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Suitability of habitat types for biodiversity offsetting in Finland

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Anne Raunio, Susanna Anttila, Minna Pekkonen, Olli Ojala

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Abstract

Biodiversity offsetting or ecological compensation is a process that aims to compensate for human-induced deterioration of biodiversity through habitat restoration or conservation measures. Habitat type is one level at which offsetting can be assessed and implemented. This publication investigates the applicability of biodiversity offsetting to habitat types occurring in Finland from the perspective of compensation and deterioration. Different habitat type groups were assessed to determine whether the human-induced deterioration of the habitat type in question could be compensated for through biodiversity offsetting and, if so, how the compensation could be implemented.

The suitability of the habitat types was assessed based on the endangerment, rarity, structure and functional features of the habitat types, as well as the effectiveness of measures to improve their status. The assessment included a total of 99 different habitat type groups, which roughly correspond to the second level of classification used in the 2008 assessment of threatened habitat types in Finland. Based on expert analyses and the best available data, each habitat type group was classified as either suitable, possibly suitable or generally unsuitable for biodiversity offsetting. The publication also describes the operating principles and concepts associated with the biodiversity offsetting of habitat types, as well as general and specific preconditions related to the suitability of habitat types for biodiversity offsetting.

According to the assessment of habitat types, the conditions for biodiversity offsetting in Finland are quite good when the general and specific preconditions are taken into consideration. Slightly more than 41 per cent of the assessed habitat types were deemed suitable for biodiversity offsetting, while only 10 per cent of the habitat type groups were found to be entirely unsuitable from the perspective of both deterioration and compensation.

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Tiivistelmä

Ekologinen kompensaatio on prosessi, jonka tavoitteena on hyvittää ihmistoiminnasta luonnon monimuotoisuudelle aiheutuvat heikennykset elinympäristöjä ennallistamalla tai suojelemalla. Luontotyyppi on yksi taso, jolla kompensaatioita olisi mahdollista arvioida ja toteuttaa. Tässä julkaisussa käsitellään Suomessa esiintyvien luontotyyppien soveltuvuutta ekologiseen kompensaatioon sekä hyvityksen että heikennyksen kannalta. Luontotyyppiryhmittäin on tehty arvio onko ihmistoiminnasta kyseiselle luontotyypille aiheutuva heikennys mahdollista ekologisen kompensaation keinoin hyvittää ja jos niin miten kompensaatiohyvityksen voisi toteuttaa.

Arvioinnin perusteena ovat luontotyypin uhanalaisuus, rakenne ja toiminta, harvinaisuus sekä luontotyypin tilaa parantavien menetelmien toimivuus. Arvioituja luontotyyppiryhmiä on 99 ja ne karkeasti ottaen vastaavat vuonna 2008 luontotyyppien uhanalaisuustarkastelussa käytetyn luontotyyppien hierarkisen luokittelun toista tasoa. Asiantuntija-arvion ja parhaan käytettävissä olevan tiedon perusteella kukin luontotyyppiryhmä on luokiteltu joko soveltuvan, mahdollisesti soveltuvan tai pääsääntöisesti olevan soveltumaton ekologiseen kompensaatioon. Julkaisussa käydään myös läpi luontotyyppien ekologisen kompensaation toimintaperiaate, käsitteistö ja luontotyyppien kompensoitavuuteen liittyviä yleisiä ja erityisiä reunaehtoja.

Ekologisten kompensaatioiden toteuttamiselle luontotyyppien kannalta arvioituna olisi Suomessa varsin hyvät edellytykset, kun yleiset ja erityiset reunaehdot huomioidaan. Hieman yli 41 prosenttia arvioinnissa mukana olleista luontotyypeistä soveltuu ekologiseen kompensaatioon ja vain 10 prosenttia luontotyyppiryhmistä arvioidaan kokonaan soveltumattomiksi ekologiseen kompensaatioon sekä heikennyksen että hyvityksen kannalta.

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Referat

Ekologisk kompensation är en process, vars målsättning är att med hjälp av restauration och skyddsåtgärder gottgöra för den försämring av livsmiljöer som mänsklig aktivitet förorsakar. Kompensation på naturtypsnivå är en metod som skulle vara möjlig att evaluera och genomföra. I den här publikationen behandlas hur de naturtyper som förekommer i Finland lämpar sig för ekologisk kompensation både med avseende på gottgörelsen och försämringen. En bedömning av olika grupper av naturtyper har gjorts för att fastställa huruvida den försämring som åsamkats en naturtyp kan gottgöras med kompenserande åtgärder och om så är fallet, hur kompensationsåtgärderna kunde genomföras.

Lämpligheten har bedömts utgående från naturtypens hotgrad, dess struktur och verksamhet, hur sällsynt den är samt hur väl metoderna för att förbättra naturtypens tillstånd uppskattas fungera. I bedömningen ingick 99 naturtypsgrupper och de utgör grovt taget den andra nivån i den klassificering som användes vid granskningen av naturtypernas hotgrad år 2008. Baserat på en expertbedömning och den bästa tillgängliga informationen har varje naturtyp klassificerats som lämplig, möjligtvis lämplig eller i huvudsak olämplig för ekologisk kompensation. I publikationen behandlas också verksamhetsprincipen och begreppsapparaten för ekologisk kompensation samt allmänna och specifika ramvillkor för naturtypernas lämplighet som kompensationsobjekt.

Det finns goda förutsättningar för naturtypsbaserad ekologisk kompensation i Finland, förutsatt att allmänna och specifika randvillkor beaktas. Av de naturtyper som ingick i bedömningen lämpar sig lite mer än 41 procent för ekologisk kompensation medan endast 10 procent uppskattas vara helt olämpliga för ekologisk kompensation med avseende både på försämringen av livsmiljöer och gottgörelsen.

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FOREWORD

It is important to see biodiversity offsetting as one of the potential ways of slowing down biodiversity loss, and its role among the set of instruments available for nature conservation needs to be clear and specific. Each instrument has its limitations and, as regards biodiversity offsetting, the limitations are primarily related to the threat status and rarity of habitat types and the methods available to improve their status. This report provides us with a clearer view of the potential and limitations of biodiversity offsetting. It lays the groundwork for the development and targeting of biodiversity offsetting in the Finnish context. A comprehensive assessment of habitat types makes it easier to target biodiversity offsetting in a way that the benefits for safeguarding biodiversity are the greatest.

The present report is important and, as far as is known, the world's first comprehensive assessment of the suitability of the habitat types of a specific geographical area for biodiversity offsetting. It is surprising that no similar reviews have been conducted elsewhere despite biodiversity offsetting being studied and developed globally and also put into practice in some countries. This can certainly be partly explained by the fact that basic data as comprehensive as in Finland concerning the occurrence, characteristics and threat status of habitat types is scarce. The Finnish data was collected for the assessment of threatened habitat types completed in 2008, and data collection and further specification has also continued ever since. The report at hand is a good example of the multiple uses of assessments of the threat status of habitat types.

Finland is well placed for the development of biodiversity offsetting also because we have excellent data on and previous experience of methods that can be employed to improve the status of ecosystems in our country. More data will, however, be needed before we can draw a complete picture of the significance of biodiversity offsetting for biodiversity conservation in Finland. Data will accrue through practical trials, but further research and reviews will also be required.

It has been a slow process to develop biodiversity offsetting that is suitable for Finnish conditions, but there are numerous projects and initiatives currently underway. This report comes out at an appropriate time and contributes towards the evaluation of the experience gained and the planning of subsequent stages.

Kristiina Niikkonen
Environment Counsellor
Ministry of the Environment

1. Introduction

This report deals with the applicability of biodiversity offsetting to habitat types in Finland. The habitat types have been divided into 99 groups on the basis of the assessment of threatened habitat types in Finland completed in 2008 (Raunio et al. 2008). The aim is to improve our understanding of the practical implementation potential of biodiversity offsetting and provide further input into the debate on the principles and practical implementation of offsetting.

Because the suitability of habitat types for offsetting is in part assessed against the principles of biodiversity offsetting, the report begins with an overview of the general principles, background and aims of offsetting. The assessment of suitability for offsetting is primarily based on the assessment of threatened habitat types conducted in Finland (Raunio et al. 2008) and its underlying data as well as guides to habitat type and habitat restoration and nature management published by a variety of organisations. The assessment has been supplemented and specified further by expert comments. The suitability of habitat types for biodiversity offsetting has been assessed from the perspectives of their threat status, structure and functional features, rarity and the effectiveness of methods available to improve their status.

Based on the assessment, the habitat types have been classified under three main categories, each of which has two sub-categories, on the basis of their suitability for biodiversity offsetting. Suitable biodiversity offsetting principles and types of measures generating biodiversity gains have also been determined for the habitat types.

In this report the suitability for offsetting is premised on the ecological characteristics of each habitat type or habitat type group. The report also contains thorough coverage of the preconditions for biodiversity offsetting as regards the habitat types. Some of the preconditions are general and apply to all of the habitat types discussed. Therefore the suitability classification must be read together with these general preconditions. It is also important to note the specific preconditions related to habitat types in suitability category 2 in particular.

The report deliberately avoids addressing how biodiversity offsetting should be put into practice. The details of the offsetting mechanisms and policies adoptedwill determine whether or not biodiversity offsetting delivers the biodiversity gains sought and which habitat types are ultimately best suited for biodiversity offsetting in Finnish conditions.

The assessments of the suitability of biodiversity offsetting for the habitat types in Finland were conducted at the Finnish Environment Institute. The assessments produced by Susanna Anttila and Anne Raunio were commented on at various stages of the work by Aira Kokko, Tytti Kontula, Katariina Mäkelä and Martina Reinikainen, the secretaries of the expert teams involved in the national assessment of threatened habitat types. Assessment work was supported by Meri Lappalainen through her literature searches for habitat type rehabilitation methods. Comments were also provided by Kaisu Aapala (Finnish Environment Institute), Aulikki Alanen (Ministry of the Environment), Eva Ehrnstén (Helsinki University & Stockholm University), Tuomas Haapalehto (Parks & Wildlife Finland, Metsähallitus), Janne Heliölä (Finnish Environment Institute), Reijo Hokkanen (Parks & Wildlife Finland, Metsähallitus), Kaisa Junninen (Parks & Wildlife Finland, Metsähallitus), Eero Kaakinen (Mires Team, assessment of threatened habitat types), Johanna Kangas (Helsinki University), Essi Keskinen (Parks & Wildlife Finland, Metsähallitus), Suvi Kiviluoto (Finnish Environment Institute), Kirsi Kostamo (Finnish Environment Institute), Saija Kuusela (Finnish Environment Institute), Antti Lammi (North Savo Centre for Economic Development, Transport and the Environment), Leena Lehtomaa (Southwest Finland Centre for Economic Development, Transport and the Environment), Henrik Lindberg (Häme University of Applied Sciences), Hannu Luotonen (North Karelia Centre for Economic Development, Transport and the Environment), Juha Pykälä (Finnish Environment Institute), Elisa Pääkkö (Parks & Wildlife Finland, Metsähallitus), Kaisa

Raatikainen (Jyväskylä University & Turku University), Katja Raatikainen (Parks & Wildlife Finland, Metsähallitus), Sakari Rehell (Parks & Wildlife Finland, Metsähallitus), Johanna Ruusunen (Parks & Wildlife Finland, Metsähallitus), Jukka Ruutiainen (Finnish Forest Centre), Lauri Saaristo (Tapio Ltd), Pekka Salminen (Mires Team, assessment of threatened habitat types), Juha Siitonen (Natural Resources Institute Finland), Maarit Similä (Parks & Wildlife Finland, Metsähallitus), Kimmo Syrjänen (Finnish Environment Institute), Anssi Teppo (South Ostrobothnia Centre for Economic Development, Transport and the Environment), Saara Tynys (Parks & Wildlife Finland, Metsähallitus) and Raimo Virkkala (Finnish Environment Institute). We warmly thank all those providing comments and photographs.

2. Background to and aims of biodiversity offsetting

Biodiversity offsetting, or ecological compensation, means compensating for adverse impacts on biodiversity (biodiversity losses) caused by human activity in one place by increasing biodiversity (generating gains) somewhere else. Increasing biodiversity may, for example, involve the rehabilitation of a damaged ecosystem or improving the living conditions of species that are threatened, rare or important for the ecosystem. If implemented successfully, biodiversity offsetting results in a measurable gain for biodiversity and enables the utilisation of natural resources while minimising biodiversity losses. Project-specific aims may vary from 'net positive impact' (NPI, 'net gain') to 'limited loss' offsetting (partial compensation). With NPI, the biodiversity gains generated exceed the losses caused by the development project, while in limited loss offsetting not all losses are compensated for.

2.1 Biodiversity offsetting under agreements and legislation

Stopping the deterioration of biodiversity and ecosystem services by using biodiversity offsetting alongside other instruments has been brought up in international agreements, objectives and strategies. Finland is a party to the Convention on Biological Diversity (CBD[1]). The Aichi Biodiversity Target 20 of the Convention pertains to the mobilisation of financial resources to safeguard biodiversity. The strategy relating to the target regards biodiversity offset mechanisms as opportunities to mobilise, where relevant and appropriate, new resources to halt the deterioration of biodiversity and ecosystem services (Aichi Target 20, Objective 4.2)[2].

1 Convention on Biological Diversity. Outcomes of the tenth meeting of the Conference of the Parties held in October 2010 in Nagoya, Japan: http://www.cbd.int/cop10/doc/

2 Aichi Target 20, Objective 4.2: https://www.cbd.int/financial/0017.shtml

The key policy documents for Finland are the EU Biodiversity Strategy[3] and the National Action Plan for the Conservation and Sustainable Use of Biodiversity in Finland 2013–2020[4]. Both contain the target of halting biodiversity loss and safeguarding ecosystem services. Biodiversity offsetting is seen as a potential additional way of achieving these targets. In strategies and environmental policy objectives, ecological compensation and particularly the term 'biodiversity offsetting' is often associated with a set of measures aiming to ensure there is 'no net loss' (NNL) of biodiversity and/or ecosystem services.

Biodiversity offsetting is not a completely new idea. Germany and the United States are the countries where a compensation obligation regarding natural assets has been included in legislation for the longest time. In Germany, avoiding and offsetting deterioration of the natural environment has been part of national nature conservation legislation since 1976 (Ketola et al. 2009, Wende et al. 2018). In the United States, offsetting was first required and implemented in the 1970s under the 1977 Clean Water Act. Wetland degradation had taken place due to increasing pressure to use wetland areas. Offsetting aimed to prevent the deterioration of wetlands, while the incentive for action was the great economic significance of natural wetlands in flood protection and water purification (Heimlich 1994).

The offsetting obligations relating to the Natura 2000 network determined in the Habitats Directive apply to all EU Member States (Ketola et al. 2009, Leino 2015, Pappila 2017, Similä et al. 2017). So far, there is no other legislation in Finland laying down a clear obligation to implement biodiversity offsetting (Ketola et al. 2009, Leino 2015, Pappila 2017, Similä et al. 2017). In Danish and Swedish legislation, offsetting is related to the issue of permits for projects that cause environmental degradation (Ketola et al. 2009). France is the only EU Member State which has included the no net loss (NNL) target in its national legislation. The NNL policy applies to projects that affect the environment and are subject to a permit (Courtejoie et al. 2014, Quétier et al. 2014).

Development of biodiversity offsetting has attracted wide interest in the Nordic countries. The current situation has been reviewed regarding each Nordic country (Enetjärn et al. 2015). Sweden has progressed the furthest in both piloting and implementing compensation projects and assessing the need for any legislative reform (Enetjärn et al. 2015, SOU 2017). Internationally, one of the nations at the vanguard of developing

3 EU Biodiversity Strategy to 2020: http://ec.europa.eu/environment/nature/biodiversity/comm2006/2020.htm

4 Saving Nature for People. National Action Plan for the Conservation and Sustainable Use of Biodiversity in Finland 2013–2020. http://www.ym.fi/en-US/Nature/Biodiversity/Strategy_and_action_plan_for_biodiversity

offsetting is Australia, particularly in creating the offset calculation system ('habitat hectares'[5]) (Parkes et al. 2003).

In Finland, biodiversity offsetting is being studied from various perspectives. The first study of the practical implementation of offsets have been conducted regarding transport infrastructure projects (Ketola et al. 2005, Känkänen et al. 2011, Nyrölä et al. 2011) and on existing legislation and any need for legislative reform (Leino 2015, Pappila 2017, Similä et al. 2017). In addition, research-driven studies have been conducted on the operating conditions for an offsetting market[6] and the role of a possible intermediary or broker organisation (Kniivilä et al. 2014, Kalliolevo 2016, Kangas 2017, Kangas & Ollikainen 2019). Key concepts and the decision-making chain related to the implementation of biodiversity offsets are presented in the report entitled 'Planning biodiversity offsets – Twelve operationally important decisions' (Moilanen and Kotiaho 2018). On the whole, biodiversity offsetting is still seeking its role and form among Finnish nature conservation tools.

2.2 Concepts relating to biodiversity offsetting

This report deals with the suitability of Finland's various habitat types for biodiversity offsetting, with the 2008 assessment of threatened habitat types used as a basis for the work (Raunio et al. 2008). The aim is to establish a clearer view of the practical implementation potential of biodiversity offsetting and add to the debate on the principles of offsetting.

If successful, biodiversity offsetting can support biodiversity, but it also involves various risks and uncertainties. The key critical factors from the biodiversity perspective are to do with ecological suitability of sites, offset timing and time delays, and uncertainty concerning biodiversity gains obtained from measures to improve ecological status.

Some of the key concepts and choices affecting the implementation and success of biodiversity offsetting are discussed in brief below.

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5 'Habitat hectare' is a site-based measure of ecological quality and quantity of a given habitat. The scoring method was originally developed for the assessment of a specific native vegetation type in Australia. A number of attributes typical of the vegetation type are examined in on-site assessments and used to calculate a score illustrating the quality of the site per unit of area.

6 'Biodiversity offsetting market' or 'market for ecological compensation'. "Developers needing compensation can carry out compensatory measures themselves or purchase them from a third party. A market for compensations emerges when landowners produce compensation by restoring, managing and conserving habitats and developers purchase these gains as compensations." https://blogs.helsinki.fi/habitaattipankki/faq/?lang=en

2.2.1 Objective of biodiversity offsetting

It is often challenging to compensate for loss of biodiversity caused by human activity, particularly if the objective is to achieve no net loss (NNL) of biodiversity. Instead of NNL, the aim may also be to achieve a net positive impact (NPI) where the aim is for the biodiversity gains produced by offsetting to outweigh the negative impacts caused. In practice, the outcome in most cases can be only partial offsets where some nature values are lost regardless of the offset measures used, which means the objective of NNL is not reached (limited loss, Moilanen & Laitila 2016).

2.2.2 Location and quality of offset sites

When implementing biodiversity offsetting, decisions need to be made on which components of biodiversity to choose for offsetting and where to implement offsets. Offset sites can be ecologically similar to ('in-kind' or 'like-for-like') or different from ('out-of-kind') the sites affected by the deteriorating impacts attributable to a project (impact sites). The term 'flexible offset' (Moilanen & Kotiaho 2018) is also used in the latter context where the loss applies to biodiversity attributes or habitats that are different from those where the gains are delivered. Flexible offsets enable trading where offset sites are ecologically more valuable than impact sites ('trading up', 'like-for-better offset'). In the biodiversity offsetting context, a 'more valuable' site means, for example, a rare or threatened habitat type regarded as in need of additional protection.

The aim is often for the offset site to be located as close as possible to the area affected by the negative impacts. The choice of offset site is also affected by whether the offset principle applied is in-kind, like-for-like or out-of-kind. Some habitat types only occur in a very small geographical area and/or in specific environmental conditions. In such cases, in-kind or like-for-like offsets need to take place close to the impact site. Species dispersal opportunities may also necessitate offsets taking place as close to the impact site as possible.

If the aim is to maximise the net biodiversity gain and suitable offset sites are not available close to the impact site, offsetting elsewhere may be justified. Offsets can, for example, take place in locations where they support an existing network of protected areas or improve spatial connectivity elsewhere.

In addition, if the offsetting objective is to also compensate for loss other than nature values, such as reductions in local recreational opportunities, it may be justifiable to find offset sites as close to the impact site as possible. This report does not assess offsetting of ecosystem services. Instead, the focus is on biodiversity and the suitability of biodiversity offsetting for the various habitat types.

2.2.3 Metrics for biodiversity offsetting

There is no common international standard for calculating losses and gains in biodiversity offsetting (metrics), but the methods used so far are based on combinations of quality and area (Alvarado-Quesada et al. 2014), such as the habitat hectares metric (Parkes et al. 2003) and, for example, the combined assessment of parameters such as the rarity and quality of a site (DEFRA 2012). The implementation of biodiversity offsets always involves choices, and efforts can be made to reduce the uncertainties related to the choices by using multipliers (offset ratios) (Moilanen & Kotiaho 2018). The basic rule is that the higher the uncertainties involved in the success of offsetting, the greater the multiplier should be so that no net loss (NNL) is achieved. In practice, this means that the area of the offset site is larger than that of the negatively affected impact site.

2.2.4 Types of offset

The alternatives available for creating biodiversity gains through offsetting can be divided roughly into two types:

1. **Restoration offsets** where the ecological state of sites which are in a poor condition is improved using methods that increase biodiversity. The aim may also be to improve the living conditions of a specific threatened or rare species. There are a variety of methods available for improving the status of habitat types, such as restoration, rehabilitation and management.
   - Biodiversity losses are compensated for by measures that increase biodiversity, such as restoring an ecologically deteriorated site. A typical case in Finland could be restoring a drained mire through promoting the recovery of its natural state by blocking ditches drying out the mire and, if necessary, by removing trees. Uncertainty as to restoration success is a challenge: Are the measures sufficient and will they be able to deliver the desired outcome at all? The slow progress towards the desired changes (time delay) also makes it difficult for offsets to be fully realised.
2. **Avoided loss offsets** (averted loss offsets) where an existing ecologically valuable site is protected permanently, for example, as a nature reserve.
   - Avoided loss offset areas are sites whose ecological status is already good and securing the permanence of the area by, for example, protecting the area as a nature reserve, is regarded as the offset. In other words, the compensation entails avoiding or averting the loss of an area that is valuable in terms of its biodiversity.

Avoided loss offsetting has been criticised: If the aim is to prevent net loss of biodiversity, it is challenging to justify how protecting existing valuable sites would increase biodiversity. A commonly used justification for avoided loss offsetting is that the site would be lost without permanent protection. In such cases, it should be demonstrated that the area's nature values are at risk without the offsetting procedure. An additional problem is the leakage of impacts that harm biodiversity: protecting one area and using it as an offset site may displace usage pressures (such as construction or commercial use of forests) to another area (Moilanen & Laitila 2016). On the other hand, avoided loss offsetting can enable the protection of sites that are important for biodiversity. In addition, if the status of the protected site is already good, uncertainties relating to the success of the nature management or restoration measures are avoided. Avoided loss offsetting may generate added conservation value if the habitat type of the impact site is common and widespread and the habitat type of the offset site is clearly more valuable in terms of biodiversity. Often the offset site also has to be larger in area than the impact site to make sure net gains of biodiversity are achieved.

Biodiversity offsetting generates net gains for biodiversity if the offset measure is additional in relation to other conservation measures or obligations under legislation or agreements. Additionality is a key requirement in biodiversity offsetting. Additionality means that the conservation outcomes delivered by a biodiversity offset are demonstrably new and additional and would not have resulted without the offset (McKenney and Kiesecker 2010, BBOP 2012). The challenge is to determine the baseline to which the properties of being new and additional are compared.

The additionality requirement means that an action which falls under existing national or international obligations to safeguard biodiversity cannot be counted as a biodiversity offset. Biodiversity offsetting does not therefore replace or reduce any existing protection obligations. The interpretation of this has varied between countries, with some only taking public-sector conservation commitments into account while others also including private-sector commitments. Some countries have only included protection measures that have already been implemented and that are pursuant to existing legislation in their baseline determination, while others have also included planned actions.

2.2.5 Biodiversity offsetting as a measure of last resort

It is recommended that biodiversity offsetting follows a mitigation hierarchy where the first priority is the avoidance of impacts, followed by minimisation of impacts that cannot be avoided and, finally, offsetting to compensate for biodiversity loss caused regardless of the mitigation measures (Figure 1, BBOP 2012). In many cases, one further stage before offsetting is also included in the hierarchy: rehabilitation or restoration of degraded ecosystems in the same area where the loss is caused. This four-step hierarchy is used by actors including the Business and Biodiversity Offsets Programme (BBOP) and the International Finance Corporation (IFC). In Finland, the principles of the mitigation hierarchy have been made known by, for example, the report on environmental compensation commissioned by the Nordic Council of Ministers (Enetjärn et al. 2015), the Pellervo Economic Research PTT publication on habitat banking (Kniivilä et al. 2014), the events and lectures of the Habitat Bank research consortium[7] and the report by Moilanen and Kotiaho (2018). The key message of the mitigation hierarchy is that offsetting is a measure of last resort after other means of minimising biodiversity loss have been employed.

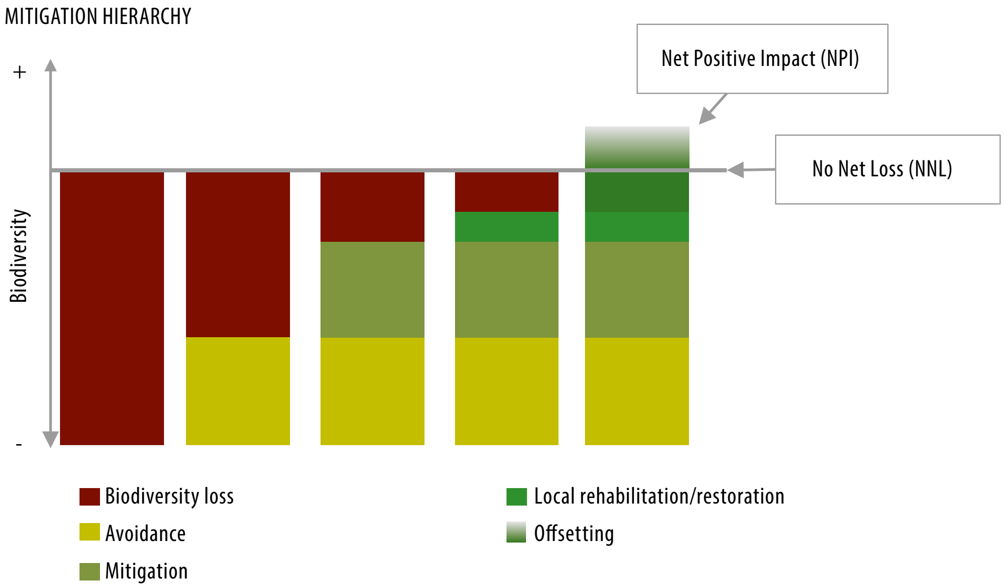


Figure 1. According to the mitigation hierarchy, the first priority must be that adverse impacts of human activity on nature are avoided and, failing that, minimised in the affected area. Any residual biodiversity loss is offset outside the project area. The relative effect of avoidance, mitigation, rehabilitation/restoration and offsetting varies on a case-by-case basis. Due to many uncertainties, the achievement of no net loss (NNL) may, in practice, require a net positive impact (NPI) for the offset to be successful. (Figure by Kostamo et al. 2018, © Finnish Environment Institute, adapted from BBOP 2012.)

7 Habitat Bank project website: http://www.syke.fi/en-US/Research__Development/Research_and_development_projects/Projects/Habitat_Bank/The_Habitat_Bank_of_Finland(39809) and the research consortium website: https://blogs.helsinki.fi/habitaattipankki/?lang=en

FACT BOX 1 CONCEPT DEFINITIONS

Biodiversity
Biodiversity can be examined at the ecosystem, habitat type, habitat, community, species, population or genetic level. For practical reasons, in biodiversity offsetting the focus is often either on specific species or groups of species, such as threatened species or EU Directive species, or on spatially definable habitat types and their key structural features.

Habitat type
Habitat types are spatially definable land or aquatic areas with characteristic environmental conditions and biota which are similar between areas of the same habitat type but differ from areas of other habitat types (Raunio et al. 2008). Environmental factors include soil and climate characteristics and topography. Characteristics of biota include the composition and structure of the species community. Habitat types can differ from one another in terms of the size of their occurrences and degree of internal variability. Concepts which are synonyms or near-synonyms of 'habitat type' include 'biotope' and 'ecosystem'.

Biodiversity offsets, ecological compensation
A biodiversity offset means a set of measures aiming to compensate for adverse impacts on biodiversity caused by human activity in one place by permanently increasing biodiversity somewhere else. The term 'ecological compensation' is often used interchangeably with biodiversity offsetting.

Habitat banks, conservation banks
Finding suitable offset sites may turn out to be a threshold matter in offsetting. Finding, rehabilitating, managing and restoring areas for offsetting in advance has been proposed as a solution to this. Such offsets selected in advance can form habitat or conservation banks (Kniivilä et al. 2014, Kalliolevo 2016). In the Finnish context, the term 'habitat bank' may also refer to an intermediary or broker of offsets (Kangas 2017, Habitat Bank research consortium).

3. Material and methods

3.1 Habitat type classification

Natural environments can be divided and classified into habitat types to varying degrees of specificity and on various grounds depending on what the classification is used for. The habitat type classification used in this work is based on the classification developed in the assessment of threatened habitat types in Finland (Raunio et al. 2008) as the work utilised the knowledge base on changes in and threats to habitat types produced by that assessment.

The habitat type classification of the assessment of threatened habitat types in Finland covers a broader entity than other classifications used in Finland. It contains all habitat types occurring naturally in Finland as well as seminatural grasslands created and maintained by long-term livestock farming. The habitat types have been divided into eight main groups:

1. The Baltic Sea
2. Coastal habitats
3. Inland waters and shores
4. Mires
5. Forests
6. Rock outcrops and scree
7. Seminatural grasslands
8. Fell areas

The habitat classification of the assessment of threatened habitat types is hierarchical and contains a total of 420 assessed units (Raunio et al. 2008). For the purpose of assessing the suitability of habitat types for offsetting and discerning the assessment results, more than 400 habitat types is too high a number. This is why, as a general rule, only Level 2 of the classification hierarchy used in the assessment of threatened habitat types, covering a group of 99 habitat types, was included in this study.

The classification of habitat types used in this report, together with its relationship to the classification in the assessment of threatened habitat types in Finland, can be found in the table in Appendix 1. The table contains all of the units used in the assessment of threatened habitat types, so the table shows which units of more specific levels of hierarchy are included in the units of Level 2 that were assessed to determine their suitability for offsetting.

For example, as regards mire types, Level 2 means that suitability for offsetting has been examined at the group level of 'pine mires and bogs' but not separately for any of the units of more specific classification, namely 'thin-peated pine mires', 'spruce-pine mires', 'Carex globularis pine mires', 'dwarf shrub pine bogs', 'Eriophorum vaginatum pine bogs', 'Sphagnum fuscum bogs' and 'frost bogs and mires'. There may be considerable variation in the characteristics of the various habitat types within the group level. This is taken into account in the specific preconditions relating to offsetting which, for example, indicate if a group contains a more threatened or rarer habitat type whose special characteristics need to be taken into consideration in offsetting plans.

A few slight changes have been made in this work to the classification and habitat type names used in the assessment of threatened habitat types to improve clarity. For example, 'rich fens' covers a broader range of mire types to include a larger number of demanding mire types resembling each other in terms of their ecology and environmental requirements.

The applicability of biodiversity offsetting to habitat types has been assessed for the 99 habitat types described above. The assessment has not been restricted to only cover threatened habitat types or those safeguarded under legislation. Instead, habitat types which are common and classified as being of Least Concern are also included. This enables the future examination of various types of offsetting models and systems based on voluntary measures as well as on legislation.

The table in Appendix 1 outlines the relationships between the habitat types included in the assessment and those protected under legislation. No separate assessment of suitability for biodiversity offsetting has been conducted for habitat types protected under legislation as it is difficult to place them in the classification system drawn up on the basis of habitat type ecology. The definitions of habitat types protected under legislation are usually narrower than the ecology-based habitat types often called the same. For example, habitat types protected under legislation must be in their natural state, of a specific size and located in a specific part of the country.

The second assessment of threatened habitat types in Finland was underway at the time of writing this report. In the new assessment, the classification of habitat types has been

adapted slightly compared with the first assessment. The changes made are minor, with the exception of the Baltic Sea and forest habitat type groups. In the second assessment of threatened habitat types, a considerably larger number of underwater habitat types have been specified for the Baltic Sea because of the completion of the HELCOM Underwater Biotope and Habitat Classification (HELCOM 2013) and the major improvements in the knowledge base following the completion of the Finnish Inventory Programme for the Underwater Marine Environment (VELMU) (Finnish Environment Institute 2017b) As regards forests, the number of habitat types has been reduced as some previous classes based on dominant tree species and stand ages have been merged.

Because the results of the second assessment of threatened habitat types were not yet available for this report, the habitat type classification of the first assessment of threatened habitat types had to be used. Changes in classification would not, however, have had a significant impact on the suitability assessments where, for example, heath forest types are only dealt with at the more general level of site types, which has remained unchanged.

3.2 Assessment of suitability for biodiversity offsetting

The data used as a basis of the assessment of the suitability of habitat types for biodiversity offsetting includes results of the assessment of threatened habitat types in Finland published in 2008 (Raunio et al. 2008) and data collected in the 2008 assessment, results and data from the 2013 Habitats Directive reporting, and guides to the restoration, nature management and rehabilitation of habitat types and habitats as well as action plans and strategies to improve their status published by Metsähallitus, the Finnish Environment Institute, the Ministry of the Environment and centres for economic development, transport and the environment (e.g. Salminen & Kekäläinen 2000, Ohtonen et al. 2005, Kittamaa et al. 2009, Koskela 2009, Leinonen and From 2009, Juutinen 2010, Sarvilinna & Sammalkorpi 2010, Similä & Junninen 2011, Virnes et al. 2011, Aapala et al. 2013, Olin 2013, Raunio et al. 2013, Ryttäri et al. 2014, Matveinen et al. 2015, Tattari et al. 2015, Tukia et al. 2015, Restoration and management of water bodies 2015, SW Finland Cultural Landscapes Organisation 2017, Kostamo et al. 2018). The work took place before the completion of the second assessment of threatened habitat types in Finland.

This chapter describes the factors and data related to habitat type characteristics and status which were used to assess the applicability of biodiversity offsetting to habitat types. The classifications used are also described. The results of the assessment are presented in Chapter 6 and in Appendix 1.

3.2.1 Threat status of habitat types

The threat status of habitat types played a key role in the assessment of their suitability for biodiversity offsetting. The national threat status according to the 2008 assessment of threatened habitat types can be seen by habitat type in the tables in Chapter 6. The table in Appendix 1 also shows the IUCN Red List Categories for Southern and Northern Finland and the threats to the habitat types.

Threatened habitat types comprise those in the categories of Critically Endangered (CR), Endangered (EN) and Vulnerable (VU) (Table 1). More detailed information about the results of and assessment methods employed in the 2008 assessment of threatened habitat types in Finland can be found in the relevant publication (Raunio et al. 2008).

Table 1. IUCN Red List Categories and their meanings (Raunio et al. 2008).

IUCN Red List Category	Meaning of category
RE, Regionally Extinct	Regionally extinct within the area assessed
CR, Critically Endangered	Facing an extremely high risk of extinction within the area assessed.
EN, Endangered	Facing a very high risk of extinction within the area assessed
VU, Vulnerable	Facing a high risk of extinction within the area assessed
NT, Near Threatened	Occurrences have declined but the criteria for Vulnerable are not met or the habitat type is so rare that its preservation can be thought to be threatened by random factors
LC, Least Concern	Occurrences and their key qualitative characteristics are not facing any significant risk of extinction within the area assessed over the medium term.
DD, Data Deficient	Risk of extinction cannot be assessed owing to deficient data

3.2.2 Status of habitat types under legislation

Occurrences of certain habitat types are safeguarded under provisions of the Finnish Nature Conservation Act, Forest Act or Water Act. Whether or not a habitat type is safeguarded under legislation has not had a direct impact on the assessment of its suitability for biodiversity offsetting. This is because the restrictions set by legislation on the utilisation of these habitat types do not usually apply to all occurrences of a habitat type but, instead, are dependent on factors including the habitat type being in its natural state or its size or location. Restrictions also usually apply to much narrower habitat type classification units than those used in this assessment. The table in Appendix 1 outlines the relationship of the habitat types included in this examination to habitat types safeguarded under legislation.

Many legally protected habitat types are rare and threatened, so their suitability for biodiversity offsetting is therefore often limited although legal protection status has not as such been taken into account in the assessments. Legally protected habitat type occurrences are also usually in a more natural state and more representative, and actions with adverse impacts on them are already restricted by the general preconditions for biodiversity offsetting (Chapter 4).

Chapter 4, section 29 of the **Nature Conservation Act** (1096/1996) lists nine protected habitat types whose natural or comparable habitats may not be altered in such a way as to jeopardise the preservation of the characteristic features of the area in question. Such prohibitions take effect as of when a centre for economic development, transport and the environment has set the boundaries of the natural habitat to be protected and has notified the site's owners and holders of its decision. By 2013, just under 1,100 of such decisions had been made, with the total area of the sites covering around 2,100 hectares (Raunio et al. 2013).

The habitat types protected under the Nature Conservation Act are:

- wild woods rich in broad-leaved deciduous trees
- hazel woods
- common alder woods (*Alnus glutinosa* swamps on the basis of the description of the Nature Conservation Decree)
- sandy shores in their natural state
- coastal meadows
- treeless or sparsely wooded sand dunes
- juniper meadows
- wooded meadows
- prominent single trees or groups of trees in an open landscape (do not correspond to any actual habitat type).

The habitat types protected under the Nature Conservation Act are described in greater detail in the Nature Conservation Decree (160/1997) and the guide to inventories of habitat types under the Nature Conservation Act (Pääkkönen and Alanen 2000).

Chapter 3, section 10 of the Forest Act (1093/1996) safeguards habitats important for the biodiversity of forests. Under the Forest Act, forests must be managed and used in such a manner that the general conditions for the preservation of important habitats are safeguarded. Habitats of special importance in terms of biodiversity are sites in their natural or seminatural state which can be clearly distinguished from the surrounding forest nature. The Act further specifies that such habitats of special importance are small in area or have little significance for forestry purposes.

The habitats of special importance under the Forest Act and their safeguarding are described in greater detail in the Government Decree on sustainable forest management and use (1308/2013) and in Tapio best practice guidelines on nature management of commercial forests (Saaristo and Vanhatalo 2015).

Habitats of special importance under the Forest Act are:

- the immediate surroundings of springs, brooks, rivulets constituting a permanent water flow channel, and ponds of less than 0.5 hectares whose characteristic features include the special growing conditions and microclimate due to the closeness of water and tree and shrub layer
- the following mire habitats listed in points a–e where the shared characteristic feature is the natural or seminatural water economy:
    a. herb-rich and grassy hardwood-spruce swamps where the characteristic features include luxuriant and demanding vegetation, uneven-aged tree stand and shrub vegetation

   b. unbroken hardwood-spruce swamps with wood horsetail and cloudberry where the characteristic features include uneven-aged tree stand and dominance of uniform wood horsetail or cloudberry vegetation
   c. rich fens where the characteristic features include nutrient-rich soil, very little tree stand and demanding vegetation
   d. wasteland and scrubland swamps with very little tree stand; and
   e. flood meadows where the characteristic features include uneven-aged deciduous tree stand or shrub vegetation and permanent impact of surface waters;
- luxuriant herb-rich forest patches where the characteristic features include herb-rich forest soil, demanding vegetation and natural and seminatural state tree stand and shrub vegetation
- heathland forest islets located in undrained peatlands or peatlands where the natural water economy has for the most part remained unchanged
- gorges in the bedrock or furrowed in mineral soil with steep slopes, as a rule more than 10 metres deep where the characteristic features include a typical vegetation deviating from the surroundings
- steep bluffs as a rule more than 10 metres high and the forest lying directly underneath
- sandy soils, exposed bedrock and boulder fields with lower wood production potential than in heathland forests with extremely barren soil where the characteristic features include a sparse tree stand.

Chapter 2, section 11 of the **Water Act** (587/2011) lists natural aquatic habitat types whose natural state it is prohibited to endanger:

- coastal lagoons (flada-lakes or glo-lakes) with a maximum area of ten hectares
- springs
- streamlets outside the region of Lapland
- ponds or lakes with a maximum area of one hectare outside the region of Lapland.

3.2.3 Structure and functional features

A brief descriptive list has been drawn up for each habitat type with regard to the structural and functional features in the desired state. The aim is to describe what each habitat type is like and which factors should be taken into account in biodiversity offsetting. In the desired state, the structure and functional features of the habitat type maintain the temporal continuity of the habitat type or its natural succession towards other habitat types. For seminatural grasslands, the natural state is not the desired state, as in their case the appropriate type of human impact maintains the habitat type. The structural and functional descriptions also give an indication of the factors which may be difficult from restoration and management perspectives and therefore reduce the habitat type's suitability for offsetting.

With regard to structure and functional features, examples of the characteristics described include the following:

- soil or bedrock characteristics and factors affecting them; (e.g. nutrition, rock types, soil types, bottom type, peat formation, mire surface level fluctuation, topography, sedimentation, dune formation/ wind force impact, land uplift);
- vegetation and tree layer (e.g. structure, dynamics and essential characteristics of species);
- water quality and hydrology (e.g. naturalness of hydrology and factors affecting it, such as
- catchment area, flooding, groundwater influence, salinity level, water depth, coastal phenomena);
- climate (e.g. microclimate, snow and ice cover, frost heaving);
- natural disturbance dynamics (e.g. fires, windthrow, storm damage), grazing, etc.

3.2.4 Rarity

Habitat types have been classified as follows on the basis of whether rarity is to be taken into account in biodiversity offsetting:

1. **Yes**
2. **Yes, for some habitat types**
3. **Yes, in parts of the country**
4. **Possibly (insufficient data)**
5. **No**

The suitability of a habitat type for biodiversity offsetting is affected by the rarity of the habitat type in at least the following ways:

- The destruction or degradation (biodiversity losses) of sites with very rare habitat types should absolutely be avoided to prevent any further risk to the habitat type or related species.
- It may be very difficult to find suitable offset sites for rare habitat types.

- Failures in restoring, rehabilitating or other offset measures as regards rare habitat types may cause greater damage to biodiversity than failures in the context of more common types. The rarer the habitat type the more important it is to have proven and reliable methods to improve its status.

Very rare habitat types are highly unsuitable for biodiversity offsetting. Because precise data on the number and area of occurrences is only available on very few habitat types, the rarity considerations in this work are not based on specific figures or limit values. It would also be impossible to set a specific area-based limit value for rarity as there is major variation in the distribution patterns of habitat types, and the size of individual sites varies from a few square metres to thousands of hectares.

Based on data available on the occurrence of EU Habitats Directive habitat types in 10 x 10 km grid cells, the indicative limit value of around 100–200 grid cells was adopted for rarity consideration in the assessment whenever no data or expert assessments were available regarding the occurrence grid cells of a habitat type. Small size and vulnerability to disturbances was taken into account in the assessment of rarity for some habitat types (e.g. calcareous rock outcrops). All in all, the assessments of rarity were difficult and in part subjective, because occurrence data on 10 x 10 km grid cells is not available for anywhere near all of the habitat types examined. Estimates of area sizes were compiled for many of the habitat types included in the 2008 assessment of threatened habitat types, and this data has been utilised in this report concerning some habitat types: if the estimated area is under 150 km^2, the rarity of the habitat type could be taken into account. Efforts have been made to consider the rarity of fell habitat types in proportion to the size of the fell area.

The assessment was done on Class 2 level habitat types (classification explained above). If an assessed habitat type consists of multiple sub-class habitat types, the rarity of these more specifically classified habitat types has been taken into account. Any rare habitat types included in an assessed habitat type have, where necessary, been taken into account when determining the preconditions for offsetting. The classification employed also takes into account cases where a habitat type is clearly rare only in part of its distribution area in Finland (Class 3).

3.2.5 Effectiveness of restoration and management methods

Habitat types have also been classified on the basis of the effectiveness of restoration or management methods:

1. Good

Measures are likely to achieve the desired state of the habitat type or start a development that will lead into the desired state. The methods have undergone long development and previous experience shows that they usually yield the desired outcome or the methods are such that the risk of failure is, overall, low.
Examples include many seminatural grasslands, Baltic Sea coastal gravel, shingle and boulder shores and Baltic Sea coastal sand beaches.

2. Moderate

Measures are well placed to achieve a status close to the desired state of the habitat type, but the objective may not be reached in some respects. There is previous experience of the methods, and methods are being developed. It may often take a long time to reach the objective set. This is also the category for those cases where there is not much previous experience of the improvement of the status of a habitat type but where the known methods for status improvement would appear to work well.
Examples include the majority of forest and mire habitat types, humic lakes, and low-humic and humic first-order and headwater streams.

3. Uncertain

There is previous experience of the management and restoration methods. These are being or should be developed, but results are contradictory or it is uncertain whether the essential components of the desired state will be achieved. The risk of not reaching the objective is significant. Further development of methods is required.
Examples include flada-lakes and glo-lakes (coastal lagoons), streams in clay-dominated catchment areas, rich fens, wooded swamps, and calcareous rock outcrops.

4. Unknown

There are no known, tested or developed methods. Often, there is no information available on the need for restoration and management of these habitat types, either, or the need has been assessed as being low.
Examples include many Baltic Sea underwater habitat types and rock outcrop habitat types.

5. No status improvement methods

There are no methods available for status improvements. These cases include habitat types that are threatened primarily by climate change and where it is not possible to improve the status of an individual occurrence without measures with broader effects. This is also the category for those habitat types whose occurrences are unique.
Examples include palsa mires, and canyons and caves.

Key considerations when assessing the suitability of habitat types for biodiversity offsetting are the probability of the offsets being successful and whether or not the status of a habitat type that has deteriorated can be improved in accordance with the objective. The assessment of the effectiveness of restoration and management methods focused on how well the methods used can improve a habitat type occurrence which has been degraded in terms of structure and functional features towards the desired state. The assessment sought to take into account key methods to improve the status of degraded habitat types, such as habitat type site management, rehabilitation or restoration or other status improvement, such as actions to improve water quality. When offsetting is carried out in practice, the effectiveness and chances of success of methods to improve the site's status must be assessed on a case-by-case basis.

Some generalisations had to be made when assessing the effectiveness of restoration and management methods. Different habitat improvement methods may address different problems. Some methods may be highly effective, while the effectiveness of others is insufficiently known and with some the outcome improves biodiversity to some extent but does not fully meet the objectives set. For example, vegetation in a coastal dune site suffering from trampling can be revived effectively by diverting visitors to paths, but there is less experience of and greater risks involved in using grazing to curb dune overgrowth. Or, restoration of a spruce mire may result in hydrological conditions that maintain spruce mire species, but the outcome may not correspond to the mire type that prevailed before drainage. For some methods, there is no overall understanding of how effective they are, as it may take decades before the success of the methods can be evaluated owing to the slow rate of recovery of the habitat type.

In addition to published data, the assessments of the effectiveness of restoration and management measures in this report are based on expert knowledge and opinions. For many habitat types, there is currently very little practical experience of methods to improve their status or possibly only an idea or vision on how their status could be improved. In cases where there is no previous experience of improving the status of the habitat type, any previous experience of improving the status of habitat types with a similar structure and functional features was utilised in making the assessment.

3.2.6 Suitability for biodiversity offsetting

The suitability of Finnish habitat types for biodiversity offsetting has been assessed based on the factors described above. The assessments covered whether, taking the general preconditions for biodiversity offsetting into account, it is possible to offset the destruction or degradation (biodiversity losses) of occurrences of each habitat type by improving the status of the same or another habitat type in some other site.

Factors reducing suitability for biodiversity offsetting include the threat status and rarity of the habitat type and any difficulties involved in status improvement. Most habitat types also have their specific preconditions, that is, factors that restrict offsetting or that need to be taken into account in the process.

Suitability for biodiversity offsetting has been divided into categories as follows:

1. Suitable for biodiversity offsetting subject to general preconditions

These habitat types are common, but some of them are threatened due to quality deterioration. There are effective methods to improve their status or improvement methods do not play a major role because the rate of quality deterioration is not significant. When considering the suitability of a specific occurrence for offsetting in more detail, the suitability of the occurrence may be restricted by general preconditions such as the occurrence being of high quality or significant to threatened species.

1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type

Habitat types whose biodiversity losses can be offset by improving the status of the same or a rarer habitat type (the like-for-like or better principle).

Examples include Baltic Sea coastal gravel, shingle and boulder shores, forests on rocky terrain, fens, and mesic heath forests.

1b Biodiversity losses can be offset by improving the status of the same habitat type

Threatened habitat types whose biodiversity losses should be offset by improving the status of the same habitat type (the like-for-like or in-kind principle). Improvement of the status of these habitat types is also suitable for offsetting biodiversity losses of more common habitat types.

Examples include mesic meadows, esker forests, spruce mires, raised bogs, and herb-rich forests.

2. Success of biodiversity offsetting uncertain

The first priority must be to avoid any biodiversity loss of these habitat types. Offsetting biodiversity losses is more difficult and involves a greater risk of failure than in Category 1 due to the threatened status and/or rarity of the habitat type and/or difficulties involved in status improvement. With these habitat types there are often specific preconditions for the implementation of offsets. In some cases it may be challenging to even meet the general preconditions. The probability of success of offsets is highest if the impact site is of poor quality. Case-specific consideration is particularly important with these habitat types.

Examples of this category include threatened and rare habitat types that are in need of restoration or management and where there are at least some good methods available to improve their status. The category also includes habitat types whose status improvement methods should be developed further.

Biodiversity losses of these habitat types must be offset by measures targeted at the same habitat type (like-for-like). Improvement of the status of these habitat types is also suitable for offsetting to compensate for biodiversity losses of more common habitat types.

2a Biodiversity losses must be avoided, status improvement possible
Threatened and quite rare habitat types, with effective methods available for status improvement.
Examples include Baltic Sea coastal sand beaches, herb-rich forests with broadleaved deciduous trees, and alluvial meadows.

2b Biodiversity losses must be avoided, status improvement challenging
Habitat types the improvement of whose status is challenging for a variety of reasons. Some are threatened while others are of Least Concern but rare. Status improvement may be challenging for reasons including a significant proportion of the habitat type sites being difficult to restore, species values necessitating particular care in measures and causing a high risk, status improvement requiring measures over a very large area, or there not yet being sufficient data on the effectiveness of measures. The category also includes some rare habitat types which currently have no clear need or measures for the improvement of their status.
Examples include Fucus spp. communities, coastal estuaries, rich fens, and low-graminoid mountain heaths.

3. Generally unsuitable for biodiversity offsetting
The habitat types in this category are very rare and threatened and should not suffer further lossess. Some are threatened by climate change, which will have adverse effects on the quality and quantity of habitat type occurrences in the future. The category also includes habitat types whose individual occurrences are typically unique, making their loss practically impossible to offset by improving the status of other occurrences. In accordance with the precautionary principle, this category also includes habitat types whose occurrence or ecological characteristics are currently known very poorly.

3a Biodiversity losses must not take place, status improvement possible
There are methods available to improve the status of these habitat types, so improving their status is suitable for offsetting biodiversity losses of more common habitat types.
Examples include coastal dunes, fen meadows, wooded swamps, Crateneurion spring complexes, streams in clay-dominated catchment areas, wooded meadows, calcareous rock outcrops, and forests on ultrabasic soils.

3a Biodiversity losses must not take place, status improvement not possible
There are no methods available to improve the status of these habitat types or the effectiveness of the methods is poor. It is difficult to improve the status of the habitat types owing to reasons including the threat status being caused by climate change or the nature of occurrences being unique.
Examples include Zostera marina communities, canyons and caves, and snowbeds and snow patches on fells.

3.2.7 Biodiversity offsetting principles and generation of biodiversity gains

Several offsetting principles shown in the tables in Chapter 6 may be applicable to a habitat type:

A. Offsetting using a rarer habitat type
Biodiversity losses of a common habitat type may also be offset by improving the status of another, rarer or more threatened habitat type (flexible offset, trading up).

B. Offsetting using an equivalent habitat type
Biodiversity losses of the habitat type must be offset by improving the status of an occurrence of the same habitat type elsewhere (in-kind, like-for-like).

C. Avoidance particularly important, but restoration/management or protection of this habitat type is recommended as offsets for other habitat types
Biodiversity losses of the habitat type are difficult or impossible to offset, but sites of the habitat type are suitable as offsets for biodiversity losses of more common habitat types.

D. Avoidance particularly important but benefits from restoration/management
The first priority must be to avoid biodiversity losses of the habitat type due to its high threat status or rarity, but the habitat type benefits from restoration or management (e.g. seminatural grasslands).

Measures to offset biodiversity losses of habitat types have been classified as follows (tables found in Chapter 6):

E. Once-off or very infrequent measure

For example, most restoration measures, including phased restoration (deadwood creation, mire ditch blocking, heath forest tree structure diversification).

F. Repeated measure

The measure needs to be repeated multiple times but not annually (e.g. overgrowth restriction, restriction of sprucification of herb-rich forests).

G. Continuous management

For example, grazing, mowing and other management of seminatural grasslands. Controlling alien species may require annual measures for a long time.

H. Permanent protection

Establishing a nature reserve or some other form of permanent protection (e.g. under an agreement). The preservation of the biodiversity of the habitat type benefits from permanent protection.

3.2.8 Habitat type-specific preconditions

For several habitat types, specific preconditions relating to biodiversity offsetting (tables in Chapter 6 and Appendix 1) have been laid out, and these must be taken into account in addition to the general preconditions regarding the habitat types concerned. Habitat type-specific preconditions may, for example, be related to factors owing to which it may be difficult to find suitable offset sites or due to which some occurrences of the habitat type are less suitable for offsetting than others.

The general preconditions are described in the following chapter and not repeated in Appendix 1 as they apply to all offsetting situations.

4. General preconditions for biodiversity offsetting for habitat types

For biodiversity offsetting to be a credible way of maintaining and increasing biodiversity and halting its continuous loss, a number of preconditions must be met. Some of the preconditions are in-built features of biodiversity offsetting (such as the mitigation hierarchy and additionality principle), while others are related case-specifically to the characteristics of impact sites (such as the avoidance of losses at high-quality habitats or sites that have high biodiversity values such as endangered species).

There are various uncertainties and risks involved in putting biodiversity offsetting into action. The general preconditions for offsetting include that if the impact site has particularly valuable nature values or is particularly rare, it is not suitable for offsetting and its biodiversity losses must be avoided. It may also be very difficult or impossible to offset biodiversity losses of a valuable and rare site by improving the status of another site. Offset sites should be such that the probability of success in improving their status is high.

The fact that a habitat type has, taking its threat status, rarity, potential for status improvement and special characteristics into account, been assessed to be suitable for offsetting does not mean that every one of its occurrences is suitable for offsetting. There may be factors that make a biodiversity loss caused by the degradation of an individual site so great that its offsetting is either not possible in practice or the risks of failure involved in offsetting are too high. It is particularly important to avoid biodiversity losses of any occurrences of such habitat types: these are 'no go' areas whose losses are impossible or very difficult to compensate for through biodiversity offsetting.

The key factors reducing site-specific suitability for biodiversity offsetting are described in this chapter. These factors are classified in this report under the general preconditions for biodiversity offsetting. These general preconditions must be taken into account when planning and implementing offsetting in order to be able to call the measures taken to improve the status of the habitat type 'biodiversity offsets'. If, for example, a project's impact is going to affect a site that is in its natural state, extensive and valuable in terms of its species, it is not suitable for biodiversity offsetting and, instead, the first priority must be to seek other solutions.

Preconditions are particularly important for threatened habitat types, but habitat types of Least Concern (LC) may also have occurrences whose location, exceptionally good structural and functional status, species or other special factors make it difficult or impossible to apply offsetting to them. There may be different emphases for habitat types with regard to how the factors described here affect the suitability of their occurrences for biodiversity offsetting. For example, there are some habitat types with a greater number of good-quality occurrences than others.

4.1 Quality of habitat type occurrences

The quality of an individual occurrence of a habitat type affects its suitability to offsetting. Quality can be described on the basis of how well the structure and functional features of the occurrence match the desired state. The desired state is usually the natural state, except for seminatural grasslands for which the desired state is a good status created through appropriate types of management measures.

In general it can be said that the further an impact site is from the desired state the smaller the biodiversity loss caused and the higher the probability of finding a suitable offset site to create biodiversity gains. The closer a site is to the desired state the greater the biodiversity loss and the more difficult it is to compensate for the loss through biodiversity offsetting. Structural and functional features of habitat types in the desired state are described in the table of Appendix 1.

If an occurrence of a habitat type is in its natural state, it may be very difficult to offset any loss of its biodiversity. With many habitat types, the first priority must be to avoid any biodiversity losses of sites in their natural state. Likewise, if the biodiversity values of a site are otherwise high (a large number of threatened and rare species, several threatened and rare habitat types), offsetting may involve too high a risk of losing significant nature values. In such cases a situation may arise where successful offsetting is not probable on the basis of a scientific assessment. In some cases, any biodiversity loss affecting just one individual site may make a species or habitat type significantly more threatened.

The higher the threat status of a habitat type, the more valuable – and more difficult to offset – its natural or seminatural sites. Risks and time delays are also emphasised in related offsetting. For example, it may in practice be impossible to offset biodiversity losses of herb-rich forests with broadleaved deciduous trees which are in their natural

state despite it otherwise being possible to offset losses of this habitat type in some contexts. On the other hand, it may be relatively easy to offset biodiversity losses of a non-natural site of even a threatened habitat type. For example, the nature values of a commercially managed, even-aged, barren heath forest featuring an overabundance of raw humus[8] and changed by eutrophication may as such be quite low, and its biodiversity losses can be offset, for example, by managing a similar type of barren heath forest site through impoverishment burning. The status of the offset site's habitat type improves if the site is protected and its biodiversity values are improved over time by natural succession, particularly if burning sessions of appropriate fire intensity can be repeated from time to time.

The structural features determining the habitat types of, for example, eskers, dune formations, canyons and gorges include specific geology and topography. Other habitat types may also have sites that are different in terms of their geomorphology or topography. These sites may be more difficult to offset or, in some cases, the first priority should be to avoid their biodiversity losses because these sites are unique – regardless of any alterations that might have already taken place in other structural and functional features of the habitat type.

8 The thickening of the raw humus layer may have a negative impact on, for example, tree seedling emergence.

4.2 Species

The preconditions for offsetting include that, as a general rule, sites that are significant in terms of their species must not be subjected to biodiversity losses. Biodiversity offsetting of such sites may also be very challenging. A site may be important in terms of its species in many ways including the following:

- A threatened species occurs or several threatened species occur in the site.
- Many rare species occur in the site.
- An indicator community for the natural state of the habitat type occurs in the site or the site has a significant occurrence of a keystone species that is important for biodiversity.
- The site has a special characteristic related to species or species composition that is rare or unique, such as the only viable occurrence of a declining species, a disjunct population of a rare species or an exceptionally diverse species composition.

Often a site with species values described above is also valuable in terms of its habitat types, but this is not always the case. Sites which are valuable in terms of their species composition may also have undergone major alteration and be located in areas including urban environments.

An impact site having significant species values, such as one or multiple threatened species, is likely to affect the opportunities to offset its biodiversity losses. The way these affect suitability for biodiversity offsetting is specific to each case and depends on how the species concerned are impacted by the losses. Some threatened species are species under special protection as laid down in the Nature Conservation Act[9]. These species are at imminent risk of extinction, whereby their remaining occurrences need to be protected. The deterioration and destruction of occurrence sites of species under special protection is prohibited under section 47 of the Nature Conservation Act. A prohibition takes effect when the centre for economic development, transport and the environment has set the boundaries of the occurrence site and notified the site's owner of the decision.

9 Nature Conservation Act: https://www.finlex.fi/fi/laki/kaannokset/1996/en19961096_20110058.pdf

4.3 Site location

The general precondition relating to the location of sites is that biodiversity offsetting is to take place locally in the same area or region where biodiversity losses will occur. Secondarily, offsetting can take place elsewhere (e.g. Nyrölä et al. 2011). If it is possible to offset locally close to the impact site, at least some of the species are likely to have better chances of relocating to the restored offset site. This increases the probability of success of the biodiversity offset and may reduce pressure to raise multipliers (offset ratios).

The preconditions for biodiversity offsetting also include that sites with locations significant to biodiversity must not be subjected to biodiversity losses. These may include geographically peripheral occurrences or disjunct occurrences of a habitat type or species and sites which are important for ecological connectivity.

Habitat type disjunctions may differ from other occurrences and therefore be unique. Their species may be genetically different from those of other occurrences, and they may therefore be significant for the preservation of genetic diversity.

Connectivity means the spatial location and accessibility of habitats from the species perspective: the opportunities of a species to move or disperse between habitat patches that are suitable for it. Well-connected areas provide species with the opportunity to disperse to new areas to source food and shelter and to reproduce (Mikkonen et al. 2018). For example, from the perspective of a forest specialist species, the network of connected sites near the primary habitat forest may include not only other natural forest patches but also seminatural forest areas nearby. The network of forest sites enables forest species to live in a more extensive entity of forest areas.

Also sites located near a known habitat of a threatened species that are highly suitable for the species although the species does not currently occur in them are important for connectivity. It is often difficult to determine specifically whether or not sites are well-connected from the perspective of a specific species as this calls for a specific understanding of the dispersal capacity and habitat requirements of the species. Things are made even more difficult if the connectivity is assessed from the perspectives of all the species in the habitat. Connectivity can be taken into account in various ways in regional conservation planning (e.g. Mikkonen et al. 2018). Preserving and improving connectivity is an important factor when aiming to prevent species from becoming threatened. It should be noted that connectivity can also be improved through biodiversity offsetting. This may be a significant way to increase the effectiveness of biodiversity offsetting as regards improving biodiversity and may reduce pressure to raise multipliers (offset ratios).

Both connectivity and disjunct occurrences of habitat types and species are important factors in adaptation to climate change. Well-connected areas enable at least some species to move to more suitable areas as the climate changes. In certain cases, peripheral occurrences may speed up species dispersal to areas with a favourable climate and adaptation of nature to changes. For example, in Finland there are disjunct relict occurrences of some species from the Holocene climatic optimum (such as *Tilia cordata*).

5. Biodiversity offsetting of habitat types

Chapter 2 provided examples of biodiversity offsetting from elsewhere in the world. In Finland, offsetting to compensate for biodiversity losses has only taken place on a trial basis and only in a small number of projects (e.g. Pulkkinen 2008, Pekkonen & Ruiz 2017). Regardless of the details of the offset mechanism, it is important to comply with the general principles that can be regarded as prerequisites for the effectiveness of biodiversity offsetting.

The chances of offsetting success are impacted by issues such as the quality the habitat type occurrence. When aiming for no net loss (NNL) of biodiversity, it needs to be possible to measure and compare the biodiversity loss caused and the biodiversity gain produced through the offset. When estimating and comparing losses and gains, the use of tools such as indicators and habitat-specific measuring tools is unavoidable as it is not possible in practice to measure all species or factors affecting the quality of the site.

From the viewpoint of protecting biodiversity, it is important in biodiversity offsetting to comply with the following principles that form the basis of the preconditions for biodiversity offsetting for habitat types (e.g. Nyrölä et al. 2017):

- Complying with the mitigation hierarchy: The first priority must be to avoid adverse impacts, the second option is mitigation and the last option is to use offsets. ”Biodiversity offsetting is the last resort.”
- Implementing offsets entirely by using sites that are equivalent (in-kind/like-for-like offsets) or of equal (or in some cases greater) value (flexible offsets, trading up).
- Aiming to implement offsets as mutually supplementary measures and using either extensive enough individual areas or entities comprising multiple smaller areas.
- Due to the uncertainties relating to offsetting, always aiming to achieve a net positive impact (NPI).

- When a biodiversity loss is permanent, the gain produced through the offset must also be permanent. Offsetting must also be effective over the long term.
- Only implementing offsetting if its success is probable on the basis of a scientific assessment.
- Those participating in the planning and implementation of biodiversity offsets must have sufficient expertise and competencies.

5.1 Stages and objectives of biodiversity offsetting of habitat types

In broad terms, for biodiversity offsetting to be successful, losses and gains must be assessed and calculated, justified and sufficiently high multipliers (offset ratios) must be used, offsets must be implemented as agreed and the monitoring and permanence of the offsets must be ensured (Moilanen and Kotiaho 2018).

The key stages in the preparation, planning and implementation of biodiversity offsets for projects causing losses of biodiversity are shown as a diagram in Fact box 2. It is important to ensure the sufficient professional competencies of the planners and the implementers of the various measures right from the initial phases (Nyrölä et al. 2011). On the basis of the project plan (1), the impact area (2) is determined. The impact area may be larger than the direct construction area. Once the impact area is known, a survey of the area's nature values is conducted and any biodiversity losses caused by the project are assessed (3). The scope of the survey of nature values, such as species composition, necessary can vary to some extent on a case-by-case basis. Sufficient baseline studies and the reliability of the studies carried out are prerequisites for the implementation of offsets and verification of their implementation. Nature values studied in most cases include the habitat types occurring in the site, their quality (structure, functional features, natural state, special characteristics) and surface area, species in the area (any threatened and rare species in particular), location (e.g. significance for connectivity, whether the occurrence is geographically peripheral) and any other factors affecting the suitability of that specific site for biodiversity offsetting (e.g. ecosystem services provided by the area). On the basis of this data, it is possible to assess the potential for mitigation of biodiversity losses (4) and those nature values that remain for offsetting (5).

Once all of the above is known, the potential for compensating for these nature values through offsets must be examined. The first stage must involve an assessment of the extent to which the preconditions for offsetting (6) discussed in Chapter 4 affect the potential for offsetting. On the basis of this, an assessment of the overall offsettability of the project is carried out (7a/b). If it appears to be possible to use offsetting to compensate for nature value losses, the next steps are the actual planning of offset measures, offset calculations and determination of offset sites (8). The plans can be used to make the final decision on measures (9) and to implement them (10). There must be a monitoring plan for offset measures, their success and impacts to verify the success of status improvement and any need for corrective measures (Nyrölä et al. 2017) (11).

The stages described above are schematic and do not cover aspects such as the following:

- In some cases, restoration may have negative impacts on the environment, and these must also be taken into account and minimised. For example, the restoration of a spruce mire may sometimes cause nutrient loading of downstream water bodies.
- Time delay in generating gains. Biodiversity losses may take place quickly but offsetting them in full may take up to decades depending on the case.

In general terms, it can be said that undertaking nature value surveys at an early stage of project planning in many cases reduces the need to make changes to plans at later stages. The poorer the impact site in terms of biodiversity (site structure, functional features and species far from the natural or desired state), the higher the potential for generating compensatory biodiversity gains in the offset site. Correspondingly, the closer the site is to the natural or desired state, the greater the biodiversity losses arising from its degradation are and the more difficult it is to offset them. For example, it is difficult to offset biodiversity losses of a natural barren heath forest type forest because, due to the slow growth rate of the trees, features such as the natural continuum of deadwood develop slowly and the positive species impacts of restoration emerge slowly. On the other hand, if the offset site is a barren heath forest that has clearly been managed as a commercial forest, the nature values to be offset are probably not very high. In certain regions, there are lots of barren heath forests whose status has deteriorated and can be improved through measures such as restoration burning.

In biodiversity offsetting of habitat types, there may be various objectives set for status improvement based on habitat type structure and functional features and the potential for improving them. Objectives may also be affected by the types of offset sites available and the degree to which their status differs from the natural state or, as regards seminatural grasslands, from a good state.

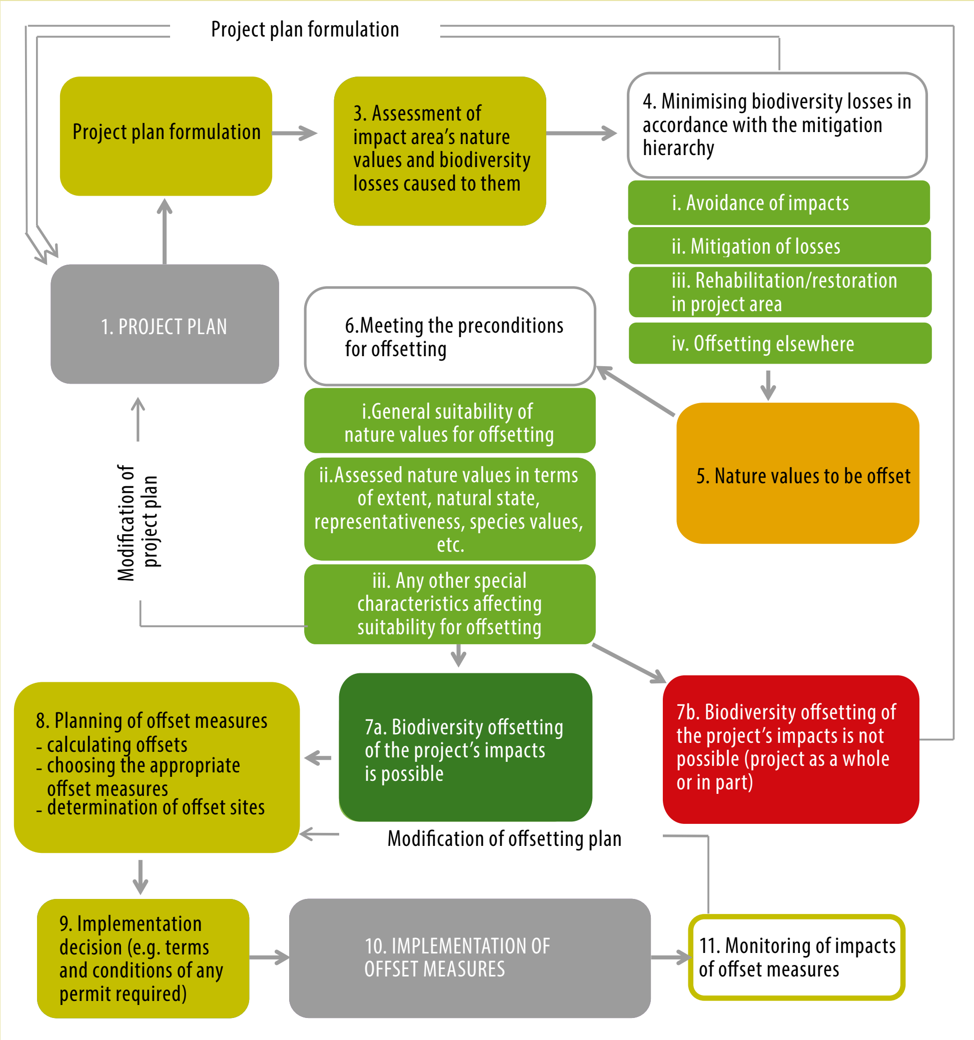
In general terms, the objectives of measures for status improvement may, depending on the site and habitat type, be to:

1. create structural features that increase species diversity and representativeness (e.g. seminatural grasslands);
2. create an ecosystem that is seminatural in terms of its structure (e.g. esker forests);
3. create an ecosystem that, over time, will function naturally in terms of its structure and functional features (e.g. mires).

For example, status improvement measures taken on seminatural grasslands aim to create a significant improvement in the species composition typical of the habitat type, which is often characterised by low herbs and graminoids as well as insects favouring open environments. To be preserved, seminatural grasslands require repeated management and there are no natural sites in terms of functional features in the same way as there are with, for example, mires. As regards esker forests, on the other hand, the objective is to create gaps in vegetation, patches of exposed soil and burnt detritus and wood even though it is not possible to restore the natural forest fire cycle that maintains the structure and functional features of esker forests. For most drained mires, the purpose of status improvement measures is to restore the functioning of the habitat type, that is, natural or natural-like hydrology and peat formation, which will before long be followed by the emergence of species characteristic of the habitat type.

FACT BOX 2 APPLICATION OF BIODIVERSITY OFFSETTING AND MITIGATION HIERARCHY AS PART OF PROJECT PLANNING

The steps of the diagram are described in Section 5.1. In addition to habitat types, nature values to be taken into account in biodiversity offsetting include the species occurring in the area (especially threatened and rare species), the site's significance as regards ecological connectivity and possibly also the ecosystem services provided by the area. The general preconditions of biodiversity offsetting (Chapter 4) apply to all habitat types and species.



5.2. Challenges faced in biodiversity offsetting of habitat types

Challenges faced in biodiversity offsetting and the significance of these challenges are discussed and analysed by Moilanen and Kotiaho in 'Planning biodiversity offsets – Twelve operationally important decisions' (2018). Some of the key challenges as regards biodiversity offsetting of habitat types are discussed below.

5.2.1 Time delays

With many methods improving the status of habitat types, it takes years or decades to generate the status improvements required by offsets. In such cases it is obvious that the nature values lost cannot be rare, highly threatened or otherwise special as their offsetting would only be achieved after a long period of time, which might make the habitat types or species more threatened. According to Moilanen and Kotiaho (2018), with habitats that are slow to recover, impact avoidance is clearly more recommendable that generating gains through restoration.

If a loss is in practice immediate but gains are not generated until much later, achieving the offset gains in full involves more uncertainty than if gains are also generated right away. In these situations time discounting is recommended in offset calculations to reduce the "value" of the offset gains and to result in an increase in the number or coverage area of status improvement measures to a level greater than would be required by direct one-to-one calculations. A specific time period also needs to be determined for the examination of gains achievement when time discounting is applied. Time discounting must never enable the loss of highly threatened or rare habitat types.

Time discounting in the context of biodiversity offsetting is discussed in greater detail in the report by Moilanen and Kotiaho (2018). Time discounting can be reduced by generating gains at least partly already before the loss takes place.

In some cases, due to time delays, the offset outcomes can be estimated only after a lengthy period of time. For example, it may take a long time for natural development and return to the natural state to take place in mires. Assessments of whether or not the objectives set as regards loss of natural values were reached can only take place after years and decades have passed. In practice, it may be difficult to organise measures such as monitoring for a period this long. Monitoring should, however, take place at least long enough to be able to evaluate if natural development in the right direction has started and to establish that there is no longer any need for corrective measures.

5.2.2 Permanence of biodiversity offsets

The permanence of biodiversity offsets must be ensured. If an offset is produced using nature values that can be preserved by protection measures, then permanent protection, for example, as a nature reserve is usually enough. But, if nature values whose good status requires repeated disturbances or regular nature management are used as offsets, it is more difficult to ensure the permanence of the offsets. This creates further challenges and costs relating also to the determination of offset measures, offset calculations and monitoring of offset implementation.

According to Moilanen and Kotiaho (2018), recurrent habitat management is not a reliable offsetting action and also makes it more difficult to evaluate the scope and scale of offsets. Habitat types such as seminatural grasslands are, however, attractive as offset sites because there is a great need to improve their status and management actions usually result in good outcomes. If sites requiring regular nature management are included in biodiversity offsetting, offset mechanisms (e.g. guarantee systems to ensure long-term management) should be developed for sufficient control and measurement of certainty and offset scope and scale.

5.2.3 Uncertainties involved in the success of biodiversity offsets

It is likely that there is often uncertainty regarding the success of biodiversity offset implementation. Measures to improve status usually aim to achieve a specific structural or functional status for the habitat type. Owing to the complexity and slow rate of nature's processes, shortcomings of status improvement methods, or dispersal difficulties of species, it may be difficult to reach objectives and to estimate the probability of success. Reaching the objective set may call for corrective or repeated measures. In some situations it is probably known in advance that the no net loss of biodiversity target cannot necessarily be achieved, but the outcome of offsetting for the species composition and ecosystem services will probably be clearly better than the baseline situation.

Some measures are quite simple and guaranteed to generate the desired gain. For example, successful diversion of hikers causing wear from areas with sensitive vegetation, returning rapid rocks into a dredged stream or clearing a spring filled with logging residue are simple measures whose effectiveness is easy to establish. Measures taken on some habitat types may be simple and generate positive impacts quickly, but they are required often enough and for a sufficiently long period. For example, it may take years of combatting the invasive alien species Rosa rugosa before it can be eliminated by repeated clearing and weakening of plants. It is also possible that it cannot be completely eliminated, but the mere restriction of the occurrence of the alien species facilitates the recovery of native species.

There is greater uncertainty regarding the improvement of the status of some habitats, including through measures known to be effective, because the processes involved are complex and ecological responses difficult to predict. For example, improving the status of a lake may ultimately require more extensive and expensive measures than could be anticipated in the baseline situation. It must, however, be required for the sake of the implementation and permanence of offsets that measures are taken to the extent that the desired impact is achieved and the status of the habitat type becomes stable.

5.2.4 Difficulties involved in biodiversity offset calculations

It is impossible to fully measure biodiversity and ecosystem services, and this is a considerable challenge involved in the implementation of biodiversity offsets (Moilanen and Kotiaho 2018). When measuring biodiversity, numerous decisions affecting the outcome have to be made. Which species and habitat types will the survey cover? What data on them is to be obtained and using which methods? As regards offset calculations, on the other hand, it is only feasible to take into account some of the factors that can be used to describe and assess the ecological status of the impact sites or the sites intended to be used as offset sites (e.g. Parkes et al. 2003, Alvarado-Quesada et al. 2014, Wende et al. 2018).

A challenge always faced in biodiversity offsetting is the verifiability of impacts, which is to do with the challenges involved in biodiversity measurement, comparability and valuation. It is important that the key decisions made concerning the measurement of nature values and offset calculations are transparent. The impacts of decisions on final outcomes should also be described. Moilanen and Kotiaho (2018) propose that the more biodiversity is simplified in offset calculation the greater the multiplier (offset ratio) should be. The multiplier is a ratio for surface area used to take into account and control delays, uncertainties and flexibility inevitably involved in offsets. For example, if species from all key species groups of an affected herb-rich forest are not taken into account in offset calculations, the offset site selected must be a herb-rich forest area that is clearly larger in area than the adversely affected forest.

5.2.5 Other challenges

Continuous deterioration of nature values

When taken in large-scale use, the implementation of biodiversity offsets may become difficult due to shortage of habitats suitable for use as offset sites. Once the most suitable habitats have been restored, various uncertainties and calculation challenges begin to increase. This is due to issues including increases in geographical distances between impact sites and offset sites and ecological differences between sites.

Climate change

The impacts of climate change should be taken into account for all habitat types. The latest data on the impacts of climate change is required for purposes including the assessment of uncertainties relating to time delays and the determination of offset permanence. Overall, the impacts of climate change increase the uncertainty of success of offset measures, and related assessments make offset calculations more complex.

6. Suitability of habitat types for biodiversity offsetting

This chapter deals with the suitability of all habitat types occurring in Finland for biodiversity offsetting. The assessment is based on data described in Section 3.2. The habitat types have been divided into eight ecologically similar groups. The suitability of habitat types for biodiversity offsetting is assessed in this report at the level of features shared by the entire group and, if necessary, at the level of individual habitat types. The habitat type groups covered are:

- The Baltic Sea
- Coastal habitats
- Inland waters and shores
- Mires
- Forests
- Rock outcrops and scree
- Seminatural grasslands
- Fell area

6.1 The Baltic Sea

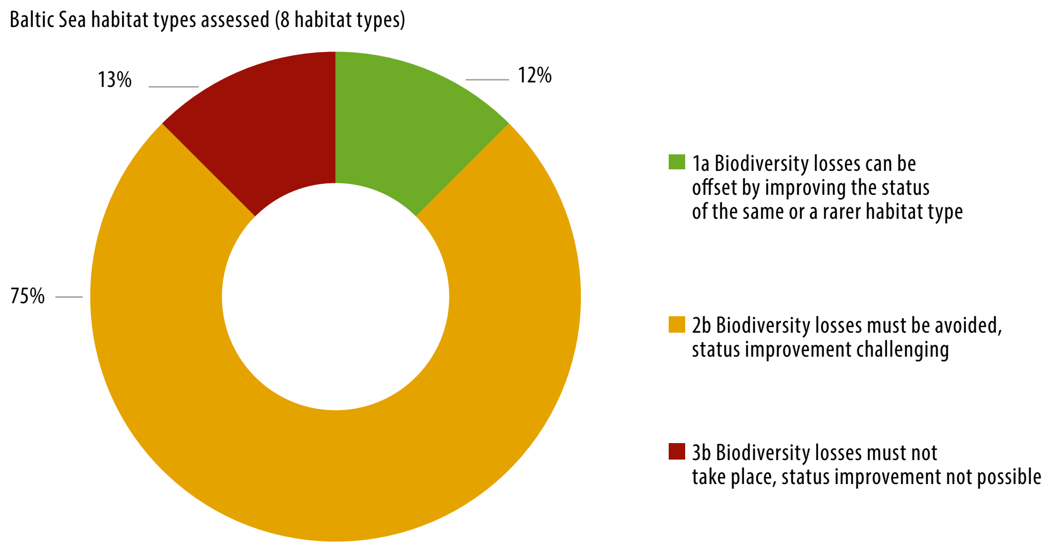
Suitability for biodiversity offsetting

Biodiversity offsetting is more challenging in the context of marine underwater habitat types than with many land habitat types as their status is strongly linked to the water quality of the Baltic Sea. Therefore it is difficult to target offset measures and make them effective enough to be able to verify status improvements of underwater habitat types in a specific area. Even in the best-case scenarios, compensating for losses is likely to only be partial. For example, reducing nutrient releases or curbing the spread of alien species are possible offset measures, but it is challenging to determine and verify sufficient offsets. Moreover, when using the protection of habitat type occurrences as offsets, it must be taken into account that protection alone will not guarantee the preservation of an occurrence if sufficient water quality cannot be guaranteed.

Only a few Baltic Sea underwater habitat types are discussed here as their classification in the first assessment of threatened habitat types in Finland was very general. The classification has since been made more specific in the HELCOM Underwater Biotope and Habitat (HUB) Classification (HELCOM 2013), and a classification based on that is used in the second assessment of habitat types in Finland under preparation at the time of writing of this report. Flada-lakes and glo-lakes (coastal lagoons) and estuaries are included in Section 6.2 on coastal habitats.

Most of the marine habitat types assessed here fall under suitability category 2b, which means their biodiversity losses must be avoided and their status improvement is challenging (Figure 2, Table 2).

Figure 2. Suitability of Baltic Sea underwater habitat types for biodiversity offsetting.



Among the Baltic Sea habitat types assessed, filamentous algal zones are the most suitable for biodiversity offsetting. Unlike other Baltic Sea habitat types, they have become more abundant due to eutrophication and there is a need to reduce rather than increase their size. In eutrophic marine areas, filamentous algal zones are replacing other habitat types such as Fucus spp. communities. Losses of filamentous algal zones can primarily be offset by protecting other, rarer marine habitat types or improving the status of other marine habitat types. Eutrophication has also caused some changes in the quality of filamentous algal zones, so their status will also improve when water quality improves even if their area is reduced and at the same time space for growth is created for other marine habitat types.

The other assessed marine habitat types are clearly less suitable for biodiversity offsetting. The most essential issue for their status improvement is improving water quality, and in that case offset measures cannot usually achieve very rapid or targeted outcomes. There is, however, an obvious need for status improvements if only through limited-loss offsets (partial compensation). Such habitat types comprise *Fucus* spp. communities, red algae communities, bottoms dominated by submerged macrophytes, charophyte meadows, blue mussel communities and zoobenthic communities.

Fucus spp., red algae and blue mussel communities attaching to hard rocky and stony bottoms may also be created on artificial structures. In principle, this could be utilised in offsetting of biodiversity losses, for example, by attaching special structures to submerged underwater pedestals of wind turbines to promote the creation of new occurrences of these keystone species. This, however, involves challenges and, for example, filamentous algae, which grow faster than *Fucus* spp., usually manage take over such surfaces before *Fucus* spp. attach to them. In addition, in Finland's marine areas rocky and stony bottoms are so common that the occurrence of these habitat types is restricted more by poor water quality than lack of suitable attachment substrates. There are naturally fewer hard bottoms in the southern Baltic Sea, and artificial reefs have been constructed to increase fish habitats and benefit fishing (Schygulla & Peine 2013). Trials of *Mytilus edulis* farming on artificial substrates have been conducted in areas including the Åland Islands and the eastern coast of Sweden to reduce nutrients from near-shore marine areas (Kraufvelin & Diaz 2015, Minnhagen 2016). More data is needed on the benefits and any adverse effects of artificial substrate use before its feasibility for biodiversity offsetting concerning marine habitat types can be assessed.

Among the Baltic Sea habitat types, *Zostera marina* communities occurring on sandy bottoms are assessed as being the least suitable for biodiversity offsetting. *Zostera marina* is at the edge of its range in Finland, and no underwater meadows formed by this seagrass occur in those marine areas of Finland where salinity levels are the lowest. In areas where salinity levels are high enough, there are naturally very few sandy bottoms, limiting the availability of habitats suitable for the species. *Zostera marina* mostly occurs in Finland's southwestern marine areas, which have suffered the most from eutrophication. Representative *Zostera marina* communities are threatened and rare but important for biodiversity. Their status depends most of all on water quality, which cannot usually be impacted very quickly or in a targeted manner through local offset measures. *Zostera marina* is slow to disperse and has not been found to naturally return to former habitats even in cases where water quality has improved (Boström et al. 2014).

Studies have been conducted in the Baltic Sea and the Kattegat into potentially reintroducing *Zostera marina* by divers hand-planting them, and successful outcomes have also been achieved. These planting methods are expensive and, in any case, their success calls for good water quality and careful planning (Eriander et al. 2016, Moksnes et al. 2016). Issues to be taken into account include ensuring the suitability of the genome of the transplanted individuals to the conditions of the receiving site and not reducing the source population too much due to the transplantation. Studies into the reintroduction of *Zostera marina* have also started in Finland, but there are no results available yet.

State of knowledge

In recent years, the Finnish Inventory Programme for the Underwater Marine Environment (VELMU) has greatly improved the availability of data on the occurrence of the Baltic Sea's underwater habitat types. The surveys conducted under the programme have covered the entire Finnish marine area. Data on seabed quality and topography has been collected using echo sounding, while occurrences of species and habitat types have been studied by diving, benthic sampling and video photography. Because it has not been possible to conduct inventories of all marine areas using precise methodology, species and community distribution models have been produced on the basis of species observations and environmental factors (Finnish Environment Institute 2017b). The models illustrate the occurrence of species and communities at the marine area level, so planning for project implementation always requires detailed surveys of underwater nature values.

End products of the VELMU project include a species and habitats information system and the VELMU map service (2017) providing access for all to data collected by the project. The information system and map service help identify areas that are potentially valuable for marine nature, but more specific data must be obtained on sites when planning projects.

There have been hardly any Finnish trials of restoring marine habitat types using planting of keystone species or constructing artificial substrates.

Need for status improvements

The status of most underwater marine habitat types has deteriorated clearly due to the poor water quality of Finland's marine areas. There is a great need for improvements in the status of these habitat types, and the priority action required is to reverse the marine eutrophication development. Eutrophication is indicated by turbidity, algal blooms, changes in the status of the seabed, and changes in communities. None of Finland's open sea or costal marine areas show a good status as regards eutrophication. The areas with the poorest status are the Gulf of Finland and the Archipelago Sea. The status of the Gulf of Bothnia is better, particularly in open sea areas and outermost coastal waters, although even there the status is assessed as poor. (Korpinen et al. 2018)

Factors deteriorating the status of habitat types and means of improving their status

Eutrophication of the Baltic Sea due to nutrient pollution (all marine habitat types)

- agricultural and forestry measures to reduce nutrient pollution in the catchment areas of streams discharging into the Baltic Sea (e.g. buffer zones, settling tanks, submerged weirs, drainage cuts, wetland creation, gypsum treatment of fields, retirement of farmland bordering on water bodies, further processing of livestock manure, see Kostamo et al. 2018)
- increasing the efficiency of industrial and municipal wastewater treatment (e.g. nitrogen removal)
- reducing nutrient releases from fish farms
- reducing atmospheric nitrogen deposition (e.g. reducing nitrogen emissions from maritime transport)
- reducing the eutrophication and overgrowing of shallow bays and flada-lakes by mowing *Phragmites australis* and removing the cut plants and taking targeted water protection measures in catchment areas
- removing nutrients or biomass locally from the sea by using methods such as algal or mussel farming or removing *Phragmites australis*, *Cyprinidae* spp. or green algae (effectiveness to be studied further)

Bioaccumulation of harmful substances in Baltic Sea organisms and deaths of organisms caused by oil and chemical discharges (all marine habitat types)

- increasing the efficiency of the removal of toxic and harmful substances from industrial and municipal wastewater
- prevention of vessel oil and chemical spill accidents and preparedness for oil spill response

Construction projects, dredging and sea sand extraction altering and destroying the seabed (all marine habitat types)

- hardly any quick and effective means available for the restoration of values of destroyed littoral areas
- potential future use of artificial reefs (e.g. concrete structures) to provide hard-bottom species with attachment substrates and fish with shelter (hardly any Finnish trials conducted and probably not very beneficial in Finland as there is an abundance of existing hard bottoms)
- potential future restoration of sand-bottom *Zostera marina* communities by planting *Zostera marina* (success requires improved water transparency)
- improving the knowledge base of underwater habitat types and taking nature values into account in marine spatial planning
- supplementing the marine protected areas network

Community changes due to alien species (zoobenthic communities in particular)

- preventing the spread of alien species transported by ships: vessel ballast water treatment, alien species monitoring at ports
- biodiversity offset plans must take into account and make efforts to prevent the spread of alien species

Permanence of biodiversity offsets

The multiple impacts of climate change on the status of the Baltic Sea are difficult to predict, but it is probable that nutrient runoff into the Baltic Sea will increase due to climate change. Climate change is projected to increase the nutrient load of the sea as increased winter precipitation will probably leach more nutrients from non-frozen ground into water bodies (Korpinen et al. 2018). The deterioration of water quality caused by climate change may therefore disrupt any favourable development that could be achieved through offset measures reducing the nutrient load.

Challenges faced in biodiversity offsetting

The status of Baltic Sea habitat types is affected, through issues such as water quality, alien species and climate change, by many factors and measures, including in areas far away from the actual habitat type occurrences, so it is difficult to target offset measures and anticipate and measure their effectiveness. Offsetting can usually only be limited-loss offsetting (partial compensation).

- Offset calculations and verifications are even more demanding in the marine environment than with other habitat types. Even at their best, offsets for marine habitat types can usually only be of the limited-loss type, and the rate of habitat type response to measures such as reducing the nutrient load is slow. Offset calculations also involve technical challenges: for example, nutrient load reduction measures taken in catchment areas of streams discharging into the Baltic Sea are in part included in the EU's agri-environmental support and, according to the additionality principle, only those measures which are not covered by the support can be regarded as genuine offsets (Kostamo et al. 2018).
- The knowledge base of the locations and status of underwater habitat type occurrences is still incomplete despite the improvements made in recent years.
- So far, there is hardly any data on or experience of the ecological impacts of artificial reefs in Finland. Particularly in the Baltic Sea context, there is the risk of rapidly spreading alien species such as *Neogobius melanostomus* ending up benefitting the most from artificial reefs. Their potential abundance could even result in biodiversity losses. (Kostamo et al. 2018)

Habitat types and sites whose biodiversity losses must be avoided in particular

- Underwater esker complexes
- Underwater rock faces

Development needs

For the purpose of offset planning, more comprehensive geographic datasets are needed on the underwater marine environment for use as background data in project planning.

Marine habitat type restoration methods such as artificial reefs or transplanting and propagation of species need to be studied and tested and related monitoring methods developed before measures can be taken into established use.

Table 2. Suitability of Baltic Sea underwater habitat types for biodiversity offsetting. The classifications used are described in Chapter 3, and further information about the habitat types assessed can be found in Appendix 1. Threat status is given as a range (e.g. LC–VU) whenever a habitat type includes multiple habitat types of more specific classification levels whose threat status classifications differ from each other (see Appendix 1).

THE BALTIC SEA				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/ management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
***Filamentous algal* zone LC–NT**	5. No	4. Unknown	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	x	x						x	Filamentous algal zones have become more abundant due to eutrophication, so there is a need to rather reduce than to increase their size in eutrophic marine areas where they are replacing other habitat types. Eutrophication has to some extent also changed the quality of filamentous algal zones, so they will benefit from water quality improvements.	
***Fucus spp*. communities VU**	3. Yes, in parts of the country	4. Unknown	2b Biodiversity losses must be avoided, status improvement challenging		x			(x)			x	Fucus spp. communities have suffered from eutrophication, and their status depends most on water quality, which cannot usually be impacted very quickly or in a targeted manner through offset measures. Measures improving the status of the Baltic Sea may work as limited-loss offsets. Underwater structures (e.g. of wind turbines) can, in principle, be designed for use as substrates for *Fucus* spp. communities, but the problem is filamentous algae that will take over new surfaces faster than *Fucus* spp.	If the offset involves creating new habitats for *Fucus* spp., the reproductive cycle of the various species should be taken into account when selecting the time when substrates are placed in the sea. This has an impact on which species will attach to the surfaces and which habitat type will be created in the site. The mechanical removal of filamentous algae from substrates during Fucus spp. dispersal may also be helpful. In addition, the choice of substrate surface material and inclination must be suitable for the target species. Further research into this is required.

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

THE BALTIC SEA				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/ management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
***Red algae* communities EN**	3. Yes, in parts of the country	4. Unknown	2b Biodiversity losses must be avoided, status improvement is		x			(x)			x	Red algae communities have suffered from eutrophication and their status depends most on water quality, which cannot usually be impacted very quickly or in a targeted manner through offset measures. Measures improving the status of the Baltic Sea may work as limited-loss offsets. Underwater structures (e.g. of wind turbines) may, in principle, be designed for use as substrates for red algae, but further research into this is still required.	If the offset involves creating new habitats for red algae, the reproductive cycle of the various species should be taken into account when selecting the time when substrates are placed in the sea. This has an impact on which species will attach to the surfaces and which habitat type will be created in the site. The mechanical removal of filamentous algae from the substrates during the dispersal of red algae may also be helpful. In addition, the choice of substrate surface material and inclination must be suitable for the target species. Further research into this is required.
***Zostera marina* communities EN**	1. Yes	3. Uncertain	3b Biodiversity losses must not take place, status improvement not possible		x	(x)		(x)			x	*Zostera marina* communities have suffered from eutrophication, and their status depends most on water quality, which cannot usually be impacted very quickly or in a targeted manner by offset measures. Measures improving the status of the Baltic Sea may work as limited-loss offsets. Studies have been conducted in the Baltic Sea and the Kattegat on potentially restoring *Zostera marina* by hand-planting them, but the methods are expensive and in any case their success calls for good water quality. *Zostera marina* communities are endangered and important for the biodiversity of the Baltic Sea, so not a single representative occurrence should be lost.	The most representative *Zostera marina* communities are found on sandy bottoms, and a low salinity level of seawater is a factor limiting the dispersal of the species in Finland's southern marine areas where sandy bottoms are not common. This restricts the availability of suitable offset sites. *Zostera marina* is naturally slow to disperse to and settle in new or previously destroyed areas even if water quality has improved.

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

THE BALTIC SEA				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/ management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Bottoms dominated by submerged macrophytes VU	5. No	4. Unknown	2b Biodiversity losses must be avoided, status improvement is challenging		x						x	Bottoms dominated by submerged macrophytes have suffered from eutrophication, and their status depends most on water quality, which cannot usually be improved very quickly or in a targeted manner by offset measures. If occurrences are located in closed bays or flada-lakes, water quality can be improved by reducing the load from the catchment area, and overgrowing of bays can be combated by using measures such as cutting reedbeds. Measures improving the status of the Baltic Sea may work as limited-loss offsets.	Bottoms dominated by submerged macrophytes are a broad group of habitat types the loss of the rarest and most sensitive to eutrophication of which must be avoided in particular.
Charophyte meadows EN	4. Possibly (insufficient data)	4. Unknown	2b Biodiversity losses must be avoided, status improvement challenging		x						x	Charophyte meadows have suffered from eutrophication, and their status depends most on water quality, which cannot usually be improved very quickly or in a targeted manner by offsets. If charophyte meadows are located in closed bays or flada-lakes, water quality can be improved by reducing the load from the catchment area, and overgrowing of bays can be combated by using measures such as cutting reeds. Measures improving the status of the Baltic Sea may work as limited-loss offsets.	

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

THE BALTIC SEA				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/ management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Blue mussel communities NT	3. Yes, in parts of the country	4. Unknown	2b Biodiversity losses must be avoided, status improvement challenging		x						x	Blue mussel communities have suffered less from eutrophication than several other Baltic Sea habitat types,but their status would also be improved by water quality improvements. Blue mussel communities are important food sources of species including *Somateria mollissima*, *Platichthys flesus* and *Cyprinidae* spp., so their ecological significance is great. It is therefore important to avoid their biodiversity losses even though the habitat type is not currently threatened. It is, however, vulnerable to climate change because of its salinity requirements. Underwater structures can potentially be designed for use as attachment substrates for *Mytilus edulis*, but further research into this is still required.	
Zoobenthic communities NT	2. Yes, for some habitat types	4. Unknown	2b Biodiversity losses must be avoided, status improvement challenging	x	x						x	There are several different types of zoobenthic communities, and they have suffered in various ways from eutrophication and alien species. Their status depends most on water quality, which cannot usually be improved very quickly or in a targeted manner by offset measures. Measures to improve the status of the Baltic Sea may work as limited-loss offsets	

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

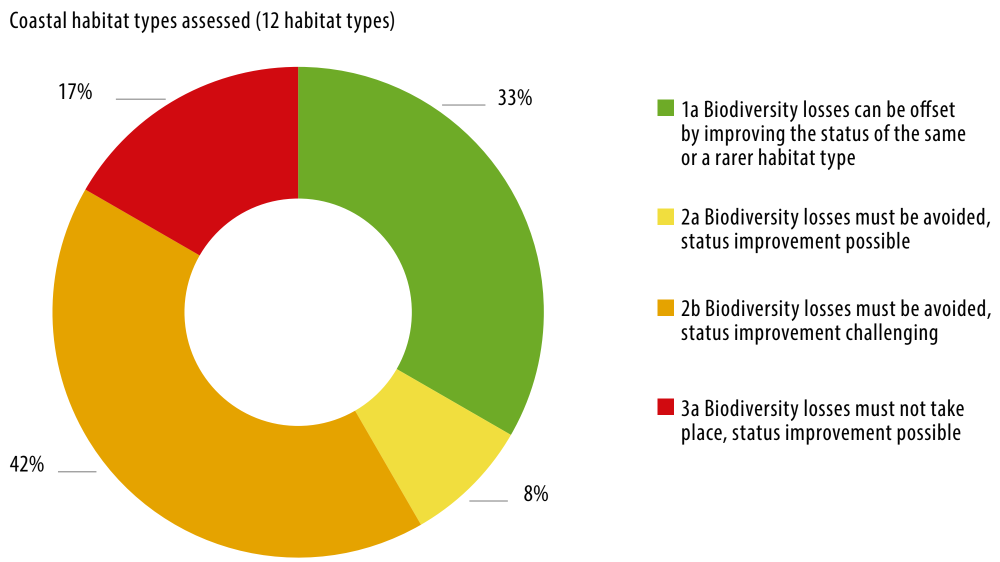
6.2 Coastal habitats

Suitability for biodiversity offsetting

Finland's Baltic Sea coastal habitats range from treeless shores to forests and from dry sands to vast estuaries. The suitability of habitat types for biodiversity offsetting varies by type depending on factors including commonness, threat status and restoration potential. Biodiversity offsets may offer new opportunities to improve the status of coastal habitat types in need of management and rehabilitation measures. These also include seashore meadows, which are discussed in conjunction with seminatural grasslands in Section 6.7. Rock outcrops on seashores are discussed in Section 6.6 under rock outcrops and scree.

Many of Finland's coastal habitat types fall under suitability category 2b, which means that their biodiversity losses must be avoided and their status improvement is challenging (Figure 3, Table 3). On the other hand, there are also common and in part even increasingly abundant habitat types the losses of which can be offset by using the same or rarer habitat types.

Figure 3. Suitability of coastal habitat types for biodiversity offsetting.



The most suitable for offsetting are the common habitat types of Least Concern: coastal gravel, shingle and boulder shores, coastal reedbeds, coastal scrubs and islands and islets in outer archipelago. There is no major need for the restoration or management of these habitat types but, if necessary, there are methods available to improve their status and any losses can also be offset by improving the status of rarer habitat types. Coastal reedbeds and scrubs differ from other coastal habitat types in that their coverage has increased due to coastal eutrophication.

Offset measures can include reducing these habitat types that have become more abundant if they have replaced other, less numerous habitat types or habitats of species.

Many other coastal habitat types may also be suitable for biodiversity offsetting, but it may be more challenging to take the general and habitat type-specific preconditions into account. Coastal sand beaches are in great need of restoration and management, and offsets may offer new opportunities, particularly as regards the recovery of nature values of overgrown sites. The first priority should be to avoid any biodiversity losses of coastal sand beach sites that are in good condition, because sand beaches are threatened and many of their insect and plant species are also threatened.

Coastal estuaries, Baltic esker islands and mire succession series of land uplift coast are extensive entities consisting of several habitat types. It is not usually possible to offset any losses pertaining to them as a whole. Instead, offsets may only be successful for a part of the entity or for a specific characteristic. There is, however, a great need for measures improving the status of coastal estuaries in particular.

The status of flada-lakes and glo-lakes (coastal lagoons) can be improved through measures including those taking place in the catchment area to improve water quality and by reducing dredging. However, it may be difficult to find sites suitable for this type of offsetting as the shores of sites in need of rehabilitation are often in the built environment and in boating use. The amount and status of drift lines with *Fucus* spp. depend most clearly on the abundance of *Fucus* spp. and the quality of seawater, and there are no offset measures that can be targeted directly at the habitat type. The status of the habitat type can, however, be improved indirectly by improving the water quality of the Baltic Sea, the living conditions of *Fucus* spp. and the openness of coastal areas suitable for drift line formation.

Habitat types that are the least suitable for biodiversity offsetting are coastal dune types and entire developmental series of coastal dunes as they are rare and threatened and special environmental conditions are required for dune formation. Consequently, the availability of potential offset sites is very limited. However, dunes benefit from management measures, and their management can be used as offsets for biodiversity losses of common habitat types.

State of knowledge
Finland's environmental administration has fairly comprehensive data on the occurrences of dunes, esker islands and estuaries based on surveys including those related to the EU Habitats Directive reporting on habitat types (Finnish Environment Institute 2017a). Preliminary assessments of many habitat types can also be conducted by using remote sensing or geographic datasets (e.g. reedbeds, flada-lakes and glo-lakes (coastal lagoons), islands and islets in the outer archipelago).

Previous experience of the use of restoration and management methods is available mainly for habitat types suffering from eutrophication and overgrowth, such as sand beaches and dunes (Ryttäri et al. 2014, Metsähallitus 2018a). Dune areas suffering from wear have also been surveyed and rehabilitated to some extent in locations including Vattajanniemi and Yyteri (Koskela 2009, Metsähallitus 2009, Nylén 2009). The number of measures directly improving the status of coastal habitat types is, however, still small.

There is not much Finnish research data on coastal habitat type response to management measures. There is data on impacts of pressures and threats at the general level but hardly any research specific to habitat types on this topic.

Need for restoration or management

There is a great need for restoration or management of coastal sand beaches suffering from eutrophication and overgrowth and of coastal estuaries affected by poor water quality and hydraulic construction. As regards other coastal habitat types, the need for management is moderate (e.g. dunes, flada-lakes and glo-lakes) or low (e.g. coastal gravel, shingle and boulder shores; coastal scrubs). The need is likely to increase as climate change progresses.

Factors deteriorating the status of habitat types and methods of restoration and management

Eutrophication and overgrowth in open coastal habitat types (sand beaches, dunes, developmental series of coastal dunes, esker islands, gravel, shingle and boulder shores)

- removing reeds, shrubs and trees
- removing masses of filamentous algae that have been washed ashore
- maintaining sunlit environments by, for example, creating gaps in ground vegetation
- grazing

Wear on the ground and vegetation or mechanical soil manipulation (sand beaches, dunes, developmental series of coastal dunes, esker islands)

- managing access, preventing off-road vehicle use
- restoring dune forms through terrain reshaping
- restoring vegetation through seeding or transplanting

Construction (all coastal habitat types)

- creating new artificial habitats, e.g. seminatural sand beaches, artificial islands, diverse shoreline formed on fill-up soil

Adverse impacts caused by alien species (coastal sand shores, dunes, islands and islets in the outer archipelago, coastal estuaries)

- removing *Rosa rugosa* from sandy shores
- removing *Neovison vison* and *Nyctereutes procyonoides* from bird nesting shores

Tree structure changes caused by logging (succession series of natural forests on the land uplift coast, coastal wooded dunes)

- forest restoration methods (see Section 6.5)
- maintaining sunlit environments by, for example, creating gaps in ground vegetation

Drying caused by drainage (estuaries, humid dune slacks)

- restoring natural hydrology by blocking ditches, etc. (see Section 6.4)

Eutrophication and overgrowth of coastal aquatic habitat types (coastal estuaries, flada-lakes and glo-lakes)

- cutting or removing reeds or other excessive aquatic vegetation
- improving water quality by reducing discharges in catchment areas

Flow changes caused by hydraulic construction and regulation (coastal estuaries, flada-lakes)

- removing structures and increasing natural-like flow of channels and basins
- natural flood protection, etc. (see Section 6.3)

Permanence of biodiversity offsets

Eutrophication and overgrowth reduce the status of many coastal habitat types and, in the future, climate change is likely to strengthen this negative development as the growing season gets longer and atmospheric carbon dioxide levels rise. In addition, rising sea levels reduce the rate of isostatic land uplift, which means that new land is exposed more slowly in the Kvarken and Bothnian Bay regions, and land uplift is projected to discontinue entirely and be followed by an upturn in sea level on Finland's southwestern and southern coast (Grinsted 2015). For these reasons, the preservation of open coastal habitat types may in many places require management measures to keep vegetation low-growing and characteristic of the habitat type. If an offset involves establishing a protected area, it often also needs to include preparedness for measures to improve the status of the habitat types.

Management to prevent overgrowing usually has to be repeated from time to time but not annually as is the case with seminatural grasslands. However, removing species such as *Rosa rugosa*, an alien species which has formed extensive thickets, initially requires management measures for a few years and, after that, monitoring of the situation and further measures whenever necessary (Aspelund & Ryttäri 2010, Kunttu et al. 2016). Another example of measures that need to be repeated is removing alien small carnivore species from nesting sites of archipelago birds (Vösa et al. 2017, Metsähallitus 2018b).

Habitat types are likely to respond quite quickly to management to combat overgrowth if there is a reasonable quantity of the desired species still remaining. The rate of response to other types of status improvement measures will be slower and more uncertain.

Challenges faced in biodiversity offsetting

- The status of coastal habitat types is also affected strongly by large-scale threats such as the eutrophication of the Baltic Sea and climate change, and impacting these in a targeted manner through offset measures is difficult and slow.
- Coastal habitat types naturally undergo a more rapid rate of change than many other habitat types as they are affected by land uplift, changes in sea level, strong storms, etc.

- Some coastal habitat types are extensive ecological entities whose functioning is affected by many factors. Offset measures may only apply to a part of the entity, but their planning must take into account the broader perspective, such as the succession of vegetation in coastal areas undergoing land uplift.
- Coastal environments face various usage pressures, and it may be difficult to find extensive sites suitable for use as offset sites, particularly on mainland shores.
- There is not much practical experience or monitoring data available yet about measures improving the status of coastal habitats.
- In sandy-soil habitat types in particular, there are threatened or rare species, mainly plants and invertebrates whose occurrences and ecological requirements must be surveyed and taken into account before offset measures are implemented.

Habitat types and sites whose biodiversity losses must be avoided in particular

- Extensive entities where natural seashore-to-inland succession series are created by zonation of habitat types (e.g. flada-lake-glo-lake series, developmental series of coastal dunes, succession series of natural forests)
- Sand beaches whose nature values have been preserved
- Dunes
- Bird islands located close to underwater feeding sites important for birds (e.g. esim. *Mytilus edulis* bottoms, shallows in open sea areas)

Development needs

So far, coastal habitat types have been managed and restored in Finland to a lesser extent than mire or forest habitat types despite their need for management being quite extensive due to issues such as eutrophication and overgrowth. Experience of nature management and monitoring of the success of measures taken is therefore needed with regard to all coastal habitat types. Examples of special needs include restoration and management practices of dune habitat types taking the valuable species into account.

Table 3. Suitability of Baltic Sea coastal habitat types for biodiversity offsetting. The classifications used are described in Chapter 3, and further information about the habitat types assessed can be found in Appendix 1. Threat status is given as a range (e.g. LC–VU) whenever a habitat type includes multiple habitat types of more specific classification levels whose threat status classifications differ from each other (see Appendix 1.

COASTAL HABITATS				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Coastal gravel, shingle and boulder shores LC–NT	5. No	1. Good	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	x	x			x	x		x	The habitat type is common and not threatened. Effective offset measures include management of overgrown sites, protection of sites or improving the status of rarer habitat types.	
Coastal sand beaches EN	3. Yes, in parts of the country	1. Good	2b Biodiversity losses must be avoided, status improvement possible		x	x	x		x		x	The habitat type has suffered from eutrophication and overgrowth, in places also from excessive ground wear. There is a great need for management, and the management of overgrown sites or rehabilitation of worn sites are effective offset measures. Even if protected, the preservation of all of the occurrences may not be possible without management. The threshold for subjecting sites that have preserved their value to losses is, however, high as sand beaches are threatened and many of their insect and plant species are also threatened.	There are many potentially threatened species, which increases the need for species surveys, raises the threshold for causing biodiversity losses of sites and has to be taken into account in management.
Coastal dunes VU–EN	1. Yes	2. Moderate	3a Biodiversity losses must not take place, status improvement possible		(x)	x	x		x		x	Dunes are rare and threatened in Finland, and their formation requires special conditions, whereby the availability of offset sites is very limited. Dunes benefit from management, but management planning is demanding and reaching all objectives is somewhat uncertain. Dune management can primarily be used to offset biodiversity losses of a common habitat type.	A large number of potentially threatened species that must be taken into account in management.

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection

COASTAL HABITATS				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Coastal reedbeds LC	5. No	1. Good	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	x	x				x	x	x	Reedbeds have increased in extent due to eutrophication and replaced other habitat types. Their planned reduction can be carried out to restore other habitat types and habitats of other species. The biodiversity values of reedbeds are related most clearly to bird and fish stocks, and loss of valuable sites must be avoided. Effective offset measures include management of over-dense reedbeds or status improvements of rarer habitat types.	
Drift lines with *Fucus spp.* VU	3. Yes, in parts of the country	5. No status improvement methods	2b Biodiversity losses must be avoided, status improvement challenging		x						x	Drift lines with Fucus spp. have suffered from the reduction of *Fucus* spp. and the increased abundance of filamentous algae and Phragmites australis caused by eutrophication. There are no restoration methods that could be targeted directly at the habitat type, but measures improving Baltic Sea water quality, the living conditions of *Fucus* spp. and the openness of shores have indirect positive impacts and can work as limited-loss offsets.	Sites where new, large drift lines with *Fucus* spp. are formed and where there are drift lines in different development stages are particularly valuable. Biodiversity losses of such sites must be avoided in particular.
Coastal scrubs LC–VU	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	x	x				x		x	Most coastal scrubs have increased in extent due to eutrophication and discontinuation of grazing. There is a need to reduce rather than increase the coverage of *Salix* spp. and *Juniperus communis* thickets as they are replacing other habitat types. Status improvements of rarer habitat types can be used as offset measures.	The rarest Finnish coastal scrub type is coastal scrubs with *Myrica gale*, which have also suffered the most from coastal overgrowth following the discontinuation of grazing. Biodiversity losses of coastal scrubs with *Myrica gale* must be avoided.

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection

COASTAL HABITATS				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Flada-lakes and glo-lakes (coastal lagoons) VU-EN	5. No	3. Uncertain	2b Biodiversity losses must be avoided, status improvement challenging		x			x	x		x	Only a small proportion of flada-lakes and glo-lakes are in their natural state, but offsetting lost biodiversity values by rehabilitating sites subjected to losses may be difficult, particularly as regards flada-lakes, if the site is in recreational or residential use. There is only very little previous experience of rehabilitation. Restricting nutrient discharges in catchment areas and cutting overgrowing coastal habitats may improve the status of sites suffering from eutrophication caused by human activity.	Extensive flada-lake areas and areas with series of flada- and glo-lakes that are in their natural state and still undergoing flada-lake formation due to land uplift are those for which avoidance is absolutely necessary and which should be protected.
Developmental series of coastal dunes EN	1. Yes	3. Uncertain	3a Biodiversity losses must not take place, status improvement possible		(x)	x	x		x		x	Series of coastal dunes are rare and endangered in Finland and their formation calls for special conditions, whereby there is a very limited number of offset sites and it is not possible to offset the loss of entire series. We cannot afford to lose a single site. Series of dunes benefit from management, but special expertise is required for management plans.	A large number of potentially threatened species that must be taken into account in management.

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection

COASTAL HABITATS				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	Rarity to be taken into account in offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	A	B	C	D	E	F	G	H	Reasoning of assessment	Preconditions in addition to general preconditions
Succession series of natural forests on the land uplift coast (formerly primary succession forests) CR	1. Yes	3. Uncertain	2b Biodiversity losses must be avoided, status improvement challenging		x	x		x	x		x	Long, representative succession series of natural forests are very rare these days and it is not possible to offset their disappearance. Gaps in succession series or minor degradation can be offset by restoring them to a seminatural state through means of nature management and protection of forests. Succession series may also contain mires, grazed woodland areas or wooded pastures whose status can be improved. Sites of better quality, or an extensive coastal area where land uplift may over a long period of time result in the development of succession series of natural forests, can also be protected (considerable net positive impact will be required due to the time delay).	
Coastal estuaries EN	1. Yes	2. Moderate	2b Biodiversity losses must be avoided, status improvement challenging		x	x		x	x	x	x	Entire coastal estuaries are extensive entities whose loss is impossible to offset fully. The status of some values or parts of coastal estuaries can be improved by, e.g. managing bird areas, diversifying aquatic vegetation or improving water quality. Achieving natural flow and cleaning contaminated sediments are more demanding tasks. There are no estuaries in their natural state left in Finland, so status improvements are highly necessary.	

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection

COASTAL HABITATS				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Islands and islets in outer archipelago LC	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	x	x				x		x	A common habitat type with no major restoration needs. The sites to be avoided the most are islands that are significant as regards their birds and ones that are important for seals. Possible offset measures include protecting valuable islands from disturbance and removing alien carnivore species as well improving the status of rare habitat types.	Valuable habitats include bird islands located close to underwater feeding sites of birds (e.g. *Mytilus edulis* bottoms, shallows in open seas), the offsetting of any losses of which is the most challenging.
Baltic esker islands VU	3. Yes, in parts of the country	2. Moderate	2b Biodiversity losses must be avoided, status improvement challenging		x				x	x	x	Large esker islands are extensive entities with values the full offsetting of which is impossible. It is possible to offset some values or parts of esker islands by, e.g., managing overgrowing sand beaches, dunes or heaths. Improving the status of underwater parts of esker islands is the slowest process because it requires water quality improvements.	Many esker islands (e.g. in the Archipelago Sea) have threatened plant and invertebrate species, and changes to such sites must be avoided in particular. Valuable species must also be taken into account elsewhere when planning offsets.

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection

6.3 Inland waters and shores

Suitability for biodiversity offsetting
It is difficult to make generally applicable assessments of the suitability of inland waters habitat types for biodiversity offsetting or the effectiveness of status improvement measures. There is major case-specific variation in both the impacts of biodiversity losses of water bodies and the potential for offsetting. Sites that are large in surface and impact area are particularly challenging. Also in general, deteriorating water quality may have an impact over an extensive area and therefore mitigation measures are particularly important. At times the most effective way of improving the status of a water body is rehabilitating or restoring a coastal forest, coastal mire or a nearby wetland area.

According to the assessment made, just over one in four habitat types of inland waters and shores are suitable for biodiversity offsetting subject to the general preconditions (Figure 4, Table 4). Biodiversity offsetting could be most applicable to inland waters and shores habitat types that are common and classified as being of Least Concern or no higher than Near Threatened and with good methods available to improve their status. Humic lakes are common in Finland. Habitat types classified as humic lakes are mostly Near Threatened due to quality deteriorations caused by eutrophication. In their case, too, it is challenging to improve water quality, but there is quite a lot of previous experience of the various methods. Provided that there are sufficient resources for status improvements, it is possible to achieve a good outcome. Ponds and small lakes are common and their status relatively good, with the exception of Southern Finland. The ecological status of streams of fell area is so far at least good. There has been no decrease in quantity, and most sites are in protected areas. Low-humic and humic first-order and headwater streams comprise a common habitat type that has undergone extensive deterioration in quality and some habitat types in the group are threatened, but there is a lot of previous experience of stream rehabilitation and, with careful planning and implementation, good outcomes can be achieved.

Stony and bushy lake shores are common and of Least Concern, and they can be regarded as being suitable for biodiversity offsetting. Because the classification and assessment of coastal habitat types was incomplete due to deficiency of data in the 2008 assessment of threatened habitat types, they are not covered comprehensively in this report. It is likely that some coastal habitat types which are open in terms of their vegetation are not as suitable for offsetting as the stony and bushy shores discussed here. Some coastal habitat types of inland waters, on the other hand, fall under other habitat type groups used in this assessment, such as rock outcrops and forests.

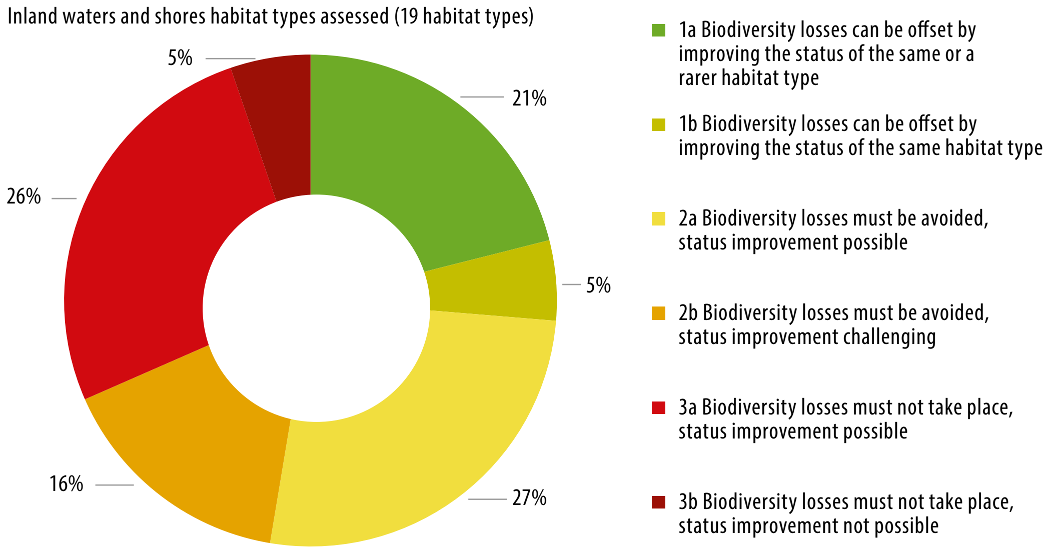
Habitat types which are challenging as regards biodiversity offsetting account for the clear majority of Finland's inland and waters and shores habitat types. Low-humic lakes are clear-water oligotrophic lakes that are sensitive to eutrophication and have undergone extensive deterioration in quality due to eutrophication and humus input. It is possible to improve their water quality by using a variety of methods, but a lot of resources and measures throughout the catchment area are often needed. North Lapland lakes have mainly been preserved in their natural state but, in the future, climate change may impact their status through rising water temperatures and shorter periods with ice cover.

Naturally eutrophic lakes and naturally eutrophic ponds and small lakes are threatened, rare and their quality has deteriorated strongly. It is often challenging to improve their water quality as it is affected by intensive land use in their catchment area.

Sandy lake shores are threatened and have been degraded due to construction and overgrowing. Only very little rehabilitation and management to increase their nature values and biodiversity has taken place so far. Spring complexes are threatened and have been degraded extensively. There is some previous experience of the rehabilitation of various types of spring complexes. In rehabilitation, it is important to survey the baseline situation and understand the special characteristics of spring complexes. At times it may be possible to improve the status of a spring even with relatively small measures, but high species values may be lost if the rehabilitation is unsuccessful. The substantial geographical variation found between spring complexes also brings its own challenges (Juutinen 2010, Juutinen et al. 2010). Low-humic and humic streams have been degraded in most of Finland, and it is difficult to improve their status because of the large size of their catchment areas. The same applies to large rivers, which comprise the eight largest rivers in Finland and whose status has deteriorated not only due to loading but also to hydropower plants.

Among Finland's inland waters habitat types, a few strongly degraded and/or naturally rare habitat types whose status is difficult to improve or, concerning whose status improvement there is hardly any previous experience, have been regarded as unsuitable for biodiversity offsetting. Chalky lakes and chalky ponds and small lakes are very rare, threatened and, particularly in Southern Finland, strongly altered. Cratoneurion spring complexes are very rare, with threatened and rare species occurring in them, but there is very little previous experience of their rehabilitation. Spring ponds and small lakes are still poorly known as regards their occurrences and status, and there is no previous experience of their rehabilitation. Strongly altered first-order and headwater streams in clay-dominated catchment areas and streams in clay-dominated catchment areas only occur in agricultural areas of Southern Finland: there are no natural-state sites of these habitat types left in the country. There is usually a great deal of human activity, such as agriculture, causing nutrient pollution in their catchment area, making it particularly difficult to improve their status.

Figure 4. Suitability of inland waters and shores habitat types for biodiversity offsetting.



State of knowledge

At the general level, the occurrence, ecology and status of various inland water bodies in Finland are known quite well, and data is easily accessible from sources including the Water Map service[10]. Centres for economic development, transport and the environment draw up regional river basin management and action plans, and therefore there is data available on the need for measures with regard to most inland waters habitat types.

The good datasets available do not, however, cover all identified habitat types. A somewhat rough classification of habitat types was used in the 2008 assessment of threatened habitat types as the datasets available at that time did not enable a more detailed assessment. For some habitat types, the availability of data on sites and their status is still poor (e.g. spring ponds and small lakes). For the assessment published in 2018, the classification has been made to some extent more specific and, for example, there are many more freshwater riparian habitat types distinguished than in the 2008 assessment. Data on the occurrence and status of riparian habitat types is, however, still highly deficient.

There are quite a few effective methods available for the rehabilitation and management of lakes and small water bodies in particular, provided that there are sufficient resources for the rehabilitation work and it is possible to control any input from the catchment

10 The Water Map service provides access to data on issues including the ecological status of lakes, streams and coastal waters http://paikka-tieto.ymparisto.fi/vesikarttaviewers/Html5Viewer_2_5_2/Index.html?configBase=http://paikkatieto.ymparisto.fi/ Geocortex/Essentials/REST/sites/Vesikartta/viewers/VesikarttaHTML525/virtualdirectory/Resources/Config/Default

area. For some threatened habitat types, there have been hardly any status improvement measures, and method development and monitoring will still be needed (Janatuinen 2016).

Need for rehabilitation

Due to various types of adverse impacts on water bodies, there are lots of inland waters and shores that have been degraded. The key problem is nutrient, organic matter and sediment loading, but other harmful substances, hydraulic and coastal construction, regulation, drainage and clearing have resulted in natural freshwater ecosystem degradation as well. The highest degree of degradation can be seen in inland waters in Southern Finland, but issues including loading from forestry and peat production, hydraulic construction and regulation have also adversely affected the quality of inland waters in Northern Finland. Rivers and streams in clay-dominated catchment areas and naturally eutrophic lakes, and small lakes and ponds in the southernmost areas of Finland have undergone particularly pronounced alteration, and it is likely that there are no sites of these habitat types left in their natural state. There is a major need for rehabilitation, but it is particularly difficult to improve their status because of intensive land use.

Factors deteriorating the status of the habitat type and methods to improve its status

There are quite a few different methods available for the improvement of the status of inland waters habitat types, some of which are listed below. New methods are also being tested and developed. Information about methods of rehabilitation of water bodies can be found in sources such as the website on restoration and maintenance of water bodies maintained by Finland's environmental administration[11].

Eutrophication and contamination of water bodies due to loading caused by forestry and agriculture (lakes, small lakes and ponds, streams, sandy shores and other open coastal habitat types)

- taking various measures restricting loading, such as buffer zones, settling tanks, submerged weirs, drainage cuts
- creating wetlands for nutrient removal
- blocking and damming ditches
- refraining from ditch network maintenance or channelling ditch water as surface runoff to mires that can be restored
- removing nutrients, e.g. selective fishing, chemical methods
- cutting reedbeds causing eutrophication and clearing coastal vegetation
- artificial aeration

11 Restoration and management of water bodies in the online service of Finland's environmental administration: https://www.ymparisto.fi/en-US/Waters/Restoration_of_water_bodies

Eutrophication and contamination of water bodies due to industry and human settlements (lakes, small lakes and ponds, streams, sandy shores and other open coastal habitat types)

- increasing the efficiency of removal of nutrients and pollutants in conjunction with water purification
- removing nutrients, e.g. selective fishing, chemical methods
- creating wetlands for nutrient removal
- artificial aeration
- cutting reedbeds causing eutrophication and clearing coastal vegetation

Dredging and stream clearing, logging residue and effects (first-order and headwater streams, intermittent streams, spring complexes)

- rehabilitating straightened streambeds for natural-like state (natural meandering, timber stream deflectors, groynes)
- blocking and damming ditches
- rehabilitating springs, e.g. blocking ditches, directing water into original intermittent streams, removing structures and logging residues preventing water release
- raising groundwater table level to the original level
- transplanting aquatic mosses, adding gravel, rocks and woody material

Hydraulic construction, dams, power stations, dredging (particularly surface waters, dredging also with lakes)

- removing unnecessary structures
- fish passes
- restoring rapid areas
- restoring the channel or bed to a natural-like state
- developing water release practices to take the needs of migratory fishes into account
- diverting floodwater to habitats that benefit from flooding
- transplanting aquatic mosses, adding gravel, rocks and woody material

Permanence of biodiversity offsets

If offset measures pertain specifically to water quality improvements, it may be difficult to ensure the permanence of the offsets. Once-off measures are only seldom sufficient in lake and stream rehabilitation. Work to improve their status often needs to take place over a long period of time. If the catchment area is large and has, for example, a great deal

of intensive human activity, it may be difficult to gain control of loading from the entire catchment area. Improving the status of a highly eutrophic lake calls for numerous active measures and takes a long time due to issues including internal nutrient load. A good ecological status or natural state may still not necessarily be achieved, but the essential point is that the status of the ecosystem may still be improved significantly. Permanent protection of areas without repeated rehabilitation measures or successful control of loading from the catchment area cannot usually ensure the permanence of offsets targeted at inland waters, with the possible exception of small water bodies (springs, streams, ponds and small lakes).

Biodiversity offset planning and the implementation of status improvement measures must, as extensively as possible, take into account all degenerating factors in the catchment area. Otherwise, the desired improvement of the status of the water body may not necessarily be achieved. Often a variety of measures are required for status improvements and reaching the aims may call for many years of sustained work.

Challenges faced in biodiversity offsetting

Finland's freshwater bodies receive a fairly large number of rehabilitation measures, and nutrient loading in restricted by a variety of measures funded from various sources[12]. River basin management plans have been drawn up for river basin districts, and the targets set in these are sought under river basin management action plans formulated for the respective regions of the centres for economic development, transport and the environment. For example, central government support is available for water body rehabilitation projects and fishery rehabilitation projects. Agri-environmental aid is available for reduction of agricultural loading. This is obviously a good thing as regards improving the status of water bodies but, in the context of biodiversity offsetting, attention must be paid to the principle of additionality being realised. Offsets cannot be measures that would in any case have been taken. The use of offsets must not have any reducing effect on financial input into the protection of water bodies, either.

Depending on the baseline situation, it may take a long time to improve the status of lakes and larger streams and possibly require many different rehabilitation and management measures over an extensive area. As mentioned above, status improvements are achieved in most cases but, depending on the baseline, a good or excellent ecological status may not necessarily be achieved. When planning measures to improve the status of water bodies, the key loading factors of the entire catchment area should be taken into account. If the catchment area is large, planning must be even more specific and, if measures are also needed in the catchment area, this will add to costs and fragmented land ownership relationships may complicate the process (Janatuinen 2016).

It may be difficult to reduce the nutrient load if there is a lot of intensive agriculture and forestry in the catchment area. Internal nutrient load released from sediments due to protracted eutrophication may also slow down or prevent the recovery of lake ecosystems. Internal loading can be reduced by artificial aeration of lakes and through biomanipulation of the food chain where the amount of phosphorus in the ecosystem is reduced by means of mass fishing of *Cyprinidae* spp. Habitat types particularly challenging from the biodiversity offsetting perspective may be those that occur almost exclusively in predominantly agricultural areas, such as naturally eutrophic lakes and ponds and streams in clay-dominated catchment areas.

Offsets to compensate for biodiversity losses of extensive water bodies and their catchment areas may be targeted at the same water body as the losses, but this is not always possible or sensible. For example, in the case of streams, it must be assessed

12 A one-stop site for information about funding sources for water body rehabilitation is available at http://rahatpintaan.fi/#loyda-rahoitus.

whether or not offset measures targeted at the same water body will deliver actual biodiversity offset gains as regards the whole. (If measures contaminating the water body take place downstream, can they be offset by reducing loading in upstream areas?) It has been proposed in conjunction with power stations preventing the passage of migratory fishes that offsets can also be targeted at other streams if they are easier to implement and have more significant impacts there (Koljonen et al. 2017).

Perhaps especially as regards lakes and streams as well as marine areas involving important recreational values and where the impact area of biodiversity losses may be very extensive, the perceived negative social impact may be significant. If the loss is caused in one water body and offset by rehabilitating another one, those experiencing the loss may regard the situation as unreasonable. The social aspects of offsetting are not, however, covered in any more detail in this work.

Habitat types and sites whose biodiversity losses must be avoided in particular

- Chalky lakes and chalky ponds and small lakes
- Stratiotes aloides lakes
- Natural sandy lake shores
- Naturally eutrophic lakes and ponds
- Cratoneurion spring complexes
- Extensive spring complexes and spring complexes with valuable species
- Rivers and streams in clay-dominated catchment areas
- Rivers and lakes with natural or seminatural catchment areas
- Streams important for threatened migratory fishes

Development needs

There is a need for the development of rehabilitation and other status improvement methods particularly as regards streams (especially those in clay-dominated catchment areas) and rare inland waters habitat types such as naturally eutrophic lakes and ponds and habitat types related to groundwater influence and calcareous waters. There is so far relatively little experience of the of inland shores habitat types. The occurrence of some rare habitat types is poorly known, and these habitat types have not been taken separately into account in geographic datasets.

Table 4. **Suitability of inland waters and shores habitat types for biodiversity offsetting. The classifications used are described in Chapter 3, and further information about the habitat types assessed can be found in Appendix 1. Threat status is given as a range (e.g. LC–VU) whenever a habitat type includes multiple habitat types of more specific classification levels whose threat status classifications differ from each other (see Appendix 1).**

	INLAND WATERS AND SHORES				Suitable offsetting principles				Offset measures					
	Habitat type and IUCN Red List Category	Rarity to be taken into account in offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	A	B	C	D	E	F	G	H	Reasoning of assessment	Preconditions in addition to general preconditions
	Low-humic lakes NT	5. No	2. Moderate	2a Biodiversity losses must be avoided, status improvement possible		x			x	x		x	A relatively common lake type which has, however, been degraded clearly, particularly due to eutrophication but also for other reasons. Status improvement measures include those related to water quality improvements in particular, but the reduction of adverse impacts of, e.g. construction and regulation also needs to be developed.	
	Humic lakes LC–NT	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat	x	x			x	x		x	A common lake type which has, however, been degraded clearly, particularly due to eutrophication but also due to other reasons. Status improvement measures include those related to water quality improvements in particular, but the reduction of adverse impacts of, e.g. construction and regulation also needs to be developed.	
	North Lapland lakes LC	5. No	2. Moderate	2b Biodiversity losses must be avoided, status improvement challenging		x						x	As a general rule, the status of North Lapland lakes is good, but they are threatened by climate change and their status may deteriorate significantly in the future. There is no previous experience of the rehabilitation of these lakes.	

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

INLAND WATERS AND SHORES				**Suitable offsetting principles**				**Offset measures**					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Naturally eutrophic lakes EN	1. Yes	2. Moderate	2b Biodiversity losses must be avoided, status improvement possible		x	x	x		x	x	x	The status of naturally eutrophic lakes is poor and there are no sites fully in their natural state. There are not as many sites suitable for offsetting as there are for more common lake types. There are rehabilitation methods available, but improving their status is challenging due to issues including internal nutrient load and intensive land use in their catchment areas. Rehabilitation is also needed for sites that are losing their bird values.	Biodiversity losses of the rare Stratiotes aloides lakes should be avoided. Rare aquatic plants and birds must be taken into account in rehabilitation.
Chalky lakes EN	1. Yes	2. Moderate	3a Biodiversity losses must not take place, status improvement possible		x	x	x		x		x	A very rare habitat type that has been degraded the most in Southern Finland. Many sites would benefit from rehabilitation and measures reducing the nutrient load.	
Ponds and small lakes LC–NT	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat	x	x			x	x		x	Most pond and small lake habitat types are common. Particularly in Southern Finland, the status of ponds and small lakes has been degraded due to nutrient and sediment loading. Load reductions would improve the ecological status of ponds and small lakes.	Biodiversity losses of ponds and small lakes in their natural status must be avoided in Southern Finland in particular.
Naturally euphoric ponds and small lakes CR	3. Yes, in parts of the country	2. Moderate	2b Biodiversity losses must be avoided, status improvement possible		x	x			x	x	x	Naturally eutrophic ponds and small lakes are rare and have been degraded strongly, particularly in Southern Finland. It has been assessed that they do not occur at all in their natural state any more. The habitat type benefits from rehabilitation and there are methods available to improve their status.	Biodiversity losses of naturally eutrophic ponds and small lakes must be avoided unless a site has already been severely degraded. Further losses of sites that can be restored must be avoided and such sites should be favoured as offset sites in biodiversity offsetting.

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

INLAND WATERS AND SHORES				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Chalky ponds and small lakes VU	1. Yes	3. Uncertain	3a Biodiversity losses must not take place, status improvement possible		x	x			x		x	Chalky ponds and small lakes are rare and strongly degraded particularly in Southern Finland. Nutrient pollution may have resulted in the reduction of the limestone influence, which changes the structure and functional features of the habitat type. There is not sufficient previous experience of the improvement of the status of the habitat type.	
Spring ponds and small lakes NT	1. Yes	3. Uncertain	3b Biodiversity losses must not take place, status improvement not possible		x	x		x	x		x	There is deficient data on the situation of spring ponds and small lakes, but they are very rare and clearly degraded, particularly in Southern Finland, and still facing many threats. There is very little previous experience of the rehabilitation of spring ponds and small lakes.	
Sandy lake shores VU	5. No	3. Uncertain	2b Biodiversity losses must be avoided, status improvement challenging		x	x			x	x	x	Sandy lake shores have been strongly degraded particularly in Southern Finland and the need for their management and rehabilitation is great. Many sites are in recreational use or constructed. Degenerated sites can be regarded as suitable for biodiversity offsetting, but there is hardly any previous experience of the rehabilitation or management of sandy lake shores. There is a need to develop rehabilitation methods.	Biodiversity losses of sites, including those that are small in size, must be avoided, particularly in Southern Finland.
Stony and bushy lake shores LC	5. No	4. Unknown	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat	x	x			x	x			Stony and bushy lake shores are common and have not been significantly degraded.	

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

INLAND WATERS AND SHORES				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Spring complexes VU	5. No	2. Moderate	2a Biodiversity losses must be avoided, status improvement possible		x		x	x			x	A habitat type that is often small in area and involves special species values. A significant proportion of sites has been degraded, particularly in Southern Finland. Some rehabilitation of spring complexes has taken place with mixed outcomes. Case-specific consideration and planning is particularly important in offsetting situations.	There is a great deal of variation in the species values of spring complexes. Biodiversity losses of sites with valuable species in particular must not take place. Rehabilitation also involves the risk of losing species values, and special care must be taken when selecting sites and planning and implementing measures.
Cratoneurion spring complexes VU	1. Yes	2. Moderate	3a Biodiversity losses must not take place, status improvement possible		x	x	x	x			x	The habitat type involves high species values. Cratoneurion spring complexes are threatened and very rare in Southern Finland. Cratoneurion spring complexes mainly occur in areas with calcareous soil and bedrock and their number is limited. There is little previous experience of restoration of such sites.	If it is not possible to avoid biodiversity losses of a site, particular care must be taken when selecting offset sites and planning and implementing measures.
Streams of fell area LC	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat		x						x	In Lapland, streams are primarily in their natural state, and the ecological status of larger streams is also good despite minor loading taking place.	
Low-humic and humic first-order and headwater streams NT–VU	5. No	2. Moderate	1b Biodiversity losses can be offset by improving the status of the same habitat type		x			x	x		x	Low-humic and humic first-order and headwater streams occur extensively throughout Finland and there are many degraded sites. Sites suitable for restoration and rehabilitation are known quite well. There is a relatively large amount of data and experience of methods and their effectiveness.	

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

INLAND WATERS AND SHORES				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
First-order and headwater streams in clay-dominated catchment areas VU–CR	1. Yes	3. Uncertain	3a Biodiversity losses must not take place, status improvement possible		x	x		x	x		x	First-order and headwater streams in clay-dominated catchment areas are highly threatened and have been destroyed through land clearing for farming purposes, cleared and straightened. The habitat type only occurs in low-lying clay-dominated areas of Southwestern Finland. The remaining streams are in great need of restoration and rehabilitation and improving the status of first-order and headwater streams of clay-dominated catchment areas is challenging.	
Low-humic and humic streams NT–VU	5. No	2. Moderate	2a Biodiversity losses must be avoided, status improvement possible		x			x	x		x	Low-humic and humic streams are common and their status can be improved through a variety of measures. It is challenging to reduce the nutrient load. The ecological significance of streams to other habitat types closely related to them is great. Stream habitats have been and are being degraded in many ways, particularly in Southern Finland. The threshold for further biodiversity losses should be high.	Biodiversity losses of streams in well-preserved stream ecosystems with natural or seminatural catchment areas should be avoided.
Streams in clay-dominated catchment areas CR	1. Yes	3. Uncertain	3a Biodiversity losses must not take place, status improvement possible		x	x		x	x			Streams in clay-dominated catchment areas are Critically Endangered and strongly degraded. There are no more streams in clay-dominated catchment areas left in their natural state. The habitat type only occurs in clay-dominated catchment areas on the southern and southwestern coast. The status of degraded sites should be improved extensively. Improving their status is challenging.	

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

INLAND WATERS AND SHORES				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in off-setting**	**Effectiveness of restoration/ma-nagement met-hods**	**Suitability for biodi-versity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assess-ment**	**Preconditions in addi-tion to general precon-ditions**
Large rivers EN	1. Yes	2. Moderate	2b Biodiversity losses must be avoided, status improvement chal-lenging		x	x	x	x	x			Large rivers (total-ling 8 in Finland) are Endangered and strong-ly degraded. The status of rivers should be imp-roved extensively. These rivers are also of great significance to other habitat types related to them due to their large catchment areas and improving their status is difficult.	Biodiversity offsetting should be targeted at the same river that is being subjected to biodiversity losses.

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly im-portant, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

6.4 Mires

Suitability for biodiversity offsetting

At the general level, the majority of Finland's mire habitat types can be regarded as suitable for biodiversity offsetting. In practice, however, their suitability is affected by the fact that there may be rare values that are difficult to offset even for individual sites representing common mire habitat types. There is a great deal of variation overall in mire areas as regards their mire type, hydrology, landscape features, species and catchment area. Both extensive mire complexes and, on the other hand, mire sites with a small area may be unique in terms of their characteristics. Biodiversity offsetting may also be made more difficult by many mire types and mire complexes varying in different parts of Finland. In regions where there are only few mires left in their natural state, no sites of mire habitat types in their natural state should be destroyed.

Mire habitat types assessed as most clearly suitable for biodiversity offsetting are those that occur throughout the country, whose restoration usually delivers a satisfactory outcome and that are less threatened than many other mire habitat types (Figure 5, Table 5). These comprise mesotrophic and oligotrophic pine mires and bogs, pine fens and fens. Also assessed as suitable for biodiversity offsetting are two habitat types that are more threatened than the above-mentioned ones, spruce mires and spruce-birch fens, as there is a reasonable amount of previous experience of their restoration and there are numerous sites that can be restored. Biodiversity losses of spruce mires which are eutrophic, with springs or with flood meadows must, however, always primarily be avoided as they are rare, strongly threatened and difficult to restore.

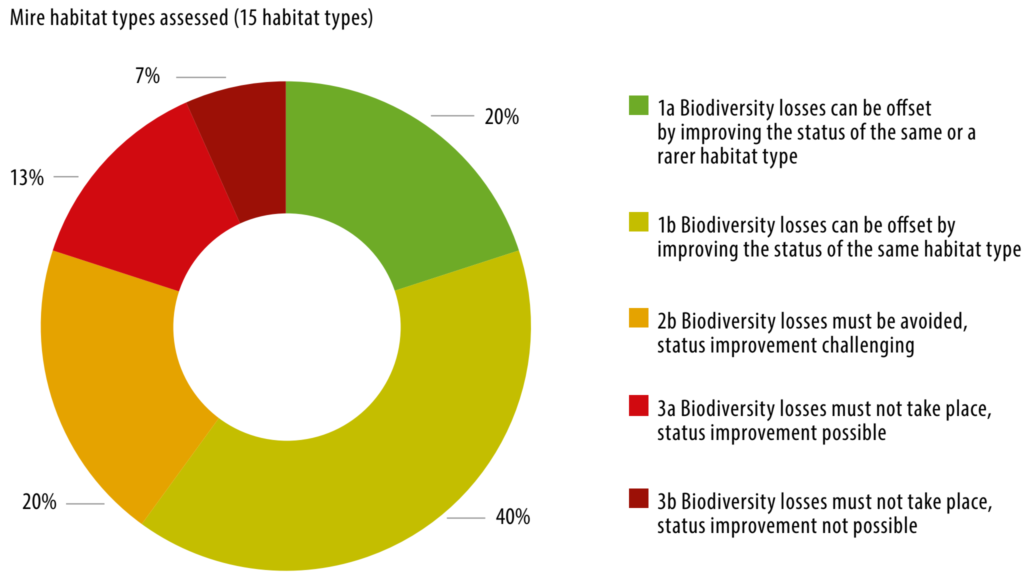
Shrub swamps and open swamps are common and therefore assessed as suitable for biodiversity offsetting despite their extensive hydrological alteration. Hardly any status improvements of swamps through restoration or rehabilitation have taken place, but new swamps of these types are also created through developments such as coastal overgrowth. Regular flooding is of key importance to swamp ecology and species, but the restoration of flooding is likely to be difficult in most cases. Biodiversity losses of rare shrub and open swamp habitat types such as *Myrica gale* swamps must be avoided.

Among mire complexes, raised bogs, with their main area of occurrence in Southern Finland, are regarded as suitable for biodiversity offsetting. Raised bogs are threatened, but it is possible to improve the biodiversity of drained sites by restoration and there are numerous sites suitable for restoration. Northern boreal aapa mires are generally suitable for biodiversity offsetting, but extensive aapa mire areas with valuable species or aapa mires with rich fens or rich birch fens must not be subjected to biodiversity losses. There is a focus on Northern Finland in the occurrence of sloping fens. They have mainly been preserved well and are in that respect suitable for biodiversity offsetting. Their more southern occurrences face a greater degree of various land use pressures and their biodiversity losses should be avoided.

The most problematic mire habitat types as regards biodiversity offsetting are those whose restoration involves risks. Rich fens are threatened and rare in most parts of the country. Rare and threatened species also often occur in them, making offsetting difficult and at times impossible. With them, status improvements through restoration are more uncertain due to their special nutrient and hydrology characteristics than with many other mires. Preserving the characteristics of rich fens in Southern Finland in particular may require continuous management (restricting overgrowth). Middle boreal aapa mires are a more clearly threatened and rarer mire complex type than the above-mentioned northern boreal aapa mires, and biodiversity losses of their sites should be avoided. On the other hand, there is potential for improving the status of many middle boreal aapa mire sites. Oroarctic mires are mostly located in protected fell areas of Lapland, and therefore land use changes do not pose much of a threat to them. There is no previous experience of their restoration or other status improvements, however.

The mire habitat types regarded as unsuitable for biodiversity offsetting comprise palsa mires, wooded swamps and mire succession series of land uplift coast. The threats to palsa mires are largely to do with climate change, and there are no known means of restoration or recovery for destroyed palsa mires. Because climate change causes a clear threat as regards the occurrence of palsa mires, their nature values must not be subjected to losses in any other ways. Most of the habitat types classified as wooded swamps are highly threatened and rare. Wooded swamps are vulnerable to disturbances and there are high species values related to them. It may be very difficult to restore their flood cycles, and hardly any attempts have been made to carry out wooded swamp restoration or recovery. On the other hand, it is specifically for these reasons that there is a great need to develop restoration methods for wooded swamps. It would be possible to favour wooden swamp status improvements and recovery in offsetting biodiversity losses of common habitat types. Mire succession series of land uplift coast are classified as Critically Endangered. Most of the series that have remained intact have been altered by drainage. Recovering entire series through restoration and other status improvement methods is likely to be very difficult. The habitat type is also threatened by the slowing down of land uplift due to climate change.

Figure 5. Suitability of mire habitat types for biodiversity offsetting.



State of knowledge

The state of knowledge of the occurrence of the most common mire habitat types in Finland is reasonably good, but the occurrence of many habitat types that are rare and more difficult to identify is poorly known.

Mires have been restored in Finland for a long time, and there is considerable knowhow about the restoration of a variety of mire sites. The challenges involved in mire restoration are also known well. Parks & Wildlife Finland of the state-owned enterprise Metsähallitus in particular has restored mires in nature reserves. The guide to the ecological restoration in drained peatlands (Aapala et al. 2013) contains diverse information about the methods and challenges of restoration and examples of practical work in a variety of sites. Restoration experience and competencies as well as research data important for methodological development have also been generated through EU LIFE-funded projects. There are some mire habitat types concerning which there is very little previous restoration experience. These include rich fens, which are difficult in terms of restoration but important as regards biodiversity. Mire restoration planning and implementation always requires comprehensive understanding and knowhow about mire ecology and hydrology.

Need for restoration and management

There are numerous mire areas altered by drainage, and the restoration of particularly those mire areas that have valuable species and are large should be promoted without any delay. Hardly any new drainage ditches are dug any more, but nature values are still being lost due to ditch network maintenance. Ditches in many drained mires remain open and dry out the mire even without any active maintenance. There are also hundreds of mires in nature reserves where access to water is restricted by ditched mires located outside the reserve, deteriorating the status of the protected mire (Rehell et al. 2016, Autio et al. 2018). It has been estimated that there are just under 300 protected mires in Finland whose status could be improved by diverting drainage water in conjunction with ditch network maintenance to the catchment area of a protected mire that has dried up (Autio et al. 2018).

Factors deteriorating the status of habitat types and methods of restoration and management

The impacts of peat extraction are so wide-ranging and recovery so slow that they cannot be rectified through restoration. This is why peat production is not taken into account here. Tree layer restoration methods for wooded mires (spruce mires, pine mires and bogs, wooded swamps) are described in more detail in Section 6.5.

Negative impacts of ditch drainage on hydrology and water chemistry: water of original quality and/or sufficient volume either cannot flow into the mire or is removed in larger volumes from the mire than in the natural state (almost all mire habitat types)

- restoring natural hydrology by blocking ditches (infilling with earth material, damming)
- diverting ditch water in conjunction with ditch network maintenance as overland flow to a mire (particularly aapa mires, raised bogs, swamps)

Forest colonisation, overgrowing and shrubification (open and sparsely wooded mires, rich fens in Southern Finland)

- removing trees and saplings (in rich fens can take place continuously, frequently)
- clearing vegetation and shrubbery
- blocking ditches

Tree stand structure differs from natural structure, particularly in having a small amount of decaying trees and no diversity (spruce mires, pine mires and bogs, wooded swamps)

- blocking ditches often results in partial death of tree stands and no other measures are needed, but death of trees taking place too extensively or rapidly must be avoided

Stream clearing and straightening (particularly spruce mires, also many other mire types)

- rehabilitation of streambeds into a state that corresponds to the natural state as closely as possible (see Section 6.3)

Prevention of natural water level variation due to issues including regulation of water bodies (swamps)

- diverting floodwater to altered swamps in conjunction with flood control
- diverting ditch water as overland flow to swampy mires in conjunction with improvement drainage

Permanence of biodiversity offsets

To ensure the permanence of biodiversity offsets, in most cases it is necessary to protect the offset site mire and some of its catchment area. The catchment area of a site to be restored should be such that there are no major changes anticipated to its status. The catchment area and its hydrology must be taken into account in full; mires, streams and lakes are interrelated and changes in one also affect the others. Once ditches have been blocked, the restoration of a mire into a seminatural state takes a long time, usually decades, depending on the baseline situation and success rate of measures. For species recovery to be possible, the restored site should be close to "species cores" from where species can disperse to the restored site. It is important to monitor progress in restoration, and corrective further measures may be needed in cases such as where the sought waterlogging is not achieved or is taking place in the wrong place. In sites that are strongly altered, and particularly those that are vulnerable as regards their species, it may be necessary to implement measures a little bit at a time over a longer period.

Challenges faced in biodiversity offsetting

There are many challenges involved in the restoration of mire habitats. Some of the key challenges are summarised below from the guide to the ecological restoration in drained peatlands (Aapala et al. 2014). Hydrology arrangements and recovery of natural hydrological conditions involve certain risks and require careful planning, expert implementation and monitoring of the impacts of the measures.

There is major regional and site-specific variation between mire habitats, which may make it difficult to offset the nature values of a specific site. Extensive mire areas may be highly valuable or even unique entities as regards their species, mire types and ecological significance. Even small sites can be highly valuable because of their species values. Spruce mires with trees in their natural state are both rare and often valuable in terms of species and cannot be offset through the restoration of spruce mire sites with a more modest tree status. The continuum of deadwood cannot be re-established in sites through restoration. Instead, it takes decades to develop (see Section 6.5). Drained mire sites may also have nature values that are so rare that they are difficult to offset by restoring another site.

The success of restoration measures and the achievement of the desired outcome depend on factors including the mire types of the site, the size of the mire, its hydrology, catchment area and the degree of alteration caused by ditch drainage. Hydrology restoration always requires careful planning, expert implementation and monitoring of the impacts of measures. If a mire area is strongly altered or its hydrology is difficult to restore, the objective may not necessarily be reached through a once-off measure. In such cases, gradual restoration, monitoring and corrective measures are needed. It may be difficult to find offset sites that can be restored for some mire habitat types. Taking sites colonised by trees back to the pre-drainage state may be difficult.

The natural forest values of drained spruce mires with tree stands developed through natural succession may be so significant that the best solution from the biodiversity perspective is to allow the sites to continue succession as forests.

The aim of mire restoration is often to restore natural hydrology and water flows. In most cases the characteristics and peat formation of the mire can be recovered. However, it is far from always that the mire type or ecological status prevailing before drainage is achieved. The pre-drainage mire type is not always known, either. Drainage has often strongly altered those mire types in particular which are the wettest in their natural state. It is common that a species composition corresponding to the original one cannot be recovered through restoration. It is especially difficult or impossible to re-establish once-lost rare and demanding mire species in a restored site.

Restoration may also have harmful impacts on the local environment, such as waterlogging in the wrong places. Therefore the land ownership and catchment area of offset sites should be such that the status improvement measures needed can be carried out.

If it is not possible to restore a mire with important nature values and take its catchment area into account as a whole, efforts should be made to improve hydrology to the extent required to preserve the mire types and species.

Water protection must also be taken into account in mire restoration. The load from a restored mire into water bodies may increase, particularly during the first years following restoration (e.g. Ronkainen et al. 2015). This is problematic particularly in the context of spruce mire restoration. Opportunities to divert runoff water to, for example, another mire area should also be utilised in these cases.

Rich fens are often demanding as restoration sites (for more information, see e.g. Aapala et al. 2014). Measures must be planned so that values regarding rare and sensitive species are not lost. There is a risk, for example, that the nutrient economy of a rich fen is altered by restoration to a state that is unfavourable to valuable rich fen species. There are similar challenges involved in status improvements of spring complexes (see Section

6.3). Preserving characteristics that are important as regards rich fen species, such as the openness of vegetation, may require continuous management.

Habitat types and sites whose biodiversity losses must be avoided in particular The Finnish Government resolution on the sustainable use and conservation of mires and peatlands outlines the policy that new land use significantly altering mires must be targeted at mires which have already been drained or whose natural state has otherwise been significantly altered (Government 2012). The following mire sites have been identified in this work as those whose biodiversity losses should primarily be avoided:

- extensive natural or near-natural mires and mire complexes throughout Finland
- mire complexes with rare and threatened mire types and/or species throughout Finland
- in Southern Finland also natural mires whose surface area is small
- rich fens as a general rule throughout the country
- eutrophic, spring-fed and nutrient-rich spruce mires
- spruce mires in a natural state in terms of trees
- wooded swamps and, among shrub swamps, *Myrica gale* swamps
- palsa mires
- mires on the land uplift coast

Development needs

More detailed data is needed about the occurrence of rare mire habitat types. Although there is quite a lot of previous experience of mire restoration, methods for the restoration of different types of mires must be developed further and tested while at the same time generating competencies, knowhow and monitoring and research data concerning the restoration of various types of mire sites. The potential for the restoration and recovery of rich fens and swamps in particular should be explored and related methods developed.

Table 5. **Suitability of mire habitat types for biodiversity offsetting. The classifications used are described in Chapter 3, and further information about the habitat types assessed can be found in Appendix 1. Threat status is given as a range (e.g. LC–VU) whenever a habitat type includes multiple habitat types of more specific classification levels whose threat status classifications differ from each other (see Appendix 1.**

MIRES				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Spruce mires VU–EN	2. Yes, for some habitat types	2. Moderate	1b Biodiversity losses can be offset by improving the status of the same habitat type	(x)	x			x			x	Spruce mires are threatened and some spruce mire habitat types are rare. There is previous experience of spruce mire restoration and also good understanding of the challenges faced in restoration. There are plenty of spruce mires that can be restored. It is possible to increase spruce mire biodiversity values through restoration. In some cases biodiversity losses of a more common spruce mire habitat type can be offset by restoring a rarer spruce mire habitat type site.	There is great variation in possibilities for biodiversity offsetting depending on spruce mire type and site. In some cases restoration may be very difficult and it may not necessarily be possible to recover a strongly altered site's habitat type. Biodiversity losses of the rarest and most threatened spruce mire habitat type sites (e.g. spring-fed and nutrient-rich types) as well as sites that are in their natural state and easy to restore must be avoided.
Spruce-birch fens NT–EN	2. Yes, for some habitat types	2. Moderate	1b Biodiversity losses can be offset by improving the status of the same habitat type	(x)	x			x			x	Some spruce-birch fen types are threatened and rare. There is previous experience of restoration, and some spruce-birch fen types are likely to be challenging to restore. There are, however, plenty of sites that can be restored and restoration can be employed to increase spruce-birch fen-related biodiversity values.	Biodiversity losses of sites of Carex nigra birch fens and Eriophorum vaginatum birch fens that are in their natural state and can be restored must be avoided.
Pine mires and bogs LC–VU	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	x	x			x			x	Pine mires and bogs are still relatively common. There are plenty of sites that can be restored and it is possible to increase pine mire and bog biodiversity through restoration.	

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

MIRES				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Pine fens LC–VU	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	x	x			x			x	Pine fens are relatively common. There is previous experience of methods for their restoration and restoration can be employed to increase pine fen biodiversity.	Biodiversity losses of pine fens preserved in their natural state must be avoided particularly in Southern Finland and in areas with intensive ditch drainage. It is not necessarily possible to restore the original type of strongly altered sites.
Fens LC–NT	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	x	x			x			x	A common habitat type with previous experience available of restoration methods, and it is possible to reach the objectives set through restoration. The wettest fen types and highly complex entities are the most challenging types in terms of restoration. Restoration can, however, be employed to increase the biodiversity of fens.	Fens preserved in their natural state should not be subjected to biodiversity losses, particularly in Southern Finland and areas with intensive ditch drainage.
Rich fens NT–CR	1. Yes	3. Uncertain	2b Biodiversity losses must be avoided, status improvement challenging		x	x		x	x		x	Rich fens are threatened habitat types that involve high species values and are rare, particularly in Southern Finland. Even strongly altered sites may have valuable species, and there may be risks involved in their restoration. Some rich fen types are challenging to restore, but there have also been good restoration outcomes.	Biodiversity losses of extensive rich fen areas and rich fen areas related to extensive mires in their natural state must be avoided. In Southern Finland, any further losses of even sites which have been degraded from their natural state should be avoided. Particular care must be exercised in the restoration planning and implementation of all sites, taking species values into account. If necessary, restoration measures must be taken gradually in separate phases.

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

MIRES				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Wooded swamps NT–CR	2. Yes, for some habitat types	3. Uncertain	3a Biodiversity losses must not take place, status improvement possible		x	x		x	(x)		x	Wooded swamps are rare and threatened. There is little previous experience of restoration and restoration is likely to be challenging in most cases. It may be difficult to find suitable offset sites. Birch swamps are more common than other swamp types, but they have also suffered biodiversity losses.	Biodiversity losses of wooded swamps in their natural state must be avoided, and the same applies to extensive wooded swamp areas. It is important to survey species values and take them into account in restoration planning.
Shrub swamps and open swamps LC–EN	2. Yes, for some habitat types	3. Uncertain	1b Biodiversity losses can be offset by improving the status of the same habitat type	(x)	x			x	x		x	Because they are common, shrub and open swamps have been assessed as being suitable for biodiversity offsetting, but they have undergone extensive quality deterioration due to various problems relating to hydrology and water quality. There is very little previous experience of improving their status. On the other hand. overgrowing and eutrophication of water bodies are creating new occurrences of this habitat type.	*Myrica gale* swamps are rare and threatened and therefore their biodiversity losses must be avoided. Shrub swamps in particular may have threatened habitat types that have yet to be identified.
Raised bogs NT–EN	2. Yes, for some habitat types	2. Moderate	1b Biodiversity losses can be offset by improving the status of the same habitat type	(x)	x			x	x		x	A substantial proportion of raised bogs are no longer in their natural state. There is a lot of previous experience of restoration methods, the methods work quite well and there are plenty of sites in need of restoration measures.	In addition to sites in their natural state, biodiversity losses of raised bog complexes that feature semi-natural hydrology and are very suitable for restoration must be avoided, and the same applies to sites that are important as regards the connectivity of mire habitats.

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

MIRES				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Middle boreal aapa mires VU–EN	3. Yes, in parts of the country	2. Moderate	2b Biodiversity losses must be avoided, status improvement challenging		x			x	x	-	x	A substantial proportion of middle boreal aapa mires are no longer in their natural state and the habitat type is very rare in places. Many aapa mire sites are difficult to restore despite there being restoration methods available.	Biodiversity losses of extensive aapa mire entities must be avoided, and the same applies to sites that are valuable in terms of their biodiversity, featuring rare mire types and rare/threatened species as well as those that are important as regards the connectivity of mire habitats (e.g. sites with wet eutrophy).
Northern boreal aapa mires LC	2. Yes, for some habitat types	2. Moderate	1b Biodiversity losses can be offset by improving the status of the same habitat type		x			x	x		x	Northern boreal aapa mires are of Least Concern and a common habitat type, but rarer and threatened mire types also occur in aapa mires (e.g. rich birch fens, rich *Calliergon richardsonii* flark fens, particularly nutrient-rich calcareous fens). Some of the sites are challenging to restore.	Biodiversity losses of extensive aapa mire entities must always be avoided. Entities that contain rich birch fens and other rich fen areas and other rare or threatened habitat types or are significant as regards the connectivity of mire habitats are sites to be avoided. Aapa mires may be challenging to restore, so planning and implementation must be exercised with care.
Palsa mires NT	1. Yes	5. No status improvement methods	3a Biodiversity losses must not take place, status improvement not possible		(x)	(x)					(x)	The degradation of palsa mires is mostly due to climate change. There are no methods available to improve their status.	
Sloping fens LC–VU	2. Yes, for some habitat types	2. Moderate	1b Biodiversity losses can be offset by improving the status of the same habitat type		x			x			x	Sloping fens are not threatened in all parts of their occurrence area. Restoration is possible but involves specific challenges.	Biodiversity losses of threatened middle boreal sloping fens must be avoided.

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

MIRES				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Oroarctic mires LC	1. Yes	4. Unknown	2b Biodiversity losses must be avoided, status improvement challenging	(x)	x						x	Oroarctic mires are not threatened and a substantial proportion of them are protected and in their natural state. Biodiversity offsetting is of very little significance to them. On the other hand, the habitat type only occurs in a relatively small area and there is no previous experience of improving its status.	
Mire succession series of land uplift coast CR	1. Yes	3. Uncertain	3a Biodiversity losses must not take place, status improvement possible		x	x	x	x	x		x	A unique habitat type with unbroken succession series entities in their natural state being very rare. Many sites are in need of restoration, but methods for the restoration of entire succession series may not necessarily be available. Biodiversity offsetting could be applicable to the extent that protection, habitat type recovery through restoration and management as offset measures are targeted at the parts of entities that have suffered biodiversity losses.	

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

6.5 Forests

Suitability for biodiversity offsetting

Biodiversity offsetting is applicable to many forest habitat types if the general preconditions for offsetting are met (Chapter 4). There is a good deal of previous experience, knowhow and research data available regarding the use of forest restoration and nature management methods. The strengths and weaknesses of the methods are also known. It is important to take the long timescale of forest processes into account in biodiversity offsetting; some restoration measures will not generate the desired species response until much later. Some sites of common forest habitat types, too, are so valuable in terms of their nature values that, even with methods available to improve their status, they are impossible to offset by improving the status of another site. Biodiversity losses of, for example, heath forests comparable to natural forests in terms of structure and species composition or the most valuable herb-rich forests as regards their species composition cannot be offset by improving the status of other sites.

Almost all heath forest habitat types as well as forests on rocky terrain are generally suitable for biodiversity offsetting, excluding the most valuable sites (Figure 6, Table 6). Herb-rich, mesic, sub-xeric and xeric heath forests cover most of Finland's forest area but, from a biodiversity perspective, are largely deteriorated in terms of quality on account of forestry in particular. There are effective restoration and nature management methods to improve their status. The use of various kinds of burning especially should be increased. Impoverishment burning can be also used to reduce mesification caused by eutrophying deposition in xeric heath forests and forests on rocky terrain.

Herb-rich forests and *esker forests* are also suitable for biodiversity offsetting even though they are clearly rarer than the above-mentioned habitat types and often need measures to preserve their key biodiversity values. Both also include such rare types and valuable sites whose biodiversity losses are difficult to offset. With herb-rich forests, offsetting biodiversity losses of eutrophic and moist herb-rich forests is especially likely to be difficult.

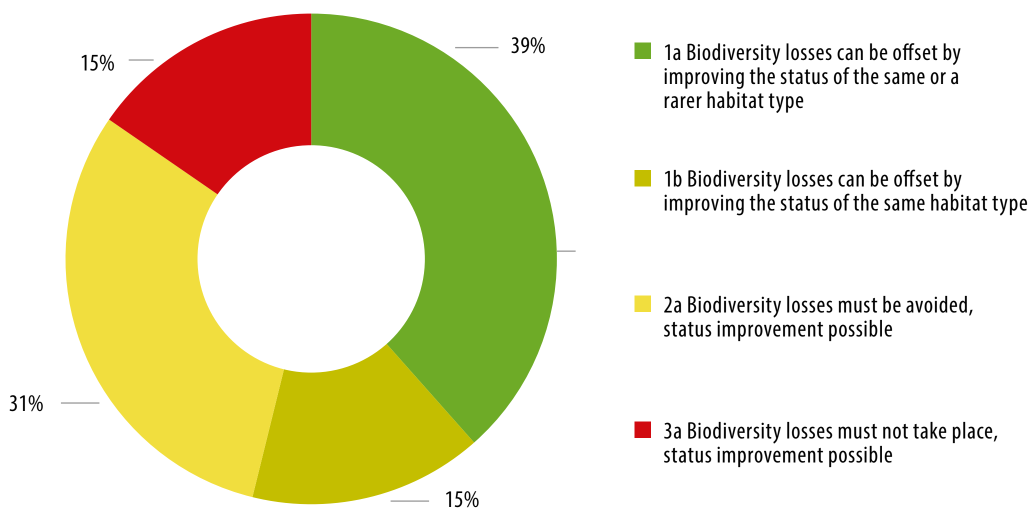
There is more uncertainty involved in biodiversity offsetting regarding *barren heath forests* than other types of heath forest due to their slow recovery rate. They resemble other forest types such as forests on rocky terrain or xeric heath forests in terms of their ecology, but barren heath forests are, however, threatened. There is a great deal of variation between sites as regards how close to their natural state they are. The development of the continuum of deadwood takes a very long time in barren heath forests. In addition to forestry, their status is deteriorated by the mesification of soil and vegetation and increased tree density caused by eutrophying deposition and, in the north, strong grazing pressure from reindeer husbandry. The tree composition of degraded barren heath forests can be restored and their soil impoverished through burning repeated as necessary.

Other forest habitat types less suitable for biodiversity offsetting are the rare forest habitat types occurring in a geographically limited area, namely *herb-rich forests with broadleaved deciduous trees*, *hardwood forests on podsolic soils* and *inland dune forests*. There are methods available to improve their status, but their rarity and special species compositions make offsetting difficult. Increasing and maintaining the nature values of forest stands with deciduous (hardwood) trees may require long-term nature management, particularly to ensure the continuum of those trees. Forests with very old hardwood trees or a continuum of decaying hardwood should not be subjected to biodiversity losses. The nature values of inland dune forests are similar to those of esker forests and benefit from restoration and management such as burning.

There are two forest habitat types regarded as unsuitable for biodiversity offsetting, and the first priority should be to avoid their biodiversity losses through various actions. Inland flooded forests have deteriorated strongly in terms of both quantity and quality, and it is often difficult to improve the status of this habitat type. It would be good to target recovery measures at flooded forests that have already deteriorated from their natural state while at the same time developing their rehabilitation and restoration. Forests on ultrabasic soils have been degraded and are also naturally very rare. There are specialised and threatened species related to them that would benefit from measures including exposing mineral soil by breaking vegetation.

Figure 6. Suitability of forest habitat types for biodiversity offsetting.

Forest habitat types assessed (13 habitat types)



State of knowledge

There is a lot of data available on the occurrence, ecology, species and significance of forest habitat types as providers of ecosystem services. Geographic datasets enable the targeting of protection, restoration and nature management so that the ecological connectivity of the existing network of nature reserves is improved (e.g. Mikkonen et al. 2018).

Experience, competencies and research data regarding forest restoration and nature management have already been generated over a longer period of time. The state-owned enterprise Metsähallitus has restored forests in nature reserves and carries out nature management in production forests owned by the State of Finland. The nature management of forests is a broad concept covering a vast variety of measures to preserve and improve biodiversity. There are also guidelines, guidebooks and training available concerning forest nature management (e.g. Saaristo et al. 2017, Saaristo & Vanhatalo 2015, the background material for the call for nature management projects maintained by the Finnish Forest Centre[13]). On privately owned land, nature management takes place with funding from sources including funding under the Act on the Financing of Sustainable Forestry[14].

Need for restoration and management

There is a great need for nature management measures in habitats such as esker forests, herb-rich forests with broadleaved deciduous trees and inland dune forests, some of the characteristics and species of which require nature management or (human-produced) disturbances to be preserved. Many sites of herb-rich forests, hardwood forests on podsolic soils, inland dune forests and forests on ultrabasic soils also require nature management measures for their key nature values to be maintained. For species of more xeric heath forests in particular, it would be important to increase various kinds of burning. Many threatened forest species benefit from increased amounts of deadwood, diversification of tree structure and, for example, measures to ensure the regeneration of Populus tremula and other deciduous trees.

Factors deteriorating the status of habitat types and methods of restoration and management

Various methods of forest restoration and nature management have been described in several publications (e.g. Kittamaa et al. 2009, Leinonen & From 2009, Similä & Junninen 2011, Matveinen et al. 2015, Tukia et al. 2015). Methods are developed and efforts are

13 Background material for the call for nature management projects https://www.metsakeskus.fi/tausta-aineistot [accessed on 8 October 2018]

14 Support under the Act on the Financing of Sustainable Forestry: https://www.metsakeskus.fi/kemera-tuet [accessed on 8 October 2018]

made to increase their use in the nature management of production forests in particular under a variety of projects implementing the objectives of the Forest Biodiversity Programme for Southern Finland (METSO) (e.g. Saaristo et al. 2017, Anttila et al. 2018, the metsonpolku.fi website[15]). Continuity is important in increasing the biodiversity of forest habitat types and ensuring their preservation, and this may require regional planning of measures so that a sufficient number of specific structural features of forests always occur. For example, species dependent on burning need fire continuum areas; new forest fires or burning sessions must take place within the dispersal range of these species every few years. It would be important for many threatened forest species to reduce the impacts of forest fragmentation by improving aspects such as the ecological connectivity of forest areas with old trees and an abundance of deadwood.

Reduction in the quantity and variety of deadwood (almost all forest habitat types)

- carrying out various kinds of burning
- increasing the volume of deadwood by using other methods (killing or cutting trunks using various methods, creating high stumps, etc.)

Loss of diversity in the age structure and species of living trees (almost all forest habitat types)

- cutting small gaps in forests with a homogenous structure
- favouring deciduous trees, for example, by clearing trees around them
- carrying out various kinds of burning
- many measures to increase the volume of deadwood also diversify the structure of the tree stand

Low occurrence of forest fires and resulting changes in forest structure (heath forests, esker forests, inland dune forests, forests on rocky terrain)

- carrying out various kinds of burning
- protecting natural wildfire areas, leaving burned trees in wildfire sites

Reductions in deciduous trees and certain tree species (herb-rich forests with broadleaved deciduous trees, hardwood forests on podsol soils, herb-rich forests and eutrophic heath forests)

15 National projects to develop nature management methods http://www.metsonpolku.fi/fi-FI/Tutkimus/Luonnonhoito- hankkeet

- favouring deciduous (hardwood) trees, *Populus tremula* and other deciduous trees and ensuring their regeneration by, e.g. clearing vegetation and trees around them, creating small gaps
- planting deciduous (hardwood) trees
- restricting the grazing of deer (*Cervidae*)
- carrying out various kinds of burning in mineral soil areas

Excessive sprucification (some herb-rich forests, herb-rich forests with broadleaved deciduous trees, esker forests, xeric heath forests)

- removing planted *Picea abies* from herb-rich forests
- restricting the regeneration of *Picea abies* by removing plantlets
- in some cases, the considered removal of larger *Picea abies*

Excessively dense tree or shrub layer, overgrowth of ground vegetation, thickening of humus layer and resulting changes in vegetation, eutrophication (esker forests, inland dune forests, barren heath forests, forests on ultrabasic soils, some herb-rich forests and forests with broadleaved deciduous trees)

- clearing ground vegetation and shrubbery
- exposing mineral soil
- restricting tree regeneration by removing plantlets
- creating small gaps
- in some cases burning (see above)
- impoverishment burning of barren sites

No regular flooding (inland flooded forests)

- diverting floodwater to flooded forests in conjunction with measures such as flood control

Permanence of biodiversity offsets

Permanent protection is important for heath forests in particular, but the nature values of all forest habitat types benefit from permanent protection if nature management and restoration are carried out in addition, as necessary. The recovery of the natural structural features of tree stands aimed for in restoration and the resulting species responses usually only take place over the long term. For example, the development of the continuum of deadwood is likely to take many decades and possibly even longer. Some of the threatened forest species only occur in old forests that have been in their natural state for a long time.

The occurrence of some species of forests habitat types need such structural features the ensuring of which calls for repeated nature management measures. Examples of these include the regeneration of deciduous (hardwood) trees, ensuring the preservation of

herb-rich forest vegetation, clearing of vegetation to prevent excessive overgrowing and at times also carrying out burning. In these cases the continuity of the activities should be ensured. It is also possible to maintain the structural features of some forest habitat types and the species dependent on them in forests that are in commercial use. For example, biodiversity related to exposed soil, sun-exposed habitats and burning can be increased and maintained in production forests when measures are planned and implemented with this in mind. To ensure the permanence of biodiversity offsets, in these cases forestry measures should be adjusted so that the desired structural features will be preserved over the long term.

Challenges faced in biodiversity offsetting

An important challenge as regards biodiversity offsetting relating to forests is that restoration gains are often delivered with a long delay. The rate of development of old trees or creation of a continuum of deadwood cannot be accelerated. Some of the species dependent on decaying trees, and threatened species in particular, are demanding as regards the quality of decaying wood. To survive, many of such threatened species need a continuum of deadwood where wood in a suitable stage of decay occurs continuously in the same area. The continuum is created naturally over a long period of time. For example, from the species perspective, a tree killed through human intervention for forest restoration purposes does not correspond to a tree that has died naturally (e.g. Laaka-Lindberg 2016). Decaying trees created by cutting or ring-barking of trees are utilised by specific species, which results in decay and saprotroph succession[16] differing from those seen in trunks that have died naturally (e.g. Pasanen et al. 2014, Pasanen 2017). Old forests with continuums of deadwood particularly in Southern Finland are rare outside protected areas, and it is likely to be impossible to offset losses of their nature values. The forest landscape surrounding a site to be restored and its species composition also affects how the species will recover after restoration.

Restoration burning of varying intensity usually creates a variety of decaying trees which in the initial stage are non-diverse but which are created naturally. Thanks to burning, the rate of decaying wood creation is also increased after the burning, which increases the diversity of deadwood. In xeric forest types, forest fires are part of the natural disturbance dynamics. Burning is, however, an expensive restoration method and challenging to implement. The areas of controlled burning have decreased in the 2000s in Finland (Korhonen et al. 2016), which is why efforts have been made to increase the use of controlled burning as a nature management method (e.g. Lindberg et al. 2018)

Habitat types and sites whose biodiversity losses must be avoided in particular

- Forests with a continuum of deadwood and very old trees
- Very old forests
- Deciduous-dominated forests created through natural succession
- Esker forests with representative sun-exposed species or whose vegetation type is of the esker variant
- Herb-rich forests with broadleaved deciduous trees and herb-rich forests with hazel
- Barren heath forests
- Inland flooded forests
- Inland dune forests
- Forests on ultrabasic soils

Development needs

Restoration and nature management methods for the various forest habitat types should be developed further and their impacts monitored. Methods for the restoration of barren heath forests, forests on ultrabasic soils and flooded forests should be tested and developed. New kinds of solutions should be found for the restoration of the floodwater impact. For example, diverting floodwater to former flooded forests could be developed

16 The fungal species living in and decomposing deadwood change as decay progresses. Some saprotrophic fungi only occur in wood decomposed by specific other fungal species.

as a flood control method. The cost-effectiveness of controlled forest burning should be improved. In addition to high costs, obstacles to the use of controlled burning include general inconvenience as well as safety and groundwater issues. Further development of methods and operating models is therefore needed. The continuity of burning-related competencies among forest professionals should also be ensured.

Table 6. Suitability of forest habitat types for biodiversity offsetting. The classifications used are described in Chapter 3, and further information about the habitat types assessed can be found in Appendix 1. Threat status is given as a range (e.g. LC–VU) whenever a habitat type includes multiple habitat types of more specific classification levels whose threat status classifications differ from each other (see Appendix 1).

FORESTS				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Herb-rich forests with broadleaved deciduous trees EN–CR	1. Yes	2. Moderate	2a Biodiversity losses must be avoided, status improvement possible		x	x	x	x	x		x	Herb-rich forests with broadleaved deciduous trees are rare and important for threatened species, so their biodiversity losses must generally be avoided. It is possible to increase the diversity of altered herb-rich forests with broadleaved deciduous trees through restoration and management. Protected sites also need measures to ensure the regeneration of deciduous (hardwood) trees.	Biodiversity losses of extensive sites and sites with a natural continuum of deciduous (hardwood) trees must be avoided. The ecological and species-related significance of the various hardwood tree species varies, which must be taken into account in biodiversity offsetting.
Herb-rich forests NT–CR	2. Yes, for some habitat types	2. Moderate	1b Biodiversity losses can be offset by improving the status of the same habitat type		x			x	x		x	Herb-rich forests are threatened and degraded sites occur extensively, but their biodiversity can be improved through restoration and management. Protected sites may also require measures to ensure the preservation of herb-rich forest species.	Biodiversity losses of all rare herb-rich forest habitat types should be avoided.
Herb-rich heath forests NT–EN	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	x	x			x			x	Some herb-rich heath forest habitat types are threatened and degraded sites occur extensively, but their biodiversity can be improved through restoration and management.	Biodiversity losses of the rarest herb-rich heath forest habitat types should be avoided.

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

FORESTS				**Suitable offsetting principles**				**Offset measures**					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Mesic heath forests LC–CR	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	x	x			x			x	Some mesic heath forest habitat types are threatened and sites whose status has deteriorated occur extensively, but their biodiversity can be improved through restoration. There is a great deal of previous experience of restoration methods and their strengths and weaknesses are known.	Biodiversity losses of sites which are deciduous-dominated, in their natural state, with a good continuum of deadwood or *Populus tremula* or special in terms of their microclimate must be avoided. The continuum of deadwood and old trees cannot be created through restoration, and these involve a large number of threatened species.
Sub-xeric heath forests NT–CR	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	x	x			x			x	Some sub-xeric heath forest habitat types are threatened and sites whose status has deteriorated occur extensively, but their biodiversity can be improved through restoration. There is a lot of previous experience of restoration methods and their strengths and weaknesses are known.	Biodiversity losses of sites which are deciduous-dominated, in their natural state and with a continuum of deadwood in particular must be avoided. The continuum of deadwood and old trees cannot be created through restoration, and these involve a large number of threatened species.
Xeric heath forests NT–CR	2. Yes, for some habitat types	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	x	x			x			x	Some xeric heath forest habitat types are threatened and sites whose status has deteriorated occur extensively, but their biodiversity can be improved through restoration. Biodiversity offsetting may increase the opportunities to use various types of burning and promote the development of fire continuum areas.	Biodiversity losses of sites with a good continuum of deadwood in particular must be avoided. Some of the habitat types of old and very old habitat types falling under sub-xeric heath forests in particular are highly threatened and their biodiversity losses must be avoided.
Barren heath forests CR	3. Yes, in parts of the country	3. Uncertain	2b Biodiversity losses must be avoided, status improvement possible		x	x	x	x	x		x	Recovery rate is slower than with other heath forest habitat types with, for example, the creation of a continuum of deadwood taking a very long time. It is possible to use burning to increase biodiversity and make sites affected by eutrophication more oligotrophic.	In addition to sites in their natural state, biodiversity losses of sites that can be restored easily must be avoided. In biodiversity offsetting situations, the permanent protection of sites is important.

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

FORESTS				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	Rarity to be taken into account in off-setting	Effectiveness of restoration/ma-nagement met-hods	Suitability for bio-diversity offsetting	A	B	C	D	E	F	G	H	Reasoning of assessment	Preconditions in addition to general preconditions
Esker forests VU	5. No	2. Moderate	1b Biodiversity los-ses can be offset by improving the status of the same habitat type		x			x	x	x	x	There are lots of de-graded esker forests. Measures are usually required to preserve sun exposure. There is a re-latively large number of rare and threatened spe-cies related to the habitat type. Forest fires are an important way of imp-roving their status and biodiversity offsetting could increase opportu-nities for burning and the develop-ment of fire continuum areas.	Biodiversity losses of es-ker forests whose status is good or which have undergone management or restoration and have important species must be avoided. Threatened species must be taken comprehensively into account in biodiversity offsetting.
Inland dune forests VU	1. Yes	2. Moderate	2a Biodiversity los-ses must be avoi-ded, status impro-vement possible		x	x		x	x		x	Inland dune forests only occur in conjunction with dune areas. There is little previous experience of the management and restoration of dune areas, but in principle the met-hods are similar to tho-se employed with, for example, esker forests. The difficulty, however, is increased by the fact that dune formations must not be broken.	Threatened species must be taken comprehensi-vely into account in bio-diversity offsetting. The focus in the selection of offset sites could be on improving the status of sites important for species.
Inland flooded forests EN	1. Yes	4. Unknown	3a Biodiversity los-ses must not take place, status imp-rovement possible		x	x	x	x	x		x	Flooded forests are ve-ry rare and threaten-ed. There is still little previous experience of improving their status. It is likely to be difficult to restore the floodwater impact and the number of sites suitable for that purpose is limited.	
Forests on rocky terrain LC	5. No	2. Moderate	1a Biodiversity los-ses can be offset by improving the status of the same or a rarer habitat type	x	x			x				Rock outcrops are non-renewable, which restricts the potential for offsetting losses of these habitats. Forests on rocky terrain is, howe-ver, a relatively common habitat type and have re-tained features of natural forests to an extent grea-ter than with any other forest habitat type.	Biodiversity losses of extensive sites which are in their natural state, special as regards their geomorphology and va-luable in terms of their species must be avoi-ded. The slow recovery of the habitat type must be taken into account in biodiversity offsetting situations.

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

FORESTS				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Forests on ultrabasic soils VU	1. Yes	3. Uncertain	3a Biodiversity losses must not take place, status improvement possible		x	x	x	x	x		x	Forests on ultrabasic soils are very rare, with rare and threatened species and habitat specialist races and forms occurring in them. Geographic variation is quite high. There is little previous experience of restoration and management, but many sites would probably benefit from measures.	There are major differences between southern and northern sites and overall great variation between forests classified under this habitat type. It is important to use equivalent sites as offset sites.
Hardwood forests on podsolic soils VU	1. Yes	2. Moderate	2a Biodiversity losses must be avoided, status improvement possible		x			x	x			Hardwood forests on podsolic soils are very rare, threatened and occur in a relatively small area in Finland. It is possible to increase the biodiversity of the habitat type through management and restoration.	Biodiversity losses of extensive sites and sites with a natural continuum of deciduous (hardwood) trees and threatened species must be avoided. The ecological and species-related significance of deciduous (hardwood) trees varies, which must be taken into account in biodiversity offsetting.

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

6.6 Rock outcrops and scree

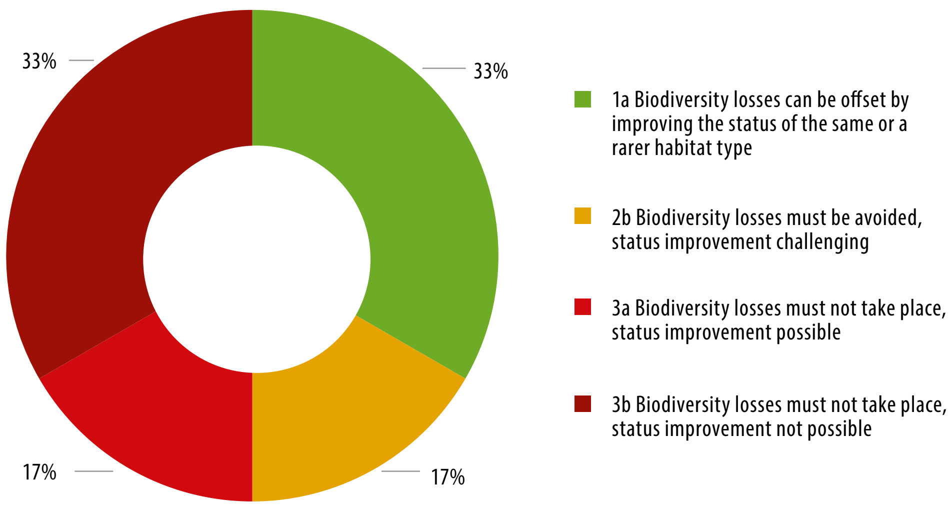
Suitability for biodiversity offsetting

In this context, rock outcrop habitat types mean rock surfaces that are at least partly exposed on the ground and on which petrophytes occur. Rock outcrops are non-renewable, which in principle restricts their suitability for biodiversity offsetting. Under the Finnish Land Extraction Act and Mining Act, however, rock outcrops are utilised for purposes including crushed rock and building stone extraction and mining industry, and they are also taken over by construction projects. Some rock outcrop and scree habitat types in Finland are very common, and excluding them from biodiversity offsetting would not provide solutions to practical situations.

Half of Finland's rock outcrop habitat types are, due to their rarity or the uniqueness of their occurrences, such that they are not as a general rule regarded as suitable for biodiversity offsetting (Figure 7, Table 7), whereas common rock outcrop and scree habitat types are assessed as being suitable for offsetting subject to the general preconditions.

Figure 7. Suitability of rock outcrop and scree habitat types for biodiversity offsetting.

Rock outcrop and scree habitat types assessed (6 habitat types)



Common and classified as being of Least Concern, siliceous rock outcrops and scree are the types most suitable for biodiversity offsetting. Protection of valuable sites or improving the status of rarer habitat types can be used as offset measures. Some occurrences of intermediate-basic rock outcrop habitat types can also benefit from management by reducing trees and shrubs if they are threatened by overgrowing. Although siliceous rock outcrops and scree are common, they contain valuable sites and subtypes whose special characteristics have to be taken into account when assessing potential for biodiversity offsetting.

Fe and Cu sulphide-rich rock outcrops are not regarded as threatened, but their occurrences and biodiversity values are more poorly known than those of other rock outcrop habitat types, and it is therefore difficult to find offset sites. This restricts the suitability of the habitat type for biodiversity offsetting.

Rock outcrop habitat types most poorly suitable for biodiversity offsetting are threatened or rare and their occurrences are intrinsically unique. Calcareous rock outcrops are rare, threatened and particularly important for threatened species, and their biodiversity losses must be avoided in particular. They do, however, benefit from management. Therefore, as offsets improving the status of common habitat types, calcareous rock outcrops suffering from overgrowing could be managed or habitats suitable for calcicole species could be provided though aftercare of closed limestone quarries.

Serpentine rock outcrops are rare and specialised communities with threatened species having been formed on them. Consequently, there are few suitable offset sites available. There is no previous experience of improving the status of this habitat type through management. For some sites, opening vegetation or taking species values into account in quarry aftercare could increase biodiversity values, but there is no certainty yet regarding their effectiveness as methods.

Canyons and caves are not threatened, but their suitability for biodiversity offsetting is restricted by the fact that rock formations with special topography are often unique occurrences and no offset sites can be found for them. Gorges can act as climate refuges for northern species, which emphasises the need to preserve them as climate change progresses.

Improving the status of rock outcrop habitat types by managing their occurrences is not an offset method with broad-scale applicability except for calcareous rock outcrops. However, in quarry areas, novel habitats could be preserved or created to provide habitats for species specialised in calcareous or serpentine rock outcrops or in other rock outcrops with a highly specific mineral composition. Quarry walls and other rock surfaces and piles of rocks left uncovered can serve as novel habitats.

State of knowledge

There is clear variation in the state of knowledge as regards the occurrences of the various rock outcrop habitat types. The most detailed occurrence data collected by the Finnish Environment Institute is on calcareous and serpentine rock outcrops, but not all of their small-sized occurrences are known yet. The rock type surveys of the Geological Survey of Finland help locate potential calcareous and serpentine rock outcrop habitat type occurrences but, in addition, on-site reviews are needed to establish whether there are exposures on the rock outcrop where vegetation specialised in these rock types occurs.

Data on valuable occurrences of other rock outcrop habitat types has mainly been generated in the inventory project concerning rock areas valuable for nature and landscape conservation

implemented by the Finnish Environment Institute (Finnish Environment Institute 2016, 2018). The locations and characteristics of rock outcrop and scree sites can in general terms also be identified by using remote sensing and geographic datasets. Data is clearly most deficient as regards occurrences, status and biodiversity significance of Fe and Cu sulphide-rich rock outcrops.

There is only little previous experience of improving the status of rock outcrop habitat types through management. Parks & Wildlife Finland of the state-owned enterprise Metsähallitus has carried out management measures on some calcareous rock outcrops suffering from overgrowing.

Need for restoration or management
The types most in need of management are small-sized calcareous rock outcrops in Southern Finland which are suffering from the increased abundance of trees and shrubs and the replacement of calcareous rock outcrop plant species by species such as forest mosses or graminoids. Some intermediate-basic and serpentine rock outcrops could possibly also benefit from management, but there is no previous experience of this.

For oligotrophic rock outcrops and scree, which form the majority of Finland's rock outcrops, the need for management is low. The situation may, however, change in the future if climate change causes the increased abundance of trees and, consequently, reduces the space for actual petrophytes

Factors deteriorating the status of habitat types and methods of restoration and management
Eutrophication and overgrowth in open rock outcrop habitat types (calcareous rock outcrops, intermediate-basic rock outcrops and possibly also serpentine rock outcrops)

- removing trees and shrubs
- creating space to grow for petrophytes that are weak competitors e.g. by removing graminoids and forest mosses
- grazing
- controlled burning (has not been tested for management purposes)

Change in microclimate caused by forest cutting on shady rock outcrops (naturally shaded occurrences of all rock outcrop habitat types)

- preserving protection zones with trees on shady rock outcrops

Wear on vegetation due to activities including off-road vehicle use, trampling or rock climbing (all rock outcrop habitat types)

- managing access, preventing off-road vehicle use

Destruction of novel habitats of rock outcrops in conjunction with quarry area aftercare when re-grading quarry faces and covering them with earth material (calcareous rock outcrops, serpentine rock outcrops)

- planning quarry aftercare in a manner taking valuable petrophyte habitats into account (preserving open rock surfaces and piles of rock)

Permanence of biodiversity offsets

The status of calcareous rock outcrops in Southern Finland in particular is deteriorated by eutrophication and overgrowing. This development is attributable to many causes: nitrogen deposition, reduced grazing and forest fires, forestry measures, and longer growing season and increased atmospheric carbon dioxide level related to climate change. The protection of calcareous rock outcrops is particularly important for biodiversity, but protection alone is not enough. In addition, many small-sized calcareous rock outcrops would need management measures to keep the rock outcrop environment open enough for species specialised in calcareous rock outcrops. Management measures may need to be repeated from time to time but not annually. There may also be a similar need for management as regards some intermediate-basic calcareous rock outcrops or serpentine rock outcrops with valuable species.

Valuable rock outcrop sites are often relatively small in size and affected by activities in the local environment which may alter the microclimate or generate nutrient or particulate emissions. This must be taken into account when establishing protected areas to preserve rock outcrop habitats.

If novel habitats such as calcareous rock faces or piles of rock left in former quarry areas are used as offsets, the permanence of the subsequent care of the areas must be ensured.

Challenges faced in biodiversity offsetting

- Rock outcrops are non-renewable, whereby the destruction of sites always results in a reduction of the rock outcrop area. The irreversibility of destruction can, however, be mitigated by creating rock exposures suitable for petrophytes in areas such as quarries if this is adopted as an objective in the aftercare of areas.

- There is not much previous experience or monitoring data concerning the improvement of the status of rock outcrop habitat types through management.
- The success of management measures is not always certain. Instead, efforts to increase openness may fail due to the sprouting of deciduous trees, accelerating regeneration of conifers or the increased abundance of *Calamagrostis epigejos*.
- On calcareous and serpentine rock outcrops in particular, there are numerous threatened species specialised in these rock types, particularly lichens and mosses, whose identification requires special expertise. Management measures must not endanger valuable species, whereby management planning is demanding and monitoring of management outcomes important.

Habitat types and sites whose biodiversity losses must be avoided in particular

- Gorges and extensive shady rock faces which may act as climate refuges for northern species
- Large rock face areas and south/west-facing intermediate-basic rock faces with a special microclimate suitable for southern species

Rock outcrop areas determined as valuable for nature and landscape conservation (Finnish Environment Institute 2016, 2018).

- Calcareous rock outcrops, scree and boulders

- Old closed limestone quarries where calcicoles occur
- Serpentine rock outcrops, scree and boulders

Development needs

There has been very little research into and monitoring of the status of rock outcrop habitat types in Finland. For example, serpentine rock outcrops contain outcrops of several ultrabasic rock types, and the relative significance of the various rock types as substrates for species specialised in serpentine rock outcrops is not clear.

The management of calcareous rock outcrops has only been carried out in a few sites, and the development and testing of management as well as the monitoring of its effectiveness must be continued.

Table 7. **Suitability of rock outcrop habitat types for biodiversity offsetting. The classifications used are described in Chapter 3, and further information about the habitat types assessed can be found in Appendix 1. Threat status is given as a range (e.g. LC–VU) whenever a habitat type includes multiple habitat types of more specific classification levels whose threat status classifications differ from each other (see Appendix 1.**

	ROCK OUTCROPS AND SCREE				Soveltuvat kompensointi-periaatteet				Kompensoivat toimenpiteet					
	Habitat type and IUCN Red List Category	Rarity to be taken into account in off-setting	Effectiveness of restoration/ma-nagement met-hods	Suitability for biodi-versity offsetting	A	B	C	D	E	F	G	H	Reasoning of assessment	Preconditions in ad-dition to general pre-conditions
	Siliceous rock outcrops LC–NT	5. No	3. Uncertain	1a Biodiversity losses can be offset by imp-roving the status of the same or a rarer habitat type	x	x				x		x	x Rock outcrops are non-re-newable, which in prin-ciple restricts the poten-tial for their biodiversity offsetting. Siliceous rock outcrops are, however, common in Finland and the protection of valuable rock outcrop sites or the improvement of the sta-tus of rarer habitat types, and possibly also the ma-nagement of overgrown intermedia-te-basic rock outcrop si-tes, can be used as offset measures.	Siliceous rock out-crops are a large group of different ha-bitat types and, des-pite being common, they include valuable sites and subtypes. Those with the highest plant species diversity are intermediate-basic rock outcrops and south/west-facing in-termediate-basic rock faces with a special microclimate suitable for southern species. Extensive shaded slopes may provide climate refuges for northern species.

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

ROCK OUTCROPS AND SCREE				**Soveltuvat kompensointi-periaatteet**				**Kompensoivat toimenpiteet**					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in off-setting**	**Effectiveness of restoration/ma-nagement met-hods**	**Suitability for biodi-versity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in ad-dition to general pre-conditions**
Calcareous rock outcrops NT–CR	1. Yes	3. Uncertain	3a Biodiversity losses must not take place, status improvement possible		(x)	x	x		x		x	Calcareous rock outcrops are rare and particular-ly important for threa-tened species, and their biodiversity losses must be avoided in particular. They benefit from mana-gement, whereby calca-reous rock outcrop occur-rences suffering from overgrowing can be used as offset measures for bio-diversity losses of more common habitat types (requires special exper-tise) or the aftercare of closed limestone quarries can be organised so that the living conditions of calcicoles are improved.	Threatened species must be taken into account when plan-ning management.
Serpentine rock outcrops and scree NT–VU	1. Yes	4. Unknown	3a Biodiversity losses must not take place, status improvement not possible		(x)	x		(x)	(x)		x	Serpentine rock outcrops are rare and threatened and their species specia-lised, whereby there are few suitable offset sites available. There is no previous experience of improving the status of the habitat type through management, either. For some sites, opening up the vegetation or taking species values into ac-count in the aftercare of quarries could increase biodiversity values, but there is no previous expe-rience of the effectiveness of methods.	Threatened species must be taken into account when plan-ning potential mana-gement.
Fe and Cu sulphide-rich rock outcrops NT	4. Possibly (in-sufficient data)	4. Unknown	2b Biodiversity los-ses must be avoided, status improvement challenging		x						x	Fe and Cu sulphide-rich rock outcrops are not assessed as being threatened, but their occurrences and biodiver-sity values are less known than those of other rock outcrop types and it is therefore difficult to find offset sites. There is no previous experience of improving the status of the habitat type through management, either. Rare species could possibly al-so be preserved in novel habitats such as waste rock piles of closed mines.	

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly impor-tant, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

ROCK OUTCROPS AND SCREE				Soveltuvat kompensointiperiaatteet				Kompensoivat toimenpiteet					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Canyons and caves LC	2. Yes, for some habitat types	5. No status improvement methods	3b Biodiversity losses must not take place, status improvement not possible		(x)						x	Rock outcrop formations of a special shape are often unique and no offset sites for them can be found. Gorges may act as climate refuges for northern species, which increases the need to preserve them.	
Scree LC–NT	2. Yes, for some habitat types	4. Unknown	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	x	x						x	The processes forming scree are very slow, which in principle restricts the potential for applying biodiversity offsetting to scree habitats and there are no management methods improving the status of scree in use. The majority of scree types in Finland are, however, common and of Least Concern, and, e.g. protecting valuable sites or improving the status of rarer habitat types can be used as offsets for biodiversity losses.	Calcareous erratic boulders and serpentine erratic boulders are the rarest, and it may be difficult to find offset sites to protect to compensate for them. Calcareous and serpentine scree has been classified here as calcareous and serpentine rock faces to which biodiversity offsetting is as a general rule not applicable.

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

6.7 Seminatural grasslands

Suitability for biodiversity offsetting

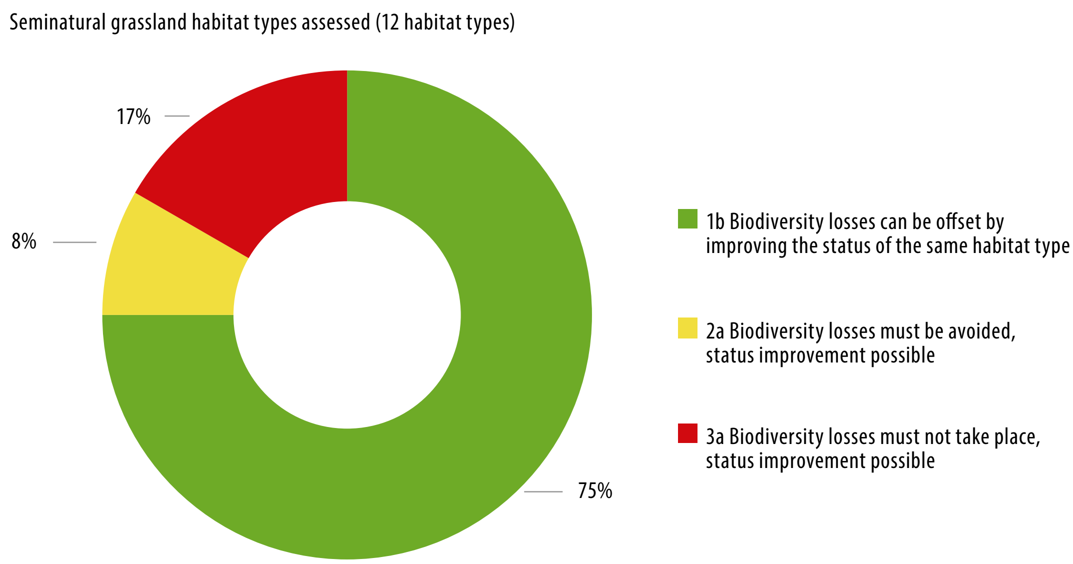
Seminatural grasslands, that is, various types of meadows created and maintained by traditional livestock farming, are the most threatened main group of habitat types in Finland. Threat status is not, however, the sole factor determining whether or not a habitat type is suitable for biodiversity offsetting. Without management, seminatural grasslands face a risk of disappearing, and the area of managed sites is currently too small. Biodiversity offsetting may offer new opportunities for organising their management.

Seminatural grasslands have been assessed to be more suitable for biodiversity offsetting than other equally threatened habitat types because there are fairly numerous occurrences of seminatural grasslands which are poor in quality or have already been altered, and their values can be recovered through management measures such as grazing or mowing. There is a great deal of previous experience of their management, which is usually successful and delivers the desired outcomes faster than the restoration of other habitat types.

The management of seminatural grasslands is primarily suitable as an offset measure to compensate for biodiversity losses of other, more common habitat types. It can also be applied to offset biodiversity losses of less valuable seminatural grassland habitat types. Occurrences of all types of seminatural grasslands that have remained representative, as well as representative seminatural grasslands entities and occurrence networks, are important for biodiversity and their biodiversity losses must be avoided.

The majority of Finland's seminatural grassland habitat types have been assessed as being quite suitable for biodiversity offsetting (Figure 8, Table 8). As a general rule, those seminatural grasslands whose management is exceptionally demanding are unsuitable for offsetting.

Figure 8. Suitability of seminatural grassland habitat types for biodiversity offsetting.



Seminatural grasslands most suitable for biodiversity offsetting do not require highly specialised environmental conditions. This means suitable sites in need of management can be found for use as offset sites. They can be managed using normal methods of clearing, grazing or mowing. Such seminatural grasslands comprise heaths, rock meadows, dry meadows, mesic meadows, freshwater meadows, seashore meadows and the wooded seminatural grassland types of wooded pastures and grazed woodlands.

Those seminatural grasslands whose recovery requires more demanding measures are less suitable for biodiversity offsetting. Alluvial meadows differ from most seminatural grassland types in that mowing or grazing alone will not maintain their characteristics over the long term. Instead, flooding and its sediment input are also needed. This makes it more difficult to find suitable offset sites. In many water bodies, flooding has decreased due to hydraulic construction, in which cases the recovery of alluvial meadows calls for more extensive measures to re-introduce flooding.

Seminatural grassland habitat types least suitable for biodiversity offsetting are those whose management in current conditions is particularly demanding and which have already become so rare that sites managed in the traditional way have almost disappeared. These comprise fen meadows and wooded meadows. Fen meadows may require flooding, and the management of wooded meadows is highly labour-intensive as it requires many different measures at different times during the growing season.

State of knowledge

The data held by Finland's environmental and agricultural administration concerning the current locations and site quality of occurrences of seminatural grasslands is quite deficient as almost 20 years have passed since the completion of the nationwide inventory of traditional rural biotopes (Vainio et al. 2001). Supplementary inventories have been launched, and the intention is to carry out further onsite inventories in the coming years.

Current inventory data does not always provide specific information about the habitat types of seminatural grassland sites, and the boundaries of the various habitat types have not been outlined on the map. Because many sites have been altered due to overgrowing, it is not always possible to interpret the seminatural grassland type correctly. After the discontinuation of management, seminatural grasslands undergo rapid alteration, whereby old inventory data is not always up to date. Centres for economic development, transport and the environment have therefore collected updated data on the valuable seminatural grasslands of their respective areas (Kemppainen & Lehtomaa 2009, Kemppainen 2017), and the state-owned enterprise Metsähallitus has compiled extensive geographical datasets concerning land areas it manages as well as data on protected areas on privately owned land. Nationwide data on seminatural grasslands is currently maintained in the environmental administration’s geographic information system (Uljas). The above-mentioned inventory data has in part also been entered in the geographic information system, as have been the map details, including value categories, of the sites included in the 1990s inventory, but work is only at the initial stages when it comes to the entry of habitat type data in particular.

Seminatural grassland management methods are known well, and related descriptions and guidelines have been published (e.g. Salminen & Kekäläinen 2000, Pykälä 2001, SW

Finland Cultural Landscapes Organisation 2017). Management advice and planning services are also available. Response of habitat types and species to management has been monitored in contexts including protected areas managed by Metsähallitus and a few studies conducted by the Finnish Environment Institute.

Need for restoration or management

There is a great need for the management of all seminatural grassland types. Seminatural grasslands have acquired their characteristics as a result of management and, without management, overgrowing begins very quickly. For many seminatural grasslands, annual management delivers the best outcome, but the appropriate intensity of management depends on the type of seminatural grassland and the conditions of the occurrence. For example, the rate of overgrowth is slower and the need for management lower in dry and sunny meadows than in mesic meadows. Floods and other coastal phenomena may keep seminatural grasslands located in riparian areas open for years or even decades even without any management.

Calculated per hectare, the management of seminatural grasslands is more expensive than that of other habitat types as management often needs to take place every year (Fact box 3). In relation to the biodiversity and landscape gains achieved, however, their management is not expensive. Over the past 20 years, the management of seminatural grasslands has undergone a revival thanks to developments including agri-environmental aid, but the land area covered by management is still considerably smaller than necessary for the preservation of the habitat types and species. Seminatural grasslands are currently annually managed over an area totalling just under 30,000 hectares, and the majority of management funding is received from the Rural Development Programme for Mainland Finland 2014–2022. (Raatikainen et al. 2015)

Factors deteriorating the status of habitat types and methods of restoration and management

Eutrophication and overgrowing due to causes including discontinued management, eutrophying use, nitrogen deposition and eutrophication of water bodies (all seminatural grasslands)

- carrying out basic rehabilitation: removing or reducing trees and shrubs in heavily overgrown sites before commencing grazing or mowing
- removing clearing waste
- removing alien species (e.g. *Lupinus polyphyllus*, *Amelanchier spicate*, *Heracleum* spp. and *Impatiens glandulifera*; in freshwater meadows and tall-herb meadows *Glyceria maxima*; in seashore meadows *Rosa rugosa*)
- controlled burning (particularly heaths)
- organising grazing (in most cases the priority management method)
- mowing
- removing mown grass
- topping and pollarding trees (wooded meadows)
- flooding through damming or diverting water from elsewhere (fen meadows)
- using slash-and-burn techniques
- managing novel habitats that are important for seminatural grassland species (e.g. meadow-like roadside verges, railway embankments, airfields, power line clearings, ski slopes and old fortress ramparts)

Change in water level and flooding caused by hydraulic construction and regulation (alluvial meadows, freshwater meadows)

- removing structures and increasing natural-like flow in channels
- natural flood protection by diverting floodwater to natural areas

Drying out caused by ditch drainage (freshwater meadows, moist meadows, seashore meadows, fen meadows)

- restoring natural hydrology by blocking ditches, etc. (see Section 6.4)

Change in tree species composition and reduction in decaying trees resulting from forest management (grazed woodlands, wooded pastures, wooded meadows)

- saving old trees and trees damaged by grazing
- saving standing and fallen decaying trees
- favouring deciduous trees
- maintaining open and well-lighted habitats, particularly for large deciduous trees
- topping and pollarding trees

Permanence of biodiversity offsets

The management of seminatural grasslands entails repeated measures, whereby the permanence of actions must be guaranteed in biodiversity offsetting projects through means including management agreements. For reasons such as the way they are created, seminatural grasslands often require repeated management, but the need for management is also increased by such human activities that eutrophy seminatural grasslands or otherwise accelerate their overgrowth. Examples of adverse impacts include nutrient pollution being transported via air or water to seminatural grasslands, measures increasing shading in the local environment or the spread of aggressively growing alien species. Seminatural grassland sites are often relatively small in size and located close to roads, fields, gardens or forestry areas, making them susceptible to external impacts. Climate change is also likely to accelerate the rate of overgrowth of seminatural grasslands and their need for maintenance as the growing season gets longer and atmospheric carbon dioxide level increases.

Seminatural grasslands can be maintained as part of both rural livelihoods and the management of protected areas. Establishing a protected area is justifiable in some cases, but the most important thing is to ensure management continuity. Even in protected areas, management involves close cooperation between those managing sites under agreements and Metsähallitus, the state-owned enterprise responsible for organising the management measures.

Challenges faced in biodiversity offsetting

- Not all current management practices for seminatural grasslands promote biodiversity, and such practices cannot be employed for offset sites. These include at least eutrophying grazing practices, such as additional feeding of grazing livestock when at pasture, grazing in conjunction with grass, night-only grazing and pasture fertilisation.
- Seminatural grasslands have numerous threatened and rare species from several different taxa, and their occurrences and ecological requirements need to be assessed and taken into account when

planning management. Setting management objectives may require expert prioritisation as, for example, the rate of grazing pressure that is ideal for plant species is usually higher than the pressure that is the most useful for insects.
- Some traditional management methods such as the multiphase management of pollard meadows, flooding of fen meadows and creating glades through slashing and burning are labour-intensive methods and currently expensive.

Habitat types and sites whose biodiversity losses must be avoided in particular
- Seminatural grasslands that have been classified as nationally or regionally valuable
- Representative seminatural grassland sites with a long, fully or almost uninterrupted management history
- Seminatural grassland sites that have been managed exclusively by mowing and without any interruptions
- Diverse interconnected entities of seminatural grasslands
- Calcareous seminatural grassland types
- Seashore meadows with salt patches
- Wooded pastures with exacting deciduous trees
- Alluvial meadows located by non-constructed and non-regulated streams
- Traditionally managed wooded meadows
- Traditionally managed fen meadows

Development needs
It would be easier to find offset sites for biodiversity offsetting if the occurrence data concerning seminatural grasslands was supplemented by specific habitat type data. Regular and frequent updates to inventory data are also needed to identify the current status and management needs of seminatural grassland sites.

FACT BOX 3

Costs arising from seminatural grassland management

Calculated per hectare, the management of seminatural grasslands is more expensive than that of other habitat types as management often needs to take place every year. Mowing is highly labour-intensive, but extensive sites in particular can also be mowed by machine. In relation to the biodiversity gains achieved, however, management is not expensive. Biodiversity gains can be examined on the basis of, for example, the number of threatened species benefitting from management per hectare. In many cases, management also delivers other gains such as improvements in the landscape and opportunities for recreational use. The management of seminatural grasslands can often be incorporated into the activities of rural entrepreneurs, in which cases it also benefits, for example, cattle and sheep farms, local food production and tourism.

In the ELITE project, the costs of seminatural grassland management were assessed as follows: grazing costs EUR 875/ha per year, including maintenance clearing, and mowing costs EUR 2,121/ha per year, including collection of mowing waste. When management commences in a site where vegetation has overgrown due to lack of management, basic rehabilitation is needed first, with its costs estimated to total EUR 1,862/ha. Any potential timber sale income generated from basic rehabilitation was not taken into account in the calculations. (Raatikainen et al. 2015)

Active farmers and registered associations may receive agri-environmental aid for the management of seminatural grasslands once they have entered into an agreement on farmland biodiversity and landscape management with a centre for economic development, transport and the environment. In 2017, the aid for nationally or regionally valuable inventoried seminatural grasslands amounted to EUR 600/ha per year and for other sites EUR 450/ha per year. Applications can be submitted for support for non-productive investments for the basic rehabilitation of new sites which are to be fenced off and require a great deal of clearing. (Finnish Agency for Rural Affairs 2017)

Table 8. Suitability of seminatural grassland habitat types for biodiversity offsetting. The classifications used are described in Chapter 3, and further information about the habitat types assessed can be found in Appendix 1. Threat status is given as a range (e.g. LC–VU) whenever a habitat type includes multiple habitat types of more specific classification levels whose threat status classifications differ from each other (see Appendix 1).

SEMINATURAL GRASSLANDS				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Heaths EN–CR	2. Yes, for some habitat types	1. Good	1b Biodiversity losses can be offset by improving the status of the same habitat type		x		x		x	x	x	Heaths are highly threatened but suitable for biodiversity offsetting because there are lots of sites that are poor in quality or have already been altered and whose values can be recovered through management measures. Without management, the habitat type is at risk of extinction, and offset measures can provide new opportunities to organise management.	Low-herb and graminoid dwarf shrub heaths are currently the rarest types as they have in many places been affected by increased dwarf shrub cover, and biodiversity losses of remaining sites must absolutely be avoided. Their characteristics can, however, be recovered through management.
Rock meadows EN–CR	2. Yes, for some habitat types	1. Good	1b Biodiversity losses can be offset by improving the status of the same habitat type		x		x		x	x	x	Rock meadows are highly threatened but suitable for biodiversity offsetting because there are numerous sites whose quality is poor or which have already been altered and their values can be recovered through management measures. Without management, the habitat type is at risk of extinction, and offset measures can offer new opportunities to organise management.	Calcareous rock meadows are the rarest and most threatened in terms of their species, their biodiversity losses must be avoided in particular and it may be difficult to find offset sites for them.
Dry meadows CR	3. Yes, in parts of the country	1. Good	1b Biodiversity losses can be offset by improving the status of the same habitat type		x		x		x	x	x	Dry meadows are highly threatened but suitable for biodiversity offsetting because there are plenty of sites that are poor in quality or already altered and their values can be recovered through management measures. Without management, the habitat type is at risk of extinction, and offset measures can offer new opportunities to organise management.	Calcareous dry meadows have more specific soil requirements than other dry meadows and are rare. Their biodiversity losses must be avoided in particular and it may be difficult to find offset sites.

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

SEMINATURAL GRASSLANDS				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Mesic meadows EN–CR	2. Yes, for some habitat types	1. Good	1b Biodiversity losses can be offset by improving the status of the same habitat type		x		x		x	x	(x)	Mesic meadows are highly threatened but suitable for biodiversity offsetting because there are plenty of sites whose quality is poor or which have already been altered and their values can be recovered through management measures. Without management, the habitat type is at risk of extinction, and offset measures can offer new opportunities to organise management.	Low-herb rich mesic meadows, particularly those occurring on calcareous soil, are the rarest. Particularly valuable are those few low-herb rich mesic meadows that have been managed exclusively by mowing and without any interruptions to their management.
Moist meadows CR	2. Yes, for some habitat types	1. Good	1b Biodiversity losses can be offset by improving the status of the same habitat type		x		x		x	x	(x)	Moist meadows are highly threatened but suitable for biodiversity offsetting because values of sites which are of poor quality or have already been altered can be recovered through management measures. Without management, the habitat type is at risk of extinction and offset measures can offer new opportunities to organise management. Moist meadows become overgrown more quickly than dry and mesic meadows, so their management is urgently needed	There are hardly any representative moist meadows left, whereby the occurrences and ecology of the habitat type are known more poorly than those of many other meadow types. Calcareous moist meadows are the rarest and most valuable types in terms of their species and can only be found in the Åland Islands and Finland's southwestern archipelago.
Freshwater meadows EN-CR	5. No	1. Good	1b Biodiversity losses can be offset by improving the status of the same habitat type		x				x	x	(x)	Freshwater meadows are highly threatened but suitable for biodiversity offsetting because there are lots of sites which are poor in quality or have already been altered and whose values can be recovered through management measures. Without management, the habitat type is at risk of extinction, and offset measures can provide new opportunities to organise management.	The habitat type is the rarest in coastal areas with few lakes ranging from Southwestern Finland to North Ostrobothnia.

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

SEMINATURAL GRASSLANDS				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Seashore meadows EN–CR	2. Yes, for some habitat types	1. Good	1b Biodiversity losses can be offset by improving the status of the same habitat type		x		x		x	x	(x)	Seashore meadows are highly threatened but suitable for biodiversity offsetting because there are lots of sites which are poor in quality or have already been altered and whose values can be recovered through management measures. Without management, the habitat type is the risk of extinction and offset measures can offer new opportunities to organise management. It is often easier to organise grazing than for other meadow types because sites are larger.	The rarest types are seashore meadows with salt patches, and their biodiversity losses must be avoided in particular.
Alluvial meadows NT–CR	2. Yes, for some habitat types	2. Moderate	2a Biodiversity losses must be avoided, status improvement possible		x	x		(x)	x	x	(x)	Alluvial meadows differ from most other seminatural grassland types in that mowing or grazing alone will not maintain their characteristics over the long term but, instead, flooding is also required. This restricts the availability of suitable offset sites. If there is natural flooding, management through clearing and mowing is sufficient to improve their status. If flooding has decreased due to reasons including hydraulic construction restoration will require more extensive measures to re-introduce flooding.	Alluvial meadows located by non-constructed and non-regulated streams are particularly valuable and their biodiversity losses must be avoided in particular. Dry and mesic low-herb alluvial meadows are currently the rarest among Finland's alluvial meadow types.
Fen meadows CR	1. Yes	2. Moderate	3a Biodiversity losses must not take place, status improvement possible		(x)	x	x		x	x	x	It is difficult to find offset sites for fen meadows because fen meadows which have even in part been managed traditionally have been almost fully lost. Management is more demanding than with other seminatural grassland types because it may also require the flooding of the fen meadow.	

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

SEMINATURAL GRASSLANDS				Suitable offsetting principles				Offset measures					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Wooded meadows CR–RE	1. Yes	1. Good	3a Biodiversity losses must not take place, status improvement possible		(x)	x	x		x	x	x	It is difficult to find offset sites for wooded meadows because wooded meadows which have even in part been managed traditionally have been almost fully lost. Management is effective but more demanding and labour-intensive than with other seminatural grassland types because it requires several different measures and involves multiple phases.	Wooded meadows may be particularly valuable in terms of their plant species (incl. epiphytic lichens and mosses growing on trees), and threatened species must be taken into account when planning management measures.
Wooded pastures CR	2. Yes, for some habitat types	1. Good	1b Biodiversity losses can be offset by improving the status of the same habitat type		x		x		x	x	(x)	Wooded pastures are highly threatened but suitable for biodiversity offsetting because there are lots of sites whose quality is poor or that have already been altered and whose values can be recovered through management measures. Without management, the habitat type is at risk of extinction, and offset measures can provide new opportunities to organise management.	Wooded pastures dominated by exacting deciduous trees are the rarest and the most diverse in terms of their species.
Grazed woodlands EN–CR	5. No	1. Good	1b Biodiversity losses can be offset by improving the status of the same habitat type	(x)	x				x	x	(x)	Grazed woodlands are highly threatened but suitable for biodiversity offsetting because there are plenty of sites whose quality is poor or which have already been altered and their values can be recovered through management measures. Without management, the habitat type is at risk of extinction, and offset measures can offer new opportunities to organise management	Although currently the most abundant seminatural grassland type and also managed in several sites with support in the form of agri-environmental aid, representative sites are very rare because the current grazing practices often differ from traditional ones.

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

6.8 Fell area

Suitability for biodiversity offsetting

Biodiversity losses of the fell area habitat types may be more difficult to offset than those of other areas as there are usually no quick and easy-to-implement measures available to improve the status of offset sites. This is because fell habitats are impacted extensively by climate change and reindeer grazing, which may make it difficult to improve the status of offset sites. Methods for status improvement and biodiversity offsetting should be developed for the fell area, too, because the need for offsetting is increasing as usage pressure grows. For example, to offset biodiversity losses caused by a construction project to fell area habitat types, protecting another area or restoring habitat types other than fell area ones may in some cases be the only way to achieve at least limited-loss offsets. Offset sites which can be rehabilitated can be found in areas such as those suffering from wear caused by recreational use.

The impacts of climate change, grazing and other land use on habitat types in the fell area are interconnected in a complex manner. In some fell area habitat types, biodiversity losses caused by climate change can already be observed, and impacts are difficult to prevent or mitigate through restoration or management. The impacts of reindeer grazing depend on the rate of grazing pressure and adequacy of grazing rotation. Reasonable grazing is part of the ecology of many fell area habitat types. Strong grazing pressure may restrain overgrowing of vegetation caused by climate change and prevent the spread of mountain birch forests further up fells. On the other hand, strong grazing pressure may reduce the amount of mountain birch forests by preventing their regeneration following damage caused by geometrid defoliators and deteriorate the quality of lichen-rich fell area habitat types in particular. Fragmentation of grazing land due to other land use, such as forestry and construction, adds to the grazing pressure in some areas.

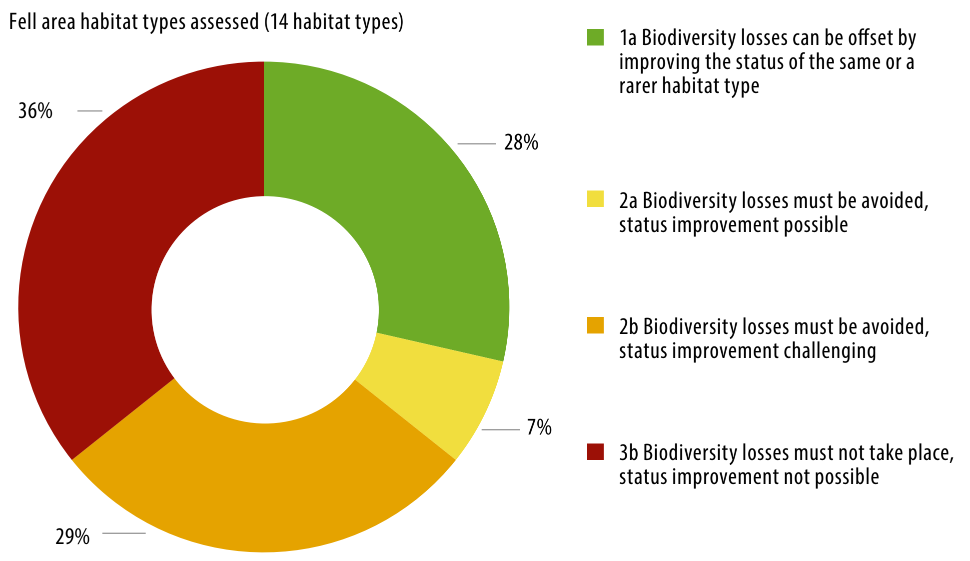
Some fell area habitat types can be regarded as suitable for biodiversity offsetting on the grounds that they are common (Figure 9, Table 9), but the challenges described above still also need to be taken into account in offset implementation concerning them. Mountain birch forests have suffered from strong reindeer grazing pressure as well as damage caused by mass occurrences of *Epirrita autumnata*. Intensive reindeer grazing has caused status deteriorations of mountain heath scrubs and oligotrophic mountain heaths. There are currently no major threats faced by mountain oligotrophic and mesotrophic bedrock outcrops and boulder fields.

The suitability of a few rarer habitat types for biodiversity offsetting is more uncertain. Herb-rich mountain birch forests and mountain meadows have been degraded locally due to strong grazing pressure, but the capacity of mountain meadows in particular to recover from grazing is good. Appropriate grazing may prevent excessive overgrowing potentially caused by climate change. Global warming caused by climate change is a threat also to low-graminoid mountain heaths. This is an open habitat type occurring in the middle oroarctic zone that is not able to move further up the fell in all of its occurrence areas in response to changes in temperature and vegetation. Created through rock and ground movement caused by ground frost, frost-influenced heaths and patterned grounds are susceptible to climate change, and decreased ground frost results in their degeneration including overgrowth.

A few fell area habitat types have been assessed as being so rare, threatened and important in terms of their species that they are not regarded as suitable for biodiversity offsetting. Those threatened most clearly by climate change are snowbeds and snow patches, which are dependent on the occurrence of snow in the summer. There are no known methods available for their recovery or status improvement. They may shrink and disappear relatively quickly as the period with snow cover shortens due to climate change. Rare *Dryas octopetala* mountain heaths have been degraded by intensive reindeer grazing. Mountain calcareous bedrock outcrops and boulder fields, mountain ultramafic bedrock outcrops and bounder fields and calcareous talus formations are rare habitat types with their respective special and threatened species. There are no good methods available for their recovery or status improvements.

A few fell area habitat types are discussed in this report in conjunction with other habitat type groups: streams of fell area, North Lapland lakes, and fjeld ponds and small lakes (included in the ponds and lakes habitat type) under inland waters (Section 6.3) and palsa mires and oroarctic mires in conjunction with mires (Section 6.4).

Figure 9. Suitability of fell area habitat types for biodiversity offsetting.



State of knowledge

The State of Finland is a significant landowner in the fell area, and various types of protected areas and wilderness reserves cover around 90% of the area (Sihvo et al. 2007). The Metsähallitus geographic information system on protected areas (SAKTI) contains data based on aerial photo interpretation of the occurrence of habitat types collected on the fell area mainly in the period 1996–1999 (Eeronheimo 1996, Sihvo 2001, 2002). It is not possible to distinguish all fell habitat types through aerial photo interpretation, and therefore the geodata on fell area habitat types is not comprehensive. More specific onsite inventories have later been conducted in the fell area to survey habitat types that are rare and small in terms of their area. Regional surveys and studies provide some data on the finest-grained habitat and vegetation types. Examples of these include publications relating to the management, use and nomenclature produced for management and usage plans of wilderness reserves and nature reserves.

There is quite a lot of research into the impacts of reindeer summer and winter grazing on vegetation (e.g. Oksanen & Virtanen 1995, Väre et al. 1996, Helle et al. 1998, Löffler 2000, Kumpula 2001, den Herder & Niemelä 2003, den Herder et al. 2004, Kumpula et al. 2004, 2011). On the basis of these studies, it can be said that the impact of winter grazing on vegetation is not as intensive as that of grazing during summer. Consequently, increasing the efficiency of grazing rotation would have a positive impact on the condition of grazing land. There is hardly any previous experience or research data concerning other methods to improve the status of fell area habitat types. In the early 2000s, Parks & Wildlife Finland of the state-owned enterprise Metsähallitus formulated a plan to restore mountain birch forests destroyed by Epirrita autumnata moths in Utsjoki, Finland, but the plan could not be implemented due to lack of funding (Kotiaho & Kumpula 2015).

Need for restoration and management

The qualitative deterioration of habitat types covers most of the fell area even though the fell area habitat types have not been reduced strongly in terms of their area. The status of many fell area habitat types is being adversely affected by excessive grazing pressure, which in this context means intensive feeding and trampling on lichens, *Betula pubescens ssp. czerepanovii* and other vegetation, particularly during the summer. According to the 2008 assessment of threatened habitat types in Finland, intensive reindeer grazing is the cause of the higher threat status of 60% of the habitat types assessed as threatened or near threatened (Raunio et al. 2008). Locally excessive grazing pressure can be made less intensive by increasing the efficiency of grazing rotation by means of leading reindeer to grazing areas that are more tolerant of wear in the summer and using lichen areas only for winter grazing. Alongside reindeer grazing, tourism, hiking and off-road vehicle use also cause localised wear.

Climate change has already resulted in changes in some fell area habitat types. Climate change increases the overgrowing of open habitat types and alters the structure of plant communities. It may also increase insect damage such as defoliation caused by *Epirrita autumnata* and *Oreophtera brumata* in mountain birch forests. Global warming is projected to result in the spread of *Betula pubescens ssp*. *czerepanovii* and *Pinus sylvestris* to higher altitudes on fells, which may reduce the distribution of oroarctic habitat types. On the other hand, reindeer grazing mitigates the effects of climate change by restricting forest colonisation. The most climate-sensitive habitat types are snowbeds and snow patches (and palsa mires discussed in Section 6.4), which may shrink and disappear relatively quickly as the period with snow cover shortens. There are no methods available other than action to curb climate change to prevent their degeneration. Frost-influenced heaths and pattered grounds are dependent on ground frost, and decreased ground frost results in their degeneration including overgrowth. (Raunio et al. 2008)

Factors deteriorating the status of the habitat type and methods of restoration and management

In this assessment, measures taken to prevent climate change are not included in biodiversity offset measures improving the status of habitat types as their scale and the targeting of their effectiveness are not relevant from the biodiversity offsetting perspective. For some special sites, however, it may be possible to reduce climate change impacts by, for example, using management measures to restrict overgrowing or alteration of species composition. Increased efficiency of grazing rotation would reduce the adverse effects of reindeer grazing on habitat types, but the capacities of small reindeer herding cooperatives in particular may be low due to lack of suitable areas.

Excessive grazing pressure

- increasing the efficiency of grazing rotation by using separate summer and winter
- grazing areas and restricting summer grazing to areas with higher tolerance of wear
- adjusting the number of reindeer to the natural wear tolerance of grazing areas
- fencing off small vulnerable sites (e.g. occurrences of threatened species)

Decrease in the oroarctic zone of fells due to overgrowing and rise of the timberline

- adjusting reindeer grazing pressure to maintain natural structure and functional features of open habitat types (it should be noted that reindeer herding does not prevent the spread of conifers)
- in special sites, clearing and removing vegetation and trees

Wear, quality deterioration and size reduction of fell area habitat types caused by hiking routes and tourism

- taking sensitive habitat types into account in the planning and construction of hiking routes and other tourism-related construction
- improving existing routes so that they will not spread out into their surroundings

Permanence of biodiversity offsets

A substantial part of the occurrences of most fell area habitat types are already in areas which are protected or the use of which is restricted, but protection does not prevent factors that cause extensive biodiversity losses, such as intensive reindeer grazing pressure or climate change. The alteration of fell area habitat types taking place as climate change progresses poses considerable challenges as regards the permanence of their status improvement.

Challenges faced in biodiversity offsetting

Projects that cause the loss of habitat type occurrences may involve the problem of how to offset the loss by improving the status of fell habitat types elsewhere. In some situations it might be possible to consider status improvements of entirely different habitat types, such as seminatural grasslands, as appropriate offsets, but in those cases the offset site would usually be located far away from the impact area.

Climate change is very likely to alter fell area habitat types in the next few decades, which increases the need to improve their status. With climate change and intensive reindeer grazing continuing, the development of status improvement methods calls for new initiatives and cooperation between a variety parties. For some habitat types, the most efficient measure to improve their status would be to increase the efficiency of reindeer grazing rotation or to reduce the number of reindeer. A working group of the Ministry of Agriculture and Forestry of Finland sets the maximum permitted number for each reindeer herding co-operative. Regulating grazing pressure is currently difficult to implement as an offset method.

Habitat types and sites whose biodiversity losses must be avoided in particular

- good-quality mountain birch forest occurrences
- among mountain birch forests, *Empertum* mountain birch forests and fern-rich mountain birch forests
- *Dryas octopetala*, *Cassiope tetragona* and *Calluna* mountain heaths
- snowbeds and snow patches
- mountain ultramafic bedrock outcrops and boulder fields
- calcareous talus formations

Development needs

Further research and surveys are needed concerning the biodiversity effects of increased grazing rotation efficiency, potential for reindeer herding cooperatives to increase grazing rotation efficiency, and impacts of climate change on the various fell area habitat types. Research and experiments concerning means to combat climate change impacts in various fell area environments would also be necessary. Data on the occurrence of the various fell area habitat types should be made more specific.

Table 9. Suitability of fell area habitat types for biodiversity offsetting. The classifications used are described in Chapter 3, and further information about the habitat types assessed can be found in Appendix 1. Threat status is given as a range (e.g. LC–VU) whenever a habitat type includes multiple habitat types of more specific classification levels whose threat status classifications differ from each other (see Appendix 1).

	FELL AREA				Suitable offsetting principles				Offset measures					
	Habitat type and IUCN Red List Category	Rarity to be taken into account in offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	A	B	C	D	E	F	G	H	Reasoning of assessment	Preconditions in addition to general preconditions
	Mountain birch forests NT–VU	2. Yes, for some habitat	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	x	x			x			x	Mountain birch forests are a common and broad-ranging habitat type whose status has deteriorated to some extent due to intensive reindeer grazing pressure in the summer. Mountain birch forests are also threatened by climate change, but not as strongly as the open fell area habitat types, and some mountain birch forest types may expand as a result of climate change. Restoration of areas damaged by geometrid defoliator moths (if possible), improved grazing rotation and protection of sites vulnerable to wear in recreational areas can be used as offsets.	Empetrum mountain birch forests are a rarer type of mountain birch forest than the others and occurs in marine climate areas mainly in northwestern parts of Käsivarsi, Finland's northwestern "arm", and in the Karigasniemi area.
	Herb-rich mountain birch forests NT	1. Yes	3. Uncertain	2b Biodiversity losses must be avoided, status improvement is		x			x			x	Herb-rich mountain birch forests are a rare habitat type that is vulnerable to wear and has been degraded locally by reindeer grazing. The status of degraded herb-rich mountain birch forests could be improved by improving grazing rotation.	Fern-rich mountain birch forests are a rare habitat type and their biodiversity losses must be avoided.

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

FELL AREA				**Suitable offsetting principles**				**Offset measures**					
Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
Mountain heath scrubs LC–NT	2. Yes, for some habitat	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	x	x			x				Mountain heath scrubs are generally suitable for biodiversity offsetting, and increasing the efficiency of grazing rotation is the most efficient way to improve the status of degraded sites. Mountain birch scrubs in particular occur in relative abundance. There are no major threats to mountain juniper scrubs, and their biodiversity may benefit from grazing. Mountain *Salix* scrubs may benefit from climate change.	
Oligotrophic mountain heaths NT–VU	2. Yes, for some habitat types	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	x	x					x		Oligotrophic mountain heaths are fairly common habitat types whose threat status is based on quality deterioration. Means of improving their status include reducing wear and reindeer grazing pressure in degraded sites.	Biodiversity losses of *Cassiope tetragona* and *Calluna* mountain heaths must be avoided.
Dryas octopetala **mountain heaths VU**	1. Yes	3. Uncertain	3b Biodiversity losses must not take place, status improvement not possible			x		x		x		Biodiversity losses of this habitat type should be avoided because it is rare and faces threats. It may be difficult to improve the status of sites whose quality has deteriorated. Status improvement methods mainly include reducing wear and reindeer grazing pressure in degraded sites.	
Low-graminoid mountain heaths LC	2. Yes, for some habitat types	5. No status improvement methods	2b Biodiversity losses must be avoided, status improvement challenging		x			x				The habitat type has remained more or less unchanged in terms of quality and quantity, but climate change is a clear threat. The habitat type occurs in middle oroarctic zone whose area will decrease due to climate change. There are no status improvement methods. *Nardus strita* mountain heaths in particular are very rare. It would be difficult to offset biodiversity losses of the habitat type.	Biodiversity losses of *Nardus stricta* mountain heaths in particular must be avoided.

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

	FELL AREA				Suitable offsetting principles				Offset measures					
	Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
	Mountain meadows LC–NT	1. Yes	2. Moderate	2b Biodiversity losses must be avoided, status improvement possible		x					x		The quality and quantity of mountain meadows is assessed to have remained unchanged, but they are rare. They are threatened locally by strong grazing pressure, but they have good capacity to recover from grazing. In some sites, suitable grazing pressure may restrict overgrowing caused by climate change.	The occurrences of this rare habitat type are usually very small in area, and climate change is a threat over the long term. Significant reductions in the habitat type must be avoided.
	Snowbeds and snow patches LC–EN	1. Yes	5. No status improvement methods	3b Biodiversity losses must not take place, status improvement not possible									There are no means available to recover snowbeds or snow patches or to improve their status. The habitat type is very rare and climate change will reduce its occurrences. Impacts are in part unclear as increased precipitation may also increase snowfall. The most obviously threatened are those snowbed types which typically retain their snow cover far into the summer.	
	Patterned grounds LC	5. No	5. No status improvement methods	2b Biodiversity losses must be avoided, status improvement challenging		x							The occurrence area is limited and over the long term the habitat type may be threatened by climate change; reduced ground frost results in increased overgrowth of vegetation. There are no actual known restoration or recovery methods.	
	Frost-influenced heaths LC	5. No	5. No status improvement methods	2b Biodiversity losses must be avoided, status improvement challenging		x							The occurrence area is limited and over the long term the habitat type may be threatened by climate change; reduced ground frost results in increased overgrowth of vegetation. There are no actual known restoration or recovery methods.	

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

	FELL AREA				Suitable offsetting principles				Offset measures					
	Habitat type and IUCN Red List Category	**Rarity to be taken into account in offsetting**	**Effectiveness of restoration/management methods**	**Suitability for biodiversity offsetting**	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**Reasoning of assessment**	**Preconditions in addition to general preconditions**
	Mountain oligotrophic and mesotrophic bedrock outcrops and boulder fields LC	5. No	4. Unknown	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	x	x							Assessed as having remained unchanged in terms of quality and quantity, with no significant threats to the habitat type. Although occurring extensively in Tunturi Lapland, some of the habitat types in this group are relatively rare.	
	Mountain calcareous bedrock outcrops and boulder fields NT	1. Yes	4. Unknown	3b Biodiversity losses must not take place, status improvement not possible									Mountain calcareous bedrock outcrops and boulder fields occur in a relatively small area and they involve significant species values.	
	Mountain ultramafic bedrock outcrops and boulder fields NT	1. Yes	4. Unknown	3b Biodiversity losses must not take place, status improvement not possible									Mountain ultramafic bedrock outcrops and boulder fields occur in a very small area and they involve significant species values.	
	Calcareous talus formations NT	1. Yes	4. Unknown	3b Biodiversity losses must not take place, status improvement not possible									Calcareous talus formations only occur in an area of around ten hectares in four locations on large fells of the northern part of the northwestern Käsivarsi "arm" of Finland. They are to some extent threatened by wear caused by reindeer grazing. The habitat type involves significant species values.	

Suitable biodiversity offsetting principles: A = Offsetting using a rarer habitat type, B = Offsetting using an equivalent habitat type, C = Avoidance particularly important, suitable as offsets for losses of more common habitat types, D = Avoidance particularly important but benefits from restoration/management
Offset measures: E = Once-off or infrequent measure, F = Repeated measure, G = Continuous management, H = Permanent protection.

7. Summary and conclusions

7.1 Summary of findings

A summary of the suitability of habitat types for biodiversity offsetting categories used in this work can be found in Table 10 and Figure 10. Of the 99 habitat types covered by this report, 41 were assessed to fall under **category 1**, that is, being suitable for biodiversity offsetting provided that the general preconditions are met. Consequently, according to the assessment, 41% of the habitat types are common enough for it to be possible to offset biodiversity losses caused to their ordinary or already degraded occurrences. Offset measures can be implemented by improving the status of the same or a rarer habitat type for 23 of the assessed habitat types (**category 1a**). For 18 of the habitat types, offsetting should take place by improving the status of the same habitat type (**category 1b**). The relatively large proportion of habitat types which are suitable for biodiversity offsetting results in particular from the fact that many of Finland's habitat types are still common and not yet irreversibly altered by human activity. Finland already has a long track record of restoration, rehabilitation and nature management of many habitat types, so there are effective and reliable methods available to improve their status.

Category 1a contains forest, mire, inland waters and shores, coastal, rock outcrop and fell area habitat types which are common and extensive in Finland and whose overall status is not, as a rule, threatened by local degeneration. This makes it possible to assess the targeting of resources used for their offsetting more appropriately from the nature conservation perspective. Some of the habitat types of this category, such as the Baltic Sea filamentous algal zone and coastal reedbeds, are continuously increasing in abundance because of human activity, and it does not make sense to create them as offset measures. Therefore biodiversity losses of these habitat types should preferably be offset by improving the status of a rarer habitat type. For other habitat types assessed as falling under category 1a, targeting offset measures at the same habitat type may be justifiable to secure, for example, recreational use or other ecosystem services, such as water or nutrient retention. To improve the functioning of the network of habitats, it is also recommendable to restore habitats suitable for rare and valuable species near known Category 1b contains a group of habitat types whose restoration or management is important and with a large proportion of their occurrences having deteriorated in quality. Most of them are threatened. Degeneration or destruction of occurrences that have already been subjected to losses can be offset by restoring or managing other occurrences of the same habitat type. There are numerous occurrences of category 1b habitat types whose status has deteriorated, and there is a great need from the biodiversity perspective to improve their status. It is important to also take the species and connectivity of the sites into account in the selection and location of offset sites. Status improvements of these habitat types can also serve as offsets of biodiversity losses of habitat types of category 1a.

A third of habitat types in category 1b are seminatural grasslands the preservation of whose nature values usually requires management repeated every year. In many cases, managing a seminatural grassland occurrence which has been degraded and not been managed also first requires a once-off rehabilitation measure. In most cases, preserving the nature values of herb-rich forests and esker forests, the forest habitat types assessed as belonging to category 1b, requires management measures repeated from time to time. There are effective restoration methods available for the rehabilitation of category 1b mire habitat types and low-humic and humic first-order and headwater streams.

A third (34) of the habitat types assessed fall under **category 2**, and any biodiversity losses of habitat types in this category must for various reasons primarily be avoided. The habitat types of this category are mainly threatened, most are quite rare and many are typically valuable in terms of their species. Biodiversity offsetting concerning category 2 habitat types often involves specific preconditions and the need for case-specific consideration is greater than with category 1. However, it may be possible to use offsets to compensate for biodiversity losses of those sites of category 2 habitat types which are of the poorest quality, strongly altered and therefore less significant for biodiversity.

A smaller proportion (12 habitat types) of category 2 habitat types are such that there are methods available to improve their status (**category 2a**). This means that it would be possible to restore or manage these habitat types, especially as offsets of biodiversity losses caused to habitat types of category 1a. It may also be possible to offset biodiversity losses of poor-quality category 2a sites by improving the status of an equivalent habitat type. There is some previous experience of the restoration or management of forest habitat types of this category (herb-rich forests with broadleaved deciduous trees, hardwood forests on podsolic soils, inland dune forests and barren heath forests) and the primary methods are known. Monitoring of restoration and management outcomes and development of methods are, of course, still needed. The same applies to Baltic Sea coastal sand beaches whose rehabilitation and management require measures to be repeated from time to time if the adverse effects of eutrophication persist and alien species cannot be controlled. There is also previous experience of the restoration of springs and, if correctly implemented for suitable sites, this can be used as an offset measure.

Status improvements of four inland waters habitat types assessed as falling under category 2a (low-humic lakes, naturally eutrophic lakes, naturally eutrophic ponds and small lakes, low-humic and humic streams) are more difficult and potentially expensive to achieve. This is because a variety of measures throughout the catchment area are often needed. Status improvements may also take a long time to achieve, and reaching the desired outcome is uncertain. Alluvial meadows are an example of a habitat type where offset gains can be delivered but whose ecological status is difficult to improve because the restoration of the habitat type requires the restoration of the flood cycle at least for part of the stream, which in most cases means altering the regulation of the stream.

A larger proportion of category 2 habitat types (22 habitat types) are such that there are no means to improve their status or the effectiveness of the methods is uncertain (**category 2b**). Consequently, their inclusion in biodiversity offsetting procedures as offset sites is not, as a general rule, justifiable, with the exception of habitat types whose status improvement methods could be developed. The protection of some category 2b habitat types can in some cases be used as an offset method to offset biodiversity losses of more common habitat types. These include rich fens, mire succession series of land uplift coast, flada-lakes and glo-lakes (costal lagoons) and Baltic esker islands.

Category 2b includes underwater Baltic Sea habitat types (6 habitat types) whose status improvements depend primarily on the water quality of the Baltic Sea. Otherwise, the category contains habitat types for which it is unlikely to be possible to develop meaningful measures for status improvements (Fe and Cu sulphide-rich rock outcrops, patterned grounds and frost-influenced heaths) as well as those whose status improvement methods require a great deal of further development (rich fens, coastal estuaries as well as flada-lakes and glo-lakes).

Category 3 covers a quarter (24 habitat types) of the assessed habitat types. Because the habitat types belonging to this category are rare and threatened or their occurrences are typically unique, every effort must be made to avoid the degeneration and destruction of their occurrences.

Of the habitat types in this category, 14 are such that there are methods available to improve their status (**category 3a**), making them suitable for use as offset sites to compensate for biodiversity losses of category 1a habitat types. This category includes the rarest or most threatened inland waters habitat types whose water quality can be improved and natural state fully or partially restored. Category 3a also covers habitat

types including coastal dunes, calcareous rock outcrops, fen meadows and wooded meadows, which need measures to restrict overgrowing, as well as wooded swamps and inland flooded forests, which benefit from the restoration of natural hydrology.

Category 3b contains ten habitat types for which there are, at least so far, no effective status improvement methods. This category also includes habitat types such as palsa mires, snowbeds and snow patches which face the threat of being lost due to climate change.

Figure 10. Breakdown of habitat types included in the assessment (99 habitat types) into suitability categories.

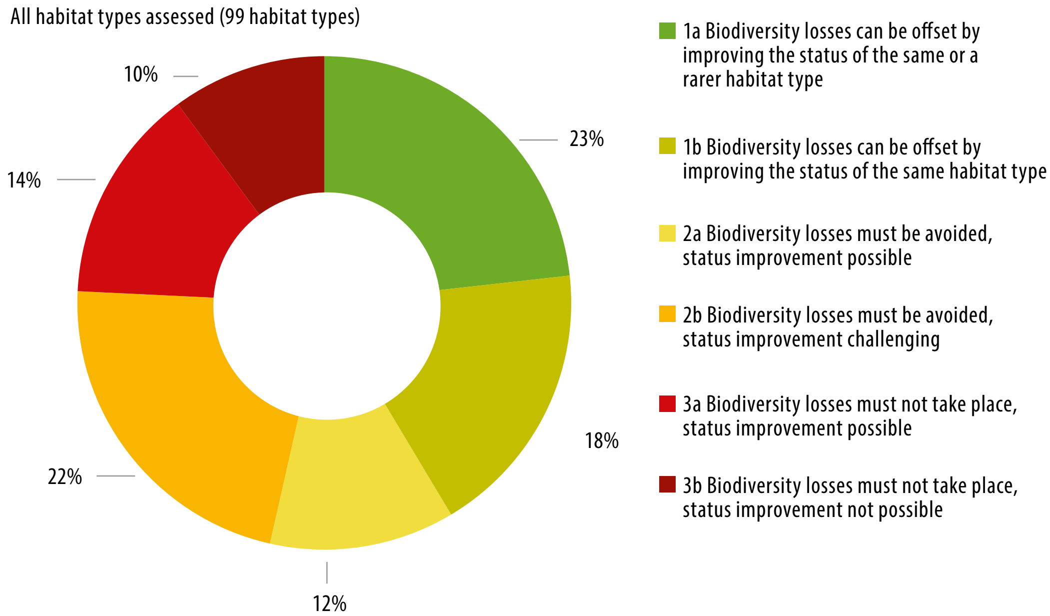


Table 10. Suitability categories used in the assessment and habitat types classified under them by habitat type group.

1 SUITABLE FOR BIODIVERSITY OFFSETTING SUBJECT TO GENERAL PRECONDITIONS (41 habitat types = 41.4%)	
1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type (23 habitat types)	
- filamentous algal zone	BALTIC SEA (1)
- coastal gravel, shingle and boulder shores - coastal reedbeds - coastal scrubs - islands and islets in outer archipelago	COASTAL HABITATS (4)
- humic lakes - ponds and small lakes - stony and bushy lake shores - streams of fell area	INLAND WATERS AND SHORES (4)
- pine mires and bogs - pine fens - fens	MIRES (3)
- herb-rich heath forests - mesic heath forests - sub-xeric heath forests - xeric heath forests - forests on rocky terrain	FORESTS (5)
- siliceous rock outcrops - scree	ROCK OUTCROPS AND SCREE (2)
- mountain birch forests - mountain health scrubs - oligotrophic mountain heaths - mountain oligotrophic and mesotrophic bedrock outcrops and boulder fields	FELL AREA (4)

1b Biodiversity losses can be offset by improving the status of the same habitat type (18 habitat types)	
- low-humic and humic first-order and headwater streams	INLAND WATERS AND SHORES (1)
- spruce mires - spruce-birch fens - raised bogs - northern boreal aapa mires - sloping fens - shrub swamps and open swamps	MIRES (6)
- herb-rich forests - esker forests	FORESTS (2)
- heaths - rock meadows - dry meadows - mesic meadows - moist meadows - freshwater meadows - seashore meadows - wooded pastures - grazed woodlands	SEMINATURAL GRASSLANDS (9)

2 SUCCESS OF BIODIVERSITY OFFSETTING UNCERTAIN (34 habitat types = 34.3%)	
2a Biodiversity losses must be avoided, status improvement possible (12 habitat types)	
- Baltic Sea coastal sand beaches	COASTAL HABITATS (1)
- low-humic lake - naturally eutrophic lakes - naturally eutrophic ponds and small lakes - spring complexes - low-humic and humic streams	INLAND WATERS AND SHORES (5)
- herb-rich forests with broadleaved deciduous trees - inland dune forests - hardwood forests on podsolic soils - barren heath forests	FORESTS (4)
- alluvial meadows	SEMINATURAL GRASSLANDS (1)
- mountain meadows	FELL AREA (1)
2a Biodiversity losses must be avoided, status improvement challenging (22 habitat types)	
- *Fucus spp.* communities - red algae communities - bottom dominated by submerged macrophytes - charophyte meadows - blue mussel communities - zoobenthic communities	BALTIC SEA (6)
- drift lines with *Fucus* spp. - flada-lakes and glo-lakes (coastal lagoons) - succession series of natural forests on the land uplift coast	COASTAL HABITATS (5)

- coastal estuaries - Baltic esker islands	
- North Lapland lakes - sandy lake shores - large rivers	INLAND WATERS AND SHORES (3)
- rich fens - middle boreal aapa mires - oroarctic mires	MIRES (3)
- Fe and Cu sulphide-rich rock outcrops	ROCK OUTCROPS AND SCREE (1)
- herb-rich mountain birch forests - low-graminoid mountain heaths - patterned grounds - frost-influenced heaths	FELL AREA (4)

3 GENERALLY NOT SUITABLE FOR BIODIVERSITY OFFSETTING (24 habitat types = 24.2%)	
3a Biodiversity losses must not take place, status improvement possible (14 habitat types)	
- coastal dunes - developmental series of coastal dunes	COASTAL HABITATS (2)
- chalky lakes - chalky ponds and small lakes - Cratoneurion spring complexes - first-order and headwater streams in clay-dominated catchment areas - streams in clay-dominated catchment areas	INLAND WATERS AND SHORES (5)
- wooded swamps - mire succession series of land uplift coast	MIRES (2)
- inland flooded forests - forests on ultrabasic soils	FORESTS (2)
- calcareous rock outcrops	ROCK OUTCROPS AND SCREE (1)
- fen meadows - wooded meadows	SEMINATURAL GRASSLANDS (2)
3b Biodiversity losses must not take place, status improvement not possible (10 habitat types)	
- *Zostera marina* communities	BALTIC SEA (1)
- spring ponds and small lakes	INLAND WATERS AND SHORES (1)
- palsa mires	MIRES (1)
- serpentine rock outcrops and scree - canyons and caves	ROCK OUTCROPS AND SCREE (2)
- *Dryas octopetala* mountain heaths - snowbeds and snow patches - mountain calcareous bedrock outcrops and boulder fields - mountain ultramafic bedrock outcrops and boulder fields - calcareous talus formations	FELL AREA (5)

7.2 Development needs

If biodiversity offsetting is to be utilised to improve the state of biodiversity, the mechanism should be made more reliable. This could be done by 1) continuing the development of restoration, nature management and other habitat type status improvement methods and by 2) improving the knowledge base concerning the occurrence of habitat types and 3) of species typical of the habitat types. Such development work and research is needed not only to improve the feasibility of biodiversity offsetting but also to increase the effectiveness of the protection of habitat types and biodiversity on a broader scale. Also needed are further multidisciplinary research on the implementation mechanisms of biodiversity offsets, piloting of offsetting in practice, monitoring and evaluation of compensation outcomes as well as development of operating models. Current and upcoming projects will also provide direction towards further development needs.

It would be advisable to steer biodiversity offset development efforts towards habitat types and habitats most affected by various projects. First step could be assessing at which habitat types the various projects requiring permits are targeted. Data as regards which habitat types are under the greatest usage pressure and, on the other hand, the information provided by this report on the suitability of habitat types for biodiversity offsetting could advance the development of permit processes and support the practical application of biodiversity offsets.

Some of the further development needs described below call for the inclusion of the biodiversity offset perspective. Separate funding is therefore needed to promote them. On the other hand, some development needs are more general and progress in them can be assumed to be made provided that sufficient future funding is allocated to the development of habitat type restoration and management, to the development of remote sensing and geographic datasets and to ecological monitoring and research.

Development of habitat type status improvement methods and assessment of costs arising from the various methods

The assessment conducted shows that increased efforts should be made concerning methods to improve the status of many habitat types so that progress takes place towards the objectives related to improving the status of ecosystems. Habitat types assessed as falling under category 2b include many that are important for biodiversity and such that special efforts should be made to develop measures aiming to improve their status. Rich fens, coastal estuaries, flada-lakes and glo-lakes (coastal lagoons) and sandy lake shores are examples of habitat types where there is previous experience of their status improvements but further research and, in particular, practical trials and monitoring are needed to be able to develop the methods, verify their effectiveness and select the correct methods for various situations.

Category 3a also contains habitat types where the status of degraded occurrences could be improved more effectively than currently is the case if reliable methods were available. Examples of such habitat types include inland flooded forests, grazed woodlands, calcareous rock outcrops and Cratoneurion spring complexes. Methods development would also provide information about the costs arising from status improvements, which is necessary for the promotion of the extensive use of biodiversity offsets.

Improving the knowledge base on habitat type occurrences

Producing and compiling geographical datasets concerning the occurrence of habitat types as well as data on the quality and status of occurrences would improve the functionality of the biodiversity offset mechanism. Good datasets would also more broadly improve capacities to halt biodiversity loss through restoration, rehabilitation and management. Good basic data on habitat types helps to avoid unintentional degeneration of valuable sites and to target offset measures in a manner that is ecologically appropriate, taking also into account issues like connectivity. The development of remote sensing methods to identify habitat type occurrences and their status would support not only the monitoring of the status of habitat types and the protection of biodiversity but also the utilisation of biodiversity offsetting by providing up-to-date and comprehensive information about common habitat types in particular.

Improving the knowledge base on species occurrences

The quality and representativeness of a habitat type occurrence is often reflected by its species composition. Habitat type inventories traditionally involve not only describing habitat type structure but in most cases at least a survey of the key vascular plant species. One area in need of further development is identifying those habitat types for which species surveys that are more detailed and targeted at a larger number of species aggregates are needed. Further work is also required to establish which site-specific factors increase the need for more detailed species inventories. Site-specific factors may include prior knowledge already available regarding threatened or valuable species or structural features of the habitat type which are advantageous to threatened species. In further surveys the focus should be on a broad group of different species aggregates.

Development of expertise

It is pointed out in Chapters 2 and 4 of this report that the quality and other characteristics of individual habitat type occurrences are important when decisions are made on whether or not a habitat type occurrence is so irreplaceable that the first priority should be to avoid its biodiversity losses. Identifying the ecological value of individual sites also plays a key role in offset calculations.

When implementing biodiversity offsets, providing good guidelines and training experts are of utmost importance to ensure the successful delivery of offset gains and to achieve the key biodiversity objectives. Expertise covering areas including quality assessments of impacted and offset sites, planning of restoration, management or rehabilitation as well as knowledge of the principles of the biodiversity offset procedure is required for the successful implementation of each individual offset procedure. Solid competencies are essential particularly when making sure that the general preconditions are met when determining the quality and uniqueness of individual occurrences.

7.3. Conclusions

The report at hand is the first review of the suitability of Finland's habitat types for biodiversity offsetting. Provided that the preconditions, the uncertainties relating to offset implementation as well as the development needs specified in this report are taken fully into account in offset activities, the potential for implementing biodiversity offsets in Finland could be quite high. Around 41% of the habitat types included in the assessment are suitable for biodiversity offsetting and only 10% are assessed as being entirely unsuitable as regards losses and gains alike.

Habitat types suitable for biodiversity offsetting are found quite evenly across the board, which makes it easier to identify suitable offset sites and may improve their availability. Knowhow has also accrued concerning the improvement of the status of various habitat types through restoration, rehabilitation, management and other methods. Opportunities for the use of biodiversity offsetting can be broadened further through methods development, research and monitoring over a sufficiently long period of time.

The biggest challenges over the next few years are to do with the development of the offset mechanism and testing it in practice, the creation of the offset market, i.e. generating sufficient supply and demand, and the flexibility of administration and other actors and their capability of adopting a new approach to safeguard biodiversity. If implemented correctly, in Finnish conditions biodiversity offsetting can improve the state of biodiversity and, together with nature conservation and protection work already carried out, promote Finland's commitments to halt biodiversity loss.

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Appendix 1

The habitat types included in the assessment of suitability for biodiversity offsetting (colour bar in front of the name) and the habitat types of a more specific classification level included in them (in italics). The names of the assessed habitat types are followed by the Finnish national IUCN Red List Category in those cases where threat status has only been assessed for habitat types of a more specific classification level. If the IUCN Red List Categories of the habitat types of a more specific classification level differ from each other, the threat status is given as a range (e.g. LC–VU). The other columns state not only the nationwide threat status but also the threat status in Southern and Northern Finland, factors threatening the habitat type according to the 2008 assessment of threatened habitat types (Raunio et al. 2008), the inclusion of the habitat types in the habitat types protected under Finnish legislation or the Habitats Directive (0=not included, 1=included in part, 2=included in or corresponds to a habitat type under an Act/the Directive), structural and functional features of the habitat types in their desired state, and assessments made in this project concerning suitability. The habitat types classification used is described in Section 3.1 and the assessments in Section 3.2. The key to the threat factor abbreviations can be found after the table (p. 190).

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
THE BALTIC SEA (8 assessed habitat types)															
Filamentous algal zone LC–NT					1	0	0	0	**Structure**: Rocky or stony bottom in shallow water. Diverse vegetation comprising several filamentous green and brown algae. Fauna includes gastropods and isopods. **Functional features:** Good water quality, high transparency. In deeper layers the filamentous algal zone transitions into other algal zones and has not increased excessively or replaced species such as Fucus spp. Filamentous algae are displaced by ice and the stands regenerate.	5. No	4. Unknown	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	Filamentous algal zones have become more abundant due to eutrophication, so there is a need to rather reduce than to increase their size in eutrophic marine areas where they are replacing other habitat types. Eutrophication has to some extent also changed the quality of filamentous algal zones, so they will benefit from water quality improvements.		Seabed construction, projects resulting in local deterioration of water quality (e.g. fish farming)
Filamentous algal zone of the hydrolittoral	*LC*		*LC*	*Weu*											
Filamentous algal zone of the sublittoral	*NT*		*NT*	*Weu, Cc*											

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Fucus spp. communities VU	VU		VU	Weu, Cc	1	0	0	0	**Structure**: Rocky or stony bottom usually at a depth of 0.5–5 m. Extensive uninterrupted *Fucus* spp. stands. Low occurrence of filamentous algae. An abundance of invertebrates and fish fry. **Functional features:** Good water quality, high transparency. Sufficient salinity (minimum 3–4 ‰). Vibrant stands of *Fucus* spp.	3. Yes, in parts of the country	4. Unknown	2b Biodiversity losses must be avoided, status improvement challenging	*Fucus* spp. communities have suffered from eutrophication, and their status depends most on water quality, which cannot usually be impacted very quickly or in a targeted manner through offset measures. Measures improving the status of the Baltic Sea may work as limited-loss offsets. Underwater structures (e.g. of wind turbines) can, in principle, be designed for use as substrates for *Fucus* spp. communities, but the problem is filamentous algae that will take over new surfaces faster than Fucus spp.	If the offset involves creating new habitats for *Fucus* spp., the reproductive cycle of the various species should be taken into account when selecting the time when substrates are placed in the sea. This has an impact on which species will attach to the surfaces and which habitat type will be created in the site. The mechanical removal of filamentous algae from substrates during Fucus spp. dispersal may also be helpful. In addition, the choice of substrate surface material and inclination must be suitable for the target species. Further research into this is required.	Seabed construction, projects resulting in local deterioration of water quality (e.g. fish farming)

Habitat type	IUCN Red List Category in 2008: Southern Finland	IUCN Red List Category in 2008: Northern Finland	IUCN Red List Category in 2008: Nationwide	Threat factors	Inclusion in Habitats Directive and Finnish legislation: Habitats Directive	Inclusion in Habitats Directive and Finnish legislation: Forest Act	Inclusion in Habitats Directive and Finnish legislation: Nature Conservation Act	Inclusion in Habitats Directive and Finnish legislation: Water Act	Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
Red algae communities EN	EN		EN	Weu, Cc	1	0	0	0	**Structure**: Rocky or stony bottom usually at a depth of 5-10 m. Extensive stands of red algae with *Mytilus* spp. and *Amphibalanus improvisus* found in the community. **Functional features:** Good water quality, high transparency. Sufficient salinity (minimum 4 ‰). Vibrant stands of red algae.	3.Yes, in parts of the country	4. Unknown	2b Biodiversity losses must be avoided, status improvement challenging	Red algae communities have suffered from eutrophication and their status depends most on water quality, which cannot usually be impacted very quickly or in a targeted manner through offset measures. Measures improving the status of the Baltic Sea may work as limited-loss offsets. Underwater structures (e.g. of wind turbines) may, in principle, be designed for use as substrates for red algae, but further research into this is still required.	If the offset involves creating new habitats for red algae, the reproductive cycle of the various species should be taken into account when selecting the time when substrates are placed in the sea. This has an impact on which species will attach to the surfaces and which habitat type will be created in the site. The mechanical removal of filamentous algae from the substrates during the dispersal of red algae may also be helpful. In addition, the choice of substrate surface material and inclination must be suitable for the target species. Further research into this is required	Seabed construction, projects resulting in local deterioration of water quality (e.g. fish farming)
Zostera marina communities EN	EN		EN	Weu, Ch, Ex, Cc, Wt	1	0	0	0	**Structure**: Clean sandy bottom in its natural state usually at a depth of 1–8 m. Dominant plant species *Zostera marina*, which forms dense and extensive meadows. Filamentous algae absent or their occurrence low. **Functional features**: Good water quality, high transparency. Sufficient salinity (minimum 5‰). *Zostera marina* stands in good condition. Vibrant zoobenthic, foliage fauna and fish communities.	1. Yes	3. Uncertain	3b Biodiversity losses must not take place, status improvement not possible	*Zostera marina* communities have suffered from eutrophication, and their status depends most on water quality, which cannot usually be impacted very quickly or in a targeted manner by offset measures. Measures improving the status of the Baltic Sea may work as limited-loss offsets. Studies have been conducted in the Baltic Sea and the Kattegat on potentially restoring *Zostera marina* by hand-planting them, but the methods are expensive and in any case their success calls for good water quality. *Zostera marina* communities are endangered and important for the biodiversity of the Baltic Sea, which is why not a single representative occurrence should be lost.	The most representative *Zostera marina* communities are found on sandy bottoms, and a low salinity level of seawater is a factor limiting the dispersal of the species in Finland's southern marine areas where sandy bottoms are not common. This restricts the availability of suitable offset sites. *Zostera marina* is naturally slow to disperse to and settle in new or previously destroyed areas even if water quality has improved.	Dredging and depositing, fairway construction and other projects increasing waterborne transport and anchorage, underwater sand extraction, projects resulting in local deterioration of water quality (e.g. fish farming)

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Bottom dominated by submerged macrophytes VU	VU		VU	Weu, Hc	1	0	0	0	**Structure**: Clean sandy or other soft bottom in its natural state. Diverse plant species composition incl. *Ruppia spp.*, *Zannichellia spp.*, *Myriophyllum* spp. and *Potamogeton* spp. An abundance of invertebrate species. **Functional features**: Good water quality, high transparency.	5. No	4. Unknown	2b Biodiversity losses must be avoided, status improvement challenging	Bottoms dominated by submerged macrophytes have suffered from eutrophication and their status depends most on water quality, which cannot usually be improved very quickly or in a targeted manner by offset measures. If occurrences are located in closed bays or flada-lakes, water quality can be improved by reducing the load from the catchment area, and overgrowing of bays can be combated by using measures such as cutting reedbeds. Measures improving the status of the Baltic Sea may work as limited-loss offsets.	Bottoms dominated by submerged macrophytes are a broad group of habitat types the loss of the rarest and most sensitive to eutrophication of which must be avoided in particular.	Dredging, depositing, fairway construction and other projects increasing waterborne transport and anchorage, underwater sand extraction, projects resulting in local deterioration of water quality (e.g. fish farming, agricultural and forestry measures in the drainage area)
Charophyte meadows EN	EN		EN	Weu, Hc, Wt	1	0	0	0	**Structure**: Clean soft bottom in its natural state, shallow water and a sheltered or quite sheltered site. Charophytes as dominant plant species but other plant species often also found. An abundance of invertebrates and fish fry. Low occurrence of filamentous algae. **Functional features**: Good water quality, high transparency. Charophyte stands in good condition.	4. Possibly (insufficient data)	4. Unknown	2b Biodiversity losses must be avoided, status improvement challenging	Charophyte meadows have suffered from eutrophication and their status depends most on water quality, which cannot usually be improved very quickly or in a targeted manner by offsets. If charophyte meadows are located in closed bays or flada-lakes, water quality can be improved by reducing the load from the catchment area, and overgrowing of bays can be combated by using measures such as cutting reeds. Measures improving the status of the Baltic Sea may work as limited-loss offsets.		Dredging, depositing, fairway construction and other projects increasing waterborne transport and anchorage, underwater sand extraction, projects resulting in local deterioration of water quality (e.g. fish farming, agricultural and forestry measures in the drainage area)

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Blue mussel communities NT	NT		NT	Cc, Weu, Hc, Ch, S	1	0	0	0	**Structure**: Rocky, stony or gravel bottom usually at a depth of 1–20 m. High density and biomass of *Mytilus* spp. Representative blue mussel communities also occur together with red algae, in which cases the invertebrate species diversity is high. **Functional features:** Good water quality, high transparency, good oxygen level. Sufficient salinity (minimum 5 ‰). *Mytilus* shell gravel creates a habitat for other species.	3.Yes, in parts of the country	4. Unknown	2b Biodiversity losses must be avoided, status improvement challenging	Blue mussel communities have suffered less from eutrophication than several other Baltic Sea habitat types, but their status would also be improved by water quality improvements. Blue mussel communities are important food sources of species including *Somateria mollissima*, *Platichthys flesus* and *Cyprinidae* spp., so their ecological significance is great. It is therefore important to avoid their biodiversity losses even though the habitat type is not currently threatened. It is, however, vulnerable to climate change because of its salinity requirements. Underwater structures can potentially be designed for use as attachment substrates for *Mytilus edulis*, but further research into this is still required.		Seabed construction, projects resulting in local deterioration of water quality (e.g. fish farming)
Zoobenthic communities NT					1	0	0	0	**Structure**: All bottom types at different depths. Diverse invertebrate species varying depending on bottom type, depth and salinity level, incl. polychaetes, bivalves, gastropods, *Chironomidae larvae*, amphipods, oligochaets, priapulids. **Functional features**: Good water quality, high transparency, good oxygen level.	2. Yes, for some habitat types	4. Unknown	2b Biodiversity losses must be avoided, status improvement challenging	There are several different types of zoobenthic communities, and they have suffered in various ways from eutrophication and alien species. Their status depends most on water quality, which cannot usually be improved very quickly or in a targeted manner by offset measures. Measures to improve the status of the Baltic Sea may work as limited-loss offsets.		Dredging and deposition, seabed construction, underwater sand extraction, projects causing local deterioration of water quality (e.g. fish farming)
Zoobenthic communities in the euphotic zone	*NT*		*NT*	*Weu, S, Hc, Wt, Ch*											
Zoobenthic communities beyond the euphotic zone	*NT*		*NT*	*Weu, S, Ex, Hc , Wt*											
COASTAL HABITATS (12 assessed habitat types)															
Coastal gravel, shingle and boulder shores LC-NT					2	0	0	0	**Structure**: Gravel, shingle or boulder field. Vegetation with gaps and low-growing. Trees and shrubs absent. Seashore species present. **Functional features:** Exposed to coastal phenomena (waves, spray, salt, wind). Natural succession on the land uplift coast.	5. No	1. Good	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	The habitat type is common and not threatened. Effective offset measures include management of overgrown sites, protection of sites or improving the status of rarer habitat types.		Construction (e.g. holiday homes and holiday centres and related structures and activities such as swimming beaches and marinas)

Habitat type	IUCN Red List Category in 2008: Southern Finland	IUCN Red List Category in 2008: Northern Finland	IUCN Red List Category in 2008: Nationwide	Threat factors	Inclusion in Habitats Directive and Finnish legislation: Habitats Directive	Inclusion in Habitats Directive and Finnish legislation: Forest Act	Inclusion in Habitats Directive and Finnish legislation: Nature Conservation Act	Inclusion in Habitats Directive and Finnish legislation: Water Act	Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
Coastal unvegetated moraine, stone and boulder shores	*LC*		*LC*	*Ch, R, Weu*											
Coastal vegetated moraine, stone and boulder shores	*NT*		*NT*	*Weu, Ch, C, Cc, Wt*											
Coastal gravel and shingle shores	*LC*		*LC*	*Ch, Weu*											
Coastal sand beaches EN	EN		EN	W, Weu, S, Ed, C, Ex, Cc	2	0	2	0	**Structure**: Sandy soil, flat topography. Vegetation with gaps, low-growing and in extensive sites zonated. Trees and shrubs absent. Species include seashore and sunlit habitat species (vascular plants and invertebrates). **Functional features**: Exposed to coastal phenomena (waves, ice, spray, salt, wind). Natural succession on the land uplift coast. Moderate wear (grazing, trampling) may prevent overgrowing.	3.Yes, in parts of the country	1. Good	2a Biodiversity losses must be avoided, status improvement possible	The habitat type has suffered from eutrophication and overgrowth, in places also from excessive ground wear. There is a great need for management, and the management of overgrown sites or rehabilitation of worn sites are effective offset measures. Even if protected, the preservation of all of the occurrences may not be possible without management. The threshold for subjecting sites that have preserved their value to losses is, however, high as sand beaches are threatened and many of their insect and plant species are also threatened.	There are many potentially threatened species, which increases the need for species surveys, raises the threshold for causing biodiversity losses of sites and has to be taken into account in management.	Construction (e.g. holiday homes and holiday centres and related structures and activities such as swimming beaches and marinas)
Coastal dunes VU–EN					2	1	1	0	**Structure**: Sandy soil, dune formations intact. Topography characteristic of the respective dune type. Vegetation with gaps, low-growing and zonated. Trees and shrubs absent with the exception of coastal wooded dunes. Species include seashore and sunlit habitat species (vascular plants and invertebrates). Coastal wooded dunes with natural tree structure. **Functional features:** Exposed to coastal phenomena (waves, spray, ice, salt, wind). Natural succession on the land uplift coast. Moderate wear (trampling, grazing) may prevent overgrowing. Fires are a natural regeneration method for coastal wooded dunes.	1. Yes	2. Moderate	3a Biodiversity losses must not take place, status improvement possible	Dunes are rare and threatened in Finland, and their formation requires special conditions, whereby the availability of offset sites is very limited. Dunes benefit from management, but management planning is demanding and reaching all objectives is somewhat uncertain. Dune management can primarily be used to offset biodiversity losses of a common habitat type.	A large number of potentially threatened species that must be taken into account in management.	Construction (e.g. holiday homes and holiday centres and related structures and activities such as swimming beaches and marinas, drying out (humid dune slacks), forest cutting and mechanical soil manipulation (coastal wooded dunes)
Embryonic shifting dunes	*EN*		*EN*	*W, Weu, Cc, C*											
Shifting dunes with Leymus arenarius	*VU*		*VU*	*W, Ed, C, Weu, S, Cc*											
Fixed coastal dunes with herbaceous vegetation (grey dunes)	*VU*		*VU*	*W, Ed, Weu, C, S, Cc*											
Fixed coastal dunes with Empetrum nigrum (brown dunes)	*VU*		*VU*	*W, Ed, Mo, C*											
Humid dune slacks	*EN*		*EN*	*Ed, Cc*											
Coastal wooded dunes	*VU*		*VU*	*F, C, W, Ed*											

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Coastal reedbeds LC	LC		LC		1	0	0	0	**Structure**: Bottom often soft (clay, mud, silt). Vegetation tall and dense, dominated by Phragmites australis. An abundance of reedbed birds, in the reedbed-open-water mosaic also aquatic birds. **Functional features:** Exposed to ice erosion. Natural succession on the land uplift coast.	5. No	1. Good	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	Reedbeds have increased in extent due to eutrophication and replaced other habitat types. Their planned reduction can be carried out to restore other habitat types and habitats of other species. The biodiversity values of reedbeds are related most clearly to bird and fish stocks, and loss of valuable sites must be avoided. Effective offset measures include management of over-dense reedbeds or status improvements of rarer habitat types.		Road and other construction may fragment extensive sites with valuable bird communities. Port construction, dredging, etc.
Drift lines with Fucus spp. VU	VU		VU	Weu, Ch	2	0	0	0	**Structure**: Large drift lines of various ages consisting mainly of *Fucus* spp. on a shore. Typical annual plant species on top of the drift lines. An abundance of invertebrates and waders feeding on them. **Functional features**: Exposed to wind and coastal phenomena. Natural dynamics in drift line creation and de-creation, drift lines in various decomposition stages. Good seawater quality maintains Fucus spp. stands.	3. Yes, in parts of the country	5. No status improvement methods	2b Biodiversity losses must be avoided, status improvement challenging	Drift lines with Fucus spp. have suffered from the reduction of Fucus spp. and the increased abundance of filamentous algae and *Phragmites australis* caused by eutrophication. There are no restoration methods that could be targeted directly at the habitat type, but measures improving Baltic Sea water quality, the living conditions of *Fucus* spp. and the openness of shores have indirect positive impacts and can work as limited-loss offsets.	Sites where new, large drift lines with *Fucus* spp. are formed and where there are drift lines in different development stages are particularly valuable. Biodiversity losses of such sites must be avoided in particular.	Coastal construction, projects deteriorating seawater quality
Coastal scrubs LC–VU					1	0	0	0	**Structure**: Located as a zone between open seashore and forest. Shrub species and ground vegetation vary depending on soil type. **Functional features:** Natural succession on the land uplift coast. Exposed to coastal phenomena (particularly coastal scrub with *Hippophaë rhamnoides* and coastal alder scrub).	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	Most coastal scrubs have increased in extent due to eutrophication and discontinuation of grazing. There is a need to reduce rather than increase the coverage of *Salix spp.* and *Juniperus communis* thickets as they are replacing other habitat types. Status improvements of rarer habitat types can be used as offset measures.	The rarest Finnish coastal scrub type is coastal scrubs with *Myrica gale*, which have also suffered the most from coastal overgrowth following the discontinuation of grazing. Biodiversity losses of coastal scrubs with *Myrica gale* must be avoided.	Coastal construction
Coastal scrub with Hippophaë rhamnoides	*LC*		*LC*												
Coastal scrub with Myrica gale	*VU*		*VU*	*Weu*											
Coastal Salix spp. thickets	*LC*		*LC*												
Coastal alder stands and scrub	*LC*		*LC*	*C, Fd, Weu*											
Coastal Juniperus communis thickets	*LC*		*LC*												

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	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Flada-lakes and glo-lakes (coastal lagoons) VU–EN					2	0	0	1	**Structure**: Flada-lakes are shallow sea bays connected to the sea via a channel separated from the sea by a narrow threshold, whereas glo-lakes no longer have a regular water connection to the sea. Low salinity level, clear water, an abundance of perennial macrophytes (charophytes, *Ruppia maritima*), thick layer of organic mud sediment, diverse zoobenthos and insect community. A reedbed zone by the shoreline. **Functional features**: Natural flada-lake-glo-lake succession caused by land uplift ending with glo-lakes gradually turning into occasionally brackish-water injected lakes and ponds or undergoing paludification. Sedimentation of organic matter onto the bottom.	5. No	3. Uncertain	2b Biodiversity losses must be avoided, status improvement challenging	Only a small proportion of flada-lakes and glo-lakes are in their natural state, but offsetting lost biodiversity values by rehabilitating sites subjected to losses may be difficult, particularly as regards flada-lakes, if the site is in recreational or residential use. There is only very little previous experience of rehabilitation. Restricting nutrient discharges in catchment areas and cutting overgrowing coastal habitats may improve the status of sites suffering from eutrophication caused by human activity.	Extensive flada-lake areas and areas with series of flada- and glo-lakes that are in their natural state and still undergoing flada-lake formation due to land uplift are those for which avoidance is absolutely necessary and which should be protected.	Dredging, port construction, recreational and other construction
Flada-lakes (coastal lagoons)	*VU*		*VU*	*Hc, Weu, Wt, F, Cc*											
Glo-lakes (coastal lagoons)	*EN*		*EN*	*Hc, Weu, F, Cc*											
Developmental series of coastal dunes EN	EN		EN	W, Weu, Ed, C, Cc, S, F	2	0	1	0	**Structure**: Young soil, not podsolised. Several scrub and forest types as a succession series from coastal scrubs via herb-rich forests to heath forests. An abundance of decaying trees, tree layer structure in its natural state. No ditch drainage. **Functional features**: Natural succession on the land uplift coast. Succession series long and uninterrupted.	1. Yes	3. Uncertain	3a Biodiversity losses must not take place, status improvement possible	Series of coastal dunes are rare and endangered in Finland and their formation calls for special conditions, whereby there is a very limited number of offset sites and it is not possible to offset the loss of entire series. We cannot afford to lose a single site. Series of dunes benefit from management, but special expertise is required for management plans.	A large number of potentially threatened species that must be taken into account in management.	Construction (e.g. holiday homes and holiday centres and related structures and activities such as swimming beaches and marinas)

Habitat type	IUCN Red List Category in 2008: Southern Finland	IUCN Red List Category in 2008: Northern Finland	IUCN Red List Category in 2008: Nationwide	Threat factors	Inclusion in Habitats Directive and Finnish legislation: Habitats Directive	Inclusion in Habitats Directive and Finnish legislation: Forest Act	Inclusion in Habitats Directive and Finnish legislation: Nature Conservation Act	Inclusion in Habitats Directive and Finnish legislation: Water Act	Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
Succession series of natural forests on the land uplift coast (formerly primary succession forests) CR	CR		CR	F, C, Dd, Weu, Cc, Ed	2	0	0	0	**Structure**: Young soil, not podsolised. Several scrub and forest types as a succession series from coastal scrubs via herb-rich forests to heath forests. An abundance of decaying trees, tree layer structure in its natural state. No ditch drainage. **Functional features:** Natural succession on the land uplift coast. Succession series long and uninterrupted.	1. Yes	3. Uncertain	2b Biodiversity losses must be avoided, status improvement challenging	Long, representative succession series of natural forests are very rare these days and it is not possible to offset their disappearance. Gaps in succession series or minor degradation can be offset by restoring them to a semi-natural state through means of nature management and protection of forests. Succession series may also contain mires, grazed woodland areas or wooded pastures whose status can be improved. Sites of better quality, or an extensive coastal area where land uplift may over a long period of time result in the development of succession series of natural forests, can also be protected (considerable net positive impact will be required due to the time delay).		Construction, forest cutting, ditch drainage
Costal estuaries EN	EN		EN	Hc, Weu, Wr, Ch, Wt	2	0	0	0	**Structure**: An intact estuary entity from the mouth of the stream to the end of the stream water impact area. Abundant and diverse aquatic vegetation. An abundance of submerged macrophytes and helophytes as well as nympheids but also with open water. An abundance of bird species. **Functional features**: Naturally varying flow rate. Uninterrupted and continuous delta formation and sedimentation of matter input by the steam. Good water quality and clean sediment. Variation in salinity levels.	1. Yes	2. Moderate	2b Biodiversity losses must be avoided, status improvement challenging	Entire coastal estuaries are extensive entities whose loss is impossible to offset fully. The status of some values or parts of coastal estuaries can be improved by, e.g. managing bird areas, diversifying aquatic vegetation or improving water quality. Achieving a natural flow and cleaning contaminated sediments are more demanding tasks. There are no estuaries in their natural state left in Finland, so status improvements are highly necessary.		Dredging, regulation, diking, ditch drainage, projects causing harmful emissions and discharges and non-point pollution, ports, waterborne transport, coastal construction
Islands and islets in outer archipelago LC	LC		LC	Weu, Ch, C,	2	0	0	0	**Structure**: Open small islands and islets and the marine area around them in its natural state. Abundant nesting sea and archipelago bird community. Vibrant underwater algal zones (incl. *Fucus* spp.). **Functional features**: Exposed to coastal phenomena (waves, spray, ice, salt, wind). Good water quality, high transparency. Undisturbed conditions for birds.	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	A common habitat type with no major restoration needs. The sites to be avoided the most are islands that are significant as regards their birds and ones that are important for seals. Possible offset measures include protecting valuable islands from disturbance and removing alien carnivore species as well improving the status of rare habitat types.	Valuable habitats include bird islands located close to underwater feeding sites of birds (e.g. *Mytilus edulis* bottoms, shallows in open seas), the offsetting of any losses of which is the most challenging.	Projects increasing disturbance of birds and seals, offshore wind farms, oil spills, projects deteriorating water quality

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	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Baltic esker islands VU	VU		VU	F , C, Weu, Ed, W, Ex	2	0	0	0	**Structure**: Sandy soil, with sandy-bottom marine areas surrounding the island. An abundance of different habitat types, particularly on large islands (incl. sand beaches, heaths). Coastal vegetation with gaps and low-growing. Species include seashore and sunlit habitat species (vascular plants and invertebrates). Low-density tree stands usually dominated by *Pinus sylvestris*. Good seawater quality, high transparency. **Functional features**: Natural vegetation succession on the land uplift coast. Exposed to coastal phenomena (waves, ice, spray, salt, wind). Clean sandy bottom in its natural state.	3.Yes, in parts of the country	2. Moderate	2b Biodiversity losses must be avoided, status improvement challenging	Large esker islands are extensive entities with values the full offsetting of which is impossible. It is possible to offset some values or parts of esker islands by, e.g., managing overgrowing sand beaches, dunes or heaths. Improving the status of underwater parts of esker islands is the slowest process because it requires water quality improvements.	Many esker islands (e.g. in the Archipelago Sea) have threatened plant and invertebrate species, and alterations of such sites must be avoided in particular. Valuable species must also be taken into account elsewhere when planning offsets.	Construction (e.g. holiday homes and holiday centres and related structures and activities such as swimming beaches and marinas, forest cutting and mechanical soil manipulation, projects deteriorating water quality
INLAND WATERS AND SHORES (19 assessed habitat types)															
Low-humic lakes NT					2	0	0	0	**Structure**: Oligotrophic lakes with low nutrient content and clear (low-humic) water. The relative share of vegetation indicating oligotrophy or mesotrophy is high. Common lake types include the *Lobelia*, *Phragmites* and *Equisetum-Phragmites* types, and in Northern Finland also the *Carex* type. Characterised by submerged macrophytes and isoetids, while heliophyte stands are usually sparse and the occurrence of aquatic mosses is low. Rich fish communities, particularly in large lakes. **Functional features:** Water residence times long. Buffering capacity of the smallest lakes low. Natural nutrient level. Low primary production. Natural water level and its fluctuation (no regulation), high transparency.	5. No	2. Moderate	2a Biodiversity losses must be avoided, status improvement possible	A relatively common lake type which has, however, been degraded clearly, particularly due to eutrophication but also for other reasons. Status improvement measures include those related to water quality improvements in particular, but the reduction of adverse impacts of, e.g. construction and regulation also needs to be developed.		Regulation of water bodies, dredging, coastal construction, water body impacts of peat production
Small and medium-sized low-humic lakes	*NT*	*NT*	*NT*	*Weu, Wr, Hc, C*											
Large low-humic lakes	*NT*	*LC*	*NT*	*Weu, Wr, Hc, Ch, C*											
Shallow low-humic lakes	*VU*	*LC*	*NT*	*Weu, Hc, C*											

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	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Humic lakes LC–NT					2	0	0	0	**Structure**: Water naturally oligotrophic or mesotrophic, depending on the subtype low-humic/very humic and moderately or more clearly acidic. Typical lake types include the *Equisetum*, *Equisetum-Phragmites* and *Nuphar* types. Aquatic vegetation features elodeids, isoetids and nymphaeids, helophytes, aquatic mosses and coastal vegetation. The abundance, and abundance ratios, of aquatic vegetation vary, incl. between subtypes depending on the lake's humus content, size and depth. **Functional features**: In the winter, oxygen deficiency may occur naturally in shallow lakes in particular. Natural nutrient level. Low-to-moderately low primary production. Natural water level and its fluctuation (no regulation), transparency moderate-low.	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	A common lake type which has, however, been degraded clearly, particularly due to eutrophication but also due to other reasons. Status improvement measures include those related to water quality improvements in particular, but the reduction of adverse impacts of, e.g. construction and regulation also needs to be developed.		Regulation of water bodies, dredging, coastal construction, water body impacts of peat production
Small humic lakes	*NT*	*LC*	*NT*	*Weu, Hc, C, Wr*											
Medium-sized humic lakes	*NT*	*LC*	*NT*	*Weu, Wr, Hc, C*											
Large humic lakes	*NT*	*NT*	*NT*	*Weu, Wr, Hc, C, Ch*											
Very humic lakes	*NT*	*LC*	*NT*	*Weu, Wr, Hc, C, Ch*											
Shallow humic lakes	*NT*	*LC*	*LC*	*Weu, Hc, C, Wr*											
Shallow very humic lakes	*NT*	*NT*	*NT*	*Weu, Hc, C, Wr*											
North Lapland lakes LC		LC	LC	Cc	2	0	0	0	**Structure**: Mostly small clear or slightly dystrophic, oligotrophic lakes. Lake type often of the *Carex* or *Elodeidi* type. Low occurrence of nymphaeids and helophytes, with the abundance of isoetids varying. *Carex* stands sparse, charophytes and aquatic mosses may be relatively abundant. Fish species favour cold and oxygen-rich water. **Functional features:** Cold water, long period of ice cover. Significant insect and zoobenthic production, low primary production.	5. No	2. Moderate	2b Biodiversity losses must be avoided, status improvement challenging	As a general rule, the status of North Lapland lakes is good, but they are threatened by climate change and their status may deteriorate significantly in the future. There is no previous experience of the rehabilitation of these lakes.		

Habitat type	IUCN Red List Category in 2008: Southern Finland	Northern Finland	Nationwide	Threat factors	Inclusion in Habitats Directive and Finnish legislation: Habitats Directive	Forest Act	Nature Conservation Act	Water Act	Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
Naturally eutrophic lakes EN	EN	NT	EN	Weu, Wr, Hc, C	2	0	0	0	**Structure**: Clay-dominated or eutrophic bedrock or soil areas or close to the groundwater basin, e.g. in the Salpausselkä ridge system area. Turbid water and low transparency in clay-dominated areas, otherwise water may be clear, pH neutral or alkaline. The habitat type includes *Potomogeton*, *Typha-Alisma*, *Scripus lacustris*, *Stratiotes* and *Elodeidi* type lakes. Diverse aquatic vegetation, with indicator species for eutrophy. Nymphaeids and helophytes often form extensive and dense stands. An abundance of Cyprinidae spp. An abundance of bird species. **Functional features**: Natural nutrient level and water level fluctuation. High primary production.	1. Yes	2. Moderate	2a Biodiversity losses must be avoided, status improvement possible	The status of naturally eutrophic lakes is poor and there are no sites fully in their natural state. There are not as many sites suitable for offsetting as there are for more common lake types. There are rehabilitation methods available, but improving their status is challenging due to issues including internal nutrient load and intensive land use in their catchment areas. Rehabilitation is also needed for sites that are losing their bird values.	Biodiversity losses of the rare *Stratiotes aloides* lakes should be avoided. Rare aquatic plants and birds must be taken into account in rehabilitation.	Regulation of water bodies, dredging, coastal construction, projects causing discharges into water bodies
Chalky lakes VU	VU	NT	VU	Weu, Hc, C	1	0	0	0	**Structure**: In calcareous bedrock and soil areas, often small and shallow or medium-deep. Water chalky (with high alkalinity), often clear and oligotrophic-mesotrophic. Water pH quite high, lake type usually the *Potamegeton filiformis-Chara* type. An abundance of elodeids. **Functional features:** Limestone influence present. Natural nutrient level and primary production, natural water level fluctuation.	1. Yes	2. Moderate	3a Biodiversity losses must not take place, status improvement possible	A very rare habitat type that has been degraded the most in Southern Finland. Many sites would benefit from rehabilitation and measures reducing the nutrient load.		Construction projects increasing nutrient loading, dredging, coastal production, mining projects
Ponds and small lakes LC–NT					2	0	0	1	**Structure**: Humus content, water colour, acidity, nutrient level and bottom quality vary. Usually oligotrophic. The abundance of aquatic vegetation and dominant life forms vary depending on the above characteristics. The largest lakes have fish. **Functional features**: Long frozen period, with the smallest and shallowest ponds freezing all the way to the bottom. May have significant insect and zoobenthic production, low primary production.	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	Most pond and small lake habitat types are common. Particularly in Southern Finland, the status of ponds and small lakes has deteriorated due to nutrient and sediment loading. Load reductions would improve the ecological status of ponds and small lakes.	Biodiversity losses of ponds and small lakes in their natural status must be avoided in Southern Finland in particular.	Dredging, coastal construction, water body impacts of peat production
Fjeld ponds and small lakes		*LC*	*LC*	*Cc*											
Esker ponds and small lakes	*VU*	*LC*	*NT*	*Weu, C, Gw, Ex*											
Rocky ponds and small lakes	*LC*	*LC*	*LC*	*Weu, Ch*											
Forest ponds and small lakes	*VU*	*LC*	*LC*	*Weu, Hc, C*											
Mire ponds and small lakes	*NT*	*LC*	*LC*	*Weu, Hc*											

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	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Naturally eutrophic ponds and small lakes CR	CR	NT	CR	Weu, Hc, C	2	1	0	1	**Structure**: Ponds with a soft bottom and often shallow, typically found in clay-dominated areas, water often turbid, alkaline, eutrophic. Diverse aquatic plant community, indicator species for eutrophy, demanding species. High rate of vegetation cover. *Cyprinidae* fish community. Good reproduction sites for amphibians. An abundant and diverse invertebrate community. **Functional features**: High primary production, natural water level.	3.Yes, in parts of the country	2. Moderate	2a Biodiversity losses must be avoided, status improvement possible	Naturally eutrophic ponds and small lakes are rare and have been degraded strongly, particularly in Southern Finland. It has been assessed that they do not occur at all in their natural state any more. The habitat type benefits from rehabilitation and there are methods available to improve their status.	Biodiversity losses of naturally eutrophic ponds and small lakes must be avoided unless a site is already severely degraded. Further losses of sites that can be restored must be avoided and such sites should be favoured as offset sites in biodiversity offsetting.	Construction, dredging, projects increasing nutrient or sediment loading
Chalky ponds and small lakes EN	EN	NT	VU	Weu, Hc, C	2	1	0	1	**Structure**: In calcareous bedrock and soil areas, water neutral or alkaline, quite clear and oligotrophic-mesotrophic. Narrow helophyte stands. Aquatic vegetation characterised by elodeids. Typical species include charophytes and demanding mosses. In loose-bottomed ponds, aquatic vegetation may be very scarce. Calcareous gyttja may be deposited onto the bottom. **Functional features:** Natural nutrient level and limestone influence present. Natural water level and its fluctuation.	1. Yes	3. Uncertain	3a Biodiversity losses must not take place, status improvement possible	Chalky ponds and small lakes are rare and strongly degraded, particularly in Southern Finland. Nutrient pollution may have resulted in the reduction of the limestone influence, which changes the structure and functional features of the habitat type. There is not sufficient previous experience of the improvement of the status of the habitat type.		Construction, dredging, projects increasing nutrient or sediment loading
Spring ponds and small lakes NT	VU	NT	NT	Weu, Gw, Ex, C, Hc	1	1	0	1	**Structure**: Water clear and at least in places cool. pH close to neutral. Aquatic vegetation sparse, mainly isoetids, elodeids and charophytes, may have an abundance of aquatic moss species. Low occurrence of *Cyprinidae*. Zoobenthos includes spring specialist species. **Functional features**: Groundwater upwelling and spring effect, low freezing rate, natural nutrient level.	1. Yes	3. Uncertain	3b Biodiversity losses must not take place, status improvement not possible	There is deficient data on the situation of spring ponds and small lakes, but they are very rare and clearly degraded, particularly in Southern Finland, and still facing many threats. There is very little previous experience of the rehabilitation of spring ponds and small lakes.		Groundwater extraction, gravel extraction, projects increasing nutrient loading, construction, dredging

Habitat type	IUCN Red List Category in 2008: Southern Finland	Northern Finland	Nationwide	Threat factors	Inclusion in Habitats Directive and Finnish legislation: Habitats Directive	Forest Act	Nature Conservation Act	Water Act	Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
Sandy lake shores VU	EN	NT	VU	W, C, Wr, Weu	0	0	2	0	**Structure**: Gently sloping open shore, soil mainly sand or fine sand, with aggregates of organic matter. Vegetation quite sparse, with gaps, featuring common riparian species. Vegetation may show zonation. **Functional features:** Natural water level fluctuation, wind-exposed, well-lighted, impact of ice and waves preventing overgrowing. Major annual and seasonal variation in vegetation.	5. No	3. Uncertain	2b Biodiversity losses must be avoided, status improvement challenging	Sandy lake shores are strongly degraded, particularly in Southern Finland, and the need for their management and rehabilitation is great. Many sites are in recreational use or constructed. Degenerated sites can be regarded as suitable for biodiversity offsetting, but there is hardly any previous experience of the rehabilitation or management of sandy lake shores. There is a need to develop rehabilitation methods.	Biodiversity losses of sites, including those that are small in size, must be avoided, particularly in Southern Finland.	Construction, water body regulation, projects increasing nutrient loading
Stony and bushy lake shores LC					0	0	0	0	**Structure**: Ground on stony shores is rocky, amount of vegetation varies: in sheltered spots and where rockiness only occurs on the surface, there is more vegetation. On bushy lake shores vegetation is dominated by dense scrub, usually of Salix spp. There is no peat formation. **Functional features:** Natural water level fluctuation, impact of wind, wave and ice forces.	5. No	4. Unknown	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	Stony and bushy lake shores are common and not significantly degraded.		Construction, water body regulation, projects increasing nutrient loading
Stony lake shores	*LC*	*LC*	*LC*	*Weu, Wr, C*											
Bushy lake shores	*LC*	*LC*	*LC*	*Weu, Wr, C*											
Spring habitats					*2*	*2*	*0*	*2*							
Spring complexes VU	EN	LC	VU	F, Dd, Gw, Ex, C	2	2	0	2	**Structure**: Springwater may emerge as spring brooks, form a spring pool or a quagmire or seepage site. The species are demanding and dependent on stable moisture and temperature conditions. Bryophyte and vascular plant species are adapted to spring habitats and indicators for groundwater influence and mesotrophy or meso-eutrophy. **Functional features**: Groundwater or perched groundwater emerging on the ground surface, with stable temperature and moisture conditions.	5. No	2. Moderate	2a Biodiversity losses must be avoided, status improvement possible	A habitat type that is often small in area and involves special species values. A significant proportion of sites is degraded, particularly in Southern Finland. Some rehabilitation of spring complexes has taken place with mixed outcomes. Case-specific consideration and planning is particularly important in offsetting situations.	There is a great deal of variation in the species values of spring complexes. Biodiversity losses of sites with valuable species in particular must not take place. Rehabilitation also involves the risk of losing species values, and special care must be taken when selecting sites and planning and implementing measures.	Projects affecting groundwater level, water withdrawal, construction, earth material extraction

Habitat type	IUCN Red List Category in 2008: Southern Finland	IUCN Red List Category in 2008: Northern Finland	IUCN Red List Category in 2008: Nationwide	Threat factors	Inclusion in Habitats Directive and Finnish legislation: Habitats Directive	Inclusion in Habitats Directive and Finnish legislation: Forest Act	Inclusion in Habitats Directive and Finnish legislation: Nature Conservation Act	Inclusion in Habitats Directive and Finnish legislation: Water Act	Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
Cratoneurion spring complexes VU	EN	LC	VU	F, Dd, Gw, Ex, C	2	2	0	2	**Structure**: Eutrophic, Cratoneurion-dominated or featuring Cratoneurion, usually a calcareous, small-area spring-fed mire with seepage or a more extensive spring complex with demanding bryophyte and vascular plant species which are indicators for groundwater influence and wet eutrophy. **Functional features:** Groundwater or perched groundwater emerging on the ground surface, stable temperature and moisture conditions.	1. Yes	2. Moderate	3a Biodiversity losses must not take place, status improvement possible	The habitat type involves high species values. Cratoneurion spring complexes are threatened and very rare in Southern Finland. Cratoneurion spring complexes mainly occur in areas with calcareous soil and bedrock and their number is limited. There is little previous experience of restoration of such sites.	If it is not possible to avoid biodiversity losses of a site, particular care must be taken when selecting offset sites and planning and implementing measures.	Projects affecting groundwater level, water withdrawal, construction, mining projects, earth material extraction
Streams of fell area LC					2	0	0	0	**Structure**: Rivers, streams and intermittent streams in the fell area. Usually oligotrophic, often low-humic. Open-landscape first-order and headwater streams in particular exposed to changes in weather and affected by groundwater and meltwater impact. Hydrogeological and biological variation in larger streams and in rivers quite high. First-order streams are important reproduction sites for Salmoniformes. **Functional features:** Major annual fluctuation in flow rate and temperature. Flooding, natural water level fluctuation. Flow and ice erosion. Natural nutrient level.	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	In Lapland, streams are primarily in their natural state, and the ecological status of larger streams and rivers is also good despite minor loading taking place.		Construction, mining projects
Intermittent streams in fell area		*LC*	*LC*												
Headwater streams in fell area		*LC*	*LC*												
First order streams in fell area		*LC*	*LC*												
Streams and rivers in fell area		*LC*	*LC*												

Habitat type	IUCN Red List Category in 2008: Southern Finland	IUCN Red List Category in 2008: Northern Finland	IUCN Red List Category in 2008: Nationwide	Threat factors	Inclusion in Habitats Directive and Finnish legislation: Habitats Directive	Inclusion in Habitats Directive and Finnish legislation: Forest Act	Inclusion in Habitats Directive and Finnish legislation: Nature Conservation Act	Inclusion in Habitats Directive and Finnish legislation: Water Act	Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
Low-humic and humic first-order and headwater streams NT–VU					2	2	0	0	**Structure**: A lot of regional and local variation in characteristics. Depending on the proportion of mineral and peatland soil in the catchment area, water colour is scarcely, slightly or strongly affected by humus. Uninterrupted stream continuum. Alternation between high-flow sections (incl. rapids) and pools, and occurrence of various types of microhabitats. **Functional features**: Major annual fluctuation in flow rate and temperature. Headwater streams may dry out in exceptionally dry years. Stream organisms affected by riparian forests (shading, nutrients). Natural nutrient level. Natural flow rate fluctuation and flooding, erosion and sedimentation of matter, interaction between water and riparian area (incl. organic matter from banks).	5. No	2. Moderate	1b Biodiversity losses can be offset by improving the status of the same habitat type	Low-humic and humic first-order and headwater streams occur extensively throughout Finland and there are many degraded sites. Sites suitable for restoration and rehabilitation are known quite well. There is a relatively large amount of data and experience of methods and their effectiveness.		Projects affecting groundwater level, water withdrawal, contamination, eutrophication and drying out of water bodies in various projects (e.g. mining activity)
Low-humic headwater streams in coniferous forest zone	*VU*	*LC*	*NT*	*F, Weu*											
Humic headwater streams in coniferous forest zone	*VU*	*LC*	*NT*	*F, Weu*											
Low-humic first-order streams in coniferous forest zone	*VU*	*NT*	*VU*	*F, Weu*											
Humic first-order streams in coniferous forest zone	*VU*	*NT*	*VU*	*F, Weu*											
First order and headwater streams in clay-dominated catchment areas VU–CR					2	2	0	0	**Structure**: Considerable clay turbidity affecting primary production. Often meandering. **Functional features:** Major annual flow rate fluctuation and susceptibility to flooding and, with headwater streams, also to drying out. Strong riparian erosion. Eutrophy. Natural nutrient level. Natural flow rate fluctuation and flooding, erosion and sedimentation of material, interaction between water and riparian area (incl. organic matter from banks).	1. Yes	3. Uncertain	3a Biodiversity losses must not take place, status improvement possible	First-order and headwater streams in clay-dominated catchment areas are highly threatened and have been destroyed through land clearing for farming purposes, cleared and straightened. The habitat type only occurs in low-lying clay-dominated areas of Southwestern Finland. The remaining streams are in great need of restoration and rehabilitation and improving the status of first-order and headwater streams of clay-dominated catchment areas is challenging.		Construction, contamination, eutrophication and drying out of water bodies in various construction projects
Headwater streams in clay-dominated catchment areas	*VU*		*VU*	*F, Weu*											

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
First order streams in clay-dominated catchment areas	*CR*		*CR*	*Hc, F, Weu*											
Low-humic and humic streams NT–VU					1	0	0	0	**Structure**: Humus content, water colour, pH and nutrient level varies a lot depending on whether the catchment area is peatland or mineral soil-dominated and on soil and bedrock characteristics. Uninterrupted stream continuum. Alternation between high-flow sections (incl. rapids) and pools, and occurrence of various types of habitats. Significance of riparian-zone trees the highest for narrow rivers. Natural flood plains and deltas. **Functional features**: Large natural flow-rate fluctuation, except for areas with numerous lakes. Flooding. Natural nutrient level and water level.	5. No	2. Moderate	2a Biodiversity losses must be avoided, status improvement possible	Low-humic and humic streams are common and their status can be improved through a variety of measures. It is challenging to reduce the nutrient load. The ecological significance of streams to other habitat types closely related to them is great. Stream habitats have been and are being degraded in many ways, particularly in Southern Finland. The threshold for further biodiversity losses should be high.	Biodiversity losses of streams in well-preserved stream ecosystems with natural or seminatural catchment areas should be avoided.	Construction, regulation, contamination and eutrophication of water bodies in various projects
Medium-sized streams in coniferous forest zone	*VU*	*LC*	*NT*	*Hc, F, Weu*											
Large streams in coniferous forest zone	*VU*	*LC*	*NT*	*Weu, Hc, Wr*											
Rivers in coniferous forest zone	*EN*	*NT*	*VU*	*Weu, Hc, Wr*											
Streams in clay-dominated catchment areas CR					1	0	0	0	**Structure**: Naturally eutrophic. Considerable clay turbidity. Uninterrupted stream continuum. Prone to erosion, meandering. Alternation of high-flow and pool sections and occurrence of different habitats. Flooded areas, in large rivers also deltas. **Functional features**: Natural flow rate fluctuation, flooding and water level. Strong riparian erosion, meandering. Natural nutrient level. Erosion and sedimentation of matter, sediment deposition in flooded areas and deltas.	1. Yes	3. Uncertain	3a Biodiversity losses must not take place, status improvement possible	Streams in clay-dominated catchment areas are Critically Endangered and strongly degraded. There are no more streams in clay-dominated catchment areas left in their natural state. The habitat type only occurs in clay-dominated catchment areas on the southern and southwestern coast. The status of degraded sites should be improved extensively. Improving their status is challenging.		Construction, contamination and eutrophication of water bodies in various projects and agriculture, regulation of water bodies
Medium-sized streams in coniferous forest zone	*CR*		*CR*	*Hc, F, Weu*											
Large streams in coniferous forest zone	*CR*		*CR*	*Weu, Hc, Wr*											
Rivers in coniferous forest zone	*CR*		*CR*	*Weu, Hc, Wr*											

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Large rivers EN	CR	VU	EN	Hc, Wr, Weu	1	0	0	0	**Structure**: Major variation in the habitat type's hydrology, physicochemical characteristics and species composition owing to variation in the presence of lakes and characteristics of catchment area, such as soil and bedrock. Uninterrupted stream continuum, alternation of high-low and pool sections and occurrence of different habitats. High-production lake outlets. Pool sections. Eutrophic flood plains, deltas with high species diversity. **Functional features**: Natural flow rate fluctuation often high. Natural water level fluctuation, flooding. Natural nutrient level.	1. Yes	2. Moderate	2b Biodiversity losses must be avoided, status improvement challenging	Large rivers (totalling 8 in Finland) are Endangered and strongly degraded. The status of rivers should be improved extensively. These rivers are also of great significance to other habitat types related to them due to their large catchment areas and improving their status is difficult.	Biodiversity offsetting should be targeted at the same river that is being subjected to biodiversity losses.	Construction, contamination, and eutrophication of water bodies in various projects, regulation of water bodies
MIRES (15 assessed habitat types)															
Spruce mires VU–EN					2	1	0	0	**Structure**: Dominated by *Picea abies* or deciduous trees, (usually) structurally heterogeneous tree stands, continuum of deadwood. Characteristic alternation of hummock and lawn levels. Species indicating for mineral soil influence and, depending on the type, also for surface water and groundwater influence. **Functional features**: Hydrology in its natural state, humid and shaded microclimate, peat formation, natural tree stand dynamics (regeneration in gaps).	2. Yes, for some habitat types	2. Moderate	1b Biodiversity losses can be offset by improving the status of the same habitat type	Spruce mires are threatened and some spruce mire habitat types are rare. There is previous experience of spruce mire restoration and also good understanding of the challenges faced in restoration. There are plenty of spruce mires that can be restored. It is possible to increase spruce mire biodiversity values through restoration. In some cases biodiversity losses of a more common spruce mire habitat type can be offset by restoring a rarer spruce mire habitat type site.	There is great variation in possibilities for biodiversity offsetting depending on spruce mire type and site. In some cases restoration may be very difficult and it may not necessarily be possible to recover a strongly altered site's habitat type. Biodiversity losses of the rarest and most threatened spruce mire habitat type sites (e.g. spring-fed and nutrient-rich types) as well as sites that are in their natural state and easy to restore must be avoided.	Road and other construction, water withdrawal, ditch network maintenance, forestry measures. Peat extraction is not targeted at spruce mires, but peat extraction in nearby areas may have impacts on spruce mires
Thin-peated spruce mires	*VU*	*LC*	*VU*	*F, Dd, C*											
Thin-peated herb spruce mires	*EN*	*NT*	*EN*	*F, Dd, C*											
Thin-peated Vaccinia myrtles spruce mires	*VU*	*NT*	*VU*	*F, Dd, C*											
Thin-peated Vaccinia vitis-idaea spruce mires	*EN*	*NT*	*VU*	*F, Dd, C*											

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	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Thin-peated herb-rich spruce mires	*EN*	*NT*	*VU*	*Dd, F, C*											
Thin-peated herb-rich fern spruce mires	*EN*	*NT*	*VU*	*Dd, F, C*											
Thin-peated rich herb-grass spruce mires	*EN*	*NT*	*VU*	*Dd, F, C*											
Thin-peated rich fen spruce mires	*CR*	*VU*	*EN*	*Dd, F, C*											
Thin-peated spring spruce mires	*CR*	*VU*	*EN*	*Dd, F, Gw, C*											
Herb-rich spruce mires	*EN*	*NT*	*VU*	*Dd, F, C, Pe*											
Fern spruce mires	*EN*	*NT*	*VU*	*Dd, F, C*											
Herb and grass spruce mires	*EN*	*NT*	*VU*	*Dd, F, C, Pe*											
Spring spruce mires	*EN*	*NT*	*VU*	*Dd, F, Gw, C*											
Herb-rich Vaccinium myrtillus spruce mires	*EN*	*NT*	*VU*	*Dd, F, C*											
Dwarf shrub spruce mires	*VU*	*NT*	*VU*	*F, Dd, C, Pe*											
Vaccinium myrtillus spruce mires	*VU*	*NT*	*VU*	*F, Dd, C*											
Equisetum sylvaticum spruce mires	*EN*	*VU*	*EN*	*F, Dd, C, Pe*											
Vaccinium vitis-idaea spruce mires	*VU*	*NT*	*VU*	*F, Dd, C*											
Rubus chamaemorus spruce mires	*VU*	*NT*	*VU*	*F, Dd, C, Pe*											
Spruce-birch fens NT–EN					0	0	0	0	**Structure**: Tree stands with heterogeneous structure, dominated by *Picea abies* or *Betula pubescens*, with dwarfed growth present in hummocks, continuum of deadwood. Fine-grained alternation of hummocks and lawns, fen sections and vegetation dominant. **Functional features:** Hydrology in its natural state, humid microclimate, peat formation, natural tree stand dynamics (regeneration in gaps).	2. Yes, for some habitat types	2. Moderate	1b Biodiversity losses can be offset by improving the status of the same habitat type	Some spruce-birch fen types are threatened and rare. There is previous experience of restoration, and some spruce-birch fen types are likely to be challenging to restore. There are, however, plenty of sites that can be restored and restoration can be employed to increase spruce-birch fen-related biodiversity values.	Biodiversity losses of sites of *Carex nigra* birch fens and *Eriophorum vaginatum* birch fens that are in their natural state and can be restored must be avoided.	Road and other construction, water withdrawal, ditch network maintenance, forestry measures. Peat extraction is not targeted at spruce mires, but peat extraction in nearby areas may have impacts on spruce mires
Tall-sedge spruce-birch fens	*VU*	*NT*	*NT*	*F, Dd, Pe, C*											
Carex nigra birch fens	*EN*		*EN*	*F, Dd, C*											
Eriophorum vaginatum birch fens	*EN*	*NT*	*EN*	*F, Dd, C*											
Pine mires and bogs LC–VU					2	1	0	0	**Structure**: Usually dominated by *Pinus sylvestris*, sometimes by *Picea abies*, natural and heterogeneous tree stand structure, variation in tree stand density, continuum of deadwood. Mainly with hummock cover, dominated by pine mire and bog species. **Functional features:** Hydrology in its natural state, humid microclimate, peat formation, natural tree stand dynamics, in the north frost heaving.	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	Pine mires and bogs are still relatively common. There are plenty of sites that can be restored and it is possible to increase pine mire and bog biodiversity through restoration.		Construction, e.g. road construction, large-scale mining and other projects: peat extraction, moss extraction, ditch network maintenance, forestry measures
Thin-peated pine mires	*NT*	*LC*	*NT*	*F, Dd, C*											
Spruce-pine mires	*VU*	*NT*	*VU*	*F, Dd, C*											
Carex globularis pine mires	*VU*	*LC*	*NT*	*F, Dd, C*											

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	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Dwarf shrub pine bogs	*NT*	*LC*	*LC*	*F, Dd, Pe, C*											
Eriophorum vaginatum pine bogs	*NT*	*LC*	*LC*	*Dd, Pe, F, C*											
Sphagnum fuscum bogs	*LC*	*LC*	*LC*	*Pe, Dd, C*											
Frost bogs and mires		*NT*	*NT*	*CC, Og*											
Pine fens LC–VU					1	0	0	0	**Structure**: Tree stands relatively sparse, dominated by *Pinus sylvestris*, (usually) heterogeneous in structure, occurring in groups, with decaying trees occurring, characteristic alternation of hummock, lawn and flark levels, dominance of pine mire and bog and fen species. **Functional features:** Hydrology in its natural state, humid microclimate, peat formation, natural tree stand dynamics	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	Pine fens are relatively common. There is previous experience of methods for their restoration and restoration can be employed to increase pine fen biodiversity.	Biodiversity losses of pine fens preserved in their natural state must be avoided, particularly in Southern Finland and in areas with intensive ditch drainage. It is not necessarily possible to restore the original type of strongly altered sites.	Peat extraction, projects related to groundwater level, road construction projects, moss extraction, ditch network maintenance, forestry measures
Tall-sedge pine fens	*VU*	*LC*	*LC*	*Dd , F, Pe, C*											
Sphagnum papillosum pine fens	*VU*	*NT*	*VU*	*Dd , F, Pe, C*											
Flark pine fens	*NT*	*LC*	*LC*	*Dd , Pe, C, Hc*											
Low-sedge pine fens	*VU*	*NT*	*NT*	*Dd , Pe, C*											
Ridge-hollow pine bogs	*LC*	*LC*	*LC*	*Pe, Dd, C, Ed*											
Fens LC–NT					2	1	0	0	**Structure**: Treeless open mire with lawn and/or flark levels, with hummock level accounting for a maximum of 20%. Fen species dominant. **Functional features:** Hydrology in its natural state, humid microclimate, peat formation.	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	A common habitat type with previous experience available of restoration methods and it is possible to reach the objectives set through restoration. The wettest fen types and highly complex entities are the most challenging types in terms of restoration. Restoration can, however, be employed to increase the biodiversity of fens.	Fens preserved in their natural state should not be subjected to biodiversity losses, particularly in Southern Finland and areas with intensive ditch drainage.	Peat extraction, mining activity, projects related to groundwater level, road projects, moss extraction, ditch network maintenance
Swamp fens	*NT*	*LC*	*LC*	*Hc, Wr, Dd,*											
Tall-sedge fens	*VU*	*LC*	*LC*	*C, Mo*											
Sphagnum papillosum fens	*VU*	*LC*	*NT*	*Dd, Pe, C*											
Flark fens	*NT*	*LC*	*LC*	*Dd, Pe, C*											
Minerotrophic low-sedge fens	*VU*	*LC*	*LC*	*Dd, Pe, Hc, C*											
Hollow bogs	*NT*	*LC*	*LC*	*Dd, Pe, C*											
Ombrotrophic low-sedge bogs	*NT*	*LC*	*LC*	*Pe, Dd, C, Ed*											

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Rich fens NT–CR				Dd, Pe, C, Ed	2	2	0	0	**Structure**: Major variation by type. Open or with sparse tree stands (rarely with trees). Lawn and/or flark levels dominant in open rich fens, in mixed types lawn or hummock-lawn-flark mosaic dominant. Often with multiple species, key indicators include demanding rich fen species indicating for eutrophy and mesoeutrophic species. Alternation of hummock, lawn or flark levels. Peat layer thickness varies. Shrub layer may be abundant. Field layer with multiple species and dominated by herbaceous plants, ground layer bryophyte species composition varies. **Functional features:** Hydrology in its natural state, humid microclimate, peat formation.	1. Yes	3. Uncertain	2b Biodiversity losses must be avoided, status improvement challenging	Rich fens are threatened habitat types that involve high species values and are rare, particularly in Southern Finland. Even strongly altered sites may have valuable species, and there may be risks involved in their restoration. Some rich fen types are challenging to restore, but there have also been good restoration outcomes.	Biodiversity losses of extensive rich fen areas and rich fen areas related to extensive mires in their natural state must be avoided. In Southern Finland, any further losses of even sites which have been degraded from their natural state should be avoided. Particular care must be exercised in the restoration planning and implementation of all sites, taking species values into account. In necessary, restoration measures must be taken gradually in separate phases.	Peat extraction, mining activity, projects related to groundwater level, road construction, hydraulic construction (any reservoir projects), ditch network maintenance
Rich spruce fens	*CR*	*VU*	*VU*	*Dd, F, C, Mo, Gw, Hc, Ex*											
Rich pine fens	*CR*	*VU*	*VU*	*Dd , F, Hc, C, Mo, Gw, Ex*											
Herb rich pine fens	*CR*	*VU*	*VU*	*Dd , F, C, Hc, Gw, Mo, Ex*											
Herb rich sedge fens	*CR*	*NT*	*VU*	*Dd, Pe, Hc, C, Gw, Mo*											
Rich swamp fens	*CR*	*EN*	*EN*	*Hc, Wr, Dd, C, Mo*											
Rich spring fens	*CR*	*NT*	*VU*	*Gw, Dd, F, C*											
Rich birch fens	*CR*	*NT*	*VU*	*Dd, Pe, Hc, Gw, C, F*											
Rich birch flark fens	*CR*	*NT*	*VU*	*Dd, Pe, Hc, Gw, C*											
Rich birch lawn fens	*CR*	*EN*	*CR*	*Dd, Pe, Hc, Gw, C, F*											
Rich lawn fens	*CR*	*EN*	*EN*	*Dd, F, Mo, Pe, Gw, Hc, C*											
Rich flark fens	*CR*	*NT*	*NT*	*Dd, Pe, Hc, C*											

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	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Wooded swamps NT–CR	VU	LC	VU	Hc, Wr, C, Dd, F, Lc	2	2	1	0	**Structure**: Natural tree stand structure dominated by deciduous trees. Fine-grained alternation of hummock, lawn and flark layers. Thin peat layer. Surface water influence, in some also field layer species indicating for groundwater influence (particularly herbs, graminoids and sedges), ground layer with gaps. **Functional features**: Natural hydrology, permanent surface water influence, nutrient input from flowing/flooding water, humid microclimate, low peat formation, natural tree stand dynamics	2. Yes, for some habitat types	3. Uncertain	3a Biodiversity losses must not take place, status improvement possible	Wooded swamps are rare and threatened. There is little previous experience of restoration and restoration is likely to be challenging in most cases. It may be difficult to find suitable offset sites. Birch swamps are more common than other swamp types, but they have also suffered biodiversity losses.	Biodiversity losses of wooded swamps in their natural state must be avoided, and the same applies to extensive wooded swamp areas. It is important to survey species values and take them into account in restoration planning.	Projects related to water level, hydraulic and coastal construction, ditch network maintenance, forestry measures
Birch swamps	*VU*	*LC*	*NT*	*Hc, Wr, C, Dd, F*											
Alnus glutinosa swamps	*VU*		*VU*	*Hc, Wr, C, Dd, F*											
Alnus incana swamps	*CR*		*CR*	*Dd, F, Hc, C, Lc*											
Shrub swamps and open swamps LC–EN					2	1	0	0	**Structure**: Depending on the type, open, dense or quite sparse shrub layer. Depending on the type, either flark or lawn layer. Thin peat layer. Shrub and field layer species indicating for surface water influence, ground layer with gaps. **Functional features**: Natural hydrology, permanent surface water influence, nutrient input from flowing/flooding water, humid microclimate, low peat formation.	2. Yes, for some habitat types	3. Uncertain	1b Biodiversity losses can be offset by improving the status of the same habitat type	Because they are common, shrub and open swamps have been assessed as being suitable for biodiversity offsetting, but they have undergone extensive quality deterioration due to various problems relating to hydrology and water quality. There is very little previous experience of improving their status. On the other hand. overgrowing and eutrophication of water bodies are creating new occurrences of this habitat type.	*Myrica gale* swamps are rare and threatened and therefore their biodiversity losses must be avoided. Shrub swamps in particular may have threatened habitat types that have yet to be identified.	Projects with impacts on water level and flood regime, hydraulic and coastal construction, ditch drainage and ditch network maintenance in the land drainage context
Shrub swamps	*NT*	*LC*	*LC*	*Hc, Wr, C, Dd, Lc*											
Willow swamps	*NT*	*LC*	*NT*	*Hc, Wr, C, Dd*											
Northern willow swamps		*LC*	*LC*	*Hc, Wr*											
Myrica gale swamps	*EN*		*EN*	*Dd, Hc, C, Lc*											
Open swamps	*NT*	*LC*	*LC*	*Hc, Wr, Dd, C, Mo, Weu*											

Habitat type	IUCN Red List Category in 2008: Southern Finland	IUCN Red List Category in 2008: Northern Finland	IUCN Red List Category in 2008: Nationwide	Threat factors	Inclusion in Habitats Directive and Finnish legislation: Habitats Directive	Inclusion in Habitats Directive and Finnish legislation: Forest Act	Inclusion in Habitats Directive and Finnish legislation: Nature Conservation Act	Inclusion in Habitats Directive and Finnish legislation: Water Act	Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
Raised bogs NT–EN					2	0	0	0	**Structure**: Mire complex formed from several dominantly ombrotrophic/oligotrophic mire types. Characteristic lower macroscale form parts with thick peat, rainwater-dependent (ombrotrophic) centre, steepening peripheral slope and minerotrophic lagg. Microscale forms with alternation of hummocks, moist hollows and open-water pools. Tree stands denser in the laggs, sparser or absent in the central parts. **Functional features:** Natural hydrology, centre received nutrients only from rainwater and dry deposition, lagg parts also from surrounding mineral soils, natural peat formation and tree stand dynamics.	2. Yes, for some habitat types	2. Moderate	1b Biodiversity losses can be offset by improving the status of the same habitat type	A substantial proportion of raised bogs are no longer in their natural state. There is a lot of previous experience of restoration methods, the methods work quite well and there are plenty of sites in need of restoration measures.	In addition to sites in their natural state, biodiversity losses of raised bog complexes that feature seminatural hydrology and are very suitable for restoration must be avoided, and the same applies to sites that are important as regards the connectivity of mire habitats.	Peat extraction, infrastructure construction, mining activity, moss extraction, ditch network maintenance, forestry measures
Plateau raised bogs	*NT*		*NT*	*Dd, F, Ed*											
Concentric raised bogs	*NT*		*NT*	*Pe, Dd, C, F, Rl*											
Eccentric raised bogs	*VU*	*LC*	*VU*	*Pe, Dd, C, F, Rl*											
Southern eccentric raised bogs	*VU*		*VU*	*Pe, Dd, C, F, Rl*											
Northern eccentric raised bogs		*LC*	*LC*	*Dd, W*											
Sphagnum fuscum raised bogs	*VU*	*LC*	*VU*	*Pe, Dd, C, Rl*											
Wooded raised bogs	*EN*		*EN*	*F, Dd, C, Rl*											
Middle boreal aapa mires VU–EN	EN	NT	EN	Dd, Pe, F, C, Gw, Hc	2	0	0	0	**Structure**: Mire complex usually with several minerotrophic mire types. Mire vegetation which can indicate for a broad range of nutrient levels from ombrotrophic to eutrophic. Level or slightly sloping mire areas, with central sections typically with lawn, flark or lawn-flark fen (more rarely rich fen), with a pine mire and bog zone typically found in the margins. **Functional features:** Natural hydrology (receives water from surrounding mineral soil), peat formation, natural tree stand dynamics.	3.Yes, in parts of the country	2. Moderate	2b Biodiversity losses must be avoided, status improvement challenging	A substantial proportion of middle boreal aapa mires are no longer in their natural state and the habitat type is very rare in places. Many aapa mire sites are difficult to restore despite there being restoration methods available.	Biodiversity losses of extensive aapa mire entities must be avoided, and the same applies to sites that are valuable in terms of their biodiversity, featuring rare mire types and rare/threatened species as well as those that are important as regards the connectivity of mire habitats (e.g. sites with wet eutrophy)	

Habitat type	IUCN Red List Category in 2008: Southern Finland	IUCN Red List Category in 2008: Northern Finland	IUCN Red List Category in 2008: Nationwide	Threat factors	Inclusion in Habitats Directive and Finnish legislation: Habitats Directive	Forest Act	Nature Conservation Act	Water Act	Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
Middle boreal lawn-surfaced aapa mires	*EN*		*EN*	*Dd, Pe, F, C, Gw*											
Middle boreal flark-surfaced aapa mires	*VU*	*NT*	*VU*	*Dd, Pe, F, C, Gw, Hc*											
Northern boreal aapa mires LC		LC	LC	Dd, F, Pe, C, Ex, Hc, W, Cc	2	0	0	0	**Structure**: Mire complex usually with several minerotrophic mire types. Mire vegetation which may indicate for a broad range of nutrient levels from ombrotrophic to eutrophic. Flat or slightly sloping mire area, with flark fen or rich flark fen found in the centre, well-developed string structure, with a pine mire and bog (or pine fen) zone found in the margins. Vegetation varies from ombrotrophic to meso- and eutrophic. **Functional features:** Natural hydrology (receives water from surrounding mineral soils), peat formation, natural tree stand dynamics.	2. Yes, for some habitat types	2. Moderate	1b Biodiversity losses can be offset by improving the status of the same habitat type	Northern boreal aapa mires are of Least Concern and a common habitat type, but rarer and threatened mire types also occur in aapa mires (e.g. rich birch fens, rich *Calliergon richardsonii* flark fens, particularly nutrient-rich calcareous fens). Some of the sites are challenging to restore.	Biodiversity losses of extensive aapa mire entities must always be avoided. Entities that contain rich birch fens and other rich fen areas and other rare or threatened habitat types or are significant as regards the connectivity of mire habitats are sites to be avoided. Aapa mires may be challenging to restore, so planning and implementation must be exercised with care.	Peat extraction, infrastructure construction, mining activity, moss extraction, hydraulic construction
Southern subtype of northern boreal aapa mires		*LC*	*LC*	*Dd, F, Pe, C, Ex, Hc*											
Northern subtype of northern boreal aapa mires		*LC*	*LC*	*F, W, Cc*											
Palsa mires NT		NT	NT	CC, W, Og	2	0	0	0	**Structure**: Mire complex belonging to aapa mires and characterised by permanently frozen elevated hummocks, or palsas, of varying shapes and of 1–7 m in height. Floodwater drains via soaks between stringless palsas or forms streams. Pounikko hummocks (frost bogs and mires) resulting from frost action in the margins. Pine mire and bog vegetation on palsas, in strings and pounikkos, open mire sections between palsas with oligotrophic or wet eutrophic pine mire and bog vegetation. *Betula spp.* and *Salix spp.* by streams and rivers. **Functional features**: Natural hydrology, formation and melting of palsas and pounikkos, natural tree stand dynamics.	1. Yes	5. No status improvement methods	3b Biodiversity losses must not take place, status improvement not possible	The degradation of palsa mires is mostly due to climate change. There are no methods available to improve their status.		

Habitat type	IUCN Red List Category in 2008: Southern Finland	IUCN Red List Category in 2008: Northern Finland	IUCN Red List Category in 2008: Nationwide	Threat factors	Inclusion in Habitats Directive and Finnish legislation: Habitats Directive	Inclusion in Habitats Directive and Finnish legislation: Forest Act	Inclusion in Habitats Directive and Finnish legislation: Nature Conservation Act	Inclusion in Habitats Directive and Finnish legislation: Water Act	Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
Sloping fens LC–VU	VU	LC	NT	Dd, F, C, W	2	0	0	0	**Structure**: Mire complex belonging to aapa mires and occurring on the slopes of fells and other areas above the timberline. Lawns dominant, with flarks decreasing when the catchment area gets smaller and the slope gradient greater. Often groundwater and supplementary nutrient effect-influenced. Major variation in vegetation, often with fens featuring *Molinia caerulea*, also rich fens with lawns, herb-rich sedge fens, various types of pine mires and bogs and spruce mires. Upper edges more wet eutrophic than central sections. Thin peat layer, streams. **Functional features**: Natural hydrology, low peat formation rate due to drying in the summer, natural tree stand dynamics.	2. Yes, for some habitat types	2. Moderate	1b Biodiversity losses can be offset by improving the status of the same habitat type	Sloping fens are not threatened in all parts of their occurrence area. Restoration is possible but involves specific challenges.	Biodiversity losses of threatened middle boreal sloping fens must be avoided.	Mining activity, tourism-related construction
Middle boreal sloping fens	*VU*		*VU*	*Dd, F, C*											
Northern boreal sloping fens		*LC*	*LC*	*Dd, F, C, W*											
Oroarctic mires LC		LC	LC		2	0	0	0	**Structure**: Groundwater- and meltwater-influenced mire complexes with thin peat layer. Lawns and/or flark levels dominant. Vegetation varies from oligo-mesotrophic to eutrophic central vegetation sections groundwater-influenced, with pounikko hummocks (frost bogs and mires) in the margins. **Functional features**: Natural hydrology, low rate of peat formation, pounikko formation, permanent groundwater influence and influence of ice and snow meltwater.	1. Yes	4. Unknown	2b Biodiversity losses must be avoided, status improvement challenging	Oroarctic mires are not threatened and a substantial proportion of them are protected and in their natural state. Biodiversity offsetting is of very little significance to them. On the other hand, the habitat type only occurs in a relatively small area and there is no previous experience of improving its status.		Recreational route construction

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Mire succession series of land uplift coast CR	CR		CR	Dd, F, C, Hc, Lc	1	1	0	0	**Structure**: Zonated succession series with thin peat layer of young mires created through land uplift. Succession progresses from eutrophic swamps via fens and pine mires and bogs to aapa or raised bog complexes. Groundwater and surface water influence typically occurs in young mires, with mineral soil influence also occurring, particularly in mires on moraine soils. **Functional features:** Natural hydrology, peat formation, thickening of peat layer, increasing oligotrophy and expansion of mire area as succession progresses.	1. Yes	3. Uncertain	3a Biodiversity losses must not take place, status improvement possible	A unique habitat type with unbroken succession series entities in their natural state being very rare. Many sites are in need of restoration, but methods for the restoration of entire succession series may not necessarily be available. Biodiversity offsetting could be applicable to the extent that protection, habitat type recovery through restoration and management as offset measures are targeted at the parts of entities that have suffered biodiversity losses.		Water and coastal construction, infrastructure construction, land clearing for agriculture
Raised bog succession series of land uplift coast	*CR*		*CR*	*Dd, F, C, Hc, Lc*											
Aapa mire succession series of land uplift coast	*CR*		*CR*	*Dd, F, C, Hc, Lc*											
FORESTS (13 assessed habitat types)															
Herb-rich forests with broadleaved deciduous trees EN–CR	EN		EN	Ft, Fa, Fd, F, C, W, S, Ot, small populations	2	2	2	0	**Structure**: Mixed herb-rich forests with deciduous (hardwood) trees and/or large *Corylus avellana* numbering at least dozens per hectare. Several tree generations, large old deciduous (hardwood) trees, an abundance of deadwood. Herb-rich forest species in the shrub and field layer, ground layer featuring bryophytes with gaps. Soil type herb-rich forest soil. Old deciduous (hardwood) trees supporting rich epiphyte and invertebrate species. Varying topography. **Functional features:** Trees, including deciduous (hardwood trees) regenerate naturally through small gap dynamics or under other trees, an abundance of deadwood in various stages of decay succession, detritus maintaining herb-rich forest soil.	1. Yes	2. Moderate	2a Biodiversity losses must be avoided, status improvement possible	Herb-rich forests with broadleaved deciduous trees are rare and important for threatened species, so their biodiversity losses must generally be avoided. It is possible to increase the diversity of altered herb-rich forests with broadleaved deciduous trees through restoration and management. Protected sites also need measures to ensure the regeneration of exacting deciduous trees.	Biodiversity losses of extensive sites and sites with a natural continuum of deciduous (hardwood) trees must be avoided. The ecological and species-related significance of the tree species varies, which must be taken into account in biodiversity offsetting.	Construction, forestry measures
Herb-rich forests with lime trees	*EN*		*EN*	*Ft, Fa, Fd, F, C*											
Herb-rich forests with hazel	*EN*		*EN*	*Ft, Fa, Fd, F, C, Ot, small populations*											

Habitat type	IUCN Red List Category in 2008: Southern Finland	Northern Finland	Nationwide	Threat factors	Inclusion in Habitats Directive and Finnish legislation: Habitats Directive	Forest Act	Nature Conservation Act	Water Act	Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
Herb-rich forests with oak trees	*CR*		*CR*	*Ft, Fd, C, W, Ot, small populations*											
Herb-rich forests with ash trees	*EN*		*EN*	*Ft, Fd, C*											
Herb-rich forests with maple trees	*EN*		*EN*	*Ft, W, C*											
Herb-rich forests with wych elm	*CR*		*CR*	*Ft, W, S, Ot, small populations, C*											
Herb-rich forests with European white elm	*CR*		*CR*	*F, C, W, S, Ot, small populations*											
Herb-rich forests NT–CR	VU	NT	VU	Ft, Fd, Fa, F, Dd, S, C	2	2	0	0	**Structure**: Mixed or *Picea abies* or deciduous tree-dominated forests in xeric, mesic or moist environments. Several tree generations, an abundance of deadwood. Herb-rich forest species in the shrub and field layer, ground layer featuring bryophytes with gaps. Soil type herb-rich forest soil, nutrient level varies from mesotrophic to eutrophic. Varying topography. **Functional features**: Trees regenerate naturally through small gap dynamics, extensive disturbances rare. An abundance of deadwood in various stages of decay succession. Herb-rich forest soil maintained by detritus.	2. Yes, for some habitat types	2. Moderate	1b Biodiversity losses can be offset by improving the status of the same habitat type	Herb-rich forests are threatened and degraded sites occur extensively, but their biodiversity can be improved through restoration and management. Protected sites may also require measures to ensure the preservation of herb-rich forest species.	Biodiversity losses of all rare herb-rich forest habitat types should be avoided.	Construction, forestry measures
Dry mesotrophic herb-rich forests	*EN*	*VU*	*EN*	*Ft, Fr, Fa, F, C, Ex*											
Mesic mesotrophic herb-rich forests	*VU*	*NT*	*VU*	*Ft, Fd, Fa, F, Dd, S, C*											
Moist mesotrophic herb-rich forests	*NT*	*LC*	*NT*	*Ft, Fd, Fa, Dd, F, S, C*											
Dry eutrophic herb-rich forests	*EN*	*VU*	*EN*	*Ft, Fd, Fa, F, C, Ex*											
Mesic eutrophic herb-rich forests	*CR*	*VU*	*CR*	*Ft, Fd, Fa, F, C, S*											
Moist eutrophic herb-rich forests	*VU*	*NT*	*VU*	*Ft, Fd, Fa, Dd, F, S, C*											

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Herb-rich heath forests NT–EN	NT	NT	NT	Fd, Fa, Ft, Dd	1	0	0	0	**Structure**: Dominated by conifers or deciduous trees, several tree generations. An abundance of deadwood. Both herb-rich forest herb vegetation and dwarf shrubs of heath forests, ground layer with bryophytes may have gaps. A distinct acidic humus layer in the soil. Varying topography. **Functional features**: Forest regenerates naturally through disturbance dynamics. An abundance of deadwood in various stages of decay succession.	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	Some herb-rich heath forest habitat types are threatened and degraded sites occur extensively, but their biodiversity can be improved through restoration and management.	Biodiversity losses of the rarest herb-rich heath forest habitat types should be avoided.	Construction, forestry measures
Young herb-rich heath forests	*VU*	*EN*	*VU*	*Fd, Ft, Fa, F, Dd*											
Middle-aged pine-dominated herb-rich heath forests	*NT*	*VU*	*NT*	*Fd, Fa, Ft, F, Dd*											
Middle-aged spruce-dominated herb-rich heath forests	*NT*	*EN*	*NT*	*Fd, Fa, Ft, F, Dd*											
Middle-aged deciduous-dominated herb-rich heath forests	*EN*	*VU*	*EN*	*Fd, Fa, Ft, F, Dd*											
Middle-aged mixed herb-rich heath forests	*NT*	*VU*	*NT*	*Fd, Fa, Ft, F, Dd*											
Old pine-dominated herb-rich heath forests	*VU*	*DD*	*VU*	*Fd, Fa, Ft*											
Old spruce-dominated herb-rich heath forests	*NT*	*NT*	*NT*	*Fd, Fa, Ft*											
Old deciduous-dominated herb-rich heath forests	*EN*	*CR*	*EN*	*Fd, Fa, Ft*											
Old mixed herb-rich heath forests	*VU*	*NT*	*NT*	*Fd, Fa, Ft*											
Very old pine-dominated herb-rich heath forests	*DD*	*EN*	*EN*	*Fd, Fa, Ft*											
Very old spruce-dominated herb-rich heath forests	*VU*	*NT*	*VU*	*Fd, Fa, Ft*											
Very old deciduous-dominated herb-rich heath forests	*EN*	*CR*	*EN*	*Fd, Fa, Ft*											
Very old mixed herb-rich heath forests	*VU*	*CR*	*EN*	*Fd, Fa, Ft*											

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Mesic heath forests LC–CR	NT	NT	NT	Fd, Fa, Ft, Dd	1	0	0	0	**Structure**: Dominated by conifers or deciduous trees, several tree generations. An abundance of deadwood. Field layer dominated by dwarf shrubs, ground layer with bryophytes. On moraine soils, soil type acidic podsol, thick humus layer. Varying topography. **Functional features**: Forest regenerates naturally in small canopy gaps and following forest fires. An abundance of deadwood in various stages of decay succession.	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	Some mesic heath forest habitat types are threatened and sites whose status has deteriorated occur extensively, but their biodiversity can be improved through restoration. There is a great deal of previous experience of restoration methods and their strengths and weaknesses are known.	Biodiversity losses of sites which are deciduous-dominated, in their natural state, with a good continuum of deadwood or *Populus tremula* or special in terms of their microclimate must be avoided. The continuum of deadwood and old trees cannot be created through restoration, and these involve a large number of threatened species.	Construction, forestry measures
Young mesic heath forests	*VU*	*VU*	*VU*	*Fd, Ft, Fa, F, Dd*											
Middle-aged pine-dominated mesic heath forests	*NT*	*LC*	*NT*	*Fd, Fa, Ft, Dd*											
Middle-aged spruce-dominated mesic heath forests	*NT*	*VU*	*NT*	*Fd, Fa, Ft, CC, Dd*											
Middle-aged deciduous-dominated mesic heath forests	*CR*	*LC*	*VU*	*Fd, Fa, Ft, Dd*											
Middle-aged mixed mesic heath forests	*NT*	*LC*	*NT*	*Fd, Fa, Ft, Dd*											
Old pine-dominated mesic heath forests	*LC*	*LC*	*LC*	*Fd, Fa, Ft*											
Old spruce-dominated mesic heath forests	*LC*	*VU*	*VU*	*Fd, Fa, Ft, Cc*											
Old deciduous-dominated mesic heath forests	*EN*	*VU*	*EN*	*Fd, Fa, Ft*											
Old mixed mesic heath forests	*NT*	*NT*	*NT*	*Fd, Fa, Ft*											
Very old pine-dominated mesic heath forests	*NT*	*LC*	*NT*	*Fd, Fa, Ft*											
Very old spruce-dominated mesic heath forests	*VU*	*LC*	*NT*	*Fd, Fa, Ft, Cc*											
Very old deciduous-dominated mesic heath forests	*CR*	*CR*	*CR*	*Fd, Fa, Ft*											
Very old mixed mesic heath forests	*NT*	*NT*	*NT*	*Fd, Fa, Ft*											

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Sub-xeric heath forests NT–CR	NT	LC	NT	Fd, Fa, Ed, Ft	1	0	0	0	**Structure**: Dominated by *Pinus sylvestris*, in the north with sparse tree stands, several tree generations. An abundance of deadwood. Field layer dominated by dwarf shrubs, ground layer dominated by bryophytes, lichen cover 5–10%. Soil type acidic podsol. Often on coarse moraine soil on tops and slopes of hills, also in conjunction with eskers and deltas. **Functional features**: Natural regeneration, particularly through forest fires, also in small canopy gaps. An abundance of deadwood in various stages of decay succession. Access to water and nitrogen limiting plant growth.	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	Some sub-xeric heath forest habitat types are threatened and sites whose status has deteriorated occur extensively, but their biodiversity can be improved through restoration. There is a lot of previous experience of restoration methods and their strengths and weaknesses are known.	Biodiversity losses of sites which are deciduous-dominated, in their natural state and with a continuum of deadwood in particular must be avoided. The continuum of deadwood and old trees cannot be created through restoration, and these involve a large number of threatened species.	Construction, forestry measures
Young sub-xeric heath forests	*VU*	*NT*	*VU*	*Fd, Fa, Ed, Ft*											
Middle-aged pine-dominated sub-xeric heath forests	*NT*	*LC*	*NT*	*Fd, Fa, Ed, Ft*											
Middle-aged spruce-dominated sub-xeric heath forests	*EN*	*EN*	*EN*	*Fd, Fa, Ed, Ft, Cc*											
Middle-aged deciduous-dominated sub-xeric heath forests	*CR*	*NT*	*VU*	*Fd, Fa, Ed, Ft*											
Middle-aged mixed sub-xeric heath forests	*EN*	*VU*	*EN*	*Fd, Fa, Ed, Ft*											
Old pine-dominated sub-xeric heath forests	*NT*	*NT*	*NT*	*Fd, Fa, Ed, Ft*											
Old spruce-dominated sub-xeric heath forests	*CR*	*EN*	*EN*	*Fd, Fa, Ed, Ft, Cc*											
Old deciduous-dominated sub-xeric heath forests	*CR*	*CR*	*CR*	*Fd, Fa, Ed, Ft*											
Old mixed sub-xeric heath forests	*EN*	*EN*	*EN*	*Fd, Fa, Ed, Ft*											
Very old pine-dominated sub-xeric heath forests	*NT*	*LC*	*NT*	*Fd, Fa, Ed, Ft*											
Very old spruce-dominated sub-xeric heath forests	*EN*	*NT*	*NT*	*Fd, Fa, Ed, Ft, Cc*											
Very old deciduous-dominated sub-xeric heath forests	*CR*	*CR*	*CR*	*Fd, Fa, Ed, Ft*											
Very old mixed sub-xeric heath forests	*EN*	*EN*	*EN*	*Fd, Fa, Ed, Ft*											

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Xeric heath forests NT–EN	VU	NT	NT	Fd, Ed, Og, Fa, Cc	1	0	0	0	**Structure**: Dominated by *Pinus sylvestris*, sparse tree stands. Several tree generations, may include cohorts formed by forest fires. An abundance of deadwood. Field layer mainly consisting of dwarf shrubs, ground layer dominated by bryophytes in the south and by lichens in the north. Soil type acidic podsol, humus layer thin. Mainly on sorted sand soil such as slopes of hills. **Functional features:** Natural regeneration, particularly through forest fires, also in small canopy gaps. An abundance of deadwood in various stages of decay succession, rate of decay slow. Access to water and nitrogen limiting plant growth.	2. Yes, for some habitat types	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	Some xeric heath forest habitat types are threatened and sites whose status has deteriorated occur extensively, but their biodiversity can be improved through restoration. Biodiversity offsetting may increase the opportunities to use various types of burning and promote the development of fire continuum areas.	Biodiversity losses of sites with a good continuum of deadwood in particular must be avoided. Some of the habitat types of old and very old habitat types falling under sub-xeric heath forests in particular are highly threatened and their biodiversity losses must be avoided.	Construction, forestry measures
Young xeric heath forests	*VU*	*VU*	*VU*	*Fd, Ed, Og, Fa, Cc*											
Middle-aged pine-dominated xeric heath forests	*NT*	*NT*	*NT*	*Fd, Ed, Og, Fa, Cc*											
Middle-aged spruce-dominated xeric heath forests	*EN*	*EN*	*EN*	*Fd, Ed, Og, Fa, Cc*											
Middle-aged deciduous-dominated xeric heath forests	*EN*	*NT*	*NT*	*Fd, Ed, Og, Fa, Cc*											
Middle-aged mixed xeric heath forests	*EN*	*VU*	*VU*	*Fd, Ed, Og, Fa, Cc*											
Old pine-dominated xeric heath forests	*EN*	*NT*	*VU*	*Fd, Ed, Og, Fa, Cc*											
Old spruce-dominated xeric heath forests	*EN*	*EN*	*EN*	*Fd, Ed, Og, Fa, Cc*											
Old deciduous-dominated xeric heath forests	*DD*	*DD*	*DD*												
Old mixed xeric heath forests	*EN*	*EN*	*EN*	*Fd, Ed, Og, Fa, Cc*											
Very old pine-dominated xeric heath forests	*EN*	*NT*	*NT*	*Fd, Ed, Og, Fa, Cc*											
Very old spruce-dominated xeric heath forests	*DD*	*EN*	*EN*	*Fd, Ed, Og, Fa, Cc*											
Very old deciduous-dominated xeric heath forests	*DD*	*DD*	*DD*												
Very old mixed xeric heath forests	*EN*	*VU*	*EN*	*Fd, Ed, Og, Fa, Cc*											

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Barren heath forests CR	CR	CR	CR	Og, Ed, Fd, Fa, F, Cc	1	0	0	0	**Structure**: Low-growing *Pinus sylvestris* forests with sparse stands. Several tree generations, major forest fires also resulting in single-storied forests. An abundance of deadwood, especially dead standing trees. Vegetation with few species, almost exclusively lichens, sparse occurrence of dwarf shrubs. On coarse sorted soil, very thin humus layer. **Functional features**: Slow rate of tree growth. Natural regeneration almost exclusively through forest fires. An abundance of deadwood in various stages of decay succession because the rate of decay is slow.	3.Yes, in parts of the country	3. Uncertain	2a Biodiversity losses must be avoided, status improvement possible	Recovery rate is slower than with other heath forest habitat types with, for example, the creation of a continuum of deadwood taking a very long time. It is possible to use burning to increase biodiversity and make sites affected by eutrophication more oligotrophic.	In addition to sites in their natural state, biodiversity losses of sites that can be restored easily must be avoided. In biodiversity offsetting situations, the permanent protection of sites is important.	Construction, mining activity, forestry measures
Young barren heath forests	*CR*	*CR*	*CR*	*Og, Ed, Fd, Fa, F, Cc*											
Middle-aged barren heath forests	*CR*	*CR*	*CR*	*Og, Ed, Fd, Fa, F, Cc*											
Old barren heath forests	*CR*	*CR*	*CR*	*Og, Ed, Fd, Fa, F, Cc*											
Very old barren heath forests	*CR*	*CR*	*CR*	*Og, Ed, Fd, Fa, F, Cc*											
Esker forests VU	EN	NT	VU	Fa, Ed, C, Ex	2	0	0	0	**Structure**: Tree stand structure with gaps, occurrence of patches of exposed mineral soil, ground layer vegetation with gaps, occurrence of decaying trees, occurrence of esker species requiring sun exposure (vascular plants and insects in particular). **Functional features:** Microclimate with extreme events, rapid decomposition of organic matter, landslip of topsoil due to steep slope inclination, occasional occurrence of fires or corresponding disturbances.	5. No	2. Moderate	1b Biodiversity losses can be offset by improving the status of the same habitat type	Many esker forests have been degraded. Measures are usually required to preserve sun exposure. There is a relatively large number of rare and threatened species related to the habitat type. Forest fires are an important way of improving their status and biodiversity offsetting could increase opportunities for burning and the development of fire continuum areas.	Biodiversity losses of esker forests whose status is good or which have undergone management or restoration and have important species must be avoided. Threatened species must be taken comprehensively into account in biodiversity offsetting.	Earth material extraction, construction, forestry activity

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Inland dune forests VU	VU	NT	VU	Fa, Ed, Og, Ex	0	0	0	0	**Structure**: Stunted and sparse *Pinus sylvestris* forests in intact dune fields trapped by vegetation. Diverse age and size structure of trees, an abundance of decaying trees. On steep slopes in particular there are treeless, sun-exposed sand sections. Vegetation with gaps, usually featuring xeric heath forest or barren heath forest species. Humus layer very thin. **Functional features**: Tree growth and decay very slow. Both surface fires and exceptionally long drought periods occur. Microclimate with extreme events. Drought kills trees and vegetation, fires impoverish the forest. Wind erosion, surface fires and drought periods create gaps in vegetation.	1. Yes	2. Moderate	2a Biodiversity losses must be avoided, status improvement possible	Inland dune forests only occur in conjunction with dune areas. There is little previous experience of the management and restoration of dune areas, but in principle the methods are similar to those employed with, for example, esker forests. The difficulty, however, is increased by the fact that dune formations must not be broken.	Threatened species must be taken comprehensively into account in biodiversity offsetting. The focus in the selection of offset sites could be on improving the status of sites important for species.	Earth material extraction, construction, forestry activity
Inland flooded forests EN	CR	NT	EN	Hc, Dd, F	2	0	0	0	**Structure**: Eutrophic, relatively sparse forests with deciduous trees on the shores of water bodies. Species tolerant of wetness and accumulating earth material, vegetation with gaps, shrub layer abundant. A lot of deadwood. Soil often mixed with clay, no sedimentation or peat. **Functional features**: Species and tree stands affected by repeated floods (annually or every few years). Floods may be spring floods caused by snow melting or summer or autumn floods caused by torrential rain. Soil dry between floods. Floods destroy *Picea abies* underbush and damage vegetation and trees. Earth material brought by floodwater suffocates some species and provides an input of nutrients and solids. Tree stands regenerate in small gaps.	1. Yes	4. Unknown	3a Biodiversity losses must not take place, status improvement possible	Flooded forests are very rare and threatened. There is little previous experience of improving their status. It is likely to be difficult to restore the floodwater impact and the number of sites suitable for that purpose is limited.		Flood protection, hydraulic construction, draining, other construction

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Forests on rocky terrain LC	LC	NT	LC	Og, Ex, Ed, Fd, Fa, W	1	1	0	0	**Structure**: Sparse forests dominated by *Pinus sylvestris* in flat rock outcrop areas. Fine-grained variation in terms of bedrock topography, aspect, soil thickness, site type and tree composition. An abundance of deadwood. Vegetation dominated by lichens and dwarf shrubs, with gaps. **Functional features**: Tree growth and decay slow. Sun exposure and extreme conditions produce specific types of decaying trees. Forest fires and longer periods of drought kill trees and increase the presence of gaps in vegetation.	5. No	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	Rock outcrops are non-renewable, which restricts the potential for offsetting losses of these habitats. Forests on rocky terrain is, however, a relatively common habitat type and has retained features of natural forests to an extent greater than with any other forest habitat type.	Biodiversity losses of extensive sites which are in their natural state, special as regards their geomorphology and valuable in terms of their species must be avoided. The slow recovery of the habitat type must be taken into account in biodiversity offsetting situations.	Rock excavation, construction, forestry measures
Forests on ultrabasic soils VU	VU	NT	VU	Ex	0	0	0	0	**Structure**: Often with stunted growth, sparse *Pinus sylvestris* forest, with an abundance of *Juniperus communis*, occurrence of ultrabasic rock types, occurrence of serpentine species in vegetation, scarcity of vegetation. Soil variation results in variation in vegetation and tree stands. **Functional features:** Natural disturbance dynamics (incl. forest fires, fallen trees with exposed roots, weathering of rock), creating new space for serpentine species to grow.	1. Yes	3. Uncertain	3a Biodiversity losses must not take place, status improvement possible	Forests on ultrabasic soils are very rare, with rare and threatened species and habitat specialist races and forms occurring in them. Geographic variation is quite high. There is little previous experience of restoration and management, but many sites would probably benefit from measures.	There are major differences between southern and northern sites and overall great variation between forests classified under this habitat type. It is important to use equivalent sites as offset sites.	Rock excavation, other mining activity, construction
Hardwood forests on podsolic soils VU	VU		VU	Hardwood forests on podsolic soils VU	1	0	2	0	**Structure**: Mixed heath forests with deciduous (hardwood) trees (*Quercus robur, Tilia cordata, Acer platanoides*) numbering at least dozens per hectare. Several tree generations, with stratification in the canopy, an abundance of deadwood. Deciduous (hardwood) trees do not reach sizes as large as in herb-rich forests. Herb-, mesic or sub-xeric heath forest. Old deciduous (hardwood) trees with rich epiphyte and invertebrate species. Varying topography. **Functional features:** Trees, incl. deciduous (hardwood) trees regenerate naturally through disturbance dynamics or underneath other trees, and there is an abundance of deadwood in various stage of decay succession.	1. Yes	2. Moderate	2a Biodiversity losses must be avoided, status improvement possible	Hardwood forests on podsolic soils are very rare, threatened and occur in a relatively small area in Finland. It is possible to increase the biodiversity of the habitat type through management and restoration.	Biodiversity losses of extensive sites and sites with a natural continuum of deciduous (hardwood) trees and threatened species must be avoided. The ecological and species-related significance of deciduous (hardwood) trees varies, which must be taken into account in biodiversity offsetting.	Construction, forestry activity

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
KALLIOT JA KIVIKOT (6 arvioitua luontotyyppiä)															
Siliceous rock outcrops LC–NT					2	0	0	0	**Structure**: Rock outcrop topography may vary (rock face/gently sloping). Humus layer thin or absent. Vegetation unworn, open and low-growing, dominated by rock bryophytes and lichens. Zonated vegetation on riparian rock outcrops. **Functional features:** Natural shading conditions and microclimate: sun-exposed faces well-lighted and dry, shady faces shaded by trees and moist.	5. No	3. Uncertain	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	Rock outcrops are non-renewable, which in principle restricts the potential for their biodiversity offsetting. Siliceous rock outcrops are, however, common in Finland and the protection of valuable rock outcrop sites or the improvement of the status of rarer habitat types, and possibly also the management of overgrown intermediate-basic rock outcrop sites, can be used as offset measures.	Siliceous rock outcrops are a large group of different habitat types and, despite being common, they include valuable sites and subtypes. Those with the highest plant species diversity are intermediate-basic rock outcrops and south/west-facing intermediate-basic rock faces with a special microclimate suitable for southern species. Extensive shady slopes may provide climate refuges for northern species.	Bedrock excavation, construction, on riparian rock outcrops water body regulation, tree cutting affecting shady slopes
Acidic rock outcrops on seashores	*LC*		*LC*	*C, Weu, W*											
Acidic rock outcrops on lakeshores	*LC*	*LC*	*LC*	*C, Wr, Weu*											
Acidic rock outcrops on riverbanks	*NT*	*NT*	*NT*	*Wr, Hc, Weu, C, W*											
Acidic open gently sloping rock outcrops near the Baltic coast	*NT*		*NT*	*Ex, C*											
Acidic open gently sloping inland rock outcrops	*LC*	*LC*	*LC*	*C, Ex, F*											
Acidic well-lighted rock faces	*LC*	*LC*	*LC*	*C, Ex, F*											
Acidic shady rock faces	*NT*	*LC*	*NT*	*F, C, Ex*											
Acidic overhanging rock faces	*NT*	*LC*	*NT*	*F, W, C, Ex*											
Siliceous rock faces with seepage water	*LC*	*LC*	*LC*	*F, C, Ex*											
Siliceous weathered rocks	*NT*	*LC*	*NT*	*Ex, F*											
Intermediate-basic rock outcrops on seashores	*NT*		*NT*	*C, Weu, W*											
Intermediate-basic rock outcrops on lakeshores	*NT*	*LC*	*NT*	*C, Wr, Weu, W*											
Intermediate-basic rock outcrops on riverbanks	*NT*	*NT*	*NT*	*Wr, Hc, Weu*											
Intermediate-basic open gently sloping rocks	*NT*	*LC*	*NT*	*Mo, F, C, Ex*											
Intermediate-basic well-lighted rock faces	*LC*	*LC*	*LC*	*C, Ex, F*											
Intermediate-basic shady rock faces	*NT*	*LC*	*NT*	*F, C, Ex*											
Intermediate-basic overhanging rock faces	*NT*	*LC*	*NT*	*F, W, Ex*											

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Calcareous rock outcrops NT–CR	VU	NT	VU	Mo, F, C, Weu, Hc, Ex	2	1	0	0	**Structure**: Rock outcrops of calcitic limestone, dolomite or with carbonate occurring as an accessory mineral. Thin humus layer. Topography may vary (rock face/gently sloping). Vegetation unworn, with gaps on sun-exposed faces, with calcicoles and calciphiles, particularly among bryophytes and lichens. **Functional features**: Natural shading conditions and microclimate (sun-exposed faces well-lighted and dry, shady faces shaded by trees and moist). On sun-exposed walls, exposure of rock through weathering creating space for small-sized calcicoles and calciphiles.	1. Yes	3. Uncertain	3a Biodiversity losses must not take place, status improvement possible	Calcareous rock outcrops are rare and particularly important for threatened species, and their biodiversity losses must be avoided in particular. They benefit from management, whereby calcareous rock outcrop occurrences suffering from overgrowing can be used as offset measures for biodiversity losses of more common habitat types (requires special expertise) or the aftercare of closed limestone quarries can be organised so that the living conditions of calcicoles are improved.	Threatened species must be taken into account when planning management.	Construction, mining activity, water body regulation (riparian rock outcrops), tree cutting affecting shady faces
Calcareous rock outcrops on seashores	*VU*		*VU*	*C, Mo, Weu*											
Calcareous rock outcrops on lakeshores	*VU*	*NT*	*VU*	*C, Mo, Weu, F*											
Calcareous rock outcrops on riverbanks	*EN*	*NT*	*NT*	*C, Wr, Hc, Weu*											
Calcareous open gently sloping rock outcrops	*CR*	*DD*	*CR*	*Mo, F, C, Ex, Ed*											
Calcareous wooded gently sloping rock outcrops	*VU*	*VU*	*VU*	*F, Ex, C*											
Calcareous well-lighted rock faces	*EN*	*NT*	*NT*	*Ex, C, F*											
Calcareous shady rock faces	*VU*	*NT*	*VU*	*F, Ex, C*											
Serpentine rock outcrops and scree NT–VU	VU	VU	VU	Ex, F, C, Wr	2	1	0	0	**Structure**: Rock outcrops of ultrabasic rock types. Topography may vary (rock face/gently sloping). Scarce tree and shrub stands. Ground vegetation with gaps, low-growing and scarce. Rare serpentine plant species or races characteristic of ultrabasic substrates. **Functional features**: Variation in moisture and shading conditions. Disturbance dynamics creating space for serpentine species to grow (weathering, fallen trees with roots exposed, forest fires, small gaps in tree stands).	1. Yes	4. Unknown	3b Biodiversity losses must not take place, status improvement not possible	Serpentine rock outcrops are rare and threatened and their species specialised, whereby there are few suitable offset sites available. There is no previous experience of improving the status of the habitat type through management, either. For some sites, opening up the vegetation or taking species values into account in the aftercare of quarries could increase biodiversity values, but there is no previous experience of the effectiveness of methods.	Threatened species must be taken into account when planning potential management.	Mining activity, construction, water body regulation (riparian rock outcrops), tree cutting affecting shady faces
Serpentine rock outcrops on shores	*VU*	*EN*	*VU*	*C, Wr*											
Gently sloping serpentine rock outcrops	*VU*	*VU*	*VU*	*Ex, F*											
Serpentine oligotrophic rock faces	*VU*	*VU*	*VU*	*Ex, F*											
Serpentine calcareous rock faces	*VU*	*VU*	*VU*	*Ex, F*											
Serpentine scree (block and gravel fields)		*NT*	*NT*	*Ex, F*											

Habitat type	IUCN Red List Category in 2008: Southern Finland	IUCN Red List Category in 2008: Northern Finland	IUCN Red List Category in 2008: Nationwide	Threat factors	Inclusion in Habitats Directive and Finnish legislation: Habitats Directive	Inclusion in Habitats Directive and Finnish legislation: Forest Act	Inclusion in Habitats Directive and Finnish legislation: Nature Conservation Act	Inclusion in Habitats Directive and Finnish legislation: Water Act	Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
Fe and Cu sulphide-rich rock outcrops NT	NT	LC	NT	F, Ex	2	1	0	0	**Structure**: Rock outcrops rich in Fe or Cu with high metal content and the metals occurring as sulphides. Distinctive vegetation: lichens typical of metal-rich rock outcrops. Often as patches among other rock outcrop habitat types. Functional features: Rock weathering creates new space for typical lichens to grow.	4. Possibly (insufficient data)	4. Unknown	2b Biodiversity losses must be avoided, status improvement challenging	Fe and Cu sulphide-rich rock outcrops are not assessed as being threatened, but their occurrences and biodiversity values are less known than those of other rock outcrop types and it is therefore difficult to find offset sites. There is no previous experience of improving the status of the habitat type through management, either Rare species could possibly also be preserved in novel habitats such as waste rock piles of closed mines.		Establishment of metal mines
Canyons and caves LC					0	1	0	0	**Structure**: Special rock morphology: canyon, gorge, cave or crevice. In addition to rock faces, canyons and gorges also feature other habitat types (incl. paludified areas, streams, boulder deposits). In caves shortage of light and humid microclimate and species adapted to these, especially bryophytes. **Functional features**: Weathering creates new space for plant species to grow. Natural light and moisture conditions.	2. Yes, for some habitat types	5. No status improvement methods	3b Biodiversity losses must not take place, status improvement not possible	Rock outcrop formations of a special shape are often unique and no offset sites for them can be found. Canyons and gorges may act as climate refuges for northern species, which increases the need to preserve them.		Construction, tourism-related projects (erosion and wear, disturbance of organisms)
Canyons	*LC*	*LC*	*LC*	*F, W*											
Gorges	*LC*	*LC*	*LC*	*W*											
Caves and crevices	*LC*	*LC*	*LC*	*W*											
Scree LC–NT					0	1	0	0	**Structure**: Scree, boulder fields and erratic boulders whose grain size varies depending on the scree creation method. Vegetation dominated by lichens and bryophytes, species depend on rock type. **Functional features:** Extensive scree areas, well-lighted and with dry microclimate. Cree-creating processes include land uplift, frost weathering, frost heaving, water erosion.	2. Yes, for some habitat types	4. Unknown	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	The processes forming scree are very slow, which in principle restricts the potential for applying biodiversity offsetting to scree habitats, and there are no management methods improving the status of scree in use. The majority of scree types in Finland are, however, common and of Least Concern, and, e.g. protecting valuable sites or improving the status of rarer habitat types can be used as offsets for biodiversity losses.	Calcareous erratic boulders and serpentine erratic boulders are the rarest, and it may be difficult to find offset sites to protect to compensate for them. Calcareous and serpentine scree is classified here under calcareous and serpentine rock faces, to which biodiversity offsetting is as a general rule not applicable.	Construction, rock extraction

Habitat type	IUCN Red List Category in 2008: Southern Finland	IUCN Red List Category in 2008: Northern Finland	IUCN Red List Category in 2008: Nationwide	Threat factors	Inclusion in Habitats Directive and Finnish legislation: Habitats Directive	Inclusion in Habitats Directive and Finnish legislation: Forest Act	Inclusion in Habitats Directive and Finnish legislation: Nature Conservation Act	Inclusion in Habitats Directive and Finnish legislation: Water Act	Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
Boulder fields of raised beaches near the Baltic coast (rather young)	*LC*		*LC*	*F*											
Boulder fields of raised beaches inland (ancient)	*NT*	*LC*	*NT*	*Ex, F*											
Fluvial boulder fields	*LC*	*LC*	*LC*	*F*											
Frost-weathered boulder fields	*LC*	*LC*	*LC*	*F*											
Frost-heaved boulder fields	*LC*	*LC*	*LC*	*F*											
Moraine boulder fields	*LC*	*LC*	*LC*	*F, Ex*											
Taluses	*LC*	*LC*	*LC*	*F*											
Erratic boulders, tors and stacks															
Siliceous erratic boulders, tors and stacks	*LC*	*LC*	*LC*												
Calcareous erratic boulders	*NT*	*NT*	*NT*	*F*											
Serpentine erratic boulders	*NT*	*NT*	*NT*	*F*											
SEMINATURAL GRASSLANDS (12 assessed habitat types)															
Heaths EN–CR	CR		CR	Mo, Ot controlled burning discontinued, C, W, F, Weu	2	0	0	0	**Structure**: Soil dry and nutrient-poor, often sandy. Vegetation open and low-growing, dominated by dwarf shrubs (in various subtypes also by low herbs or graminoids). Trees and shrubs absent or low in number. **Functional features:** Harsh marine climate conditions. Continuity of grazing and/or controlled burning. Natural succession on the land uplift coast.	2. Yes, for some habitat types	1. Good	1b Biodiversity losses can be offset by improving the status of the same habitat type	Heaths are highly threatened but suitable for biodiversity offsetting because there are lots of sites that are poor in quality or have already been altered and whose values can be recovered through management measures. Without management, the habitat type is at risk of extinction, and offset measures can provide new opportunities to organise management.	Low-herb and graminoid dwarf shrub heaths are currently the rarest types as they have in many places been affected by increased dwarf shrub cover, and biodiversity losses of remaining sites must absolutely be avoided. Their characteristics can, however, be recovered through management.	Coastal construction, projects increasing seawater and riparian eutrophication
Low herb dwarf shrub heaths	*CR*		*CR*	*Mo, Ot controlled burning discontinued, C, W, Weu*											
Graminoid dwarf shrub heaths	*CR*		*CR*	*Mo, Ot controlled burning discontinued, C, W, Weu*											
Dwarf shrub heaths	*EN*		*EN*	*Mo, Ot controlled burning discontinued, C, W, F, Weu*											

Habitat type	IUCN Red List Category in 2008: Southern Finland	IUCN Red List Category in 2008: Northern Finland	IUCN Red List Category in 2008: Nationwide	Threat factors	Inclusion in Habitats Directive and Finnish legislation: Habitats Directive	Inclusion in Habitats Directive and Finnish legislation: Forest Act	Inclusion in Habitats Directive and Finnish legislation: Nature Conservation Act	Inclusion in Habitats Directive and Finnish legislation: Water Act	Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
Rock meadows EN–CR	EN		EN	Me, Mo, F, C, Ex, Ed	2	0	0	0	**Structure**: Thin soil layer on bedrock, Vegetation open and low-growing, ground layer with gaps. Diverse plant and insect species, incl. annual and biennial angiosperms. Rare species, particularly in calcareous and mesotrophic rock meadows. Trees and shrubs absent. **Functional features**: Dry and well-lighted habitat, microclimate with extreme events. Continuity of grazing.	2. Yes, for some habitat types	1. Good	1b Biodiversity losses can be offset by improving the status of the same habitat type	Rock meadows are highly threatened but suitable for biodiversity offsetting because there are numerous sites whose quality is poor or which have already been altered and their values can be recovered through management measures. Without management, the habitat type is at risk of extinction, and offset measures can offer new opportunities to organise management.	Calcareous rock meadows are the rarest and most threatened in terms of their species, their biodiversity losses must be avoided in particular and it may be difficult to find offset sites for them.	Construction, lime extraction
Calcareous rock meadows	*CR*		*CR*	*C, F, Mo, Me, Ex, Ed*											
Acid rock meadows	*EN*		*EN*	*Me, Mo, F, C, Ed*											
Dry meadows CR	CR	CR	CR	Mo, Me, C, Ed, F, Lc	2	0	1	0	**Structure**: Soil dry, with sand, gravel or moraine. Vegetation open and low-growing, dominated by low herbs. Nitrophilous species, tree and shrub stands absent or small in number. Vascular plant, fungal and insect species that are typical of dry meadows and have become rare. **Functional features**: Continuity of grazing or mowing. Well-lighted and dry habitat.	3.Yes, in parts of the country	1. Good	1b Biodiversity losses can be offset by improving the status of the same habitat type	Dry meadows are highly threatened but suitable for biodiversity offsetting because there are plenty of sites that are poor in quality or already altered and their values can be recovered through management measures. Without management, the habitat type is at risk of extinction, and offset measures can offer new opportunities to organise management.	Calcareous dry meadows have more specific soil requirements than other dry meadows and are rare. Their biodiversity losses must be avoided in particular and it may be difficult to find offset sites.	Construction
Calcareous dry meadows	*CR*		*CR*	*Mo, F, C, Me, Ed*											
Acid low herb rich dry meadows	*CR*	*DD*	*CR*	*Mo, Me, C, F, Ed*											
Dwarf shrub rich dry meadows	*CR*	*CR*	*CR*	*Mo, F, Me, Ed*											
Avenula pubescens dry meadows	*CR*		*CR*	*Mo, Me, Ed, F*											
Grass rich dry meadows	*CR*	*CR*	*CR*	*Mo, Me, Ed, C, F, Lc*											

Habitat type	IUCN Red List Category in 2008: Southern Finland	IUCN Red List Category in 2008: Northern Finland	IUCN Red List Category in 2008: Nationwide	Threat factors	Inclusion in Habitats Directive and Finnish legislation: Habitats Directive	Forest Act	Nature Conservation Act	Water Act	Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
Mesic meadows EN–CR	CR	CR	CR	Mo, Me, F, S, Lc, C , Ed	1	0	0	0	**Structure**: Soil unscarified and unfertilised. Soil type may vary, often clay or moraine. Vegetation dominated by low herbs, graminoids or tall herbs. Trees and shrubs absent or small in number. Vascular plant and insect species characteristic of meadows that have become rare. **Functional features:** Continuity of grazing or mowing. In Eastern Finland often with a history of slashing and burning.	2. Yes, for some habitat types	1. Good	1b Biodiversity losses can be offset by improving the status of the same habitat type	Mesic meadows are highly threatened but suitable for biodiversity offsetting because there are plenty of sites whose quality is poor or which have already been altered and their values can be recovered through management measures. Without management, the habitat type is at risk of extinction, and offset measures can offer new opportunities to organise management.	Low-herb rich mesic meadows, particularly those occurring on calcareous soil, are the rarest. Particularly valuable are those few low-herb rich mesic meadows that have been managed exclusively by mowing and without any interruptions to their management.	Construction
Low herb rich mesic meadows	*CR*	*CR*	*CR*	*Mo, Me, F, S, Lc, Ed*											
Tall herb mesic meadows	*CR*	*CR*	*CR*	*Mo, Me, F, Lc, C, S*											
Graminoid mesic meadows	*EN*	*CR*	*EN*	*Mo, Me, F, S, Lc, C*											
Moist meadows CR	CR	CR	CR	Mo, Dd, F, Me, Lc, C	1	0	0	0	**Structure**: Soil moist or wet, unfertilised. In mineral soil depressions or slopes or soils with poor water permeability (these are not riparian meadows). Vegetation dominated by herbs or graminoids. Trees and shrubs absent or small in number. **Functional features**: Surface water or groundwater influence. Continuity of mowing or grazing.	2. Yes, for some habitat types	1. Good	1b Biodiversity losses can be offset by improving the status of the same habitat type	Moist meadows are highly threatened but suitable for biodiversity offsetting because values of sites which are of poor quality or have already been altered can be recovered through management measures. Without management, the habitat type is at risk of extinction and offset measures can offer new opportunities to organise management. Moist meadows become overgrown more quickly than dry and mesic meadows, so their management is urgently needed.	There are hardly any representative moist meadows left, whereby the occurrences and ecology of the habitat type are known more poorly than those of many other meadow types. Calcareous moist meadows are the rarest and most valuable types in terms of their species and can only be found in the Åland Islands and Finland's southwestern archipelago.	Construction, ditch drainage
Calcareous moist meadows	*CR*		*CR*	*Mo, Dd, C, Me, Lc, F*											
Herb rich moist meadows	*CR*	*CR*	*CR*	*Mo, Dd, F, Me, Lc*											
Grass rich moist meadows	*CR*	*CR*	*CR*	*Mo, Dd, F, Me, Lc*											

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Freshwater meadows EN–CR	EN	EN	EN	Weu, Mo, Wr, Hc, C, Dd, S	1	0	0	0	**Structure**: In open, low-relief riparian areas on mineral soils. Vegetation herb- or graminoid-dominated, zonated parallel to the shoreline. Trees and shrubs absent or small in number. Nesting birds such as waders. **Functional features**: Exposure to coastal phenomena (water level fluctuation, ice movements, short-term flooding). Continuity of mowing or grazing.	5. No	1. Good	1b Biodiversity losses can be offset by improving the status of the same habitat type	Freshwater meadows are highly threatened but suitable for biodiversity offsetting because there are lots of sites which are poor in quality or have already been altered and whose values can be recovered through management measures. Without management, the habitat type is at risk of extinction, and offset measures can provide new opportunities to organise management.	The habitat type is the rarest in coastal areas with few lakes ranging from Southwestern Finland to North Ostrobothnia.	Hydraulic construction, water body regulation, ditch drainage, dredging, diking, construction
Eleocharis acicularis freshwater meadows	*DD*	*DD*	*DD*	*Weu, Mo, Wr, Hc, Dd, S*											
Spike-rush and club-rush freshwater meadows	*DD*	*DD*	*DD*	*Weu, Wr, C, Hc, Mo, S*											
Tall sedge freshwater meadows	*EN*	*VU*	*EN*	*Weu, Wr, Mo, Hc, Dd, S*											
Low freshwater graminoid meadows	*CR*	*CR*	*CR*	*Weu, Mo, Wr, C, Hc, Dd*											
Tall freshwater meadows	*EN*	*VU*	*EN*	*Weu, Wr, Mo, C, Dd, S*											
Seashore meadows EN–CR	CR		CR	Mo, Weu, Hc, Dd, Cc	2	0	2	0	**Structure**: On open, low-relief seashores. Soil at least in part consisting of fine-grained fine sand, fine silt or clay, with salt patches in the best sites. Vegetation low-growing, herb- or grass-dominated, zonated parallel to the shoreline. Vegetation includes species benefitting from salinity. Trees and shrubs absent or small in number. Nesting and migrating birds such as waders and Anserinae. **Functional features:** Exposed to coastal phenomena (water level fluctuation, waves, ice movements, saline water influence). Continuity of mowing or grazing. Natural succession on the land uplift coast.	2. Yes, for some habitat types	1. Good	1b Biodiversity losses can be offset by improving the status of the same habitat type	Seashore meadows are highly threatened but suitable for biodiversity offsetting because there are lots of sites which are poor in quality or have already been altered and whose values can be recovered through management measures. Without management, the habitat type is at risk of extinction and offset measures can offer new opportunities to organise management. It is often easier to organise grazing than for other meadow types because sites are larger.	The rarest types are seashore meadows with salt patches, and their biodiversity losses must be avoided in particular.	Ditch drainage, dredging, construction, projects increasing seawater and coastal eutrophication
Eleocharis parvula - E. acicularis seashore meadows	*DD*		*DD*	*Weu, Mo, Hc, Cc*											
Spike-rush and glaucous and sea club-rush seashore meadows	*DD*		*DD*	*Hc, Dd*											
Tall sedge seashore meadows	*CR*		*CR*	*Mo, Weu, Hc, Dd, Cc*											

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Low graminoid seashore meadows	*CR*		*CR*	*Mo, Weu, Hc, Dd, Cc*											
Tall seashore meadows	*EN*		*EN*	*Mo, Weu, Hc, Dd, Cc*											
Salt patches	*CR*		*CR*	*Mo, Weu, Hc, Dd, Cc*											
Alluvial meadows NT–CR	EN	EN	EN	Mo, Hc, Wr, Weu, Lc	2	0	0	0	**Structure**: In open, low-relief riverside areas on mineral soils or very thin peat soil. Vegetation dominated by herbs or graminoids, zonated parallel to the shoreline depending on flood water level and flood regime. Trees and shrubs absent. Nesting birds such as waders. **Functional features:** Covered by floodwater at least in the spring. Accumulation of sediment input of flooding. Deposition and erosion caused by water and ice create unstable environments such as flood islands and capes. Continuity of mowing.	2. Yes, for some habitat types	2. Moderate	2a Biodiversity losses must be avoided, status improvement possible	Alluvial meadows differ from most other seminatural grassland types in that mowing or grazing alone will not maintain their characteristics over the long term but, instead, flooding is also required. This restricts the availability of suitable offset sites. If there is natural flooding, management through clearing and mowing is sufficient to improve their status. If flooding has decreased due to reasons including hydraulic construction restoration will require more extensive measures to re-introduce flooding.	Alluvial meadows located by non-constructed and non-regulated streams are particularly valuable and their biodiversity losses must be avoided in particular. Dry and mesic low-herb alluvial meadows are currently the rarest among Finland's alluvial meadow types.	Hydraulic construction, water body regulation
Equisetum fluviatile alluvial meadows	*NT*	*NT*	*NT*	*Hc, Wr, Weu, Mo*											
Tall sedge alluvial meadows	*NT*	*NT*	*NT*	*Hc, Wr, Weu, Mo*											
Moist graminoid alluvial meadows	*VU*	*VU*	*VU*	*Hc, Mo, Wr*											
Mesic graminoid alluvial meadows	*CR*	*CR*	*CR*	*Mo, Hc, Wr, Lc*											
Mesic tall herb alluvial meadows	*CR*	*CR*	*CR*	*Mo, Hc, Wr, Lc*											
Dry low herb alluvial meadows	*CR*	*CR*	*CR*	*Mo, Hc, Wr, Lc*											
Fen meadows CR	CR	CR	CR	Mo, Dd, Pe, F, C	1	0	0	0	**Structure**: Mowed natural meadows or flood-irrigated meadows of open mires. With both mire and meadow vegetation, but herbs, graminoids and Bryidae more abundant than in mires. Trees and shrubs absent or small in number. **Functional features:** Soil wet naturally or through artificial flood irrigation. Continuity of mowing.	1. Yes	2. Moderate	3a Biodiversity losses must not take place, status improvement possible	It is difficult to find offset sites for fen meadows because fen meadows which have even in part been managed traditionally have been almost fully lost. Management is more demanding than with other seminatural grassland types because it may also require the flooding of the fen meadow.		Peat extraction, ditch drainage, hydraulic construction

Habitat type	IUCN Red List Category in 2008: Southern Finland	IUCN Red List Category in 2008: Northern Finland	IUCN Red List Category in 2008: Nationwide	Threat factors	Inclusion in Habitats Directive and Finnish legislation: Habitats Directive	Forest Act	Nature Conservation Act	Water Act	Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
Wooded meadows CR–RE	CR		CR	Mo, Lc, F, C	2	0	2	0	**Structure**: Sparse deciduous tree cover and open meadow vegetation alternate in a mosaic pattern. Diverse vegetation, with both meadow and herb-rich forest species. An abundance of insects, birds, bats, fungi and epixylic lichens and bryophytes on old trees. **Functional features:** Continuity of traditional, multiphase management.	1. Yes	1. Good	3a Biodiversity losses must not take place, status improvement possible	It is difficult to find offset sites for wooded meadows because wooded meadows which have even in part been managed traditionally have been almost fully lost. Management is effective but more demanding and labour-intensive than with other seminatural grassland types because it requires several different measures and involves multiple phases.	Wooded meadows may be particularly valuable in terms of their plant species (incl. epiphytic lichens and mosses growing on trees), and threatened species must be taken into account when planning management measures.	Construction
Pollard meadows	*CR*		*CR*	*Mo, Lc, F, C*											
Coppice meadows	*CR*		*CR*	*Mo, Lc, F, C*											
Alder meadows	*RE*		*RE*												
Wooded pastures CR	CR	CR	CR	Mo, Me, F, C, Lc, Ft	2	0	0	0	**Structure**: Meadow with tree stands where open meadow vegetation covers more than half of the area. Sparse cover of trees of varying ages, including decaying trees and trees damaged by grazing. Meadow and forest plant species, fungal species adapted to semi-open habitat. **Functional features:** Continuity of grazing. Some sites with a history of slashing and burning. Semi-open habitat.	2. Yes, for some habitat types	1. Good	1b Biodiversity losses can be offset by improving the status of the same habitat type	Wooded pastures are highly threatened but suitable for biodiversity offsetting because there are lots of sites whose quality is poor or that have already been altered and whose values can be recovered through management measures. Without management, the habitat type is at risk of extinction, and offset measures can provide new opportunities to organise management.	Wooded pastures dominated by exacting deciduous trees are the rarest and the most diverse in terms of their species.	Construction
Wooded pastures dominated by exacting deciduous trees	*CR*		*CR*	*Mo, F, Me, C, Lc, Ft*											
Wooded pastures dominated by deiduous trees	*CR*	*CR*	*CR*	*Mo, Me, F, C, Lc, Ft*											
Wooded pastures with deciduous and coniferous trees	*CR*	*CR*	*CR*	*Mo, Me, F, C, Lc, Ft*											
Wooded pastures dominated by coniferous trees	*CR*	*CR*	*CR*	*Mo, F, Me, C, Lc*											

Habitat type	IUCN Red List Category in 2008: Southern Finland	Northern Finland	Nationwide	Threat factors	Inclusion in Habitats Directive and Finnish legislation: Habitats Directive	Forest Act	Nature Conservation Act	Water Act	Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
Grazed woodlands EN–CR	EN	CR	EN	Mo, F, Ft, Fd, Me	1	0	0	0	**Structure**: Forest with sparse tree stands and meadow gaps. Trees with varying ages and structure, including decaying trees and trees damaged by grazing. Meadow plant species amidst forest vegetation. **Functional features:** Continuity of grazing. Some sites with a history of slashing and burning.	5. No	1. Good	1b Biodiversity losses can be offset by improving the status of the same habitat type	Grazed woodlands are highly threatened but suitable for biodiversity offsetting because there are plenty of sites whose quality is poor or which have already been altered and their values can be recovered through management measures. Without management, the habitat type is at risk of extinction, and offset measures can offer new opportunities to organise management.	Although currently the most abundant seminatural grassland type and also managed in several sites with support in the form of agri-environmental aid, representative sites are very rare because the current grazing practices often differ from traditional ones.	Construction, forest cutting and forest regeneration
Grazed woodlands dominated by deciduous trees	*CR*	*CR*	*CR*	*Mo, F, Ft, Fd, Me*											
Grazed woodlands with deciduous and coniferous trees	*CR*	*CR*	*CR*	*Mo, F, Ft, Fd, Me*											
Grazed woodlands dominated by coniferous trees	*EN*	*CR*	*EN*	*Mo, F, Fd, Me*											
FELL AREA (14 assessed habitat types)															
Mountain birch forests NT–VU		NT	NT	Og, Cc	2	0	0	0	**Structure**: Natural tree stand structure with *Betula pubescens* ssp. *czerepanovii* the clear dominant species. Unworn *Cladina rangiderina* cover (dry and dryish types). Vegetation varies depending on soil and climate: in dry and nutrient-poor types *Empertum nigrum*, *Cladina rangiderina* and *Pleurozium schreberi* dominate, whereas in moister sites the abundance of *Vaccinium myrtillus* and herbaceous plants increases. **Functional features:** *Betula pubescens ssp. czerepanovii* regenerates naturally and recovers from damage caused by occasional mass occurrences of *Epirrita autumnata* and *Oreophtera brumata*.	2. Yes, for some habitat types	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	Mountain birch forests are a common and broad-ranging habitat type whose status has deteriorated to some extent due to intensive reindeer grazing pressure in the summer. Mountain birch forests are also threatened by climate change, but not as strongly as the open fell area habitat types, and some mountain birch forest types may expand as a result of climate change. Restoration of areas damaged by geometrid defoliator moths (if possible), improved grazing rotation and protection of sites vulnerable to wear in recreational areas can be used as offsets.	*Empetrum* mountain birch forests are a rarer type of mountain birch forest than the others and occurs in marine climate areas mainly in northwestern parts of Käsivarsi, Finland's northwestern "arm", and in the Karigasniemi area.	Tourism-related construction and related wear and erosion of terrain
Dry and dryish mountain birch forests															
Empetrum-Lichenes mountain birch forests		*VU*	*VU*	*Og, Cc*											
Empetrum-Lichenes-Pleurozium mountain birch forests		*NT*	*NT*	*Og, Cc*											
Empetrum-Myrtillus mountain birch forests		*NT*	*NT*	*Og, Cc*											
Mesic mountain birch forests															
Variksenmarjatunturikoivikot		*VU*	*VU*	*Og, W, C, Cc*											

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Cornus-Empetrum-Myrtillus mountain birch forest		*NT*	*NT*	*Og, W, C*											
Cornus-Myrtillus mountain birch forests		*NT*	*NT*	*Og, W, C*											
Low-herb mountain birch forests		*NT*	*NT*	*Og*											
Herb-rich mountain birch forests NT					2	0	0	0	**Structure**: Low-growing forests dominated by *Betula pubescens ssp. czerepanovii* on fells, with natural tree stand structure and closed or near-closed canopy layer. Field layer of herb-dominated tall-herb mountain birch forest or fern-rich mountain birch forest. **Functional features**: *Betula pubescens ssp. czerepanovii* regenerates naturally.	1. Yes	3. Uncertain	2b Biodiversity losses must be avoided, status improvement challenging	Herb-rich mountain birch forests is a rare habitat type that is vulnerable to wear and has been degraded locally by reindeer grazing. The status of degraded herb-rich mountain birch forests could be improved by improving grazing rotation.	Fern-rich mountain birch forests is a rare habitat type and their biodiversity losses must be avoided.	
Tall-herb mountain birch forests		*NT*	*NT*	*Og, C, W*											
Fern-rich mountain birch forests		*NT*	*NT*												
Mountain heath scrubs LC–NT					1	0	0	0	**Structure**: Mountain scrubs where the most abundant species may be *Salix* spp., *Juniperus communis* or *Betula pubescens* ssp. *czerepanovii*. Scrub stand height below 2 m. Tree canopy cover below 10%. **Functional features:** Scrub stands and other vegetation regenerate naturally.	2. Yes, for some habitat types	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	Mountain heath scrubs are generally suitable for biodiversity offsetting, and increasing the efficiency of grazing rotation is the most efficient way to improve the status of degraded sites. Mountain birch scrubs in particular occur in relative abundance. There are no major threats to mountain juniper scrubs, and their biodiversity may benefit from grazing. Mountain *Salix* scrubs may benefit from climate change.		
Mountain Salix scrubs		*NT*	*NT*	*Og*											
Mountain juniper scrubs		*LC*	*LC*												
Mountain birch scrubs		*NT*	*NT*	*Og, Cc*											

Habitat type	IUCN Red List Category in 2008: Southern Finland	IUCN Red List Category in 2008: Northern Finland	IUCN Red List Category in 2008: Nationwide	Threat factors	Inclusion in Habitats Directive and Finnish legislation: Habitats Directive	Inclusion in Habitats Directive and Finnish legislation: Forest Act	Inclusion in Habitats Directive and Finnish legislation: Nature Conservation Act	Inclusion in Habitats Directive and Finnish legislation: Water Act	Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
Oligotrophic mountain heaths NT–VU					2	0	0	0	**Structure**: Mountain heaths are characterised by being treeless or having sparse tree cover (canopy cover < 10 %) and dominated by dwarf shrubs (incl. *Empetrum nigrum*, *Betula nana*, *Vaccinium myrtillus*, *Phyllodoce caerulea*, *Calluna vulgaris*). Ground layer with bryophytes and lichens. The type and type-specific vegetation of mountain heaths are affected by altitude, topography (snow depth) and continental/marine climate variation. In wind-exposed areas, vegetation is non-uniform and wind damage occurs. **Functional features**: Tree regeneration poor, dwarf shrubs, bryophytes, lichens and other vegetation regenerate naturally.	2. Yes, for some habitat types	2. Moderate	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	Oligotrophic mountain heaths are fairly common habitat types whose threat status is based on quality deterioration. Means of improving their status include reducing wear and reindeer grazing pressure in degraded sites.	Biodiversity losses of *Cassiope tetragona* and *Calluna* mountain heaths must be avoided.	Tourism-related construction
Wind-exposed mountain heaths		*VU*	*VU*	*Og, W*											
Empetrum mountain heaths		*NT*	*NT*	*Og, W*											
Betula nana mountain heaths		*NT*	*NT*	*Og, Cc*											
Myrtillus mountain heaths		*NT*	*NT*	*Og, Cc*											
Phyllodoce caerulea mountain heaths		*NT*	*NT*	*Og, Cc*											
Calluna mountain heaths		*VU*	*VU*	*C, W, Cc*											
Cassiope tetragona mountain heaths		*NT*	*NT*	*W, Og, Cc*											
Dryas octopetala mountain heaths VU		VU	VU	Og, W, Cc	2	0	0	0	**Structure**: Calcareous nutrient-rich bedrock and soil. Tree, field and ground layer species include an abundance of calcicoles and calciphiles, with *Dryas octopetala* as the character species. Species composition varies depending on moisture conditions and protection provided by snow cover. Dryer areas with wind-exposed places, moist areas with meadow features. Areas with low snow cover with open vegetation and mineral soil patches. Field and ground layer with multiple species. Occurrences often fragmented in patches. **Functional features:** Natural variation in snow cover, humidity/moisture and wind rate, openness.	1. Yes	3. Uncertain	3b Biodiversity losses must not take place, status improvement not possible	Biodiversity losses of this habitat type should be avoided because it is rare and faces threats. It may be difficult to improve the status of sites whose quality has deteriorated. Status improvement methods mainly include reducing wear and reindeer grazing pressure in degraded sites.		

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Low-graminoid mountain heaths LC		LC	LC	Cc	2	0	0	0	**Structure**: Treeless fell area habitat type with graminoids dominant in the field layer. Greater abundance of lichens than of bryophytes in the ground layer. **Functional features:** Preservation of graminoid dominance, appropriate grazing pressure.	2. Yes, for some habitat types	5. No status improvement methods	2b Biodiversity losses must be avoided, status improvement challenging	The habitat type has remained more or less unchanged in terms of quality and quantity, but climate change is a clear threat. The habitat type occurs in middle oroarctic zone whose area will decrease due to climate change. There are no status improvement methods. *Nardus strita* mountain heaths in particular are very rare. It would be difficult to offset biodiversity losses of the habitat type.	Biodiversity losses of *Nardus stricta* mountain heaths in particular must be avoided.	
Nardus stricta mountain heaths		*LC*	*LC*	*Cc*											
Festuca ovina-Juncus trifidus mountain heaths		*LC*	*LC*	*Cc*											
Mountain meadows LC–NT		LC	LC	Cc, YS	1	0	0	0	**Structure**: Treeless fell area habitat type on nutrient-rich soil, field layer of low- or tall-herb meadow vegetation. *Salix* spp. also found in brookside mountain meadows. Greater abundance of lichens than of bryophytes in the ground layer. **Functional features**: Spring moisture, occasionally strong (not continuous) grazing pressure.	1. Yes	2. Moderate	2a Biodiversity losses must be avoided, status improvement possible	The quality and quantity of mountain meadows is assessed to have remained unchanged, but these meadows are rare. They are threatened locally by strong grazing pressure, but they have good capacity to recover from grazing. In some sites, suitable grazing pressure may restrict overgrowing caused by climate change.	The occurrences of this rare habitat type are usually very small in area, and climate change is a threat over the long term. Significant reductions in the habitat type must be avoided.	
Low-herb mountain meadows		*LC*	*LC*	*Cc*											
Tall-herb mountain meadows		*NT*	*NT*	*Og, Cc*											
Willow-rich brookside mountain meadows		*LC*	*LC*												
Fern-rich mountain meadows		*NT*	*NT*												
Snowbeds and snow patches LC–EN					1	0	0	0	**Structure**: In snowbeds, the snow melts between late June and August, depending on the snowbed type, whereas snow patches do not melt during the summer and are covered by snow for several years. Snowbeds have a thin humus layer, vegetation dominated by low-growing sedges, herbs, graminoids or Salix arbuscula or may be dominated by bryophytes. Snow patches consist of soil and scree without vegetation. **Functional features**: Occurrence and permanence of snow in the summer.	1. Yes	5. No status improvement methods	3b Biodiversity losses must not take place, status improvement not possible	There are no means available to recover snowbeds or snow patches or to improve their status. The habitat type is very rare and climate change will reduce its occurrences. Impacts are in part unclear as increased precipitation may also increase snowfall. The most obviously threatened are those snowbed types which typically retain their snow cover far into the summer.		

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Oligotrophic snowbeds		*NT*	*NT*	*CC, Og*											
Oligotrophic Salix polaris snowbeds		*LC*	*LC*	*Cc*											
Oligotrophic low-graminoid snowbeds		*LC*	*LC*	*Cc*											
Oligotrophic low-herb snowbeds		*NT*	*NT*	*Cc*											
Oligotrophic bryophyte-rich snowbeds		*NT*	*NT*	*Cc*											
Oligotrophic Ranunculus glacialis snowbeds		*NT*	*NT*	*Og , Cc*											
Eutrophic snowbeds															
Eutrophic heathlike snowbeds		*NT*	*NT*	*Cc*											
Eutrophic low-herb snowbeds		*NT*	*NT*	*Cc*											
Eutrophic bryophyte-rich snowbeds		*VU*	*VU*	*CC, Og*											
Snow patches		*EN*	*EN*	*Cc*											
Patterned grounds LC		LC	LC	Cc	1	0	0	0	**Structure**: Circular stone formations and their networks, sorted stripes, sorted sheets and solifluction sheets whose occurrence and shapes are affected by sloping of the ground. Variation in soil type and snow cover, which affect the intensity of frost heaving. Pioneer species, field layer may be scarce or absent, diversity of bryophyte and lichen species. Limestone influence in places. **Functional features:** Movement of stones and other ground material, emergence of stones above the ground, gradual downslope creep.	5. No	5. No status improvement methods	2b Biodiversity losses must be avoided, status improvement challenging	The occurrence area is limited and over the long term the habitat type may be threatened by climate change; reduced ground frost results in increased overgrowth of vegetation. There are no actual known restoration or recovery methods.		
Patterned grounds on flat areas		*LC*	*LC*	*Cc*											
Patterned grounds on slopes		*LC*	*LC*	*Cc*											
Frost-influenced heaths LC		LC	LC	Cc	1	0	0	0	**Structure**: Treeless or near-treeless areas in the fell area, in the ecotone of mineral soil and peatland areas. Hardly any peat or *Sphagnum* spp. Earth hummocks or other sections (hummock levels) interspersed with humus, exposed mineral soil or stone pits with water (lawns). Lawns affected by frost heaving in part without vegetation, with plants such as dwarf shrubs in hummock levels. **Functional features:** Snow cover thin due to wind impact, frost heaving extend deep into the ground, groundwater very close to surface.	5. No	5. No status improvement methods	2b Biodiversity losses must be avoided, status improvement challenging	The occurrence area is limited and over the long term the habitat type may be threatened by climate change; reduced ground frost results in increased overgrowth of vegetation. There are no actual known restoration or recovery methods.		

Habitat type	IUCN Red List Category in 2008			Threat factors	Inclusion in Habitats Directive and Finnish legislation				Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
	Southern Finland	Northern Finland	Nationwide		Habitats Directive	Forest Act	Nature Conservation Act	Water Act							
Mountain oligotrophic and mesotrophic bedrock outcrops and boulder fields LC					1	0	0	0	**Structure**: Flat rock outcrops, steeps, boulder fields, moraine boulder fields, block fields and talus formations in the fell area. Species dominated by various siliceous rock outcrop bryophytes and lichens, usually with low occurrence of vascular plants. **Functional features:** Natural weathering process, scree emerging from moraine soil owing to frost heaving.	5. No	4. Unknown	1a Biodiversity losses can be offset by improving the status of the same or a rarer habitat type	Assessed as having remained unchanged in terms of quality and quantity, with no significant threats to the habitat type. Although occurring extensively in Tunturi Lapland, some of the habitat types in this group are relatively rare.		
Mountain oligotrophic and mesotrophic flat bedrock outcrops		*LC*	*LC*	*0g*											
Mountain oligotrophic and mesotrophic steeps		*LC*	*LC*												
Mountain oligotrophic and mesotrophic boulder fields		*LC*	*LC*												
Oligotrophic and mesotrophic talus formations		*LC*	*LC*												
Mountain calcareous bedrock outcrops and boulder fields NT		NT	NT		1	0	0	0	**Structure**: Bedrock outcrop or boulder field, rock type dolomite, with stones cracked by frost weathering often occurring and may form fields on southern and western slopes. A habitat type covering a small area. Calcicoles and calciphiles, open vegetation cover, occasionally covered by lichens and bryophytes, vascular plant species composition may be diverse. **Functional features**: Natural limestone weathering and increase access to space for plants, vegetation remaining open.	1. Yes	4. Unknown	3b Biodiversity losses must not take place, status improvement not possible	Mountain calcareous bedrock outcrops and boulder fields occur in a relatively small area and they involve significant species values.		
Mountain ultramafic bedrock outcrops and boulder fields NT		NT	NT	W	1	0	0	0	**Structure**: Rock type with low silica and high magnesium levels, e.g. peridotite, dunite and serpentinite. Rock outcrops often broken into block fields. Vegetation scarce and with gaps, in gravel areas with low-growing vascular plants, ground layer also scarce. **Functional features:** Natural rock weathering and increased access to space for plants, vegetation remaining open.	1. Yes	4. Unknown	3b Biodiversity losses must not take place, status improvement not possible	Mountain ultramafic bedrock outcrops and boulder fields occur in a very small area and they involve significant species values.		

Habitat type	IUCN Red List Category in 2008: Southern Finland	IUCN Red List Category in 2008: Northern Finland	IUCN Red List Category in 2008: Nationwide	Threat factors	Inclusion in Habitats Directive and Finnish legislation: Habitats Directive	Inclusion in Habitats Directive and Finnish legislation: Forest Act	Inclusion in Habitats Directive and Finnish legislation: Nature Conservation Act	Inclusion in Habitats Directive and Finnish legislation: Water Act	Structure and functional features in desired state	Rarity to be taken into account in biodiversity offsetting	Effectiveness of restoration/management methods	Suitability for biodiversity offsetting	Reasoning of assessment	Preconditions in addition to general preconditions	Examples of project types that could be offset
Calcareous talus formations NT		NT	NT	Ku	0	0	0	0	**Structure**: Open vegetation, with closed heath or meadow vegetation in dolomite rock areas. Bryophyte and lichen cover absent or very scarce. **Functional features:** Natural downslope creep of soil and rock, maintaining the scarcity of vegetation.	1. Yes	4. Unknown	3b Biodiversity losses must not take place, status improvement not possible	Calcareous talus formations only occur in an area of around ten hectares in four locations on large fells of the northern part of the northwestern Käsivarsi "arm" of Finland. They are to some extent threatened by wear caused by reindeer grazing. The habitat type involves significant species values.		

Future threat factors (Raunio et al. 2008)

W	=	wear: wear of vegetation as well as soil and bedrock due to, e.g. trampling, off-road vehicle use or rock climbing
Og	=	overgrazing (incl. reindeer): includes trampling as well as feeding on vegetation and applies to ground vegetation as well as trees (not used in the context of seminatural grasslands)
C	=	construction (on land): construction and construction-related earthworks and soil disposal (incl. disposal of dredged material on dry land) relating to human settlements, economic activity, transport and recreation
Ex	=	extractive activities: extraction of soil and rock (incl. underwater), mining activities, gold panning
Lc	=	land clearing for agriculture: turning forests, mires and seminatural grasslands into arable land
Mo	=	overgrowing of open areas: overgrowing caused by the discontinuation or reduction of the traditional use of pastures and meadows; incl. discontinuation of grazing, mowing, slash-and-burn agriculture, pollarding and flood irrigation and reduction of grazing pressure (in addition to meadows, may also apply to other open areas, e.g. sands and rock outcrops)
Me	=	meadow eutrophication: eutrophication of pastures and meadows, e.g. additional feeding of grazing livestock, seminatural grassland grazing in conjunction with grass, night-only grazing, fertilisation of meadows and pastures as well as eutrophying dust from fields
F	=	forest regeneration and management measures: without further specification, also including afforestation and taking timber for home use
Ft	=	changes in forest tree species composition: reduction in deciduous trees and sprucification of herb-rich forests
Fa	=	changes in forest age structure: reduction in old forests, large trees, burnt areas and initial stages of natural succession
Fd	=	reduction in deadwood continuum: reduction in decaying wood, dead or dying trees and decaying and hollow trees
Dd	=	ditch drainage: also includes ditch network maintenance and later impacts of previous ditch drainage
Pe	=	peat extraction
Hc	=	hydraulic construction: power stations, sawmill and mill dams, port and fairway construction, dredging and clearing, channel straightening, structural alteration of littoral/riparian zone (diking, erosion protection), lake draining, reservoir construction
Gw	=	groundwater extraction: extraction of groundwater and utilisation of springs, incl. changes caused by lowering of groundwater table
Wr	=	regulation of water bodies: including shore erosion caused by regulation
Wt	=	waterborne transport: impacts of propeller wash and anchorage, shore erosion caused by transport
Weu	=	eutrophication and contamination of water bodies: agricultural and forestry, fishery, residential and industrial (non-toxic) discharges and non-point pollution (incl. impacts of water eutrophication on terrestrial coastal habitat types)
Ed	=	eutrophying deposition: atmospheric nitrogen deposition, lime dust
Ch	=	adverse chemical effects: atmospheric and water pollution (incl. acid deposition), environmental toxins, pesticides, oil spills
Cc	=	climate change: global warming, increased precipitation and extreme weather phenomena over the next 20–30 years (only when special grounds for impacts)
S	=	alien species and species transplantations if affects habitat type structure or functional features
R	=	random factors: threat caused by random factors to occurrences (can be used if the number of occurrences is very small)
Ot	=	other known cause: e.g. overfishing, discontinuation of controlled burning

Human activities shape and alter habitats, often causing decline in biodiversity. New approaches such as biodiversity offsetting are emerging to support traditional nature conservation methods. Biodiversity offsetting is a process aiming to compensate for biodiversity losses caused by human activity in one place by increasing biodiversity somewhere else through rehabilitation, restoration or protection of habitats.

This report assesses the suitability of habitat types for biodiversity offsetting from the perspectives of offset gains and losses alike. Each habitat type has been assessed as being suitable, possibly suitable or generally unsuitable for biodiversity offsetting. The assessment is based on the threat status, structure and functional features and rarity of each habitat type as well as on the effectiveness of the methods available to improve its status. The publication also covers the principles of biodiversity offsetting, related concepts and the general and specific preconditios concerning the suitability of habitat types for biodiversity offsetting. Finland is quite well placed for the application of biodiversity offsetting to habitat types provided that the preconditions for offsetting are met.

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