European Commission

Results-based Payments for Biodiversity

Supplement to Guidance Handbook

Result indicators used in Europe

The selection, testing, measurement and verification of indicators of biodiversity results

Environment

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Disclaimer: The arguments expressed in this report are solely those of the authors, and do not reflect the opinion of any other party.

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1 Introduction

The Guidance Handbook explains that the indicators of biodiversity results are the key to successful results-based payments schemes and demonstrates how to select effective and reliable result indicators.

This Supplement provides more detailed technical information about the many different types of results indicators being used in results-based schemes in Europe. It will be of particular interest to biologists, agricultural experts and managing authority staff working on the selection of indicators for results-based schemes

Drawing on information from the inventory and published material this Supplement presents, for nine different types of results-based schemes the following information (where available):

- the biodiversity objectives
- the related indicators and thresholds
- how the indicators were developed and tested
- how the indicators are measured and verified for payment purposes;
- the advantages and limitations of the indicator; and lists
- the schemes using the indicator, with references to relevant literature.

Illustrations of some of the field guides for farmers developed for results-based species-rich grassland schemes can be found in a separate Supplement to the Guidance Handbook.

2 Species-rich grassland (indicator: characteristic plant species)

2.1 Biodiversity objective

Maintain species-rich grasslands with their typical plant communities.
The meadow communities and other mesophile grasslands identified in the Habitats Directive Annex I[1] are in an unfavourable-poor or unfavourable-bad conservation status all over Germany, and both the area and condition of these habitats is continuing to decline rapidly (BfN, 2014a; BfN, 2014b; Dieterich and Kannenwischer, 2012). In France and Switzerland, grasslands are in a similar situation, and the biodiversity objective of the schemes is similar. This is the context against which the results-based schemes are trying to maintain the management and species diversity of these habitats.

Plant species diversity in these grasslands is a good indicator for animal diversity and for the provision of ecological services, as research demonstrates a strong positive correlation between plant species diversity in grasslands and pollination (Albrecht et al, 2007), and pest regulation functions (Balvanera et al, 2006). Flower-rich grasslands also contribute to the aesthetic and recreational value of the landscape.

2.2 Indicators

Indicators can be either species or groups of several species (from the same genus or several similar species from different genera within the same family) that are characteristic of the particular grassland habitat.

Because indicators must be suitable for the habitat and bio-geographical region they are used in, each of the regions implementing these schemes has developed its own indicator list. The importance of this was demonstrated in Germany, where a standardised botanical survey of grasslands in all the biogeographic regions showed that grassland species richness is lowest in the north-west (12 species per 25 square metres) and highest in the south-west (21 species per 25 square metres), whilst in central-east and central-west Germany it is at the average level (17 species per 25 square metres) (Güthler and Oppermann, 2005; Oppermann et al, 2009). Some species that could be used as indicators of species-rich grassland in the north would not be suitable as indicators in the south-west, where they are too common.

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[1] **Lowland hay meadows** (Habitats Directive Annex I 6510) characterised by *Alopecurus pratensis*, *Sanguisorba officinalis*, belonging to the Arrhenatherion and the Brachypodio-Centaureion nemoralis alliances (other characterising species: *Arrhenatherum elatius, Trisetum flavescens ssp. flavescens, Pimpinella major, Centaurea jacea, Crepis biennis, Knautia arvensis, Tragopogon pratensis, Daucus carota, Leucanthemum vulgare, Alopecurus pratensis, Sanguisorba officinalis, Campanula patula, Leontodon hispidus, Leontodon nudicaulis, Linum bienne, Oenanthe pimpinelloides, Rhinanthus lanceolatus, Malva moschata, Serapias cordigera*); **Mountain hay meadows** (Habitats Directive Annex I 6520) of the montane and subalpine levels usually dominated by *Trisetum flavescens* (and with *Heracleum sphondylium, Viola cornuta, Astrantia major, Carum carvi, Crepis mollis, Crepis pyrenaica, Bistorta major/Polygonum bistorta, Silene dioica, Silene vulgaris, Campanula glomerata, Salvia pratensis, Centaurea nemoralis, Anthoxanthum odoratum, Crocus albiflorus, Geranium phaeum, Geranium sylvaticum, Narcissus poeticus, Malva moschata, Valeriana repens, Trollius europaeus, Pimpinella major, Muscari botryoides, Lilium bulbiferum, Thlaspi caerulescens, Viola tricolor ssp. subalpina, Phyteuma halleri, Phyteuma orbiculare, Primula elatior, Chaerophyllum hirsutum* and many others).

The indicator lists of the current schemes in Germany contain between 24 and 36 indicators, covering the main grassland types in that federal state, with photos and identification guide. Some of the indicator lists are presented in a way that shows clearly the different grassland types being targeted (wet, dry and mesic), which makes it easier to identify them in the field.

In Germany:

- In Baden-Württemberg, the results-based scheme agri-environment MEKA B 4 used (until 2014) an indicator list of 28 flowering plant species groups of species. From 2015, in the follow up programme FAKT B 3, it will have a slightly longer list of 30 indicator species).
- The Bayern indicator list contains 35 flowering plant species and groups including one easily recognisable grass species (LfL 2014). The list includes species typical of alpine meadows and pastures, as well as wet, mesic and dry grassland types.
- The Brandenburg indicator list contains 27 flowering plant species and groups, including a grass, two sedge groups (large species and small species), and a rush group (Land Brandenburg 2007).
- The Hessen indicator list contains 31 flowering plant species and groups including one easily recognisable grass species, and sedges and rushes as grouped indicators (Hessen 2014).
- The Niedersachsen and Bremen indicator list contains 31 flowering plant species and groups including sedges (as a group) and a rush and a grass species (NLWKN 2014).
- The Rheinland-Pfalz indicator list contains 35 flowering plant species and groups (no grasses), divided into damp or wet grassland indicators, mesic indicators and semi-dry grassland indicators (Rheinland-Pfalz 2010).
- The Sachsen indicator list contains 36 flowering plant species and groups including small sedges (as a group) and soft rushes (as a group) (Freistaat Sachsen 2014).
- The Thüringen indicator list has 30 species and genera (dicotyledons only), including subgroups for dry, mesic and damp to wet grassland types (Freistaat Thüringen, 2008).

In France, indicator lists must be specific to regional or local conditions, and because each scheme has developed its own indicator list, but there is currently no oversight into how many different indicator lists are in use. For example, the scheme in the Massif des Bauges Regional Natural Park uses a list of 24 indicators (species and groups but a survey in 2009 identified 20 different lists ranging in length from 8 to 114 indicators (Fargier et al 2009). The national flowering meadow competition is an opportunity to test the scaling-up of the results-based approach from site or habitat-specific to a comprehensive list that could describe the range of biodiverse meadows existing across France.

In Switzerland two indicator lists are federally defined. A list of 34 indicator species applies to the northern part of Switzerland (north of the Alps) and a list of 47 indicators applies to the areas south of the Alps, and there are two different list for low and for high altitude meadows (there are fewer species in the latter, because it is more difficult to fulfil). The cantons may adapt the standard indicator lists if they ensure that this does not lead to decrease in the level of biodiversity.

2.3 Indicator thresholds

The schemes in Germany and France all apply a minimum threshold of four indicators in each section of the grassland parcel. In Germany, this was first defined by the Baden-Württemberg scheme and subsequently defined as a criterion for the federal state funding for results-based agri-environment schemes. More recently most of the German regional schemes have introduced stepped thresholds with higher payment levels for six and/or eight indicator thresholds. Switzerland uses a single threshold of at least six indicators. In Switzerland the minimum (federally defined) threshold is a two-stage process, in which first, the presence of at least three indicators from a short list of indicators (list A) is used to determine whether the parcel is of high ecological value (generally corresponding to higher altitude) or medium ecological value; and second, the parcel is scored using either list B for high ecological value (and high altitude) or list C for medium ecological value (and lower altitude, with fewer species, ie it is easier to meet) (BLW 2014 a).

2.4 How the indicators were developed

Indicators must be specific to the bio-geographical region they are used in, but the option of having a series of different indicator lists for different types of grassland (wet, mesic or dry) has generally been rejected as it is considered to be inefficient and also less acceptable to farmers because it is less transparent. This means that indicator lists must work for all the different grassland types covered by the results-based scheme in that region.

Two examples from Brandenburg and from Bayern show different approaches to how to develop indicator lists:

1. The regional government of Brandenburg, a large federal state in north-eastern Germany, commissioned the Leibniz Centre for Agricultural Landscape Research to develop an indicator list for species rich meadows. The list was developed as follows (Kaiser et al, 2010; Matzdorf et al, 2008):
    - A database was compiled of existing grassland surveys in Brandenburg - mainly Habitats Directive Annex I survey data plus some other existing grassland vegetation data (it was not possible to carry out any new surveys). This resulted in a large but heterogeneous data set of 1,551 samples with 730 species.
    - These 730 species grouped according to mean moisture value (dry, mesic, or damp grassland) as the defining environmental characteristic of Brandenburg grasslands, according to the Brandenburg grassland habitat typology. Species records from grassland types with more extreme environmental conditions (very dry or wet) were excluded, (it is assumed that these grasslands are maintained only under nature conservation arrangements and not as agriculturally productive grassland).
    - The species list was then screened to exclude rare, ubiquitous, highly toxic and ruderal species, and also species that indicate nutrient-rich conditions or those that are highly tolerant of cutting, grazing and trampling. Species that occur frequently on abandoned grassland and in tall forb vegetation were also removed from the list. Species with higher threat categories on the Brandenburg Red List were excluded because they are likely to be too rare to be useful indicators.

- This resulted in a draft indicator list of 48 species. This was then tested and narrowed down to 27 indicators (see below).

2. Bayern in south-east Germany, the largest German federal state, required an indicator list that would work on all the different hay meadow types ranging from the relatively dry chalk grassland in Franken to the mesic damp meadows in Swabia and the alpine meadows in the south, and on relatively small and heterogeneous fields. The indicator list was developed from a large homogenous data set of 6,108 grassland survey samples from all the biogeographic regions of Bayern:
   - The data was assessed for species richness, and around 20 per cent of the grassland survey samples were identified as species-rich because they contained at least 25 species per 25 square metres. The analysis found 100 different species that were reliably present in these species-rich samples (Heinz et al, 2013).
   - To make it easier to use, the list was then simplified for easy use by excluding all grasses and other easily misidentified species (except one easily identifiable grass) and similar species were grouped together. This resulted in a list of 35 indicators (LfL Bayern, 2014).
   - Some of these good indicators were deliberately excluded because they could easily be confused with common species that indicate intensive grassland management (including *Ranunculus* and *Cirsium* species).
   - The final list is designed for use as results indicators on hay meadows across Bayern (but is not recommended for use on other grasslands of very high nature conservation value).

2.5 How the indicators were tested

These two indicator lists from Germany (plus a third from Niedersachsen) provide useful examples of how the indicators were tested before being put into use, to check that they were reliable indicators of the overall biodiversity objective of conserving and improving species-rich grasslands.

The validity of the draft Brandenburg indicator list was tested using targeted vegetation surveys on approximately 120 selected grassland fields outside Natura 2000 areas. This found highly significant correlations between the occurrence of indicator species from the indicator list and overall species richness. Each proposed indicator species was subjected to an aptitude test of how well it was associated with overall species richness and with a number of plant species that indicate extensive agricultural management. The final list of 27 indicators was selected to provide a balanced range of indicators for all moisture levels, and to include indictors with a high suitability weighting as indicators of extensive use. Some species were combined into species groups to facilitate botanical identification. Certain grass species were included, but the difficult to identify sedge (*Carex*) species were included only as two groups (large or small sedges).

The indicator testing in Bayern (Ruff et al, 2013) also showed a strong correlation between indicator presence along the transect and the total plant species richness in the grassland parcel. The survey results showed that it was necessary to find at least seven indicator species to detect species-rich grasslands (defined as grasslands with at least 25 species per 25 square metres). However, there is also an error rate of nine per cent (with equal probability of not detecting species richness or detecting spurious species richness) and therefore, to avoid the danger of parcels failing the test even though they are species-rich grassland, an indicator threshold of six species is recommended for these high quality grasslands. The four indicator threshold is intended to be used for grassland in which species richness has been degraded due to past agricultural intensification.

The validity of the indicator list for Niedersachsen (Bertke et al, 2008; Most and Keienburg, 2006), a large federal state in north-western Germany, was tested by carrying out a vegetation survey on 258 grassland parcels in eight of the typical bio-geographical regions of north-western Germany using the same transect method as is used to measure scheme results, and at the same time surveying the complete species richness of the parcel. The survey resulted in a relatively small but homogenous data set. Each indicator was demonstrated to have a high correlation with overall plant species diversity and with the number of Red List plant species. The survey also showed that of the 31 indicators, around half occurred in 10 per cent or fewer of the sampled transect sections, being typical of only a few of the bio-geographical regions, whilst four of the indicators (*Rumex acetosaorR.thysiflorus*, *Cardamine pratensis*, *Ranunculus acris*, and *Anthoxanthum odoratum*) occurred reliably in over 40 per cent of the transect sections in all regions.

2.6 Protocols for measuring the indicators on the farm

The results-based schemes for species-rich grasslands in Germany and France all use a similar indicator measurement system, first developed in Baden-Württemberg in Germany and in Switzerland (Oppermann and Gujer, 2003). This uses a transect along the longest diagonal across the field, along which indicators are counted in a two metre wide band extending one metre on each side of the line. The transect is divided into equal segments, usually 50 or 100 metre lengths in each third of the transect or in each half (depending on the size of the parcel) and the indicator count must be done separately along each segment. The grassland parcel only achieves the result if a sufficient number of indicator species (or groups) to meet or exceed the threshold are present on every segment. The transect line is defined using aerial photos and personal knowledge, or agreed between the farm advisor and the farmer at the beginning of the scheme period. The transect line can cross habitat features (shrubs, ditches etc) within the field and plants growing on these features can be counted. The survey should be done annually before the first grass cut when the indicators are in flower. Farmers survey their own fields annually and record results in the standard form. This method is easy to set up and quick to carry out in the same way each year. Farmers can learn it in a half day or one day training session.

All biodiversity measurement methods are influenced by the size and shape of the area being measured – the larger the area and the longer the transect, the more species are likely to be found on the transect. Therefore, the average transect segment length needs to be roughly the same in all fields if the results are to be fair and comparable between fields.

The validity of the transect method was tested in two contrasting regions of Germany, in Bayern where the average grassland field size is 0.58 hectare and in Brandenburg where the average field size is several hectares. The Bayern study compared three different methods on a sample of 52 different parcels in two different biogeographic regions (Ruff et al, 2013). The diagonal transect method using 100 metre lengths on each transect segment was found to capture around 80 per cent of the species richness on parcels larger than one hectare in size. The presence of indicators along the transect was found to be highly correlated with the overall species richness compared to the other monitoring methods tested (circular patches and a transect across the shorter diagonal). To increase accuracy on fields smaller than one hectare, the study recommends that the transect segments should be at least 50 metres in length. The Brandenburg study (Kaiser et al, 2009) tested the transect method on 122 parcels by counting indicators on different lengths of transect segment. As a result it recommends that a 100 metre length on each transect segment is surveyed, and that on most fields, the transect is divided into three equal segments. In fields where the longest diagonal is less than 300 metres in length (ie in fields less than four hectares in size), the transect should be divided into two, and a 100 metre stretch on each of the two segments counted. In fields where the diagonal is less than 200 metre in length (ie in fields less than two hectares in size), two transects could be used, either in parallel or across both the diagonals. In fields less than one hectare in size, the transect is divided into two segments of 50 metres. In contrast to these findings, in Baden-Württemberg no relationship was found between the size of the parcels and the species richness – probably because the smaller sized parcels tend to be managed more extensively than the larger parcels (Krismann et al, 2006).

The Swiss scheme uses a slightly different measurement system, as qualified experts check the presence of indicators in several circles of three metre radius. The survey must be done to meet an annual reporting date in early May. An alternative survey method was developed in Niedersachsen, but has not been adopted (Wittig et al, 2006).

2.7 Verification of indicators and controls for payment

Control takes place through a field visit by the paying agency inspector using the same method to check presence of indicators against the scheme's minimum threshold. There is a standard period for the field visit (usually between mid-May and the beginning of June). Farmers in Germany must keep records of their surveys annually and make them available for checking to the agricultural managing authorities if they are inspected. The farmer survey can easily be repeated or checked by controlling authorities. In Switzerland the sites are controlled by experts once in each six to eight year contract period.

2.8 Advantages of the indicator and the measurement protocols

- Indicators are characteristic of hay meadows (no very common species, species typical of meadows, no invasive alien species).
- Indicators are reasonably common across the whole region.
- Indicators are sensitive to negative changes in management, eg too much fertilisation or cutting (no indicator species that are typical of intensively used grassland or of high nutrient levels, or tolerant of high cutting frequencies, or are typical of abandoned meadows).
- Indicators correlate well with overall plant diversity and habitat condition, and plant diversity is closely related to animal diversity (eg flying insects) and ecosystem services in such grasslands.
- Indicators can be used at different thresholds (four, six or eight indicators) to correspond to the different levels of species richness.
- Indicators are easily identified by farmers after a short training course.

- Indicators can be assessed by the farmer consistently over a considerable period of years.
- Indicators exclude species that are highly toxic to livestock, such as Autumn Crocus (*Colchicum autumnale*), and include some species that have a good forage value, such as Red Clover (*Trifolium pratense*).
- Measurement uses a simple, scientifically robust survey technique that can be learned in half to one day training sessions and takes a reasonably short time to complete.
- Measurement method captures a high proportion of the total species presence in the field, and also captures most pockets of localised species richness, eg in wet or dry patches.
- Farmer-led measurement increases farmer awareness and appreciation of plant diversity.
- Control through a field survey rather than control of paperwork is perceived by some farmers as being more fair.

2.9 Limitations of the indicator and the measurement protocols

- Indicators and measurement method may not pick up deterioration in the grasslands with highest species richness if only the lowest indicator threshold is used (four indicators); however, the six- or eight-indicator thresholds are designed to avoid deterioration of these species rich grasslands.
- Some botanical knowledge is required to carry out indicator measurements (but this is not considered to be a disadvantage by most farmers as the indicators are easily learned and identified).
- This type of indicator and measurement are not considered suitable for high conservation value grassland habitats other than meadows (eg *Nardus* grasslands), because these habitats are not necessarily very species rich, have environmental constraints and are generally of extremely low productivity (for example, some Habitats Directive Annex I natural and semi-natural mountain grassland types, dry calcareous grasslands, and dry sandy grassland types).

2.10 Schemes using this indicator

Germany: agri-environment schemes in four German Länder are continuing from the 2007-2013; and another three Länder have set up new schemes for the 2014-2020 period. There is one non-CAP scheme. In 2013, the schemes covered nearly 88,000 hectares of grassland and involved some 5,500 farmers. They are:

- Baden-Württemberg, Rheinland-Pfalz, Thüringen and Niedersachsen-Bremen agri-environment schemes.
- Flowering Steinburg, a local scheme in Schleswig-Holstein (funded by a foundation) .

New schemes are planned for the 2015/6-2020 period in Bayern, Sachsen, and Hessen. In Brandenburg, the indicator list and the four indicator threshold and monitoring method is used as an additional entry criterion for a management-based agri-environment scheme.

France: In 2011, there were 1,053 farmers taking part in Herbe_07 schemes on 19,300 hectares. There are at least 5 territorial schemes representing about two thirds of the area under Herbe_07 contracts. By contrast, the scope of site-specific schemes was quite small (nine to 100 hectares) with a handful of farmers involved.

Switzerland: Around 21,800 farmers in Switzerland (almost half of all Swiss farmers) with the minimum number of indicators in their meadows have claimed the top-up quality payment to their ecological compensation area commitment; depending on the region, it is assumed that the programme includes between 50 and 90 per cent of the meadows that would fulfil the quality requirements (ie a qualifying area of around 37,700 hectares).

References

Baden-Württemberg: (Oppermann et al, 2009; Oppermann and Gujer, 2003)
Bayern: (Ruff et al, 2013) (LfL Bayern, 2014)
Brandenburg: (Kaiser et al, 2009) (Kaiser et al, 2010) Kaiser et al (2007) (Matzdorf et al, 2008) (Land Brandenburg 2007)
Hessen: (Hessen 2014)
Niedersachsen: (Bertke et al, 2008; Most and Keienburg, 2006)
Nordrhein-Westfalen: (NLWKN 2014)
Rheinland-Pfalz: (Rheinland-Pfalz 2010)
Sachsen: (Freistaat Sachsen LULG 2014)
France: (De Sainte Marie et al, 2010)(De Sainte Marie et al, 2010)(De Sainte Marie et al, 2010; De Sainte Marie, 2014; Plantureux and de Sainte Marie, 2011) (Fargier et al, 2009)
Switzerland: (Oppermann and Gujer, 2003; BLW 2014)

3 Semi-natural grazed habitats (indicator: composite quality index)

3.1 Biodiversity objective

Maintain and restore semi-natural species-rich habitats and their associated species reliant on grazing by livestock.

In Ireland, the target habitats are all habitats listed in Annex I of the Habitats Directive within a Natura 2000 area, and the overall objective is to achieve favourable conservation status of these habitats in the Burren (a glaciated karst landscape used for livestock farming). The results-based payment is part of a package of measures for farmers to invest in maintaining and restoring the habitat. In Switzerland, extensively used pastures and wood pastures are a widespread habitat particularly in the mountains, but are under pressure from intensification in some places, and abandonment in others. All Swiss farmers in receipt of direct payments are obliged to declare at least seven per cent of their land as ecological compensation area, and the results-based pasture quality payment is a top-up payment that incentivises the maintenance or restoration of the ecological value of some of these areas

3.2 Indicators

Composite index: ('health' assessment) of habitat condition with indicators of species (vegetation value), structural criteria (structure value), and absence of negative indicators (negative values). The index is applied to each parcel or field that is clearly defined within boundaries (wall, fence, stream etc).

Burren indices: the Burren uses two different indices to measure upland winter pastures (known as 'winterages') and lowland grasslands.

Upland winterages are scored for both positive and negative indicators:

- *Positive and negative grazing management indicators*: feed site damage, below optimum grazing level, amount of plant litter.
- *Condition of natural water sources*: damage that necessitates protection, such as fencing off water flows from cattle (as water bodies are principally subterranean, it is difficult to test their quality directly).
- *Negative ecological integrity indicators*: modification due to agricultural improvement or prolonged summer grazing, absence of species rich and typical flora, scrub or weed encroachment above certain thresholds.
- *Carbon storage potential*: little or no bare soil, no signs of erosion.

Lowland grassland indicators are:

- *Botanical value*: Presence of indicator plant species in five categories (from common species of improved pasture, to 'high quality' species).
- *Conservation bonus*: this is generally used on fields of lower botanical value to recognise that the field may be providing other benefits that support insect diversity eg support for pollinators, structure that favours roosting of butterflies such as the Dark Green Fritillary (*Argynnis aglaja*), nesting sites for birds.

The Burren index is scored from one to nine (where one is very poor and nine is exemplary) for each field, and then the score is multiplied by the field area (hectares). The grassland index score is calculated using an Excel tool.

The Swiss ecological quality index Ökologische Qualitäts-Verordnung (ÖQV) sets minimum thresholds for the parcel in both vegetative and structural criteria:

- *Vegetation value*: presence of a minimum of six indicator plant species from the regional list for that habitat (pasture or wood pasture) on the parcel. If the vegetation is heterogeneous, at least 20 per cent of the overall area must have botanical value.
- *Structural value*: presence of structural elements of ecological value (hedges, bushes, trees, dry stone walls, stone heaps, rocks, open ground, water). Each pasture, one hectare or more in size, must contain at least one sub-unit of high structural value. This sub-unit must have at least five per cent coverage of species-rich and thorn-rich scrub, trees or hedges. The woody vegetation must have at least five different species or consist of more than 20 per cent thorny scrub. Each wood pasture unit must have at least nine per cent tree coverage and at least 2.5 per cent coverage of species-rich and thorn-rich scrub or hedges. This hedge or scrub vegetation must have at least five different species or consists of more than 20 per cent thorny scrub. Regional authorities can define alternative structural criteria for grassland above the wood or hedge zone, such as presence of ecologically valuable deciduous tree or shrub species or animal species indicators typical of structural elements.

For parcels of one hectare or more, the pasture must be divided into several subareas, and each of these must meet the structural criteria separately. On parcels of less than one hectare the criteria are applied to the whole parcel area.

The vegetation value indicator is assessed using one of three standard indicator lists (some of the Swiss regions have added additional species to these lists):

- The L (easy) list, used in the lowland (MIttelland) and other areas north of the Alps and at an altitude below 1,000 managing authority, has 66 species of flowering plant including a few grasses and sedges.
- The M (middle) list, used in the Jura region, in areas south of the Alps at an altitude below 1,000 metres and in the northern Alps above 1,000 metres has 58 species of flowering plants including a few grasses and sedges.
- The S (difficult) list, used in the southern Alps above 1,000 metres and in the western and eastern central Alps, has 41 flowering plant species including a few grasses and sedges.

3.3 Indicator thresholds

In the Burren scheme, fields must score a minimum of three to qualify for payment. Fields where there is evidence that cattle receive significant amounts of supplementary feeding of silage or bales of hay receive a score of zero. Payment rates are degressive (in 40 hectare bands) as the area of land in the scheme increases, and each farmer's payments are calculated starting with their lowest scoring field, which provides an incentive for the farmer to improve the condition of this field. Bonus rates are also payable, applying a nine per cent increase for each point improvement in a field's classification.

In the Swiss scheme the threshold is least six indicators for vegetation value, plus the minimum requirements for elements of structural value (including coverage and vegetation composition). No invasive alien species are allowed in the structural elements, in particular the tree species *Ailanthus altissima* and *Robinia pseudoacacia*.

3.4 How the indicators were developed

In the Burren, the indices were developed by the project scientist based on the experience and findings of the BurrenLIFE project and of previous research carried out in the Burren. The development of the winterages index was based on the assumption that agricultural management plays a significant role in determining the ability of the Burren pastures to achieve their potential botanical richness and diversity (Parr 2014). Winterages are generally already species-rich, and the expected range of species is present, except where modified by agricultural improvement or over-grazing. Consequently, the main focus of the index is on assessing management and ecological integrity. In contrast, Burren lowland grasslands have higher agricultural productivity and vary widely in floral diversity, largely because of past management. Even if current management is optimal, the floral diversity may actually be of low conservation interest, and an index based only on management would overestimate the conservation value of these fields, whilst failing to incentivise improvements in poorly managed fields that have high conservation potential. However, it was also felt that an index based on conservation value alone would not incentivise farmers to improve conservation value at the expense of agricultural productivity.

The composite quality indicator that was developed for the lowland grasslands is a combination of scores for the presence of indicator species and for evidence of management (using negative indicators similar to those used for the winterages). The indicator plant species are grouped into five categories for different grassland types, from a group of indicators for improved pasture to a group for high quality habitat.

One problem was the difficulty of developing a scoring system for the turloughs (temporary water bodies characteristic of the Burren) because there are no clear management indicators (Parr 2014). Turlough management must be adapted flexibly according to flooding periods which differ between turloughs and from year to year. Ideally, grazing should be adjusted so as to create a patchwork of 'lawns and roughs' creating structural variation attractive to plants, invertebrates and birds. It was decided to score the turloughs in the same way as the grassland, because turloughs are usually part of a larger grazing area (Dunford et al 2013).

3.5 How the indicators were tested

The Burren scheme and indicators have not yet been subject to a formal scientific evaluation but the results of monitoring in the Burren show a gradual increase in habitat quality over time. A plan to carry out detailed vegetation monitoring on a limited number of farms has not been realised due to lack of staff time and resources.

An initial evaluation of the Swiss composite quality index was carried out in 2003 (Herzog et al 2005), and an in-depth scientific evaluation will be carried out over the period 2014 to 2016.

3.6 Protocols for measuring the indicators on the farm

In the Burren, when a field is entered into the scheme an initial assessment of the index score is done by a trained farm advisor, paid for by the farmer. Farmers can choose their advisor from a list of advisors that are trained and certified by the managing organisation The assessment should be carried out in the spring before the first grazing of summer pastures, or in the summer for winter grazing areas. The advisor should if possible carry out the assessment together with the farmer, and advise on priority management tasks. The index scoring assessments are repeated annually by trained advisors during a farm visit in the summer. For example, in 2013 (the fourth year of the programme) 998 fields (7,520 hectares) were scored by farm advisors and/or programme staff. The lowland grassland conservation value assessments, which require botanical surveying, will probably be repeated only every three to five years, or where there are indications of a possible change (either positive or negative) in the conservation value.

In Switzerland, after the initial assessment, the farmer is responsible for measuring whether the fields continue to comply with the criteria for the quality index. In the middle and at the end of the contract period (usually eight years) the fields are assessed by experts (see description of the control method below).

3.7 Verification of indicators and controls for payment

In the Burren, a proportion of farm plans, actions and scores is cross-checked independently by the programme team. Annual checks took place on all 160 farms in 2012 during which around 1,000 fields were assessed for their compliance with the reported habitat condition (Dunford et al, 2013). In some cases all the fields are scored again by programme staff, in other cases only the fields with a changed score are checked. Fields where the index score changes by two points or more are always checked. In addition to the above, Department of Agriculture officials conduct a whole farm check of five per cent of farms annually. The farmers are trained to apply the scoring system and are encouraged to ‘challenge’ allocated scores – only a handful of farmers have chosen to do so and in all cases they have been satisfied with the explanation given for their score.

In Switzerland, controls are carried out by the agricultural authorities or by certified experts. All parcels are inspected every three to four years, and also at the end of the contract period if the land is being entered into a subsequent contract. Land that is also part of an ecological network commitment will be controlled at least once during the contact period.

3.8 Advantages of the indicator and the measurement protocols

The component indicators of the composite index have certain advantages:

- Management indicators are simple to assess.
- Negative indicators are likely to be highly correlated with damage to or destruction of grassland plant communities.
- Species indicators are directly linked to the biodiversity objective of favourable conservation status of Annex I habitats because these habitats are partly defined through their vegetation composition.

The composite index as a whole:

- scores a broad range of different dimensions of the biodiversity value of the habitat including features related to management

- allows direct negative scoring of certain types of damaging management, whilst allowing farmers the flexibility to make other management decisions (eg grazing frequency and period)

3.9 Limitations of the indicator and the measurement protocols

The component indicators of the composite index have some limitations:
- Species indicators can only be assessed by botanically trained experts.
- A low or zero score for negative plant indicators does not guarantee presence of species-rich grassland, except in special circumstances.
- A high score for structural value will not guarantee that species-rich grassland is actually present, except in special circumstances, and so the structural indicator must be combined with an indicator of vegetation value.

The use of a composite index has certain limitations:
- Care needs to be taken to ensure appropriate weighting of each indicator and to prevent the masking of unacceptable results for one indicator when others occur at high levels (by multiplying indicator results rather than adding them or by using minimum thresholds for particular indicators of importance).
- Requires a higher degree of farmer acceptance and transparency in how it is applied, for example by scoring in the presence of the farmer because an index is slightly more complex than a single indicator.

3.10 Schemes using this indicator

Ireland: Burren Farming for Conservation Programme has operated since 2010 in an area of 13,256 hectares of Natura 2000 habitats. The scheme currently includes 158 farms.
Switzerland: All farmers in Switzerland who have extensive pastures and wood pastures are able to claim the top-up quality payment to their ecological compensation area commitment if their pastures meet the minimum criteria of the ecological quality index. Many cantons have adapted the basic scheme or offer additional schemes.

References
Ireland: (Dunford et al, 2012), (Dunford et al, 2013), (RBAPS, 2014), (Parr, 2014),
A proposal to use the index scoring approach for results-based agri-environment schemes across Ireland: (McGurn and Moran, 2013)
Switzerland: BLW (2014), BLW (2013), (Herzog et al, 2005), (RBAPS 2014)
Germany: Researchers developed a list of plant species that could be used as indicators of species-rich grazed habitats in north-eastern Germany, but it has not been used (Höft et al, 2010).

4 Mosaic habitats (farm-specific indicators)

4.1 Biodiversity objective

Two schemes use biodiversity objectives defined at farm or parcel level for mosaics of habitats.

In France, the biodiversity objective is to maintain target habitats of Mediterranean upland grazing areas within Natura 2000 sites, with mosaic structures of grassland, scrub, rocks, trees, wetlands, and other features that are important habitats for birds (eg *Tetrao tetrix*), mammals (eg *Marmota marmota*), plants (eg *Arnica montana*), and invertebrates of European conservation interest. The mosaic structure and habitat features are the result of extensive, shepherded grazing by sheep and goats.

In Austria, the biodiversity objectives for maintaining and restoring species and habitats are specific to each farm or parcel in a pilot results-based scheme for High Nature Value livestock farms and mixed farms with grazing and meadow land and some fodder crops.

4.2 Indicators

These schemes use results indicators for species and habitats related to the farm-specific biodiversity objectives. In the French HERBE 09 scheme for upland extensive grazing areas, vegetation-state indicators are set individually in site management plans, usually in the context of the Natura 2000 area management plan. The desired result differs for each site and is defined at the scheme inception stage by the advising expert together with the site manager(s), usually the shepherd. Criteria could include for example:

- Desired scrub coverage between 30 and 80 per cent.
- *Molinia* grazed back on at least 20 per cent of the degraded heath area.
- Intact *Sphagnum* cover on all bog areas, with no desiccation.
- Minimal area of bare peat soil in bog areas.

In the Austrian pilot project 'Ergebnisorientierter Naturschutzplan' (results-based nature conservation plan) the general and specific targets and also a set of control indicators are determined for each farm by advisors working with the farmers during a field visit. The biodiversity outcomes are set according to the local conservation objectives, habitats, and species present in the area. These might include, for example increasing the number of breeding Whinchat (*Saxicola rubetra*) pairs from two to five by the end of the contract.

The specific targets focus on habitat characteristics that can be used by the farmer to guide his/her management throughout the contract period, such as:

- Vegetation shall not be higher than 25 cm from beginning of May to end of September.
- Upright Brome (*Bromus erectus*) should not cover more than 50 per cent of the parcel.

The control indicators are intended to prevent unfavourable habitat changes that would prevent the biodiversity outcomes from being achieved. For example:

- Orchard grass (*Dactylis glomerata*) must not cover more than 50 per cent of the parcel and may be controlled only before the first mowing.
- At least 25 scattered thorn bushes per hectare, of different sizes.
- No more than five plants of Broad-leaved Dock (*Rumex obtuslifolius*) per parcel

4.3 Indicator thresholds

These are set at farm or parcel level, as described above.

4.4 Protocols for measuring the indicators on the farm

In the French HERBE 09 scheme, experts making field inspections use photographic reference information to assess the degree of desirable change in the vegetation state (eg shape of trees, amount of scrub). These inspections and broader habitat monitoring programmes in the Natura 2000 areas are carried out by staff from the regional nature park, botanical conservatories or farm advisory organisations.

In the Austrian scheme, the famer has a a 'farmers' logbook', which sets out the detailed objectives, targets and indicators for each parcel and provides space for the farmer to document day-to-day management and record observations. The expert advisor carries out an assessment midway through the five-year minimum contract and again at the end.

4.5 Verification of indicators and controls for payment

In Austria the control criteria are verified by the paying agency (these are the results indicators upon which the payments depend).

4.6 Advantages of the indicator and the measurement protocols

- Relevant to the specific biodiversity value of each farm.
- Directly related to the conservation value and management of the farm, and are therefore more easily understood by the farmer and more likely to encourage 'ownership' of the biodiversity objectives.
- Site-specific indicators and targets facilitate adaptive management.

4.7 Limitations of the indicator and the measurement protocols

- Requires visit(s) by an expert advisor to each farm, working with farmer or land manager to build and specify clear ecological objectives (consistent with Natura 2000 management documents) across a large range of situations.
- Depends on effective communication with the farming community and shepherds, and gaining their trust and acceptance.
- Adaptive management depends on availability of human resources for each site (eg for extra shepherds).

4.8 Schemes using this indicator

France: the HERBE 09 scheme for upland extensive grazing areas in Natura 2000 sites operates principally in the southern regions of Rhône-Alpes, Languedoc-Roussillon and Provence-Alpes Côte d'Azur. In 2011 the scheme included 2,621 land managers on 84,067 hectares.

Austria: The scheme launched in 2014 is a pilot for a results-based scheme across Austria in the 2015-2020 RDP.

References
France: (Agreil et al, 2009; Lécrivain et al, 2011) (Conservatoire d'espaces naturels, 2009)
Austria: http://static.suske.at/86/download/aktuelleprojekte/enp-infoschreiben-a5_low.pdf

5 Vineyards (indicator: composite quality index)

5.1 Biodiversity objective

The objective of this Swiss scheme is to increase the biodiversity value of vineyards. The characteristic semi-natural dry grassland, habitat features and micro-climates of vineyards can provide habitats for a diverse range of species, including a high proportion of endangered species. Typical species of conservation interest include lizards (e.g. *Lacerta viridis*), snakes (e.g. *Vipera aspis*), birds (e.g. *Lanius collurio*) and rare plants (e.g. *Bufonia panicolata*) and shrubs (e.g. *Prunus malaheb).*

All Swiss farmers receiving CAP direct payments are obliged to declare between three and seven per cent of their land as ecological compensation areas, and the results-based vineyard quality payment is a top-up payment to encourage farmers to maintain and restore the ecological value of these areas.

5.2 Indicators

The indicator is a composite index of indicator species (vegetation value) and structural criteria (structure value) combined with the absence of negative indicators (negative values).

The Swiss ÖQV quality index provides a comprehensive measure of botanical and structural components of biodiversity in the whole habitat:
Vegetation value (species) indicators:

- Species on a list of species of biodiversity value, each with a points 'score' that corresponds with its conservation value. The list contains 59 species typical of extensively managed vineyards covering all regions of Switzerland. The point scores range from 2 for relatively common species, such as *Viola arvensis*, to 25 for relatively rare species such as *Hyoscamus niger*, and 50 for one particularly threatened species *Bufonia panicolata*.
- Additional (non-listed) species are scored with one point (except woody species, which are counted structural indicators).

Negative (zero value) indicators:

- A list of negative plant species indicators that are not awarded any score. This includes all species on the Swiss black list and watch list of invasive alien species, plus 12 other indicators of intensive management.

Structural value (habitat features) indicators:

- Hedges or groups of trees at least three metres in length, one metre wide and 1.5 metres high; the indicator score is doubled if more than 20 per cent of these are from a list of five thorny species of high wildlife value (*Prunus spinosa, Crataegus laevigata, C.monogyna, Prunus malaheb, Colutea arborescens*).
- Single bushes or patches of scrub at least three metres apart, one metre high, and one metre wide, and the indicator score is doubled if more than 20 per cent of these are from a list of five thorny species of high wildlife value (as above)
- Single trees of at least 20 cm stem diameter; this indicator score is doubled if more than 50 per cent of trees are typical vineyard species (*Prunus dulcis, Prunus persica*, or *Ficus carica*).

- Dry stone walls of at least 0.5 metre height and nine metres in length (but there can be gaps).
- Rocks and stone heaps of at least five square metres in area.
- Fallow areas and slopes, flowering set-aside, arable margins at least nine square metres in area.
- Water features (streams, ponds, ditches), of at least 20 square metres in area.
- Sparsely vegetated slopes of loess or molasse rock or sandy soil, at least five square metres in area.

How the vegetation value is calculated: each of the listed species occurring between the vine rows is scored and additional species are noted. The points are added together. Then each of the listed species and additional species occurring in the turning areas above and below these rows are scored and the points added together to a maximum of nine. The row species score and the turning area species score (up to nine) are *added together*. The minimum qualifying score for that region is *subtracted* from this total (for northern side of Alps and Chablais Valaisen in the western central alps the minimum qualifying score is 15, for the southern side of the Alps it is 25 and for the western central Alps (except Chablais Valaisen) it is 30. The reduced score that results from this calculation is then divided by five, to give the final score of vegetation value.

5.3 Indicator thresholds

To meet the quality index threshold the sum of the scores for vegetation value and habitat value must be at least six, and the vegetation value score must be at least three.

5.4 How the indicators were developed

The indicator was developed by experts at the Swiss agricultural research station.

5.5 How the indicators were tested

There is no evaluation so far and no current ecological results, but an in-depth scientific evaluation will be carried out over the period 2014 to 2016.

5.6 Protocols for measuring the indicators on the farm

The index is scored by botanical experts employed under contract to the farmers. The scoring is done on a defined, mapped area with at least four rows or terraces which include the different types of vegetation management used in the vineyard (eg alternating mowing and clearance of vegetation below vines). Access tracks cannot be scored. In vineyards less than two hectares the sample area should be 200 square metres. In vineyards between two hectares and five hectares the sample area should be at least 10per cent of the vine area. Vineyards over five hectares in size should be divided into sub-units of less than five hectares, and a sample area of either 200 square metres or ten per cent of area mapped within each sub-unit, depending on their size. Habitat features that are within the sample area or less than ten metres away are scored. In large vineyards, each habitat feature must be allocated to only one of the sample areas.

The measurement should be carried out in August, but if the area does not meet the minimum standard, it can be repeated in April. The farmer is then responsible for ensuring that the area continues to meet the standard during the eight year contract period.

5.7 Verification of indicators and controls for payment

Controls for the eight-year (previously six-year) contracts for the ÖQV quality payments are carried out by the administration or certified control bodies. Each area is controlled at least once in the contract period, sometimes twice.

5.8 Advantages of the indicator and the measurement protocols

- A comprehensive measure of botanical and structural components of biodiversity in whole habitat.
- Species with biodiversity value are awarded scores that correspond to their conservation value.
- Additional species can be scored.
- Negative indicator species are not scored.

5.9 Limitations of the indicator and the measurement protocols

The use of a composite index has certain limitations:

- The assessment is relatively complicated and time consuming, and the species indicators can only be assessed by botanically trained experts.
- Care needs to be taken to ensure appropriate weighting of each indicator and to prevent the masking of unacceptable results for one indicator when others occur at high levels – this is ensured in the Swiss index by the use of minimum thresholds for each component indicator and for the overall result.
- Requires a high degree of farmer acceptance and transparency in how it is applied, for example by the expert scoring in the presence of the farmer, because an index can be perceived as being more complex than a single indicator.

5.10 Schemes using this indicator

Switzerland: About 335 hectares of vineyards with high ecological quality managed by about 232 farmers received the ÖQV quality payment for vineyards in 2012 (BLW 2013).

References

BLW (2014), BLW (2013)

6 Traditional orchards (indicator: number of trees, and quality criteria)

6.1 Biodiversity objective

There are a number of related biodiversity objectives for traditional orchards: to maintain their value as habitat eg for birds, bats, insects; to maintain their aesthetic and cultural contribution to the landscape; and to maintain the diversity of local fruit varieties. Traditional orchards in central Europe can host over to 5000 animal and plant species (NABU 2013). The species richness is obtained through the combination of species-rich grassland, old trees with abundant holes and other habitat features, and other structures such as bushes, hedges, dry stone walls, and water. Some bird species are closely associated with mature orchard trees, nesting in tree holes, such as Little Owl (*Athene noctua*), Scops Owl (*Otus scops*), Hoopoe (*Upupa epops*), Eurasian wryneck (*Jynx torquilla*), Common Redstart (*Phoenicurus phoenicurus*), and Collared Flycatcher (*Ficedula albicollis*). Orchards maintain thousands of local varieties and landraces of fruit (apples, pears, plums, damsons, cherry, etc) and nut (common walnut *Juglans regia*, black walnut *Juglans nigra*, and sweet chestnut (*Castanea sativa*). Traditional fruit tree varieties live for 60 to 100 years provided they are maintained through regular pruning. In Germany it is estimated that between 300,000 and 500,000 hectares of traditional orchards are left (NABU 2013). However, most of these are more than 50 years old, and because so few new orchards were planted between 1950 and 1990, there is a serious threat that the remaining area will soon be lost through old age and neglect as well as to the continuing pressures of urban development or farmland intensification.

6.2 Indicators

For the schemes in Germany and Switzerland the indicator is the number of fruit and/or nut trees of a specified size and spacing (with some additional quality criteria in Switzerland).

The German schemes generally specify a minimum tree size, and a maximum and minimum tree density, eg in Nordrhein-Westfalen between 55 and 35 trees/hectare on at least 0.15 hectare (with at least nine trees); in Rheinland-Pfalz between 100 (previously 80) and 20 trees/hectare on at least 0.58 hectare; and in Baden-Württemberg, Bayern, Brandenburg and Saarland a maximum of 100 trees per hectare.

The Swiss payments are only for mature trees not in fruit plantations, and for a minimum of 20 mature trees. In Switzerland it is possible to apply for an additional top up payment for ecological quality criteria, which in some cases doubles g the payment value. The quality payments require a minimum of 0.2 hectare with at least 30 and no more than 120 trees per hectare (or 100 trees per hectare if they are cherry or nut trees). The trees must be no more than 30 metres apart pruned regularly. At least one third of the trees must have a canopy of at least three metres in diameter. The quality criteria consist of:
Vegetation value:

- The trees must be associated with an area of vegetation of at least 0.005 hectare per tree (or 0.0025 hectare for trees above the 200 tree threshold), which must meet the minimum quality for extensively managed meadow, pasture or wooded pasture, or flower-rich fallow or hedge (see above for a description of the Swiss pasture criteria).

Habitat value:

- At least one natural nest hole or installed nest box per nine trees, distributed throughout the orchard; only a few boxes can be positioned outside the orchard up to 30m from the outermost trees (nest boxes must be suitable for hole-breeding orchard species and follow Swiss bird protection society guidelines, and be cleaned annually before 31 January).

In rare cases where the vegetation value cannot be met for the whole orchard, because the area is too small or some other reason, it is possible instead to meet criteria for at least one structural element per 20 trees with a total of at least three structural elements. These can include: water (ditch or pond), stone heap, dry stone wall, fallow area, open ground, pile of branches or woodpile, bee nest pile or hornet nest box, dead tree or tree with large proportion of dead branches (but no diseased *Erwinia amylovora*), hedge (but not when counted for vegetation value), single bush or tree, ivy covering a tree up to at least two metres, woodland margin with thorny bushes, orchard trees above 55 cm in diameter, mosaic management of vegetation (leaving at least 25 per cent unmown each time), and at least three different orchard tree species (eg apple, pear, quince, cherry).

6.3 How the indicators were developed

The Swiss quality criteria were developed by experts at a national agricultural research institute.

6.4 Protocols for measuring the indicators on the farm

Trees that meet the criteria are counted. Most schemes explicitly state that dead trees should not be counted but nor can they be removed (except in the case of certain disease precautions). The count is generally done during a site visit by the agricultural control authorities, as described below. Farmers are responsible for maintaining the number of trees throughout the contract period, by planting new trees to replace dead ones. In Switzerland the additional quality criteria are assessed by an expert at the beginning and the end of the contract period.

6.5 Verification of indicators and controls for payment

In Germany, the number of live and dead trees and their size is checked at the beginning and end of the five-year contract period. In Switzerland farmers are subject to regular control inspections, both of the number of trees and of the criteria for the ecological quality top-up payment.

6.6 Advantages of the indicator and the measurement protocols

- Indicator is a direct incentive to maintain a key habitat feature (i.e. mature orchard trees).
- payment for the orchard increases with the number and density of qualifying trees (up to the maximum threshold), in direct relationship to decreasing agronomic value of the grassland on the site (because the grass under more densely spaced trees has little or no value for grazing or hay).
- Indicator is a direct incentive to maintain the quality of the trees, provided it is linked to criteria for regular pruning (see below).

6.7 Limitations of the indicator and the measurement protocols

- Indicator is not necessarily associated with any tree management or quality criteria – only some schemes specify that trees must be maintained through regular maintenance and rejuvenation (restoration) pruning, and offer appropriate per tree payments.
- Setting a qualifying criterion of a minimum number of trees excludes the possibility of payments for many small orchards and potentially valuable single trees along field edges or in pastures and meadows.
- A feature of the current programmes in Germany is that the per tree payment varies greatly between federal states, and in some cases is too low to cover the costs of maintaining the tree. The most important way to incentivise the maintenance of traditional orchards is An economically viable orchard support system requires a combination of mechanisms covering tree, grassland, and other habitat features maintenance, investment support for restoration and new orchard creation, support for creation and development of new market opportunities eg direct marketing, new products, labelling schemes and group or cooperative initiatives (eg through LEADER) to ensure markets for the produce (which can include fruit, juice, preserves, spirits, wine and honey).

6.8 Schemes using this indicator

Germany: per tree payments are available in most federal states including Baden-Württemberg, Bayern, Brandenburg and Berlin, Nordrhein-Westfalen, Rheinland-Pfalz, Saarland.

Switzerland: per tree payments were made for 2,239,074 trees on 31,067 farms in 2012 (BLW 2013)

References

BLW, 2013; BLW 2014c; NABU 2014; RBAPS 2014.

7 Arable weed populations (indicator: arable plant species)

7.1 Biodiversity objective

The objective is to increase the populations of arable weed species and hence the populations of associated insect species and their predators.

Arable weed species have declined dramatically in the last few decades, both in total abundance and the abundance and distribution of rare species, as weed control in arable crops has become more efficient and crops have been managed more intensively. Arable weeds now make up a high proportion of endangered Red List plant species. Seed eating birds benefit from weed species that produce abundant seed (eg *Chenopodium album*, *Polygonum aviculare)*. Insects that provide natural pest control or pollination services benefit from flowering weeds rich in nectar and pollen (eg *Centaurea cyanus, Vicia sativa*), and insect-eating birds and mammals benefit from the increased abundance of insects. Crop losses due to weeds are often caused by a few particularly pernicious weed species, and increased weed diversity can sometimes lead to a reduction in the negative impact of the problem weeds. Usually, however, a higher abundance of ecologically desirable weed species is associated with a considerable reduction in crop yields. Arable fields which still have diverse weed populations and seed banks are now mostly restricted to certain regions within a few countries where low intensity High Nature Value farming systems survive, although some organic farming systems in less intensive farming areas also retain diverse weed species.

7.2 Indicators

The indicator is the number of non-crop dicotyledonous arable plant species. In the Northeim pilot scheme in Germany all dicotyledonous arable weeds were counted, as no target species were defined (Ulber et al, 2009). A previous research project had developed a list of 20 dicotyledonous arable plant indicators characteristic of particularly threatened arable plant communities (Braband et al 2003).

7.3 Indicator thresholds

The Indicator threshold for the pilot scheme required at least ten different arable plant species per arable field. The research project set a threshold of at least four arable indicator species in every subsection of the field (ie every segment of a transect across the field).

7.4 How the indicators were developed

The threshold of nine indicator species used in the Northeim pilot project was defined by regional stakeholders, based on their expert knowledge, and underpinned by scientific studies on the number arable plant species in the project region (Ulber et al 2009). The threshold deliberately referred only to dicotyledonous arable species, to allow farmers to continue using control measures against highly competitive grass weed species (Ulber et al 2011).

The research project compiled a list of 37 arable weed indicators, based on expert experience. This was tested on around 100 arable fields in five different German federal states and then narrowed down to 20 species that are easily identifiable.

7.5 How the indicators were tested

The pilot scheme results showed that in the first and second years of the scheme 73 per cent and 90 per cent of the fields entered into the scheme were successful in achieving the threshold. A subset of 14 fields was compared with similar fields that did not take part in the scheme, and in each pair the indictors were measured both fields using the same methodology on the same day. The scheme fields had a total of 45 different dicotyledonous arable plant species, with an average of eight species per field - almost three times as many species as in the comparison non-scheme fields. Interviews with farmers confirmed that this was mainly attributable to lower fertiliser levels and reduced inputs of broad-spectrum herbicides in the scheme fields. The indicator did not take any account of the rarity or conservation value of arable weed species. Survey results showed only two Red List species, and most of the species were common and widespread weeds.

The research project found a strong correlation (r=0.8) between the occurrence of indicator species and total arable weed species diversity. The four species threshold in all parts of the field was met by only 9.5 per cent of 569 surveyed arable fields on 27 different farms across Germany (Braband et al. 2003, Oppermann et al. 2005).

7.6 Protocols for measuring the indicators on the farm

In the pilot scheme researchers surveyed the species in a 100 square metre plot located in the centre of each field, at the end of the contract period each year.

The research project measured indicator species on each segment of a transect across the longest diagonal of the field, using the same method as the results-based hay meadows schemes in Germany. In fields over 20 hectares in size, six parallel transects were used. The method was designed for farmers to use to measure results on their own fields.

7.7 Verification of indicators and controls for payment

Because the Northeim scheme was a pilot project, the control was the measurement by researchers. Similarly, in the research project all farmer surveys were followed with parallel researcher surveys.

7.8 Advantages of the indicator and the measurement protocols

- If particular threatened arable weed species are identified as indicators, the payment is directly linked to the priority species whose conservation is the objective of the scheme.
- Sensitive to management such as changes in herbicide use and tillage, which means that increases in arable weed diversity can be obtained quickly if the seed bank is present.
- Farmers measure the indicators in their own fields using a simple methodology within a reasonable time.

7.9 Limitations of the indicator and the measurement protocols

- Indicator species vary according to field type and region so it is difficult to create a standard easy-to-use indicator list. Some of the most threatened arable weed communities are associated with particular crops and soils.

- If all arable weed species are used as indicators, this is an indirect measure of biodiversity value of the weed flora.
- Arable weeds are not necessarily a good indicator of bird or pollinator populations, as only certain species offer good bird seed food or good pollen or nectar sources for insects.
- Species can be difficult to identify even with introductory training.
- Only applicable where there is still a good weed seed bank present in the field or nearby.
- Some crops, which may form part of the crop rotation, are not suitable because they have dense crop cover and poor arable weed populations (eg clover-grass leys).
- Difficult or not appropriate to standardise measurement period as it must correspond to weed flowering, which varies with crop rotation, crop development and weed flora.
- Difficult to control due to variations in crop rotations and weed flowering period
- Measurement methods need improvement to accommodate patchy weed occurrence in fields.

7.10 Schemes using this indicator

None in current use. In Germany the indicator was used in a pilot scheme in Northeim, Niedersachsen, in the context of an annual auction mechanism which was held for two consecutive years in 2008 and 2009, but was then discontinued. 12 farmers with 43 hectares participated in the first auction and 11 farmers with 94 hectares in the second.

References

(Ulber et al, 2009), (Ulber et al, 2011), (Braband et al 2003), (Böhnert et al 2012), (Oppermann et al, 2005)

8 Breeding birds of grassland and arable land (indicator: protected nest sites)

8.1 Biodiversity objective

The biodiversity objective is to prevent egg and chick mortality caused by farm management, thereby improving the reproductive rate and contributing to maintaining and increasing target bird populations (breeding waders, Skylark (*Alauda arvensis*) and Harrier species).

Grassland-nesting bird populations in northern Germany and the Netherlands have declined considerably, and as a large proportion of Europe's populations breed in these regions this is of concern at the EU level. A key cause of these declines has been agricultural improvements (e.g. drainage of wet grassland) and management intensification (e.g. increased use of fertilisers and reseeding of grasslands) as the breeding birds mainly nest on permanent grassland used for dairy farming. Harrier species show steep population declines in northwest Europe and Montagu's Harrier (*Circus pygargus*) is now classified as highly endangered in Germany. Increasingly, Montagu's Harriers and to a lesser extent also Marsh Harriers (*Circus aeruginosus*) and rarely Hen Harriers (*Circus cyaneus*) are nesting in intensively used arable fields, where their reproductive success rate is severely reduced by the loss of eggs and chicks to harvest machinery.

8.2 Indicators

The indicators are: the number of nests of specific species protected from agricultural actions on permanent grassland (see below for explanation) including Lapwing (*Vanellus vanellus*), Black-tailed Godwit (*Limosa limosa*), Curlew (*Numenius arquata*), Oystercatcher (*Haematopus ostralegus*), Redshank (*Tringa totanus*), Common Snipe (*Gallinago gallinago*) and Skylark (*Alauda arvensis*); and the number of nests of Montagu's Harrier (*Circus pygargus*) in arable fields that have been protected from harvest damage; and to a lesser extent also Marsh Harrier (*Circus aeruginosus*).

8.3 How the indicators were developed

Nest mortality through agricultural management activities is generally very high on intensively used farmland without protective measures. These schemes are attempting to bring down mortality for a sufficiently high proportion of the population so that the population decline is slowed or halted. Nests are protected by either delaying agricultural operations until the chicks have fledged, or protecting the nest area from grazing or cutting or harvesting actions, for example through fences or retaining uncut areas.

8.4 How the indicators were tested

The German schemes additionally monitor the annual rate of successfully fledged young per breeding pair in order to assess whether the nest protection measures are reducing the overall nest mortality rate. The number of successfully fledged young per breeding pair per year is compared to the long-term average reproductive rate as a direct measure of the degree of benefit to the bird populations. There is generally good long-term monitoring data on the overall reproductive rate for these target bird species in Germany, which makes it possible to test whether the nest protection is improving the overall population status, or whether there are other problems driving down the reproductive rate.

In the Netherlands, there is a monitoring programme of the number of breeding pairs, and in some cases also the fledging rate, associated with an agri-environment programme for grassland waders. However, this is not connected to the per nest payment arrangements organised by the agricultural co-operatives, and there is therefore an information gap as there is no direct link between the monitoring data on the number of breeding pairs and the number of protected nests. The German schemes are also associated with on-going scientific evaluations that are collecting detailed data on breeding success in order to test the success of the schemes. For example, detailed data on breeding success are being collected on a 431 hectare area in the Eider-Treene-Sorge-Niederung, including breeding territories, egg brooding time, predation rate, fledging rate, chick survival rate and number of chicks per territory (Jeromin and Evers 2013b).

In the Netherlands, there is a lack of scientific evidence to show how grassland bird populations respond to the nest protection payments. There is some evidence that payments have increased hatching success (Schekkermans and Müskens 2000, Musters et al 2001), but this does not seem to be having any impact on the overall population reproductive rate, perhaps because of high chick mortality.

8.5 Protocols for measuring the indicators on the farm

In the German schemes, staff and volunteers regularly visit all known and expected breeding areas and search for breeding pairs and nests. Each person is assigned as contact person for one particular region. A small proportion of nests are also identified and notified by the farmers themselves. The contact person and/or farmers generally mark the identified nests, eg with coloured poles. Bird clutches killed through farmer management actions are quite easy to identify because of the evidence of management on the parcel (eg cut grass and track marks), as well as direct damage to the marker posts and nest spot. It is easy to check whether arable farmers have left the 50 metre x 50 metre (0.25 hectare) protective zone of cereal crop unharvested around Montagu's Harrier nests. If eggs or chicks vanish without any traces of damage through management actions, the losses are attributed to predators or other natural factors and the farmer receives the appropriate payment. Successfully hatched clutches are identified by the remains of eggshells. The contact person checks whether the bird family or families remain on the site. As soon as the contact person notices that the birds have left the site, he or she removes the markers and the farmer is free to manage the parcel without restrictions. The German schemes carry out assessments to test the proportion of nests that the scheme volunteers and staff are able to locate; for example, for Montagu's Harrier in Nordrhein-Westfalen this is assessed to be around 95 per cent.

In the Netherlands schemes, farmers themselves are responsible for mapping and reporting species and numbers of nests to the agricultural cooperatives.

8.6 Verification of indicators and controls for payment

The contact staff in the German schemes check the nesting areas regularly and verify whether protection measures and/or management actions have been carried out correctly in their region. The nature conservation organisation running the payment arrangements is responsible for ensuring that these contact staff (who are often volunteers) are given sufficient support and oversight to ensure that they are able to carry out both measurement and control duties, and to intervene in any potentially difficult situations, for example in cases of conflict with the farmer.

In the Netherlands, the agricultural cooperatives administering the nest payment schemes carry out random checks every year and report the results in annual reports (de Lijster and Prager, 2012). In the previous government-funded scheme, inspection of the management was carried out randomly by the Paying Agency, and monitoring of the results was carried out by a three-year government field inventory. This process was viewed as having a high administrative burden with too many inspections needed in order to verify results. Further, there was scope for multiple interpretations of results (between farmers and land managers and monitoring officials), which led to difficulties in agreeing whether or not a result was achieved and to what extent.

8.7 Advantages of the indicator and the measurement protocols

- Indicator relates directly to the species that are the objective of the scheme (but see indicator limitations below).
- Indicator rewards farmer initiative to improve habitat management and increase nest protection and to detect and report nests.
- Most farmers are motivated to protect birds and take pride in the scheme – involving farmers in the bird surveying is important for increased awareness and adaptive management.
- The Netherlands arrangements, which involve thousands of farmers and many tens of thousands of hectares of grassland, are run by agricultural cooperatives which provide on-going training to participants at no additional cost to the farmer

8.8 Limitations of the indicator and the measurement protocols

- A nest or clutch indicator does not relate directly to breeding success, due to other factors such as chick mortality.
- A payment rate based on income foregone for nest protection is not a sufficient incentive for the maintenance or improvement of habitat quality, which is essential for overall population viability. As waders tend to remain close to the nest site unless disturbed, the birds are reliant on the habitat quality of that field to provide sufficient chick food for good chick survival. Even if the indicator measures the presence of the bird family until they have left the site, this does not necessarily mean the habitat quality is sufficient for the chicks to survive. Grassland-nesting birds do not necessarily respond immediately to changes in management – there may be a time lag. Furthermore, adjusting management to improve habitat quality for grassland birds without significant reductions in economic productivity is not easy and may require collaborative action at the landscape scale – for example, delayed effects of autumn grazing patterns may be essential to create suitable sward structures in spring (Durant et al, 2008).
- Measurement is time consuming, particularly if also measuring chick survival.
- Measurement relies heavily on volunteer effort to patrol fields and alert farmers to presence of nesting birds, and in Bayern Germany the schemes are trying to cope with rapidly expanding bird populations.

8.9 Schemes using this indicator

Netherlands: Agricultural cooperatives in the western part of the country. The number of participants and the area involved in these schemes is not known exactly, as statistics are lacking.

Germany:

Schleswig-Holstein: grassland breeding waders on around 220 km^2 in six regions (scheme expanding rapidly).

Bremen: grassland breeding waders on around 45 km^2 in one region.

Nordrhein-Westfalen: Montagu's Harrier nests (and to a lesser extent also Marsh Harrier nests) in arable fields on nearly 2000 km^2 in and around the Hellwegbörde Natura 2000 SPA

Bayern: Montagu's Harrier nests in arable fields on around 1800 km^2 in the Mainfranken area.

References

Netherlands: Ministerie van Landbouw, Natuur en Voedselkwaliteit (2006), (Musters et al, 2001), Netherlands Environmental Assessment Agency (2007), (Schekkermans and Müskens 2000), (de Lijster and Prager, 2012)

Germany: (ABU Soest 2013), (Landesbund Vogelschutz Bayern 2014), (Jeromin and Evers, 2013), (Kuno e.V. 2014), (BUND Bremen 2014)

General: (Durant et al, 2008), (RBAPS 2014)

9 Populations of large predators (indicator: predator offspring)

9.1 Biodiversity objective

The biodiversity objective is to stabilise and allow for increase in populations of Wolverine (*Gulo gulo*), Lynx (*Lynx lynx*) in the northern (Lapland) regions of Sweden, and populations of Golden Eagle (*Aquila chrysaetos*) in northern (Lapland) Finland.

The schemes are primarily designed as a disincentive to poaching and illegal killing of species protected by the EU Habitats or Birds Directives. Sami herders lose on average 20per cent of their reindeer stocks to predators. It is estimated that Golden Eagles cause about half of overall reindeer calf first summer mortality in Finnish Lapland, though predation rates vary greatly from year to year (Nieminen et al, 2011). Disturbance during breeding and poaching by reindeer herders is considered to be a serious threat to all three species. The scheme objectives in Sweden are tied to Swedish government objectives that aim to achieve a favourable conservation status for the Wolverine and Lynx populations (Swedish Government Bill 2000 quoted in Zabel et al 2013). These national targets are broken down to targets for approximately 400 Wolverine and 400 Lynx in the Lapland reindeer region of Sweden. The scheme translates this target into a requirement to protect at least 90 Wolverine litters and 80 Lynx litters a year (Swedish Naturvardsverket 2013a,b). The Finnish Golden Eagle population is estimated at 310-390 breeding pairs. The objective is to stabilise the population in the North and to increase it in the South.

9.2 Indicators

The indicator is the number of predator offspring or nests and number of breeding territories of Wolverine (*Gulo gulo*), Lynx (*Lynx lynx*) and Golden Eagle (*Aquila chrysaetos*) in the reindeer grazing areas.

The Golden Eagle territories and nests in tundra receive higher payments than those in forest, because of the higher proportion of reindeer calf kills in the open tundra

9.3 How the indicators were developed

The indicators are a proxy for population reproductive rate. The payment rates are based on the expected reindeer income forgone from each predator offspring in its expected average lifetime damage to reindeer. Each Lynx and Wolverine is estimated to annually prey on an average of 40 reindeer (Swenson and Andrén 2005 quoted in Zabel et al 2013). In Finland the payment level changes annually in relation to the market price for reindeer meat.

9.4 How the indicators were tested

Ecological observations indicate that there has been an increase in population trends for all three species since 2000. Surveying efficiency has greatly increased for all three species during this period. For example, knowledge about the Golden Eagle population in Finland shows that the number of known territories has increased from 294 in 1998 to 498 territories in 2013, but it is difficult to disentangle the actual population trend from the increased surveying efficiency. It is also very difficult to determine whether the population increase is a direct consequence of the result-based payment scheme or if other factors have played a more important role. There is some evidence to suggest that incidents of

Wolverine and Lynx poaching have fallen since 1996; although it is not clear how much of this poaching can be ascribed to the Sami reindeer herders.

9.5 Protocols for measuring the indicators on the farm

Annual surveying jointly by rangers and Sami village predator scheme representatives according to detailed surveying protocols. The Golden Eagle surveying also involves volunteers.

The Wolverine and Lynx winter survey methodology measures breeding territories (location of dens, tracks) and regular and occasional occurrence of adults (through tracks of adult animals, camera traps etc). The Golden Eagle survey methodology measures occupation rate of the known territories and number of chicks per nest. Nests are usually checked from mid June to mid July in order to provide a more reliable chance of observing a chick. Overall payment rates are calculated from the combination of the number of occupied territories and nests in each community area.

9.6 Verification of indicators and controls for payment

The surveying and control is expert-driven, organised by the government ranger services. The Sami village predator representatives must complete training in surveying and measurement.

The Golden Eagle surveying results in Finland are compiled at the national golden eagle register run by Natural Heritage Services of the State Forest Agency. Based on this, conclusions are made in regard to the species protection. In Sweden the scheme is associated with a severe government clamp down on illegal poaching, with significantly increased monitoring and prosecution of poaching. However, it is also currently associated with a policy of permissions for limited protective hunting (*skyydsjakt*), of particular identified animal(s) that are causing a lot of damage, which plays an important role in diffusing tensions.

9.7 Advantages of the indicator and the measurement protocols

- Directly measures the species whose conservation is the objective of the scheme.
- Indicator provides no incentive for illegal killing of predators.
- Indicator makes the predator offspring into sources of financial value for the Sami communities – the payment rates are calculated to replace the income lost from predated reindeer, so the communities are on average receiving more than they did under the previous scheme which compensated for livestock killed. (There is substantial variation in the number of offspring between communities due mainly to differences in habitat areas). The indicator seems to have stimulated dramatic change in attitudes to predators, for example in Finland Golden Eagles are reported to now be seen as a resource rather than a pest.
- Indicator operates at the level of the whole reindeer herding community, thus questions of how to deal with social justice issues caused by highly unequally distributed predator losses are solved within the village community.
- Measurement is done jointly by rangers and reindeer herders, which has established good relations between the herders and rangers, greatly increasing stakeholder engagement in the scheme.

- Increased surveying is contributing to greatly increasing knowledge and oversight of predator populations.

9.8 Limitations of the indicator and the measurement protocols

- Measurement and assessment is complex and expert driven and requires a great deal of time – it is largely recognised that there is no way around this challenge.
- Indicator does not measure other parameters affecting population size such as winter mortality, and confirming fledging success of Golden Eagles is logistically very challenging and not normally possible within the normal indicator measurement framework.
- As the indicator is applied at the community level, conservation outcomes are influenced by intra-community institutional arrangements, in particular to what degree payments are allocated directly to the herders who have lost most reindeer.

9.9 Schemes using this indicator

Sweden: Carnivore scheme for Lynx and Wolverine in 51 Sami villages possessing reindeer grazing rights over 262,231 km^2 of forest and tundra in the Swedish Lapland region. The communities in the north and west of the reindeer region have predominantly mountainous open tundra with Wolverine whereas the southern and eastern communities are predominantly in forest with Lynx.
Finland: Golden Eagle scheme on nearly 123,000 km^2 of forest and tundra in the Finnish Lapland region. All the 56 Sami communities are involved, with approximately 5,980 reindeer owners.

References
(Zabel et al, 2010), (Zabel and Holm-Müller, 2008), (Zabel et al, 2013)
(RBAPS 2014)
(Nieminen et al, 2011)
(Swedish Naturvardsverket 2013 a,b)
Swedish Environmental Protection Agency (2014) – links to Lynx and Wolverine monitoring protocols.http://www.naturvardsverket.se/Stod-i-miljoarbetet/Vagledningar/Vilt/Inventeringsmetodik-for-stora-rovdjur/

10 Genetic diversity of farm animals (indicator: number of animals with breed characteristics)

10.1 Biodiversity objective

The objective is to maintain animal genetic diversity in agriculturally used animals and their associated cultural, environmental and other values (cattle, horses, goats, sheep, pigs, chickens, geese, rabbits, honeybees and other animals).

Threatened and rare animal breeds have an intrinsic cultural value, and are often closely associated with regional farming identities and traditions. They often have a value as a source of genetic variation for breeding desirable traits into modern breeds, such as disease resistance. Many breeds are also very useful habitat management tools, as they have been bred to live and feed in low productivity environments. For example, the Hinterwälder cows in the Black Forest in Germany are adapted to graze on steep slopes in a humid climate. These breeds do not deliver high milk or meat yields and are endangered because most farmers choose to keep high yielding breeds instead. However, some endangered native breeds are no longer associated with economic value for animal breeding (if they do not have recognised valuable traits such as resistance to a particular disease) or for regional or high quality products conservation (due to their low productivity). These breeds require strong support measures to maintain viable breeding populations.

10.2 Indicators

The indicator is the number of animals of threatened breeds, which retain the genetic characteristics and purity of the breed (cattle, horses, goats, sheep, pigs, chickens, geese). Animals must be tagged and identified and registered in the herd or breed books kept by the approved breeding society.

10.3 Indicator thresholds

The EU legislation sets thresholds for minimum population sizes for certain farm animal species, below which a local breed is considered as being in danger of being lost to farming and therefore eligible for financial support (Regulation 1974/2006/EC Annex IV). These were: 7,500 breeding females of cattle breeds, 10,000 breeding females of sheep breeds, 10,000 breeding females of goat breeds, 5,000 breeding females of equine breeds, 15,000 breeding females of pig breeds, and 25,000 breeding females of bird breeds. The legislation also specified that Member States must identify appropriate bodies that have the competence to define endangered breeds that are. Other payments may be available for rare breeds of other species, including sheep dogs, bees, and rabbits.

10.4 How the indicators were developed

European countries publish regular reports on the status of their animal genetic resources to the FAO Global Plan of Action for Animal Genetic Resources. Some countries have developed red lists with defined threat categories for animal breeds. For example, Germany publishes a regularly updated red list (BLE 2013), and the German federal states decide which breeds to support in their region based on the national evaluation. Italy has a published national red list (MiPAAF 2007) and has also developed criteria for conservation schemes based not only on the threat of extinction for breeds, but also on the overall assessment of their current and future importance in economic, cultural, social and historical terms (MiPAAF 2013). In addition, the Italian regions that have implemented a specific law for agricultural biodiversity conservation usually also have a regional list of endangered breeds to be protected.

10.5 Protocols for measuring the indicators on the farm

Measurement is based on a check of the herd book or documentation and the declared head count (e.g. checking ear tags). Farmers must be members of the appropriate breed association, and register their animals in the corresponding breed book. In some schemes, payments are differentiated between breeding female animals, breeding males, and juveniles. The breeding females must have produced pure breed offspring at least once during the payment contract period, and the breeding males must be entered into certified breeding programmes annually. In other schemes, payments are made per livestock unit, with mature breeding cattle and horses counting as one unit, and immature cattle, ewes and lambs as partial units. Payments are sometimes differentiated according to breed, sometimes not.

10.6 Verification of indicators and controls for payment

Controls are based on the farmers' herd or breed books and the logbooks of the breed associations. The farmer is subject to control checks of his or her declared head count of breeding animals and of the herd or breed book, for example by comparison of animal ear tags with herd book entries. Breeding associations verify herd or breed books and monitor breed population numbers to judge whether the minimum viable population size is being maintained, and are in turn checked by the agricultural authorities. The national biodiversity coordination point monitors and collates information from the herd or breed books and coordinates and collates information from other research, for example on genetic diversity.

10.7 Advantages of the indicator and the measurement protocols

- Indicator is a direct measure of the conservation objective ie the maintenance of the breed.
- Indicator is simple if farmers are members of the breeding association, as the associations are responsible for the overall breed monitoring.
- Indicator is targeted at certain breeds identified as particularly threatened.

10.8 Limitations of the indicator and the measurement protocols

- Farmers can usually choose between a small range of breeds that qualify for support in each region, and this may not be a sufficient incentive to maintain the least popular breeds (ie the ones that are least economically attractive) unless payment rates are sufficiently differentiated between breeds.

10.9 Schemes using this indicator

Widespread across Europe.

References

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