

THE BIOTOPE METHOD 2005

A METHOD TO ASSESS THE IMPACT OF LAND
USE ON BIODIVERSITY



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SUMMARY

This report presents the Biotope Method, a method intended for the quantification of impacts on biodiversity caused by changes in land use, e.g. the utilisation of land and water for the purpose of electricity generation. The method is based on a comparison of the utilised area's biotopes before and after the change.

The method was developed during the 1998-2000 period, and has been applied to a number of different operations within the energy-generation field. The approach is intended to yield a coherent structure allowing descriptions, quantifications and comparisons between different types of land uses and their impacts on biodiversity.

A limitation in traditional Life-Cycle Assessment (LCA) methodology is that impacts on biodiversity has rarely, if ever, been quantified. This has meant that such impacts have not been used in the comparison between different products and services.

The Biotope Method is based on the identification and assignation of utilised biotopes, in the Swedish context partially on the red lists developed by ArtDatabanken at the Swedish University of Agricultural Sciences. The areas for the respective assigned biotope categories are measured, yielding a quantitative measure of impact. Every assignation must be accompanied by a qualitative description, since all such work is coloured by subjective decisions. This qualitative description provides a source of motivation for various decisions.

A precondition for using the method in a general setting is that it is standardised, i.e. objective, clear and replicable. It is assumed that a satisfactory level of input data quality can be reached through air-photo interpretation, study of existing inventories, database searches etc. Checklists with suggestions for data sources (in the Swedish context) are provided.

The method has been developed as a tool in order to illustrate the environmental performance of electricity and heat products. It does not claim to be an environmental impact assessment (EIA), but can be used as one of several tools for an EIA study. Neither is it supposed to result in detailed species inventories or give a complete picture of the impacts to flora and fauna. Instead it utilises existing information and knowledge of species and impacts.

The above is important to keep in mind, since the Biotope Method can lead to simplifications of something very difficult to describe in a quantitative manner. The target is that effects caused by the land use shall not be underestimated. The "shortcuts" allowed and identified in the methodology document have been drafted with this ambition as a basis.

1 BACKGROUND

For many years, the work with life cycle assessments (LCA), has been focussed on the quantification of resource use and emissions. The impacts on flora and fauna resulting from the utilisation of land and water have, however, mostly been described in general terms and rarely if ever quantified. However, several attempts at quantifying the impacts of land use do exist (cf. Swan, 1998)

Conservation biology has also tended to describe impacts on species level biodiversity in a qualitative manner, a very reasonable approach considering the complexity of the concept of diversity. With the aid of the so called red lists (international and national listings of threatened species) and the causes of threat given therein, it is for instance possible to deduce that forestry threatens more species than hydropower in Sweden. Yet another quantitative measure is the area of protected areas. What is missing is a method which enables comparisons between different but similar activities, e.g. different hydropower projects.

As a part of the collation of background information for a certified Environmental Product Declaration (EPD), the Biotope Method was developed within the Vattenfall Group in Sweden in order to quantify impacts on biodiversity (Blümer & Kyläkorpi 1998, 2001). This was voluntary work, inspired by the realisation that only a qualitative description would be unsatisfactory. The method was originally developed for use in retrospective analyses of hydropower in Sweden. Later, during the 1998-2005 period, the method has been tested and further developed through applications to many different aspects of energy generation.

1.1 AIMS

The aim of this report is to describe the method for quantification of biodiversity impacts which has been developed and tested in the Vattenfall Group in Sweden. It is our ambition that the method should supply a clear structure allowing objective descriptions, quantifications and comparisons of different types of land use and the impacts on biodiversity following from these. Consequently, it is used to provide standardised information on the ecological changes caused by various types of land use. One advantage of this is that a company's work with improvement (conservation/management measures) can be quantified.

The Biotope Method has been developed as a tool for the illustration of environmental performance of electricity and heat products/services. Thus, it is not aimed at replacing a full-scale environmental impact assessments or thorough ecological inventories, nor does it yield complete descriptions of the effects on flora and fauna. This is important to keep in mind, since the method simplifies something that is very difficult to quantify. It is necessary to reach a balance between comprehensiveness and necessary simplification.

1.2 READING GUIDELINES

The Biotope Method and its principles are described in this report. The method is based on Swedish/Nordic conditions, but it is our ambition that the approach should be applicable in other geographical areas as well.

In order to facilitate the reading of the report, there is a list of definitions of the terminology we have used (Chapter 5). Because the method exists in two earlier version (Blümer & Kyläkorpi 1998 and 2001), there is also a cross reference (Chapter 6), to facilitate understanding of the changes made to adopted terminology. Earlier versions have had separate user's guides for various types of land use. These are removed from this version, in order to provide a unified and clear description of the methodology.

2 METHODOLOGY

All types of utilisation of land and water resources will affect flora and fauna. The level of impact will, apart from the utilisation itself, largely be determined by the types of environments (biotopes/habitats) that existed in the area before the land use change took place. There are several factors which characterise the biotopes; climate, geology, geographic location, degree of prior anthropogenic impact as well as certain more or less typical sets of species compositions.

The Biotope Method is based on the assumption that the gains and losses of biotopes, caused by a change in land use, are indicators of the resulting changes in biodiversity. These gains and losses are quantified by calculating the acreage of the various biotopes. This allows a comparison between different types of land use changes. Application of the method thereby implies a comparison between the distribution and quality of the biotopes "Before" and "After" the land use change takes place. The differences in how biodiversity is affected in a particular place by the harnessing of natural resources are obviously quite significant, but the Biotope Method is intended to be applicable on most kinds of land and water utilisation (called land use here).

Somewhat simplified, the ecological consequences of different types of land use can be divided into three principal groups: change; impact and; removal of ecosystems. Change implies a situation where land use alterations create possibilities for new species to establish themselves, while existing ones are disadvantaged. Impact implies a continuous use of land that causes changed preconditions for existing species. Removal implies the conversion of an area into e.g. hardmade surfaces (asphalt, concrete), which does not allow at least surface-living species to exist. Table 1 below gives examples of some common land uses and their division into these three groups.

CHANGE	IMPACT	REMOVAL
Transmission corridors Impoundments Peat mining Depositories	Agriculture Forestry Forest bio-fuel outtake Cooling-water releases	Buildings Roads Foundations Draw-down zone (reservoir)

Table 1 Different types of land use

Most activities fall into more than one of these groups. A hydropower project for instance, results in removal in the form of buildings access roads and (maybe) draw-down zones, but is often dominated by storage reservoirs, which rather represent change. Most applications of the method also have to handle more than one form of ecological consequence.

The Biotope Method is divided into four steps, see Table 2 and Appendix 1. In the following sections we describe these steps.

STEP	CHAPTER
1. Determine system boundaries and calculate areas 2. Identifications of biotopes 3. Assignment of biotopes into four categories 4. Collation, presentation of results	2.1 Delimitations 2.2 Biotope identifications 2.3 Assignations of Biotope category 2.4 Presentation of results

Table 2 The four steps of the Biotope method

The following sections describe the different steps of the method, and how to apply it to various kinds of land use. They also demonstrate alternative approaches for those cases where a complete application of the method is impossible.

2.1 DELIMITATIONS

The most important delimitation in the method is of a principal nature. The Biotope Method is not a tool for analysis of the total environmental impact from a project or an activity. It is developed in order to assess the impacts on biodiversity. In order to arrive at a comprehensive environmental impacts statement for a project/activity, other complementary methods must be utilised for the assessment of e.g. impacts on air and water quality.

The first step in the Biotope Method is to determine the (technical) system boundaries and the impact area. System boundary in this case is defined as in LCA methodology. This means the technical, geographic and temporal systems analysed in a life-cycle assessment. Impact area is defined as in an Environmental Impact Assessment (EIA) setting, i.e. as the area affected, directly or indirectly, by an activity or project. The delimitation step involves the definition of what is to be included into the study, and what is to be excluded from it, both in sense of geographic and temporal aspects. The impact area is normally more inclusive than the system boundary. Delimitation is a prerequisite for a results presentation with maps of identified biotopes for the directly affected area. With the aid of collated information, the biotopes can then be assigned into the different categories.

2.1.1 System boundaries

The temporal delimitation is basically the same in all types of applications. The "Before" situation is defined as just before, or as close before as possible, the actual land use change took place. The "After" situation is defined as a point in time long enough after the change so that the biotopes have been able to recover/stabilise. The meaning of "long enough" unfortunately has to be determined on a

case-by-case basis. For already developed hydro-power plants in a cold temperate climate, this can be 40–50 years (cf. Bååth, 1999, Figure 1), while in the case of transmission-line corridors it is in the bracket of 0–10 years.

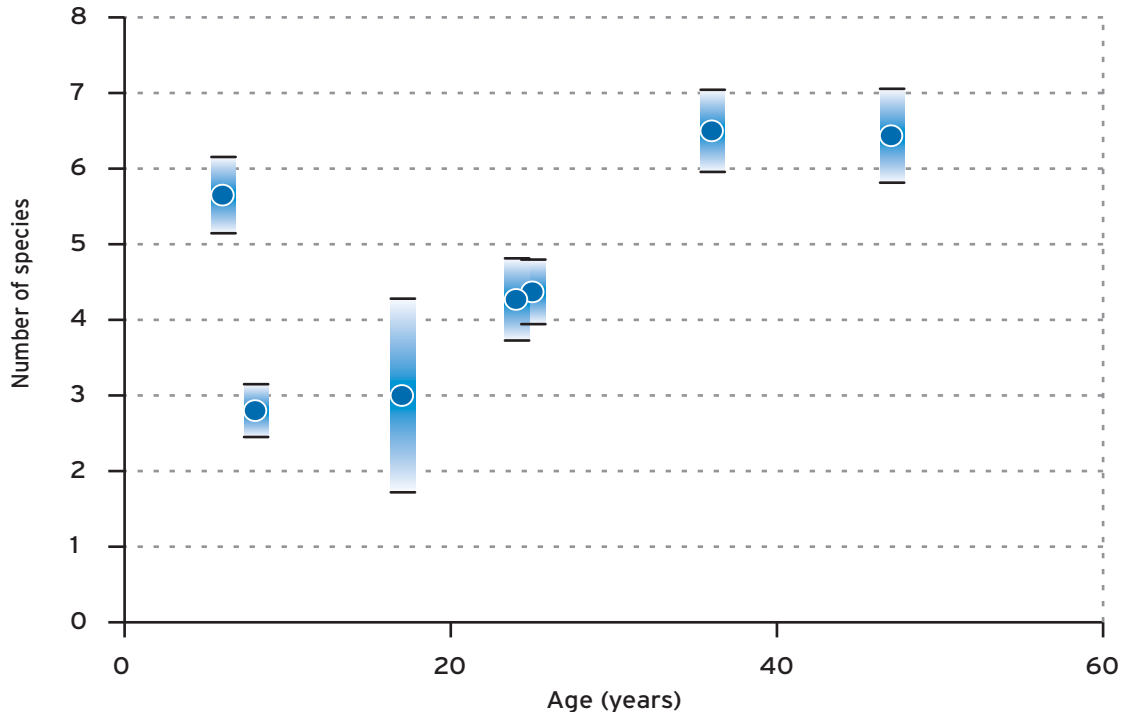


Figure 1 The number of vascular plants on hydropower dams of varying age. Average and standard deviation (adapted from Bååth 1999).

There are, however, a few special cases. In application on an on-going expanding activity, e.g. open-pit mining, depositories and dumps, the "After" situation is normally defined as the actual time of the study. This means that there has been no time for biotope stabilisation, nor for rehabilitation measures. In such cases it is recommended to describe planned and budgeted mitigation in a qualitative manner, but to exclude them from the quantitative analysis.

Since the method is intended for the analysis of marginal impacts, there is no need for the definition of a "natural state". The Biotope Method includes only the impacts on flora and fauna from the studied project, nothing that has occurred in the area previously.

An important methodological delimitation is that the method includes no definition or analysis of mitigative measures. This step, which is a basic requirement in all forms of impact assessments, is outside of the Biotope Method, but always has to be performed if the method is used as one part of e.g. a formal EIA. However, the method does make it possible to include already performed conservation measures or other mitigation into the results, see also chapter 4.

The geographic delimitation is a very important step. The quantitative part of the method aims at land use with a direct connection to the analysed project/activity, meaning it:

- has clear geographic limits;
- mainly is not shared with other projects/activities

The quantitative step includes only the direct impact area in the immediate vicinity of the project. In practice this means that inclusion or exclusion has to be determined on a case-by-case basis. The delimitation should always be clearly motivated and reported.

There are some differences in approach between different types of land use. A particularly complex case is that of nuclear power since an application, at least in the case of LCA/EPD, has to include the

entire life cycle (nuclear-fuel cycle in this case) – from mining via enrichment, conversion, fuel production, the actual generation of electricity and waste management (spent fuel etc.).

2.1.2 Sources of information

The deciding factor for whether it is possible to determine system boundaries or not is the access to technical descriptions and other relevant background materials. These should make identification and measurement of affected areas possible.

The access to information obviously differs from case to case. Table 5 gives examples of information sources (for the Swedish case) that can be valuable/necessary for the determination of system boundaries.

2.1.3 Area calculations

After the determination of system boundaries, the affected areas are preferably measured with the aid of GIS software and digital aerial photographs from the "After" situation.

2.1.4 Impact area

It is of the utmost importance that the areas that are excluded from the geographically strict system, and thus are not analysed quantitatively, are treated separately. In the qualitative analysis of the areas which fall inside the impact area, but outside the technical system boundary, one in principle follows the methodology of an ecological impact assessment, see chapter 3. This focuses on:

- qualitative description of effects
- identification and description of impacts
- assessment of impacts

2.1.5 Alternative approaches

If the system boundaries cannot be determined, the Biotope Method is not applicable as a quantitative tool. Where appropriate, other methods for quantitative and/or qualitative analysis should be employed.

2.2 Biotope identification

The second step in the method is the identification of the biotopes/habitats that have been affected, both in the "Before" and "After" situations. This includes an assessment of what is known about biotopes and natural values within the system boundaries. In order to accomplish this, one primarily needs an applicable identification system for existing biotope types. There are a number of such systems for aquatic, littoral and terrestrial environments. See Table 3 for some examples from Sweden.

NAME	REFERENCE*
Vegetationstyper i Norden (Vegetation types in the Nordic countries) Swedish CORINE Land Cover System Aqua Biotoper som naturvärdeskriterium (Biotopes as a valuation criterion) Svenska Naturtyper (Natura 2000) (Swedish environments)	Påhlsson (ed.), 1994 www.lantmateriet.se Willén et al., 1996 Renman et al., 1998 Löfroth (ed.), 1997
* See Bibliography, chapter 7	

Table 3 Some Swedish identification systems that can be used in the generation of biotope lists.

The identification focuses on developing as much knowledge as possible about the affected biotopes. The Biotope Method relies on existing classes and typology, adapted to relevant situation and purpose. This is the basis for the assignation into biotope categories – a central feature of the method itself (section 2.3).

The Biotope Method assumes identification systems which encompass a wide variety of environments. Since the method was developed in the context of Swedish/boreal conditions, environments such as lakes, rivers, forests, agricultural land and urban areas should be manageable. Furthermore, the systems have to be feasible from high mountain to coast, and from north to south. An identification system able to do all this is difficult to construct. There is, to a certain extent, a contradiction between need for generalisation and need for detail. The level of detail is determined by the background information available (e.g. aerial photographs).

In applying the Biotope Method, one can and should develop situation-specific identification systems based on the characteristics of the area, and available background information.

Table 4 shows how such a system can be designed. All identifiable biotopes, e.g. in aerial photographs, should be attended to in the identification step. The identification of areas without preconditions for biological production (see 2.3.1) is also included in this step.

Table 5 below shows an example of background information for biotope identification. Appendix 2 shows an area of identified biotopes and categories (see section 2.3) in the "After" situation.

MAIN GROUP	SUBGROUP
Biotopes in an aquatic location	Marine waters Brackish waters Rapids (>0.7 m/s) Fast-flowing water (0.2-0.7 m/s) Slow-flowing water (0-0.2 m/s) Oxbow lakes
Biotopes in a littoral location	Littoral meadows Rocky shores Littoral forests Temporarily exposed sandbanks Ravines/gullies (forested) Steep sandy riverbanks (erosion-prone) Littoral mires Bouldery shores
Biotopes in a terrestrial location	Coniferous forest Deciduous forest Heath/open land Clear-cut area (not clearing before impoundment) Agricultural land Mire/bog Exposed rock/bouldery area Exposed rock above vegetation line Mixed forests
Other "environments"	Buildings/construction surfaces Glaciers

Table 4 Example of a biotope identification system for boreal areas

2.2.1 Sources of information

A great number of sources for biotope identification exist (cf. Table 5), and in the ideal case one has good access to aerial photographs and map materials for both the "Before" and the "After" situations, facilitating high-resolution biotope maps. In the "After" situation one normally also has the opportunity for site visits if the material is of dubious quality. Areas which sort under the removal

group above are not put into a biotope type, but rather as some sort of technical structure. A very important source of information is archives of old aerial photograph, where documentation from the "Before" situation can often be found, even for post-project assessment long after the land use change took place. These photos are, however, rarely shot with e.g. vegetation mapping in mind. In the ideal case there are photos in infrared, but this will be the exception before about 1980. In practice this means that the photos may be shot in a less than perfect season, or at a less than ideal height, for vegetation/biotope mapping. When the Biotope Method is applied on linear features such as roads, rivers and transmission-line corridors, it is especially important with high-resolution photos.

Table 5 ranks different data sources in relation to suitability for biotope identification, based on experience from actual applications.

DATA SOURCE (CHECK LIST)		BEFORE*	AFTER*
Aerial photographs	Infrared (IR)	1	1
	Panchromatic (B&W)	2	2
General maps	Topographic	3	3
	Economic	3	3
	Vegetation	2	2
	Soil	3	2
Special-purpose maps	Situation maps	4	4
	Impact maps	2	4
	Historic maps	2	4
Other	Site visit	1**	1
	Inventories	1	1
	Technical descriptions	4	4
	EIA, permit applications	3	3
	Environmental reports	4	4
* Priority according to usefulness. 1 is the highest and 4 is the lowest score			
** Rarely applicable in retrospective analyses, see section 2.2.2			

Table 5 Sources of information and their usefulness

2.2.2 Alternative approaches

For very recent land use changes, or for changes where the surrounding environments decidedly have not changed appreciably, there is an alternative approach. The identification of biotopes for the "Before" situation can be done with available aerial photographs and site visits in combination. This is for instance true for most wind power developments. Since the land use change in these cases can normally be considered very minor, mainly consisting of access roads and small turning areas, it is satisfactory to study surrounding areas under the assumption (possibly supported by aerial photographs from before the development took place) that the changed area resembled that which now surrounds the development.

The ideal situation describes a situation with good access to information. In practice, however, the background material can be very unsatisfactory. In many developments there were no documentation of the "Before" situation, neither in the form of aerial photographs nor as maps. In those cases where it is not possible to identify the biotopes, the following step (assignment of biotope category) has to be made with other means, in this case an assignment key (see 2.3.4 and Appendix 1).

2.3 ASSIGNATION OF BIOTOPE CATEGORY

Different identification systems and approaches yield a great number of biotope types, classes or indications of environments and/or features. In order to create a uniform assessment for the Biotope Method, standardisation of these is necessary. This means that the various classes or groups from the

identification step are divided into four categories. These categories are the basis of the method. The assignation of category also constitutes an assessment of what biotopes/habitats belong to which category in accordance with the Biotope Method.

In order to perform the assignation there is a need for good background material. In the ideal case, there are detailed inventories of the flora and fauna of the area under study, both "Before" and "After" the land use change (see Table 7). In such a case, the remaining necessary work to facilitate category assignation is to tie existing species to the various biotope types that have been mapped in the area.

The four categories used in the Biotope Method are critical, rare and general biotopes, as well as technotopes (see section 2.3.1 or chapter 5 for definitions). The approach is the same for the "Before" as for the "After" case. It is important to note that the assignation is performed with present knowledge and values - also for past actions. Further knowledge development and changes in value systems might mean that future assessments yield different results.

Figure 2 below shows a principal sketch of the changes in categories between the "Before" and the "After" situations. The areas in the figure represent changes in the proportions of critical, rare and general biotopes as well as technotopes. Note that this is an example only. Technotopes are, for instance, often missing in the "Before" situation.

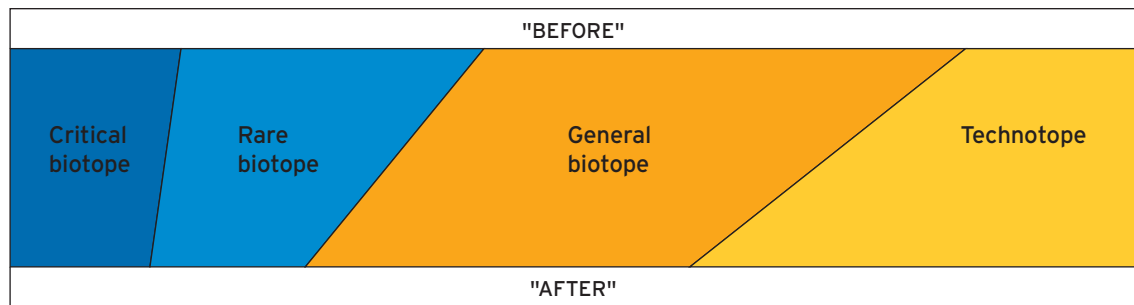


Figure 2 Principles for the Biotope method

An important aspect of the methodology is that created environments should be included in the assignation in the same manner as all other environments. The purpose of this is to encourage mitigation and habitat management measures (see also chapter 4).

In order to enhance the transparency and replicability of the method's applications, the assigned biotope types should also be described in a qualitative manner. These descriptions should contain motivations for the choices made. As stated above, qualitative descriptions are needed when determining system boundaries and identifying biotopes as well, but are considered particularly important in the assignation process.

Technotopes are mapped at the stage of biotope identification, and further assignation is not necessary.

2.3.1 The categories of the Biotope Method

The identified biotopes are divided into the following four categories:

- *Critical biotopes, CB*
- *Rare biotopes, RB*
- *General biotopes, GB*
- *Technotopes, T*

The four categories are defined below.

Critical biotope

Definition of critical biotope (CB):

A critical biotope is an area which, by its structure, species content, history and physical environment, has very high significance for flora and fauna. It harbours, or can be expected to harbour, red-listed species.*

*The biotope exhibits qualities that indicate the existence of red-listed species, but actual documented finds are missing.

Rare biotope

There are biotopes which do not satisfy the demands for CB, but whose high species richness still warrants separation from AB (below). These are called rare biotopes.

Definition of rare biotope (RB):

Biotope which differ from its surroundings through high species richness or the existence of regionally rare species or key features*

*E.g. rare according to Krok & Almquist (1984) (in the Swedish setting).

General biotope

Apart from the critical (CB) or rare (RB) biotopes, the more general environment is also affected by land use changes and developments. These types of habitats are commonly occurring over a large area. They might harbour occasional rare or even red-listed species, but since they themselves are common, they have been assigned to their own category. This category is called general biotopes.

Definition of general biotope (GB):

Other biotopes, i.e. those that cannot be assigned to any of the other categories

Biotopes in all types of locations, aquatic, littoral and terrestrial, can obviously fall into any of these categories.

Technotope

Certain kinds of land use lead to almost complete loss of flora and fauna. These areas should be distinguished from the others. Technotopes are e.g. such areas where the soil cover has been removed or eroded away, or hard-made surfaces like buildings, roads and parking lots. It can also represent severely affected areas that will recover over the long term, but totally lack flora and fauna at the time of assessment.

Definition of technotope (T):

Areas without preconditions for biological production (e.g. hard-made surfaces)

Technotopes can obviously exist before the particular studied land use change, and are then included in the "Before" description.

2.3.2 Indicators

The biotope assignment requires some sort of indicators. The Biotope Method uses red-listed species and key features (see below) to divide the studied areas into general, rare and critical biotopes. The following sections will describe the reasoning behind this choice of indicators.

During the development of conservation biology, scores of different systems for the classification of the environment in accordance with its biotic and non-biotic conditions have been advanced. Many of these have chosen to identify areas of particular interest, often on the grounds of a potential to harbour red-listed species. One example of this is the key biotope system developed by Skogsstyrelsen in 1994 (the National Board of Forestry in Sweden). Key biotopes are small areas harbouring, or with the potential to harbour, red-listed species. Other indicators could be different structures/elements in the landscape creating the necessary preconditions for a rich ecology (see Table 6).

Red-listed species

National lists (so called red lists) of species, whose survival is in some way threatened, are developed in many countries around the world. In Sweden it is ArtDatabanken (the Swedish species information centre) that has this responsibility of gathering information and assess the threats (Gärdenfors 2005). The Biotope Method uses red-listed species as indicators of critical biotopes. The use of these species as indicators is not entirely without problems, but can be motivated with the following:

"A common denominator for red-listed species is that they are considered to be at risk of disappearing in the near future. Thus, red-listed species are not representative of the biodiversity of various ecosystems. However, the proportion of red-listed species belonging to a certain type of biotope might reflect the degree of anthropogenic disturbance and, thus, the deterioration of resident biodiversity. The red-listed species can be considered as the vulnerable pinnacle of species diversity within an ecosystem. This means that red-listed species are often also indicative, and useful as monitoring organisms." [...] "Biodiversity is mainly composed of non red-listed species. They obviously have the same conservation value, but often get much less attention in conservation inventories, since their existence is not threatened in the same manner. Red-listed species are often more specialised than other species and, therefore, indicate conditions of particular conservation value"..... (translated quote from Cederberg et al. 1997)

Key feature

The concept of a key feature (see Table 6) concerns different structures in the landscape which create preconditions for high biodiversity, and can thus be used as indicators for the assignation procedure, particularly for rare biotopes, RB. The existence or lack of key features guide the assignation in accordance with the definitions in 2.3.1.

THE FOREST LANDSCAPE ¹	THE AGRICULTURAL LANDSCAPE ²	SPECIAL ENVIRONMENT ³ NEAR WATER COURSES
Hollow trees and trees with birds' nests	Coppiced trees	Waterfall
Old trees and bushes	Large previously free-growing spruce on pasture land, solitary trees	Spray zone
Lying (dead) trees, tree stumps (fire stumps and high stumps)	Coarse branches on deciduous trees	Spring
Dry trees	Trees and bushes producing berries and fruits	Rich fen
Uprooted trees (wind-affected)	Wetlands	Creek, creek shore
Creek		Spawning grounds

¹ According to e.g. FSC. 1997, Enström, 1996 etc.
² Several environments are mentioned in e.g. Bringman, 1995
³ According to e.g. Renman et al., 1998, and Willén et al., 1996. The demand for "richness" of key features is less relevant (see 2.3.1). The existence of single elements can be sufficient, e.g. waterfalls, rich fens and spray zones.

Table 6 Examples of key features

Endemism

Endemism has been advanced as a possible indicator of biodiversity, but the concept has not been selected for the Biotope Method. There are two reasons for this: The primary one is that conditions typical of endemism are already covered by threatened (red-listed) species, and the secondary one is that there are serious problems of definition. Endemism means that a species is naturally occurring only in one area, that it exists in no other place. It is thus the area under study which determines how one looks at endemism (Townsend Peterson and Watson, 1998). On the other hand, if an endemic species is found in the study area, it is almost certainly also a red-listed species.

Species

The Biotope Method does not determine which species are most interesting for the assessment of biodiversity. That judgement has to be made in each case, guided by the type of environment that is the object of the study. Since the Biotope Method has mainly been applied in the Scandinavian coniferous zone so far, vascular plants, mosses and lichens have been extensively used to assess biodiversity. One advantage of using these indicators is that they do not move, as is the case with e.g. mammals and birds. If the latter kind of species are used, special considerations have to be made, such as territorial needs and reproduction areas.

Protected areas

In Sweden there is a great number of areas with formal protection status of some kind. These areas consist of e.g. national parks, natural reserves, cultural reserves, conservation areas, natural monuments as well as fauna and flora protection areas, see Appendix 5. In most cases these protected areas are (at least in Sweden) considered as minimum rare biotope according to the Biotope Method, even if exceptions do exist.

There are many international systems for the protection of sensitive environments. Valuable wetlands all over the world are protected by the Ramsar convention. Natura-2000 areas in the European Union is another system, which largely coincides with the national protected areas in the case of Sweden. Natura-2000 is also linked to the EU Birds directive.

Outside of Sweden the general guideline is that all areas protected by law and/or international treaties should be assigned no less than rare-biotope status. Further guidance should be sought in the definitions for the respective systems.

2.3.3 Sources of information

In the ideal situation, there is plenty of environmental information regarding "Before" situation in the studied area. Table 7 gives examples of some important sources to aid in the biotope assignment procedure, for the Swedish context.

Information on observations of red-listed species in Sweden are collated in the observation register of ArtDatabanken. This collation is, however, not 100% comprehensive - some information is also filed with the respective county administrative boards and municipalities.

Existing systems for environmental categorisation

There are many different types of environments which have been assigned "values" in relation to each other by various existing inventories. In case such areas can be found in the study area, these "values" can be useful for the biotope category assignment procedure. Table 8 lists several such valuation approaches/methods and gives a suggestion for how to translate the classes of those methods into Biotope categories.

	NAME*	REFERENCE*
Publications	Rödlistade arter i Sverige 2005 (red list) Rödlistade kärlväxter i Sverige (vascular plants) Rödlistade svampar i Sverige (funghi) Rödlistade mossor i Sverige (mosses) Rödlistade lavar i Sverige (lichens) Rödlistade evertetrater i Sverige (invertebrates) Rödlistade ryggradsdjur i Sverige (vertebrates) Svenska djur och växter i Natura 2000 (Swedish species in Natura 2000)	Gärdenfors (ed.), 2005 Aronsson (ed.), 1999 Larsson (ed.), 1997 Hallingbäck (ed.), 1998 Thor & Arvidsson (eds.), 1999 Ehnström et al., 1993 Ahlén & Tjernberg (eds.), 1996 Cederberg & Löfroth (eds.), 2000
Other sources	KVA:s avhandlingar (various) ArtDatabankens observationsregister SLU Växtplankton (phytoplankton) SLU Bottenfauna (benthic fauna) SLU Djurplankton (zooplankton) Elfiskeregistret (electro-fishing registry) Sötvattenslaboratoriets provfisken i sjöar (test fishing in lakes)	www.kva.se www.dha.slu.se www.ma.slu.se www.ma.slu.se www.ma.slu.se www.fiskeriverket.se www.fiskeriverket.se

Table 7 Some information sources for the category assignment (check list for Sweden).

ASSESSMENT METHOD CLASS	CLASS*	BM-CATEGORY**
Conservation programmes of the County administrative boards	1-2 3	CB RB
Meadow and grassland inventories (County administrative boards)	1-2 3-4	CB RB
Key biotope inventories (National Board of Forestry)	Key biotope Conservation object Other forest	CB RB GB
Old-growth forest inventories (Swedish EPA)	1 2-3	CB RB
Wetland inventories (County administrative boards and Swedish EPA)	1-2 3 4	CB RB GB
Inventories of marshy forests (National Board of Forestry)	1 2 3-4	CB RB GB
Priority areas in Natura 2000	All	At least RB
Wetlands protected by the Ramsar convention	All	At least RB
*Class which has been defined within the respective environmental valuation **Category according to the Biotope method		

Table 8 Existing classifications and their relationship to the categories of the Biotope method.

2.3.4 Alternative approaches

When no or very scarce background information can be found, other approaches are necessary to accomplish the assignment of both lost and resulting biotopes. One solution is to develop and use an area-specific standard chart encompassing the biotopes of the affected area. Such a chart should be locally/regionally adapted according to the general understanding of biotope assessment in the area. The procedure involves applying the classification system presented in section 2.2, assigning a category to each occurring biotope type (CB, RB, GB and T, according to Section 2.3.1). An example of such an area-specific standard chart for a near-mountain area in the Swedish county of

Norrbotten can be found in Appendix 3. The chart can then be used as an interpretative aid during the assessment, e.g. in aerial photo interpretation. In this case one knows the distribution of critical, rare and general biotopes already at the identification stage. There is no need to correlate documented observations of specific species and individual identified biotopes. However, there is always the possibility to deviate from the standard chart for individual objects where available information allows. These deviations must, however, as always when applying the Biotope Method, be clearly documented and justified.

When it is impossible to find information allowing identification and assignation in accordance with the standard chart, pre-defined assignation keys can be used (see the box below). With these keys, the areas are assigned directly, without prior identification. The rationale of the keys is to, with ample safety margin, assign the original and/or resulting areas a category. The keys are developed with a great deal of care and are supposed to be used in situations with very limited access to information. The proportions of categories in the keys are considered to more than safely ascertain that no underestimation of impact occurs. In practice this means that the keys are designed to overestimate the area of critical and rare biotopes in the "Before" situation, and underestimate it in the "After" situation. There should be no risk that they are used as a quick way to achieve a (for the developer) overly favourable result.

Alternative 1: When there is a lack of inventory information, but the biotopes of the affected areas have been identified, they are assigned a category in accordance with an area-specific standard chart (example in Appendix 3).

Alternative 2: When it is impossible to find information for both identification and assignation, pre-determined assignation keys have to be used.

·Assignation key B for the "Before" situation: Measured area of T*, the rest is assigned according to 40% CB, 40% RB and 20% GB.

·Assignation key A for the "After" situation: 0% CB, 0% RB, $(100 - X^*)\%$ GB and $X^*\%$ T (measured).

*The area of technotopes can usually be measured in e.g. economic maps. If it is not possible to determine the area of the T category, it is assumed to be 0% in the "Before" situation and 100% in the "After" situation.

2.4 PRESENTATION OF RESULTS

2.4.1 Levels of quality and reporting documents

Information developed by LCA and other environmental assessment methods has to be presented in a standardised manner. It is important to present utilised background information in such a way that readers can assess its quality and relevance. Table 9 lists the demands for reporting at the different quality levels defined in the Biotope Method. The demands relate partly to the quality and comprehensiveness of available input data (which in turn is partly dependent on the alternative approaches/shortcuts adopted), but also the extent of the resources that the developer is prepared to put into the environmental analysis. The results are grouped into different quality levels - more available information and more time spent on the collation and analyses of data yield higher levels of quality.

The highest level of quality, level A, is attained when one has access to comprehensive inventory information for both the "Before" and "After" situations. This case yields fully identified biotopes assigned to the four categories of the method: critical, rare and general biotopes as well as technotopes. If inventory material is missing either for the "Before" or the "After" situations (or both), the assignation has to be accomplished with the aid of an area-specific standard chart. This results in quality level B. If there is no standard chart either, and assignation is accomplished with an assignation key (either "Before" or "After"), the resulting quality level is C. If there is a difference between quality levels in the "Before" and "After" situations, the one with the lowest quality level determines the overall quality level.

Sub-levels have been defined for quality levels B and C, depending on what combination of alternative approaches that have been adopted.

The quality is also reflected in the permitted number of value figures in the final results tabulation. This concerns the final results presentation only, and not analyses and calculations leading up to this. Quality level A allows three value figures, quality level B allows two and with quality level C, only one value figure may be used.

It is desirable to aim for uniform and clear presentation of results in the tables. This means that one should seek to use only at most every third power figure (i.e. 10^{-3} , 10^{-6} , 10^{-9}), preferably the same, when expressing impact (m^2) per produced good (e.g. kWh). The example in Appendix 4 shows how this can look in practice. A negative consequence of this is that one can be misled regarding the number of value figures used (see Appendix 4 for discussion).

Examples of design of maps and tables are given in Appendices 2 and 4. The area information can be presented either as a separate report, or given in relation to the good generated by the development activity/project, e.g. m^2/kWh of electricity. In this manner it is possible to produce an impact assessment allowing for comparisons with other similar projects/activities generating the same good. More on the connection to generated good is given below in sections 2.4.2 and 2.4.3.

	BEFORE	AFTER	RESULTS			
	Method	Method	Minimum demand on the presentation*			
Quality level			Number of value figures	Maps	Table	Description
A	Inventory	Inventory	3	X	X	X
B1	Inventory	Standard chart	2	X	X	X
B2	Standard chart	Inventory	2	X	X	X
B3	Standard chart	Standard chart	2	X	X	X
C1	Inventory	Assignment key	1	X	X	X
C2	Assignment key	Inventory	1	X	X	X
C3	Standard chart	Assignment key	1	X	X	X
C4	Assignment key	Standard chart	1	X	X	X
C5	Assignment key	Assignment key	1		X	

*Maps: At quality levels A and B the "Before" and "After" maps should describe both identified and assigned biotopes.
 Tables should contain area measurement for identified and assigned biotopes.
 The description should contain written motivations for system boundaries and identifications and assignments of biotopes, both in the "Before" and "After" situations.

Table 9 Overview of the Biotope method's quality levels.

2.4.2 Functional unit

Functional unit is a concept from life-cycle assessment methodology. It means the unit of produced good that is used for comparison or efficiency measurement in an LCA. If the impact determined with the Biotope Method shall be used for an efficiency comparison between two or more ways of producing the same good, it must be related to such a functional unit. In the case of electric energy, for which the Biotope Method was originally conceived, that unit is kWh. One can obviously use other related units, e.g. MWh or GJ, but it is of the utmost importance that impacts are consistently related to the same unit.

2.4.3 The concept of life cycle/life span

Biodiversity will be affected for as long as the activity/project is active in the specific location analysed. The longer the life span used in calculating the results, the smaller the impact per unit of

produced good (specific impact), since the impacts on the biotopes are assumed to be constant over the entire life span. The size of the impact is determined by the situation at the chosen "After" situation.

The concept of a project/activity's life cycle, from the cradle to the grave, is central to LCA methodology. The life cycle (life span) is governed by the life span of the constituent parts of the project/activity. It is obviously possible to modernise or even completely replace an entire installation, thus achieving a longer life span for the activity/project than those valid for the constituent parts. It is, as an example, likely that there will be a windpower plant located in a particularly suitable location for more than the 25 years that one set of equipment will last. There are, thus, two different perspectives – the technical life span and the estimated length of time that the technology will be utilised on the site. When applying the Biotope Method as a part of an LCA study, it is advisable to use the same life cycle as in the technical part. However, in cases where the user of the information wants to study and compare impacts on biodiversity between different technologies within the same field of activity (e.g. wind power and nuclear power in electricity generation), the fairest comparison is achieved when assuming the same life span for all studied technologies. In conclusion, it is advisable to use the same life span when comparing different ways of achieving the same good. For power generation the recommended figure is 50 years, a long-term but still manageable time perspective. If special importance is given to this factor, it is fully possible to demonstrate the sensitivity of this parameter by presenting a table where results are given for e.g. three different assumptions or sets of variables.

Two results can be reported from an application of the Biotope Method:

1. One result should be useful in connection to an LCA of the activity/project. The affected areas are related to a total net production during the entire life cycle of the activity/project.
2. The other result should be used for comparison with other similar activities/projects. The affected areas are related to a total net production during a common time span which is the same for all analysed activities/projects. Fifty years is suggested for power generation.

3 QUALITATIVE ASSESSMENT OUTSIDE OF THE TECHNICAL SYSTEM BOUNDARIES, AND USE IN EIA WORK

The qualitative description of impacts outside of the technical system boundary should result in a presentation of the significant impacts and consequences that have occurred, or could be expected to occur, as a result of the project/activity.

3.1 QUALITATIVE ASSESSMENT WITHOUT FORMAL EIA STANDARDS

The study should be performed in accordance with the principles set out in the International Association for Impact Assessment's "Biodiversity-inclusive Impact Assessment – Principles and Practices" (IAIA, 2005). Deviations from the EIA-adapted multi-step principle described in that document are, however, allowed.

3.1.1 Project description

- Short introduction (app. ½ page) about typical impacts on biodiversity caused by the kind of project/activity concerned, e.g. hydropower, wind power, mining etc.
- Short description of existing habitats in the area harbouring significant and known biodiversity values.
- Short description/commentary of results from the quantitative assessment inside the technical system boundary, and its relevance for the entire impact area.
- Description of the relation between the size of the entire impact area, and that located inside the technical system boundary, which has been assessed in a quantitative manner.

3.1.2 Identification of impacts

Use primarily secondary data in the identification of impacts. Identify both direct and indirect significant impacts. Field studies are only to be implemented in the case of major data gaps. In such cases, remote sensing supported by ground-truthing should be the methodological first choice. Identified impacts on the following qualities and functions of the environment are important for this description:

- Protected areas; national parks, reserves etc.
- Documented "hot spots" for biodiversity
- Biotopes with vulnerable and threatened species (including species for which compensation and management plans have shown poor success rates)
- Biotopes with, or with potential for, high species richness
- Important corridors and buffer zones
- Important key features
- Biotopes with long continuity
- Large contiguous areas with no prior serious disturbances
- Unusual and sensitive biotopes, and biotopes with slow recovery
- Refuges for species under pressure (climate, development etc.)

In doing this, the following impacts should be analysed and described:

- Biotopes changing size
- The functionality of the biotope is changed
- Cumulative impacts
- Are thresholds reached?
- Fragmentation
- Barrier effects
- Edge effects

3.2 QUALITATIVE ASSESSMENT WITH FORMAL EIA STANDARDS

The study should be performed in accordance with the principles set out in the International Association for Impact Assessment's "Biodiversity-inclusive Impact Assessment - Principles and Practices" (IAIA, 2005).

3.2.1 Assessment principles

The methodological approach in an EIA demands a stepwise analysis utilising standard steps: screening; scoping; impact assessment; mitigation; valuation; reporting; review; decision-making and; management - monitoring - evaluation/auditing.

3.2.2 Project description

- Introduction (app. 2 pages) about typical impacts on biodiversity caused by the kind of project/activity concerned, e.g. hydropower, wind power, mining etc.
- Detailed description of existing habitats in the area harbouring significant and known biodiversity values.
- Short description/commentary of results from the quantitative assessment inside the technical system boundary, and its relevance for the entire impact area.
- Short description of the relationship between the general geography and ecology of the entire impact area and that located inside the technical system boundary, which has been assessed in a quantitative manner.
- Description of the relation between the size of the entire impact area, and that located inside the technical system boundary, which has been assessed in a quantitative manner.

3.2.3 Identification of impacts

Use primarily secondary data for the initial planning and identification of project/activity consequences (scoping). Identify both direct and indirect significant impacts. Field studies are only to be implemented in the case of major data gaps. In such cases, remote sensing supported by ground-truthing should be the methodological first choice. Apart from this, other standard ecological inventory methods can be used, but the emphasis should be on cost efficiency and relevance. Identified impacts on the following qualities and functions of the environment are important for this description (the same as above in 3.1.2):

- Protected areas; national parks, reserves etc.
- Documented "hot spots" for biodiversity
- Biotopes with vulnerable and threatened species (including species for which compensation and management plans have shown poor success rates)
- Biotopes with, or with potential for, high species richness
- Important corridors and buffer zones
- Important key features
- Biotopes with long continuity
- Large contiguous areas with no prior serious disturbances
- Unusual and sensitive biotopes, and biotopes with slow recovery
- Refuges for species under pressure (climate, development etc.)

In doing this, the following impacts should be analysed and described:

- Biotopes changing size
- The functionality of the biotope is changed

- Cumulative impacts
- Are thresholds reached?
- Fragmentation
- Barrier effects
- Edge effects

3.3 Assessment of impacts

Indicators for the assessment should basically be the same as for the quantitative assessment inside the technical system boundary. For reasons of resource efficiency it is, however, important to refer to existing assessments of similar projects/activities in similar environments.

Table 10 below is read from column A to column E. The first column where one comes across an actual outcome from the studied project/activity will be the resulting impact category, if only one result for the entire project is to be presented. It is, however, fully possible to assess different components individually, particularly if these differ from a geographic perspective, i.e. site, extent etc. In the case of a full EIA study, this more detailed approach is **a requirement**.

Motivate your assessment in text. Comment on size, extent and importance of identified significant impacts, with a special focus on factors determining the assignation in an impact category.

A	B	C	D	E
Severe negative impact	Moderate negative impact	No significant impact	Positive impact	Impossible to assess due to a lack of data or resources
<ul style="list-style-type: none"> · Impact on Natura 2000, Ramsar areas or other internationally listed object · Significant impacts on nature reserves, habitat protection etc. (nationally protected areas) · Significant impacts on key habitats, meadows, regional objects with high values · Significant impacts on red-listed species · Significant risk of cumulative impacts · Significant risk of permanent severe damages 	<ul style="list-style-type: none"> · Impact on object with local environmental values · Minor impacts on national or regional objects with high environmental values · Limited impacts on red-listed species · Limited risks of cumulative impacts · Limited risks of permanent severe damages 		<ul style="list-style-type: none"> · New biotopes have been established (areas which earlier had no preconditions for biological production) · Biotope has changed to a higher category · Changed biotopes contribute to strengthen biodiversity in a landscape perspective 	<ul style="list-style-type: none"> · Information on environmental values in the landscape is missing · Information is difficult to find and resources are not assessed.

Table 10 Impact-category matrix

4 DISCUSSION

It is reasonable to assume that by reporting the areas of biotope categories that have been affected, a good account is given of the biodiversity impact caused by the development. This facilitates adequate comparisons between different impact types and land uses, a comparison that can be used in the communication of environmental performance.

In situ measurements, e.g. monitoring of signal species, clearly yield more exact results at the population or community level. However, this type of studies are frequently both very expensive and very time-consuming, and can cause interpretation problems if the equivalent information is lacking for the "Before" situation. The Biotope Method aims at cost-effective assessments of biodiversity impacts. The use of simplifications and shortcuts is, therefore, deemed necessary and acceptable in order to achieve the desired result – a simple-to-understand measure of impact with a reasonable input of resources. The simplifications and shortcuts are defined in such a way that they should not lead to underestimation of actual impacts.

The biotope assignation is carried out with today's knowledge and values, sometimes applied to past actions. Improved knowledge and changes in value systems will necessitate regular revisions of the assessments.

In the Biotope Method it is assumed that all environments, even if they are man-made, which harbour red-listed or other valuable species should be assigned to a higher category than others. There are many environments, e.g. certain managed forests, agricultural land, roadsides and gravel quarries which are generally accepted to be of an elevated conservation value, well worth caring for. The time scale is important to this discussion. The management of grasslands over the centuries, by scything, has created highpriority conservation areas. The same is true for overgrowing meadows harbouring threatened insect species. The latter is an example of a temporary stage. Examples from the energy sector is e.g. observations of redlisted vascular plants on hydropower dam walls (Bååth 1999), and in transmission ROWs (Mårs 1999).

This point of view is, however, not uncontroversial, but the potential value of created environments has been advanced by other authors. Bengtsson (1997, see below) talked about compensating lost values by creating similar values elsewhere. The new Swedish environmental legislation incorporates a compensation requirement with the aim of preventing, or at least limit, damages to the natural environment.

"Compensation should primarily be focused on replacing lost environmental values with created ones, but it is often impossible to correct impacts in this manner. In such a case the developer responsibility of conserving and managing threatened environments of similar types as exploited".

Translated from Bengtsson, 1997.

This quote supports the idea that created environments with high quality features, such as red-listed species, can be important and should be included in descriptions of land use changes and developments.

5 GLOSSARY

"After"	Temporal end point, after the development or land use change.
Area-specific standard chart	List of biotopes which are assigned to a specific quality (category) according to local and regional conditions.
Assignment	Step in the Biotope Method in which identified biotopes are assigned a certain quality (category).
Assignment key	The "coarsest" shortcut in the Biotope Method. The areas which have been identified at the determination of the system boundaries are assigned into a biotope category immediately based on certain set proportions, without any prior identification process.
"Before"	Temporal starting point, before the development or land use change.
Biodiversity	The variation between all living organisms and the ecological complexes they are part of; this includes diversity within species, between species and of ecosystems.
Biotope	An area with uniform environment and organism composition. The area is naturally delineated by a particular set of local climate, soils, plants, animals etc. Similar to the habitat concept.
Category	Level of quality of a biotope (type); General Biotope, Rare Biotope, Critical Biotope or Technotope.
Critical biotope, CB	A critical biotope is an area which, by its structure, species content, history and physical environment, has very high significance for flora and fauna. It harbours, or can be expected to harbour, red-listed species.
Endemic species	A species which occurs only in one area and nowhere else.
EPD©	Environmental Product Declaration - A method for the description of a product's environmental performance in accordance with ISO 14025.
Functional unit	The unit in which a produced good is measured. When applying the Biotope Method in conjunction with LCA or EPD work, biotope impacts are related to this unit, thus allowing comparisons between different methods to produce the same good.
General biotope, GB	Other biotopes, i.e. those that cannot be assigned to any of the other categories.
Identification	Step in the Biotope Method in which the various biotopes are identified (see biotope).
Impact area	The area which is significantly affected by the studied project/activity.
Key biotope	A qualitative concept meaning small forested areas where one can find, or could be expected to find, red-listed species (except species with particular demands on landscape ecology).

Key feature	Singular structures which are particularly important to plant and animal life, such as hollow trees and spray zones.
LCA/LCI	Life-cycle assessment /life-cycle inventory. A methodological approach to describing resource use and emissions from the "cradle" to the "grave" for the production of a good.
Linear structure	Various types of utilisation of land and water which are by nature long and narrow, e.g. roads and transmission lines.
Rare biotope, RB	Biotope which differ from its surroundings through high species richness or the existence of regionally rare species or key features
Red-listed species	Organisms whose continued survival is uncertain. The species are classified by ArtDatabanken as regionally extinct (RE), critically endangered (CR), endangered (EN) vulnerable (VU) near threatened (NT) or as data deficient (DD).
Signal species	Species which clearly indicates a certain biotope.
System boundary	Limitation of the studied system. Concept from LCA methodology. Geographically more limiting than impact area (see above).
Technotope, T	Areas without preconditions for biological production (e.g. hard-made surfaces).

6 CROSS REFERENCES

Two earlier versions of the Biotope Method exist (Blümer&Kyläkorpi 1998 and Blümer&Kyläkorpi 2001). During revision of the method, certain concepts have been changed. In order to facilitate an understanding of our revisions, the following cross reference has been produced:

Biotope Method [©] (1998)	Biotope Method [©] (2001)	Biotope Method (2005)
Baseline	"Before"	No change from 2001
Present situation	"After"	No change from 2001
Valuation	Characterisation	Assignment
Value class	Category	No change from 2001
Biotope class	Biotope type	No change from 2001
Standard chart	Area-specific standard chart	No change from 2001
Valuation key	Characterisation key	Assignment key
Valuation key N	Characterisation key A	Assignment key A
Valuation key B	Characterisation key B	Assignment key B
	Classification	Identification
	Biotope loss	Technotope

Table 11 Development of concepts

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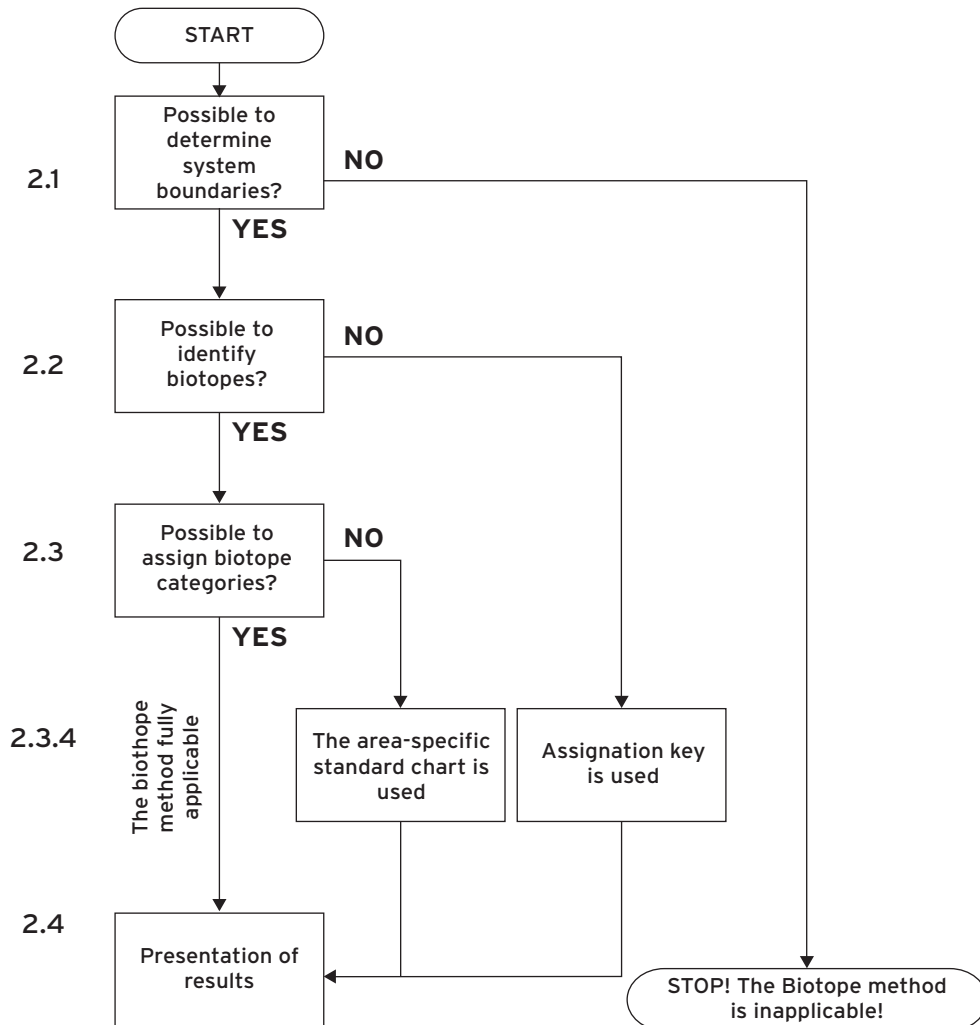
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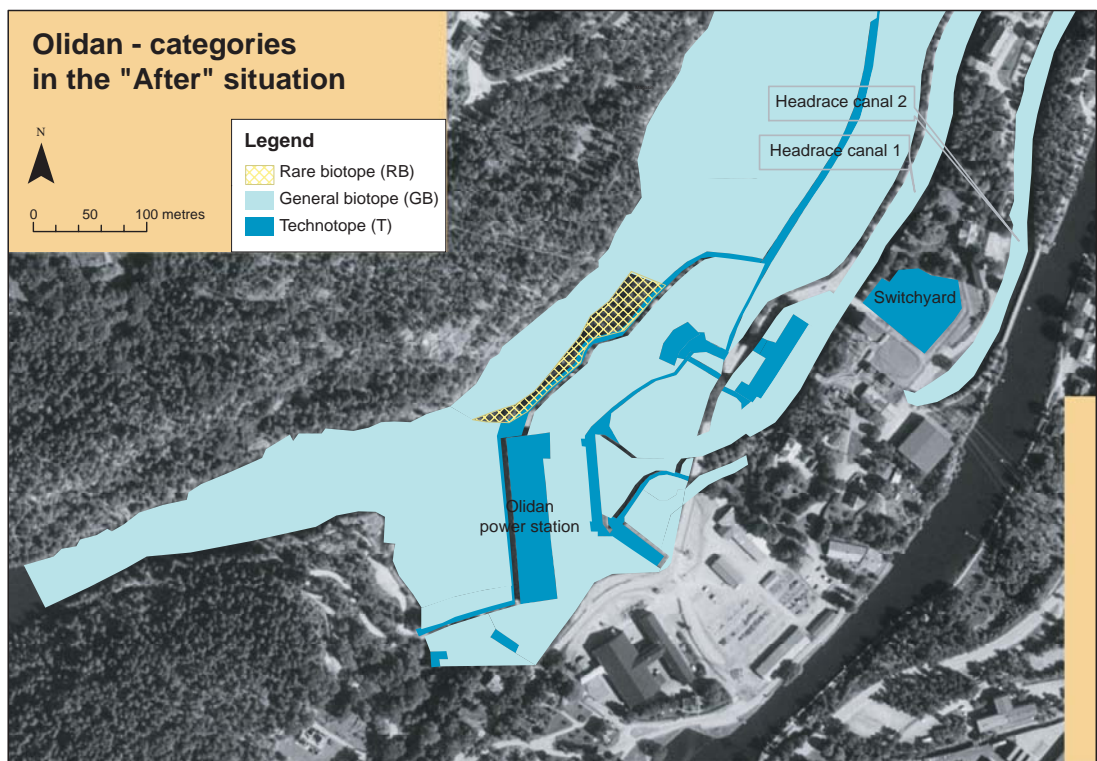
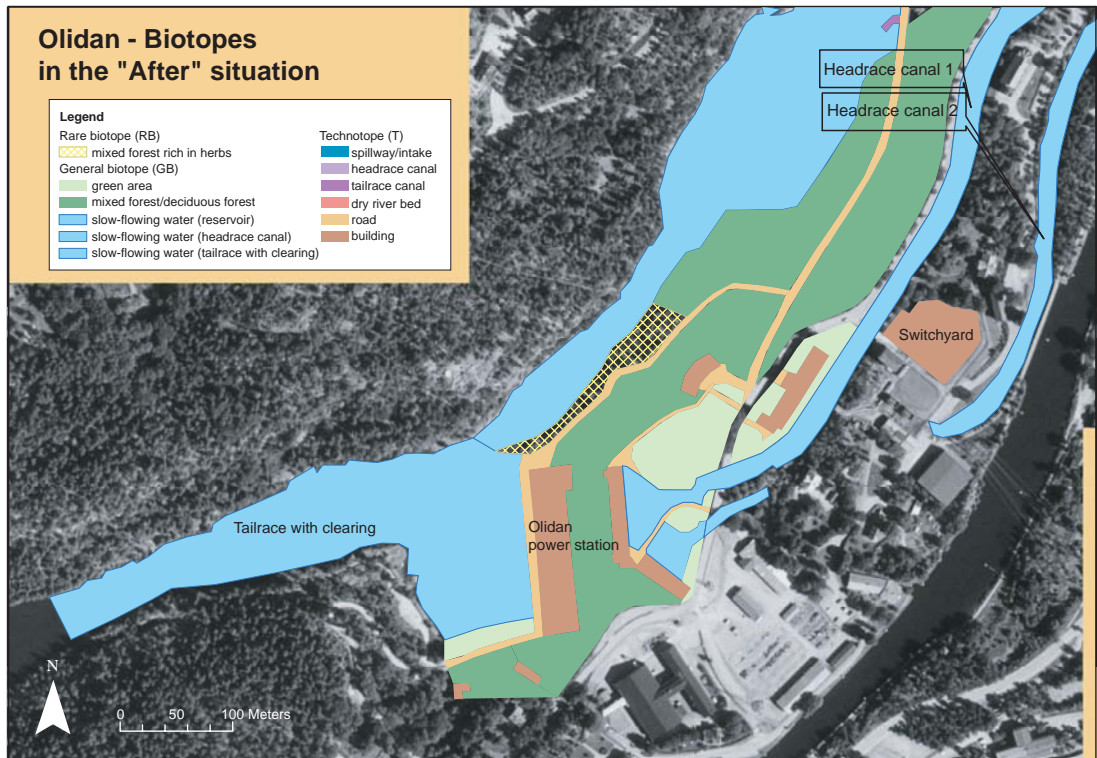
Under this heading we present a number of Internet sites with general information and access to data bases. This type of information changes on a continuous basis. Therefore, it cannot be overemphasised that this is **our** selection of valuable sources at the time of writing this document (April 2005).

ORGANISATION	LINK
ArtDatabanken (Swedish species information centre)	www.dha.slu.se
CORINE Land Cover	www.lantmateriet.se
Elfiskeregistret (Electro-fishing registry)	www.fiskeriverket.se
Kungliga Vetenskapsakademien (Royal Academy of Science)	www.kva.se
Lantmäteriverket ((Swedish Survey)	www.lantmateriet.com
Naturvårdsverket (Swedish EPA)	www.naturvardsverket.se
Nyckelbiotopsinventeringar (Key biotope inventories)	www.svo.se/skogensparlor
Ramsar (internationally protected wetlands)	www.iucn.org
SLU, Sveriges Lantbruksuniversitet (Swedish University of Agricultural Sciences - general)	www.md.slu.se , www.umea.slu.se
SLU bottenfauna (benthic fauna)	www.ma.slu.se
SLU Djurplankton (zooplankton)	www.ma.slu.se
SLU Växtplankton (phytoplankton)	www.ma.slu.se
Sötvattenlaboratoriets provfisken i sjöar (test fishing in lakes)	www.fiskeriverket.se

APPENDIX 1. Schematic presentation of the principal steps of the Biotope Method.



APPENDIX 2. Example of map layout with identified biotopes and assigned categories in the "After" situation.



APPENDIX 3. Example of an area-specific standard chart for the assignation of biotope category.

An example of an area-specific standard chart for the category assignation of affected biotopes at the Seitevare power station and the long-term storage reservoir Tjaktjajaure (Larsson, 2000).

MAIN GROUP	SUBGROUP	CATEGORY
Biotopes in an aquatic location	Slow-flowing water (0-0.2 m/s)	GB
	Fast-flowing water (0.2-0.7 m/s)	CB
	Rapids (>0.7 m/s)	CB
	Oxbow lakes	CB
Biotopes in a littoral location	Littoral meadows	CB
	Littoral forests	RB
	Littoral mires	GB
	Bouldery shores	CB
	Rocky shores	-
	Temporarily exposed sandbanks	-
	Steep sandy riverbanks (erosion-prone)	-
	Ravines/gullies (forested)	-
Biotopes in a terrestrial location	Coniferous forest	CB
	Deciduous forest	GB
	Mixed forest	RB
	Clear-cut area (not clearing before impoundment)	-
	Heath/open land	-
	Agricultural land	CB
	Mire/bog	GB
	Exposed rock/bouldery area	GB
	Exposed rock above vegetation line	-
	Buildings/constructions surfaces	T
* Abbreviations: CB = critical biotope, RB = rare biotope, GB = general biotope and T = technotope (see section 2.3.1 for definitions).		

APPENDIX 4. Sample layout for the final results tables.

The table below shows the results of an application of the Biotope method on Vattenfall's wind power. Three installations were studied, two with quality level A (three value figures) and one with quality level C3 (one value figure).

Note that in the interest of clarity, we have consistently used the same power figure (-6) when we express "change per unit good" in the table below. An unwanted consequence of this approach is the apparent use of more value figures than the quality level C3 in the Sigvards case allows. The results are really given with only one value figure, but should correctly have been written 5×10^{-5} , 2×10^{-5} , 2×10^{-5} and 1×10^{-5} . This, however, results in very hard-to-read tables, with different power figures everywhere. In accordance with the recommendation in section 2.4 we, therefore, give all results with the same power figure, -6. The change per unit good is, in accordance with the discussions in 2.4.3, given for two different "life spans".

		"BEFORE"	"AFTER"	DIFFERENCE	CHANGE PER UNIT GOOD 25 YEARS	CHANGE PER UNIT GOOD 50 YEARS
		m ²	m ²	m ²	m ² /kWh	m ² /kWh
Skärbo* 133 GWh electricity life-cycle generation	Technotopes	0	9 400	9 400	70.7×10^{-6}	35.3×10^{-6}
	Critical biotopes	0	0	0	0	0
	Rare biotopes	360	0	-360	-2.71×10^{-6}	-1.40×10^{-6}
	General biotopes	9 040	0	-9 040	-70.0×10^{-6}	-34.0×10^{-6}
Biegg-ålmåi* 42 GWh electricity life-cycle generation	Technotopes	300	1 260	960	22.9×10^{-6}	11.4×10^{-6}
	Critical biotopes	0	0	0	0	0
	Rare biotopes	0	0	0	0	0
	General biotopes	1 000	40	-960	-22.9×10^{-6}	-11.4×10^{-6}
Sigvards** 98 GWh electricity life-cycle generation	Technotopes	0	4 500	4 500	50×10^{-6}	20×10^{-6}
	Critical biotopes	1 800	0	-1 800	-20×10^{-6}	-10×10^{-6}
	Rare biotopes	1 800	0	-1 800	-20×10^{-6}	-10×10^{-6}
	General biotopes	900	0	-900	-10×10^{-6}	-5×10^{-6}

* Quality level A, 3 value figures

** Quality level C3, 1 value figures

APPENDIX 5. Areas with protected status in Sweden.

National parks According to Swedish law, national parks should partly preserve representative landscapes in their natural states, but also beautiful environments which can yield strong positive experiences. Facilitating human access to the environment is also a priority.

Nature reserves are the most common form of protected area status. The possibility to gazette nature reserves was introduced by the Conservation Act of 1964. Nature reserves can be gazetted in order to: protect biodiversity; care for, conserve, protect, reclaim or create valuable environments; satisfy the need for recreation; protect, reclaim or create habitats for species of special concern. Reserves can encompass both private and public lands. They are gazetted after compensation negotiations with the land owner, or following purchases.

Management guidelines are tailored for each reserve, and vary considerably from case to case depending on the reasons behind the gazetting. In some reserves all economic land use is banned, while in others – primarily gazetted in favour of recreation – e.g. agriculture and forestry operations are allowed to proceed.

Decisions on the creation of a nature reserve is made by the county administrative board or the municipality. The latter was made possible by the new Environmental Law (1999).

Cultural reserves are similar to nature reserves, and introduced by the Environmental Law of 1999. They are gazetted in order to preserve valuable anthropogenic landscapes.

Based on the Conservation Act, the county administrative boards could, earlier, also proclaim **conservation areas**. The status was weaker than that of a reserve, and was not allowed to interfere with e.g. forestry operations. Most conservation areas were gazetted in order to preserve aesthetic values or to maintain the practice of managed pastures. Some municipalities have used them to preserve popular recreation areas. The possibility to proclaim new conservation areas ceased with the enactment of the new law in 1999. Existing areas are, however, still valid, and should, according to the law, be treated as nature reserves.

Natural monuments are either single objects like glacial boulders, giant's cauldrons or old and large trees, or by very small areas harbouring interesting natural features. They are gazetted by the county administrative board. The concept was introduced in 1909, and the bulk of existing monuments were gazetted before the enactment of the Conservation Act of 1964. In the year 2000 there were 1 436 natural monuments in Sweden.

Fauna- and flora-protection areas are proclaimed in order to protect rare or sensitive animals or plants. In these areas hunting, fishing and access may be restricted, but apart from this there are no limitations on land use. The bulk of the over 1 000 existing areas are located on the coast or in/around lakes, and have been proclaimed in order to protect sea fowl or seals.

(Translation from the Internet site for "Nature and conservation" of the Swedish EPA: www.naturvardsverket.se)

