegetation are present in the habitat
J11	Disappearance of the monocots
J12	Disappearance of the dicots
J13	Absence of the characteristic species
J14	Disappearance of the dominant species
J15	Decrease in the number of the sub-dominant species
J16	Decrease of the total species number
J17	The vegetation became featureless
J18	The canopy is composed of a single species
J19	The canopy became dominated by a sub-dominant species
J20	Species poor canopy
J21	The canopy is mixed with non-native species
J22	The canopy is dominated by non-native species
J23	Species poor shrub layer
J24	Presence of weeds in the shrub layer
J25	Species poor herb layer
J26	The herb layer is dominated by grasses
J27	The herb layer is dominated by weeds
J28	The herb layer became featureless
J29	The dominance of a non-native species in the herb-layer
J30	The characteristic species are present, but the structure is lost
J31	Accelerated natural succession
J32	The invasion of a treeless vegetation by non-native tree species
J33	Any layer of the grassland is missing
J34	Disappearance of the cryptogams
J35	Absence of the herb layer
J36	Disturbed herb layer
J37	Absence of the shrub layer
J38	The woodland became invaded by shrubs
J39	The standing timber does not regenerate
J40	The standing timber is infected
J41	Opening canopy
J42	The natural stratification of the canopy simplified
J43	Absence of the canopy

4. melléklet: Examples of thematic maps

