Defining and applying the concept of Favourable Reference Values

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Technical Report for the Service contract No. 07.0202/2015/715107/SER/ENV.B.3 - "Defining and applying the concept of Favourable Reference Values for species and habitats under the EU Birds and Habitats Directives"

Contents

List of abbreviations

Member State codes

Austria	AT
Belgium	BE, BE-VLG (Flanders), BE-WAL (Wallonia)
Bulgaria	BG
Cyprus	CY
Czech Republic	CZ
Germany	DE
Denmark	DK
Estonia	EE
Spain	ES
Finland	FI
France	FR
Greece	GR
Croatia	HR
Hungary	HU
Ireland	IE
Italy	IT
Lithuania	LT
Luxembourg	LU
Latvia	LV
Malta	MT
Netherlands	NL
Poland	PL
Portugal	PT
Romania	RO
Sweden	SE
Slovenia	SI
Slovakia	SK
United Kingdom	UK

Other abbreviations

BD	Birds Directive
CS	Conservation status
CV	Current value. The value reported by the Member State for the present reporting period, which is to be compared to the favourable reference value
EC	European Commission
EEA	European Environment Agency
FCS	Favourable Conservation Status
FRA	Favourable reference area (for habitats only)
FRP	Favourable reference population (for species only)
FRR	Favourable reference range (for habitats and species)
FRV	Favourable reference value (specified as FRA, FRP or FRR)
HD	Habitats Directive
DV	Directive value. Population size, area or range of a species or habitat at a time as close as possible to the date when the Directive came into force
MS	Member State
MVP	Minimum Viable Population
PVA	Population Viability Analysis
SDM	Species Distribution Model

Preface

by EC/EEA

1 Introduction

1.1 Background

Conservation status (CS) is a key concept in European nature conservation laws and policy, because the aim of Habitats Directive is to restore or maintain a favourable conservation status (FCS) for all species and habitats included in the Annexes of the Habitats Directive (HD). In order to assess the conservation status under this Directive, it is necessary to determine favourable reference values (FRVs) for the range of habitat types and species (FRR), for area of habitat types (FRA) and for population size of species (FRP). FRVs are key reference levels to define in specific terms when FCS is being achieved for individual species and habitats. Similar concepts apply to the Birds Directive (BD) even though they are spelled out less clearly and different terms are used.

Despite the fact that FRVs are essential elements to determine the 'distance to target' (i.e. the distance to FCS), the latest reporting under Article 17 has shown that they are still poorly developed and often inconsistently applied across Member States (MS). This is considered problematic, as it could lead to very different interpretations as to the overall goal to be achieved under the nature directives. Until now, the FRV was a concept to be applied at the level of a biogeographical region within a Member State. However, for some species, it may be more relevant to set reference values at the geographical scale of a biogeographical region or even larger scale. These types of inconsistencies have also become increasingly obvious in the new bio-geographical process (Natura 2000 seminars), where Member State authorities have raised the need for streamlining and harmonisation of the concept behind assessing FCS, particularly establishing FRVs as a priority issue for the coming years.

In order to achieve a more coherent way to establish FRVs amongst MS and, where appropriate, develop such FRVs at the biogeographic level, the European Commission DG ENV issued a call for tenders for the service contract 'Defining and applying the concept of favourable reference values for species and habitats under the EU Birds and Habitats Directives' (ENV.B.3/SER/2015/0009). The BD does not use FRVs but requires Member States to take measures to maintain bird populations at a level which corresponds to their ecological, scientific and cultural requirements and to ensure sufficient extent and quality of habitat for all species of birds. According to the tender specifications the terms and definitions used under the HD should be used for birds as well.

The project closely cooperated with the Ad hoc group 'favourable reference values' of the Expert Group on Reporting under the Nature Directives, consisting of experts from Member States, the European Environment Agency (EEA), the European Topic Centre on Biological Diversity (ETC-BD), the Bern Convention, NGOs and the Commission.

1.2 Objectives

The three main objectives of the service contract are:

1. Support the development of methodologies and guidance on how to establish FRVs including testing of these methods;
2. Apply the resulting method (i.e. establishing FRVs) for a defined group of habitats and species;
3. Translate the biogeographic or population based FRVs by way of examples and guidelines to concrete measures and action on MS level.

The project must provide relevant input for the:

- EU review of the reporting procedures (in particular the ad-hoc group on FRVs) and thereby into the next reporting round under the nature directives (reports due by mid/end 2019);
- New biogeographic process (Natura 2000 seminars) providing concrete recommendations and examples on how to set and harmonise FRVs at local, regional, national and/or bio-geographical level across the EU.

1.3 The consortium

Organisation	Country	Representative	Role in the project
Wageningen Environmental Research	NL	Rienk-Jan Bijlsma John Janssen	Project manager (PM) and deputy PM; Experts terrestrial habitat types, flora
BirdLife International	UK	Iván Ramírez	Expert Birds Directive
Comunità Ambiente	IT	Emiliano Agrillo Fabio Attorre	Experts terrestrial habitat types
Deltares	NL	Ruurd Noordhuis	Expert Birds Directive and Water Framework Directive
Istituto di Ecologia Applicata (IEA)	IT	Michela Pacifici Carlo Rondinini Luigi Boitani	Experts terrestrial mammals
Radboud University Nijmegen	NL	Henk Siepel	Expert invertebrates
Sea Watch Foundation	UK	Peter Evans	Expert marine mammals
Sovon Dutch Centre for Field Ornithology	NL	André van Kleunen Marc van Roomen Ruud Foppen	Experts Birds Directive
Stichting BirdLife Europe	NL	Wouter Langhout Ariel Brunner	Experts Birds & Habitats Directive
Susan Gubbay	UK	Susan Gubbay	Expert marine environment and marine habitat types
Wageningen Marine Research	NL	Erwin Winter	Expert migratory fish

1.4 Structure of the project and reading guide

The objectives of the project have been reached through the following set of tasks:

Task	Activities
A	Review Member State approaches & literature: criteria, role of references, tools, data requirements
B	Develop options for harmonising: criteria and parameters to decide on assessment levels (national, EU-biogeographic, population); criteria and parameters to justify different methods within levels; define corresponding data requirements; proposal for assessment of levels and methods for different groups of species and habitat types
C	Support the ad-hoc group on FRVs: discuss and adjust proposal on levels and methods; contribute to the guidelines for next reporting round under the nature directives in 2019
D	Develop and discuss a FRV-sheet format
E	Test methods on biogeographic and population levels
F	Apply methods for selected species and habitat types (HD Annex I, II, IV; BD Annex I, II)
G	Translate and discuss FRV-sheets with respect to measures and action: consequences for planning and implementation of measures; consequences for reporting; links to the Natura 2000 network; links to conservation objectives on the site level

This Technical report presents the findings of the project under the service contract and provides elaborated methods and guidance which support the Explanatory Notes and Guidelines for Reporting under Article 17 of the Habitats Directive (period 2013–2018), in particular the sections on favourable refererence values (see http://cdr.eionet.europa.eu/help/habitats_art17/index_html).

Chapter 2 gives the review of Member State approaches for setting FRVs (task A) based on questionnaires filled by the MS. The questionnaire itself is included in Annex 1.

Chapter 3 presents the definitions of FRVs and summarizes literature and documented methods used for setting FRVs (task A).

Chapter 4 presents a general analysis of opinions and methods for setting FRVs (task A) and introduces a stepwise approach for setting FRVs at different spatial scales and for different kinds of populations and habitat types (task B). Further guidance is provided by tables en boxes (task D).

Chapter 5 elaborates on guidance for particular groups of species and habitats. Annex 2 presents lists of migratory species and/or species with large home ranges (task D, E and F).

A set of FRV sheets have been completed by experts of the consortium to serve as inspiring examples of how to apply the stepwise approach in setting FRVs (task F). The examples comprise habitat types and species groups (including birds) differing greatly in life histories, biological functioning and spatial requirements. The sheets are available from (accompanying report part 2?).

Chapter 6 explores the consequences of FRVs for the planning of measures within and outside the Natura 2000 network (task G).

Minutes from the meetings of the Ad hoc group (task C) can be found on the CIRCABC-website: https://circabc.europa.eu/faces/jsp/extension/wai/navigation/container.jsp.

2 Review of Member State approaches for setting FRVs

2.1 Introduction

Primary input to the project (task A, Review of Member State approaches) was provided by questionnaires filled by Member State representatives involved in Article 12 (Birds Directive) and Article 17 (Habitats Directive) reporting. The inquiry focused on methods for setting FRVs. The questionnaire format is given in Annex 1.

The response rate was high: 23 out of 27 Member States! Croatia was not addressed because of its recent EU membership and BG, PL, PT and RO didn't respond. Apart from insight in approaches used by Member States the filled questionnaires gave many valuable suggestions and references.

This chapter presents a review of the responses (§ 2.3) in the context of Article 17 reports on current values and reference values for HD features for the period 2007-2012 (§ 2.2). Specific methods used by MS in setting FRVs are given in § 2.4. The subsequent analysis of MS approaches is included in a broader synthesis of methods given in chapter 4.

2.2 Reporting context

The Article 17 reporting format and guidelines for the period 2007-2012[1] allowed reporting of FRVs as unknown ('x') or using operators (using the symbols ≈, >, >>) apart from providing real values in km^2 for FRR and FRA and number of individuals/agreed exceptions/other units for FRP. The questionnaires sent to the MS asked among others for criteria used to report FRVs as 'x' or with operators.

This paragraph shows how MS actually reported these categories, based on a documented database compiled by EEA from the Article 17 reports for the period 2007-2012[2]. This database was used to find out for how many habitats and species FRVs have been reported as 'x', by operators or real values (Figure 2.1). Table 2.1 explains the different categories used in this figure.

[1] https://circabc.europa.eu/faces/jsp/extension/wai/navigation/container.jsp. In this database (tables data_habitats_regions_MS_level and data_species_regions_MS_level) operators are given by the fields complementary_favourable_range_q, complementary_favourable_area_q and complementary_favourable_population_q and real values for FRVs by the corresponding fields complementary_favourable_range, complementary_favourable_area and complementary_favourable_population. Current values occur in the fields range_surface area, cover_surface_area and population_minimum_size.

[2] http://www.eea.europa.eu/data-and-maps/data/article-17-database-habitats-directive-92-43-eec-1

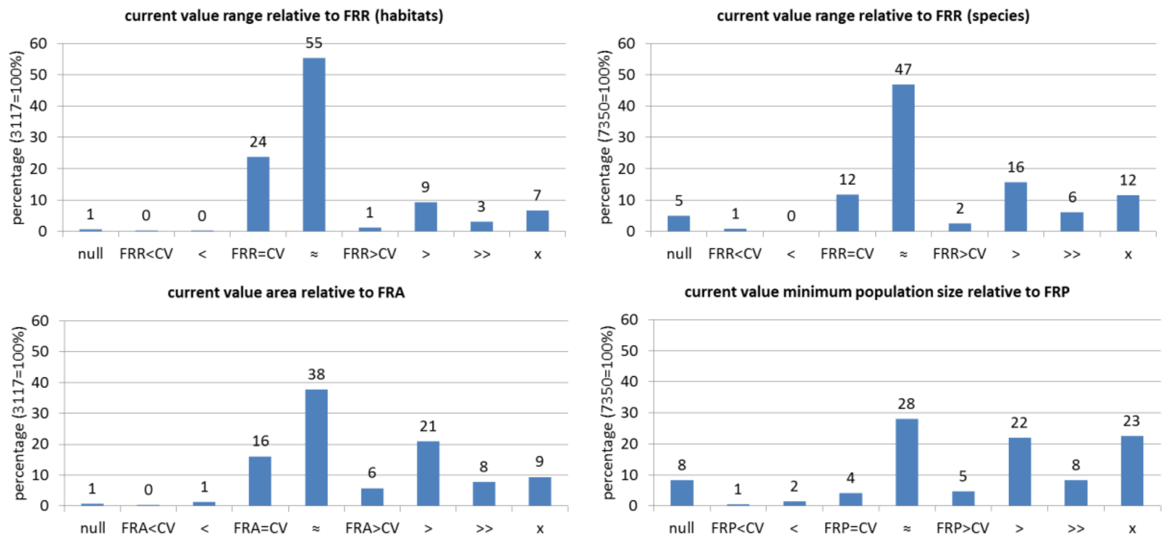


Figure 2.1. Categories of FRVs reported for habitats (3117 records in EU27) and species (7350 records). See Table 2.1 for explanation.

Table 2.1. Explanation of FRV-categories used in figure 2.1 as extracted from the database of Article 17 reports for the period 2007-2012. CV (current value) is the reported value for the range, area or minimum population size.

category	explanation
null	current value not reported and no operator reported
FRV<CV	real value for FRV < current value (only in exceptional cases) and no operator reported
<	< operator reported (idem)
FRV=CV	real value for FRV = current value and no operator reported
≈	≈ operator reported
FRV>CV	real value for FRV > current value and no operator reported
>	> operator reported
>>	>> operator reported
x	FRV reported as unknown

The figure shows that the current range is considered sufficient (FRR=CV or FRR ≈) for 80% and 60% of the reported habitats and species respectively. For area and population the corresponding figures are about 55% and 30%. Real values different from current values (mostly FRV>CV), are only reported for 1% (FRR habitats), 2% (FRR species), 6% (FRA) and 5% (FRP) of the habitats or species.

For the project, reported real values different from current values provide the most interesting information, because these values are the result of explicit considerations about reference values relative to current numbers and areas. Table 2.2 presents the number of habitats and species reported as real values.

Table 2.2. Number of habitats (nhab) and species (nspec) reported with real-valued FRA>CV and/or real-valued FRP>CV and as percentage of total numbers. Empty fields mean that MS didn't report values as indicated. MS not in this table didn't report this kind of real values.

country	tothab	nhab with FRA>CV	%hab	totspec	nspec with FRP>CV	%spec
BE	59	25	42	85		
BG	90	1	1	204	33	16
CY	43			56	3	5
DE	92	19	21	199	10	5
DK	60			83	5	6
EE	60			99	1	1
ES	117	5	4	425	17	4
FR	132			312	6	2
IE	58	10	17	69	8	12
IT	132			336	1	0
LT	54			99	1	1
LV	57	6	11	114	7	6
PL	81	5	6	187	5	3
SE	89	44	49	166	102	61
SK	66	1	2	195	8	4
UK	83	22	27	133	13	10

The table shows that only a few other Member States than SE assessed real-valued FRVs systematically. Apparently, species are more often assessed this way than habitats; BE is a notable exception.

2.3 Summary of Member State approaches

2.3.1 General aspects

Documented methodology for setting FRVs
The Article 17-reporting format includes entries to describe the methods used to set reference values and this information is available from the database compiled by EEA (see § 2.2). However, general considerations and methodology used to set FRVs have been documented by a few Member States only: BE, FR, NL and UK. Their approaches are summarized in chapter 3. Some MS didn't determine FRVs explicitly (DK, FI). Expert opinion is mentioned as the main basis for setting FRVs e.g. by ES, GR, HU, LT and SI, but in fact most if not all MS somehow included expert opinion in considering and weighting factors in setting FRVs (see § 2.3.2).

Using 'unknown' and operators
The Guidelines (Evans & Arvela, 2011: 21) state: *'The use of operators should help to reduce the use of 'unknown' to a minimum. Expert judgement will be required to determine if the operator should be '>' or '>>'. If the operator is '>>', the current value is very likely to be 'more than 10% below FRV and the parameter 'Unfavourable-Bad'.*

Most MS use 'unknown' as expected: in the case of lack of data, mostly actual distribution data but sometimes historical data. Particular situations or species groups include marine caves and several marine species (IE) and *Cladonia* spp./*Lycopodium* spp. of HD Annex V (NL, SE). Some MS use 'unknown' in case of occasional findings (EE) or new arrivals (BE-VLG, CZ, MT). Another reason for using 'unknown' is discussion about the occurrence or definition of a feature (AT).

The use of operators is far less harmonised and occurs in several unrelated cases:

1. As a result of expert opinion and sufficient confidence despite the lack of proper data. This is the situation envisaged in the Guidelines.
2. Several MS reported only operators (see Table 2.2). Reasons are uncertainty about methods for the assessment of real values and/or uncertainty about the interpretation and (political) consequences of real values. For species, BE-VLG uses general population ecological (genetic) rules which '*give a good indication whether or not the actual population has a FCS (= meets the FRP), but do not allow a quantitative approach to set a real value for FRP (or such values are subject to important scientific discussions)'*. NL didn't report population figures for common, widespread species occurring in 'the whole of the Netherlands'. Some MS consider the use of operators 'balanced', 'sufficient' or 'adequate' for the final assessment of CS (e.g. DK, GR).
3. Specific interpretations: '>' has been used for habitats with restoration potential (EE); '≈' for species and habitats confined in range due to physical constraints (MT).

Values when the HD came into force

A FRV must be at least the value (range, surface area, population size) when the HD came into force (Evans & Arvela, 2011). For FRR the spatial configuration must be included as well.

As stated implicitly or explicitly by several MS, this requirement is not very relevant for the process of setting FRVs. Some MS note that increased knowledge and better data resulted in adjusted (including smaller) FRV estimates in 2013 (GR, NL, UK). Some MS remark that exact values when the HD came into force are and will remain poorly known (AT, BE-VLG).

Feasibility

About half of the MS indicates that feasibility considerations have not been used in setting FRVs (AT, BE-VLG, CZ, DK, ES, FI, FR, GR, HU, IT, LV, SI, SK), whereas the other MS somehow included technical, social and/or financial aspects. It is noted that potential habitat can be irreversibly destroyed, e.g. by cities, land reclamations or closing of sea arms, resulting in technical constraints on restoration and that this kind of feasibility inevitably must be included in setting FRVs (NL, UK). Some MS emphasise that more guidance on feasibility is needed (BE-WAL, IT, LT).

Concerns about including or not feasibility aspects might be the result of uncertainty about the interpretation and consequences of FRVs. IE states: '*it is more important to demonstrate that efforts are being made to move towards an ecological/conservation target rather than setting a lower target for financial and social reasons'*.

2.3.2 Factors and methods

FRR and factors to be considered

The Guidelines mention the following factors which should be considered in setting a FRR (Evans & Arvela, 2011, III.a.i): 1 Current range; 2 Potential extent of range; 3 Historic range and causes of change; 4 Area required for viability of habitat type/species including consideration of connectivity and migration issues; 5 Variability including genetics.

Most MS (AT, BE-WAL, CZ, DE, EE, ES, FR, GR, HU, IE, IT, LT, LU, LV, MT, NL, SE, SI, SK, UK) consider both current and historical range. Potential extent (BE-VLG, BE-WAL, CZ, EE, ES, FR, GR, HU, IE, IT, LT, LU, LV, MT, NL, SE, UK) and area required for viability (BE-VLG, BE-WAL, CZ, EE, ES, FR, GR, IE, LT, MT, SE) are used less and variability only by DE, EE, ES, GR, IE, MT, SE. The latter factor was explicitly rephrased by DE as plant-sociological, altitudinal and regional variation based on natural landscape units. NL includes the requirement that FRP/FRA must be covered by the FRR.

Connectivity and viability issues emerge in the assessment of FRP as well and require more guidance in setting FRVs (see also the paragraph Connectivity aspects).

FRP and factors to be considered
The Guidelines mention the following factors which should be considered in setting a FRP (Evans & Arvela, 2011, III.a.ii): 1 Population should be sufficiently large to accommodate natural fluctuations and allow a healthy population structure ; 2 Potential range; 3 Historic distribution and abundances; 4 Biological and ecological conditions; 5 Migration routes and dispersal ways; 6 Gene flow or genetic variation including clines (slightly re-ordered to show correspondence with factors mentioned under FRR).

Historical distribution is used by most MS. Only BE-VLG, CY, DK and FI didn't use this factor. Next comes the requirement that populations must be sufficiently large (BE-F, BE-W, CZ, DE, EE, FR, HU, IE, IT, LU, MT, NL, SE, SI, SK, UK). Potential range (BE-WAL, CZ, EE, FR, GR, HU, IE, IT, LT, LU, LV, MT, NL, SE), Biological and ecological conditions (BE-VLG, BE-WAL, CZ, DE, EE, ES, FR, GR, HU, IE, IT, LT, LV, MT, NL, SE) and Migration routes and dispersal ways (BE-VLG, BE-WAL, CZ, DE, EE, FR, GR, IE, LT, LU, LV, MT, NL, SE) are used by 60-70% of the MS. Gene flow or genetic variation only by BE-VLG, EE, GR, IE implicitly, SE.

BE-WAL considers connectivity as well (number of linked populations, colonies, grid cells). Likewise NL includes considerations on current population size, the number of metapopulations needed and/or the population density for more common species (see also the paragraph Connectivity aspects).

FRA and factors to be considered
The Guidelines mention the following factors which should be considered in setting a FRA (Evans & Arvela, 2011, III.a.iii): 1 Actual distribution and actual variation (including quality of habitat); 2 Potential natural vegetation; 3 Historic distribution and causes of change; 4 Requirements of typical species (including gene flow); 5 Dynamics of the habitat type; 6 Natural variation (slightly re-ordered to show correspondence with factors mentioned under FRR).

The first three factors correspond to those already considered for setting the FRR. MS used these factors likewise in setting the FRA. 'Natural variation' for FRA resembles 'variability' for FRR and was used by about 40% of the MS (BE-VLG, BE-WAL, DE, EE, ES, FR, GR, IE, MT, NL, SE, UK) as was 'Dynamics of the habitat type' (BE-WAL, CZ, EE, ES, FR, GR, IE, LT habitat 7120 only, LV, MT, NL, SE, UK). 'Requirements of typical species' was far less used (DE, HU, IE implicitly, MT, NL, SE, UK) despite the primary importance of this factor apparent from the Guidelines. BE-VLG and NL considered the Red List status of typical species.

Connectivity aspects
The questionnaire asked *What method(s) did you use in the assessment of connectivity aspects of FRP and/or FRR?* More than 40% of the MS didn't use specific methods. Seven MS (BE-VLG, EE, ES, FR, LT, LU, MT) used GIS-analyses of habitat coverage in the landscape, and just a few (BE-VLG, EE, LU, SE) used direct or indirect genetic methods or dispersal studies. Expert opinion is mentioned as well. SE notes that connectivity is related to both the area and quality of the habitat (barriers to dispersal). In fact, this dual role of connectivity, 1) as factor to be considered in setting FRVs and 2) to be assessed as a component of the CS parameter Structure & functions or Habitat for the species, is implied in the Guidelines as well (see above, FRA and factors to be considered).

Whether, at which level (FRR or FRA/FRP) and how connectivity aspects are relevant in setting FRVs need more guidance, including the marine environment where connectivity is even less understood than on land.

Use of historical references
Although historical range and distribution have been used as important factors in setting FRVs by a majority of MS (see above), specific historical references have much less been considered. Some MS use more or less fixed reference years or periods: BE-VLG, BE-WAL, EE, ES, FR, LT, LU, NL (habitat types), SE, SI (mostly) and SK. DE uses fixed reference values with Red Lists as orientation. Specific references, such as a period when a feature was supposed to have FCS, are used (as well) by BE-VLG (only for birds), CZ, EE, ES, GR, IE, IT, LU, MT, NL (some habitat types and species) and SE. Five MS indicate that they didn't use historical references: DK (species), FI, HU, LV, UK.

Some countries (BE-WAL, IE, NL) elaborate on the decision rules used. Several MS included questions or suggestions on the use of references in general and more particular on reference periods. Clearly these aspects need more guidance.

Use of trend data

The use of trend data for setting FRVs is highly diverse across Member States. AT, CZ, DE, DK (HD-species), ES, FI, LT, LV, MT, SI and SK didn't use trend data. BE-WAL only for bats, BE-VLG only for species with large dispersal rates and DK only for habitats; EE, FR, GR, HU, IT, LU, NL, SE and UK for habitats and HD-species while EE, GR and LU mention birds as well.

Use of estimates of MVP

The questionnaire asked *Did you use or include estimates of minimum viable population size?* The following MS didn't use MVPs: AT, CZ, DE, DK, EE, FI, HU, IT, LT, SE (not for the reporting), SI and SK. For DK this is remarkable considering Box 3.4 in McConville & Tucker (2015) devoted to the use of MVPs by Denmark. BE-VLG, GR, LU, LV and NL use MVP-values from literature. Some MS applied specific analyses: CY (PVA: birds), ES (handful of species), GR, LU, MT (special cases e.g. *Aphanius fasciatus*), LV and UK (special cases, e.g. Fisher's estuarine moth).

Differentiation in methods

BE-VLG, CZ (for groups of species/habitats), DE, EE, FR, LU, LV, SK and UK performed standardized approaches in setting FRVs for species and habitats; NL only for terrestrial habitats. GR and IT used different approaches depending on the taxonomic group.

Other species-related contrasts resulting in different methods are: marine vs. terrestrial (IE, LT, MT, NL), annex V vs. other annexes (BE-VLG), migratory vs. non-migratory species (BE-VLG, LT, NL), colonial vs. non-colonial birds (CY), common widespread vs. other species (NL) and population units, e.g. individuals vs. tree trunks (SE).

Data-driven differentiation results from differences in monitoring programmes e.g. dune habitats, saltmarsh, upland etc. (IE, SE), data quality (SE, SI) and availability of historical data (MT).

2.3.3 Spatial scale

FRVs for mobile species

The questionnaire asked *How did you assess references values for mobile species with dynamic ranges crossing national boundaries or going beyond EU territories?*

This species group was not considered explicitly by AT (but lynx in discussion), CY (island situation), CZ (despite cross border exchange), DK, ES, FI, FR, HU, LT (mostly reported as unknown), MT (island situation; most marine species reported as unknown) and SK. Although there may be movement of several terrestrial fauna across the border with Northern Ireland, IE considers it unlikely that the conservation status of most of these species are impacted by activities outside Ireland.

BE-WAL, EE, LU and SI (taking into account adjacent countries) did assess mobile species explicitly using expert opinion. GR considers only bird species with dynamic ranges crossing national boundaries as mobile; in setting FRVs the conservation status at the national and European level are taken into account. SE sets FRVs for large carnivores based on data in neighbouring countries. For mobile species DE assumes that an appropriate minimum share of the population must be present/maintained and that migration routes must be kept viable (e.g. fish migration) irrespective of the location of the reproduction/spawning sites. For some marine species, UK utilised data from large-scale international population surveys, cut to UK boundaries.

BE-VLG applies generalised genetic rules for mobile species: '*For mobile species with more widespread migration patterns, the real meta population could occur within a region much larger than FLanders. In these cases it is not always possible to reach the FRP in Flanders alone; if there are less than 5,000 individuals within Flanders, and the population is not decreasing, then it can still be considered in FCS. This system was used for several of the bat species*' (from McConville & Tucker, 2015). The whole of

Flanders is considered as FRR for mobile widespread species. For migratory fish, NL calculated a FRP based on estimates of how many fish should reach the spawning sites (outside the country) taking mortality rates into account; for bats, only wintering in the Netherlands, FRVs are based on the wintering populations only; for cross border populations of *Euplagia quadripunctata* NL calculated its national FRV assuming that the neglected part of the population also would contribute to the survival of the species (compare assumptions used by DE above); for common widespread species NL assesses the FRR as the whole country and FRP as ≈ (operator).

Features requiring reference values above MS-level
The tender specifications for the Service contract acknowledge that '*for some habitats and species FRVs might best be set on national (-biogeographic) level, for others the level of the EU-biogeographic region might be more appropriate and again for others (e.g. large carnivores) the population level might be considered the most relevant one to set FRVs'*.

The filled questionnaires suggest reference values above MS level for large carnivores, seals, marine migratory species (sea turtles, some cetaceans), migratory fish, migratory bats and large birds (of prey) with large home ranges. Apart from considerations about individual behaviour, methods above the MS level are motivated to avoid double counting and to recognise all parts of a species life cycle (IE).

Small countries (BE, LU, NL) note that many species and habitats inherently show relevant trans-boundary dynamics but don't suggest FRVs above MS level in this case (see also FRVs for mobile species, above).

Population-based FRVs are suggested for small, isolated populations by FR (for species occurring in one biogeographic region), GR (e.g. *Vipera ursinii*), HU, and IT and in principle for all HD-species with small dispersal capacity (e.g. amphibians) by BE-VGL.

SE proposes to reconsider the calculation of FRVs for biogeographic regions within Member States (a point raised by BE-WAL as well):

- A FRV should be calculated for a biogeographic region part of the MS for 1) species with regionally important populations, 2) species or habitats with regionally differentiated management or 3) when threats and pressures are different between different biogeographic regions.
- One FRV for the entire MS (covering several biogeographic regions) is appropriate for species which are migrating throughout the MS and between the regions, and where a separation of sub-populations is not meaningful. This can also apply to habitats where conditions in the previous point are not met.

For habitats, the questionnaires present no arguments for considering trans-boundary FRVs, except (BE-WAL) when a habitat is supposed to host very mobile species or if a habitat has a small, trans-boundary distribution. Examples for these cases are not given. BE-WAL further notes that '*a huge issue is the lack of homogeneity for habitats definitions, between MS or between regions. Even for forest habitats or heaths, the definition may be very different from one MS to another*'.

2.4 Documented approaches by Member States

McConville & Tucker (2015) already reviewed practices and underpinning assumptions used by Member States in interpreting FCS and setting FRVs, in particular with regards to widespread species with extensive populations outside Natura 2000-sites.

This paragraph summarizes explicitly documented approaches for setting FRVs by Member States. Table 2.3 provides references to this documentation (extracted from the MS questionnaires).

Table 2.3. References to documentation on defining and setting FRVs by Member States.

MS	Reference	Link
BE-VLG	Louette et al. (2011)	DOI: 10.1016/j.jnc.2011.02.001
	Louette et al. (2013)	www.inbo.be/nl/publicatie/staat-van-instandhouding-status-en-trends-habitattypen-en-soorten-van-de-habit
FR	Bensettiti et al. (2012)	spn.mnhn.fr/spn_rapports/archivage_rapports/2012/SPN%202012%20-%2027%20-%20Guide_methodologique_EVAL_V1_fev-2012.pdf
NL	species: Ottburg & Van Swaay (2014)	library.wur.nl/WebQuery/wurpubs/fulltext/359115
	habitats: Bijlsma et al. (2014)	library.wur.nl/WebQuery/wurpubs/fulltext/342755
UK	JNCC (2007)	jncc.defra.gov.uk/PDF/FCS2007_ukapproach.pdf

2.4.1 Belgium - Flanders

Louette et al. (2011) describe the stepwise approach used by Flanders to derive its conservation objectives. The first step is the assessment of the current conservation status at the regional level (i.e. both within and outside the SCIs) based on the HD-parameters range, area/population, specific structures & functions of habitats/quantity and quality of the habitat of species, and future prospects. Secondly, reference conditions that mirror a favourable conservation are drawn from knowledge of the current conservation status, as well as indicative, but not yet allocated nature development potentials in the landscape. Setting up reference conditions is furthermore supported by historical and actual distribution and abundance data of habitats and species, ecological signatures of habitats and species, complemented with expert judgment. These reference conditions were further fine-tuned with socio-economical considerations, via a participation process with stakeholders. Louette et al. (2013) describe the setting of FRVs in more detail.

FRR for habitats were set by adding critically evaluated historical locations to the current distribution; for some habitats locations of site-specific, future conservation targets were added as well. Likewise, FRA includes current area and the area corresponding to decided future targets at the site level.

FRR for species was often taken as the area when the HD came into force (1994) or to correspond to federal conservation objectives. FRPs were mainly based on generalised genetic rules provided by Mergeay (2012) who recommends a minimum effective population size N_e = 500 corresponding to a census population of at least 5000 adult individuals, possibly distributed outside Flanders and across several metapopulations. For the conservation of one metapopulation, the objective is to conserve 95% of the genetic diversity in 100 year, with required population numbers given by Mergeay (2012). Apart from these recommendations, FRPs resulted from site-specific objectives for isolated populations near range limits as well.

2.4.2 France

Bensettiti et al. (2012) discuss the approaches for setting FRVs, explored and applied by France. As a general strategy, information from species or habitat specific survival and viability studies is preferred over historical data.

In setting FRR (ARF) for species and habitats a minimum value of 100 km^2 is assumed, corresponding to the threshold of IUCN Criterion D Vulnerable (Rodriquez et al., 2011). Historical data are used to estimate a sufficiently large potential range.

In the absence of complete demographic and abundance data, several alternatives for setting FRP (PRF) are considered, based on Sanderson (2006), often including a historical approach.Reported FRPs can be the sum of FRPs for individual, more or less isolated populations. The use of a single, universal minimum population size, e.g. derived from Traill et al. (2007), is considered not satisfactory.
FRA (SRF) is considered the most difficult FRV to estimate. Different approaches are used depending on the extent of the habitat. For localised habitats mainly determined by physical conditions, such as

caves, spring areas, bogs and lakes, the area of occurrence of the particular conditions is used as FRA, generally corresponding to the actual area, and sometimes adjusted using historical data from the period 1950-60, e.g. for bogs. For widespread habitats, the FRA depends on the natural variation judged from the number of defining phytosociological associations. In this case they suggest a FRA of 2000 x the number of associations, based on the threshold of 2000 km^2 for the area of occupancy corresponding to IUCN Criterion C Vulnerable, as given by Rodriquez et al. (2011). In any case, values can be adjusted by expert judgement. For (unspecified) special cases they suggest to derive the FRA from the FRPs of key species of the habitat.

2.4.3 Netherlands

The process of setting FRVs for species in the Netherlands has been reported by Ottburg & Van Swaay (2014). First, the FRP was determined, based on the minimum number of adult individuals necessary to ensure the long-term survival of the species. This was achieved by applying the MVP-concept, based on Traill et al. (2007), and by taking risk spreading into account. The latter consideration generally required several viable population core areas, i.e. with their own reference values, distributed over the (historical) range. Secondly, the FRR was determined, derived from the actual distribution and the requirement to encompass the FRP.

Bijlsma et al. (2014) derived FRVs for habitats in the Netherlands. Again, first the FRA was set using a stepwise approach based on (1) area trends relative to the historical surface area (i.e. stable or increasing, <1% decrease, >1% decrease), (2) current structure and function (in three classes) and (3) current Red-List status of typical species and the threat to qualifying vegetation types (in two classes). The reference year for the historical surface area is usually 1950, the year that is also used for Red Lists. For habitat types with a negative trend, this approach results in an expansion requirement for current area, expressed as a percentage of the 'area lost', i.e. the historical area minus the current area. Appendices of the report present estimates of the historical surface areas of heaths, drift sands, raised bogs and a few grassland types in the Netherlands around 1950. Secondly, setting the FRR involved assessing whether there was a negative trend and whether the historical geographic diversity and required spatial connectivity in distribution were accounted for.

2.4.4 United Kingdom

The methodology used by the UK in setting FRVs is documented by the Joint Nature Conservation Committee (JNCC, 2007). The documentation clearly describes how the general instructions for setting FRVs in the Guidelines were interpreted and structured into practical approaches with inherent shortcomings and uncertainties. This description probably applies to the approach of many Member States and therefore is reproduced here for the case of setting FRRs for habitats: '*The EC Guidance did not provide a definitive method by which viability of habitat range could be assessed, e.g. by specifying metrics and the thresholds for judgements. Nor was there a widely accepted 'off the shelf' method that could be applied. To overcome this problem, some key factors and questions were identified to take into account in determining viability. These factors were not necessarily exclusive, nor did they absolutely prove or disprove viability. They were used to give a reasonable indication of viability, based on expert judgement as to the significance of particular factors and the general weight of evidence. The approach relied on expert opinion, trends and general knowledge*'.

In setting FRRs for species, '*1994 was used as a preliminary baseline. Where 1994 data were not available the nearest, most recent alternative was considered. No presumptions have been made as to whether range was favourable or not at that time, but consideration was given to whether the range was sufficiently large to support a long-term viable population of the species. In the absence of detailed modelling, defining favourable reference values at a UK level has been problematic. To help overcome this, current trend data were used as an indicator and have been transposed into a decision tree to assist in setting favourable reference range values'*.

In setting FRPs '*due to time and resource constraints, population viability analyses were not carried out. Instead, current trend data were used as an indicator for determining viability and,* as for FRR, *transposed into a decision tree. Long-term has been interpreted by the UK as 12 -15 years or three generations (whichever is longer)'.*

Applying the concept of viability to habitats was considered problematic. In setting FRRs for habitats '*the approach relied on expert opinion, trends and general knowledge. In most cases this approach did not precisely define the FRR, but it did help to clarify if the current range was more or less than 10% below the FRR, i.e. if the range should be judged as inadequate or bad*'. '*Two main factors were considered: (i) the total range area; and (ii) how fragmented the range appeared to be (by way of the number and size of each range block, and how well each block was filled). The view taken was that habitats which covered a large part of the UK, or which had a relatively compact range were generally more likely to be viable. Habitats that had only a limited range or which had a fragmented range were less likely to be viable. A number of other factors were also considered. A recent decline in range triggered some concern, especially if the decline had been rapid (>1% per annum) and extensive. Allowance was made for habitats that are naturally scarce or have been scarce for many centuries, i.e. their current scarcity was not necessarily taken as a cause for concern*'.

In setting FRAs two main factors were considered. '*Firstly, total habitat area. As a crude guide, habitats covering less than about 3,000 ha were taken as 'scarce' and therefore at possible 'risk'. The second main factor was the area of individual habitat patches. The view taken was that larger patches of habitats are generally more likely to be viable than smaller ones and provide some interior conditions'.* Regarding habitat loss and fragmentation '*it was judged that fragmentation and isolation were unlikely to lead to a conclusion that the current habitat area need to be increased by more than 10% to ensure viability, i.e. the current area was not more than 10% below the favourable reference area*'. This conclusion results from the consideration that '*fragmentation and isolation are most likely to result in impoverishment (rather than actual habitat loss). They can be remedied (at least in part) without increasing the actual habitat area (but by way of buffer zones, which could be of another habitat, or improving agricultural practices)'*.

3 Definitions and concepts for setting FRVs

3.1 Definitions

3.1.1 Conservation status and Degree of conservation

The Habitats Directive (article 1i) considers the conservation status of a species as 'favourable' when:

- population dynamic data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and
- the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and
- there is, and will probably continue to be, a sufficiently large habitat.

Likewise (HD article 1e), the conservation status of a natural habitat will be taken as 'favourable' when

- its natural range and areas it covers within that range are stable or increasing, and
- the specific structure and functions which are necessary for its long-term maintenance exist and are likely to continue to exist for the foreseeable future, and
- the conservation status of its typical species is favourable as defined in (i).

Regarding the concept of typical species, the Guidelines (Evans & Arvela, 2011: IV.c.iii) state: '*Although the Directive uses the term 'typical species' it does not give a definition, either for use in reporting or for use in impact assessments. As it would be a considerable increase in the necessary work to undertake an assessment of the conservation status of each typical species using the methodology used for species of Annexes II, IV & V, the assessment of typical species is included as part of the assessment of the structure & function parameter'.*

In the context of the Habitats Directive, the concept of Conservation Status relates to the national/regional scale only. At the site level the concept of Degree of conservation is used (Table 3.1).

Table 3.1. The importance of scale for instruments, assessments and objectives related to Conservation Status and Degree of conservation[3].

	National/Regional level (e.g. Atlantic France)	Site level (SAC, SPA)
Instruments	General targets derived from the national implementation of the Directive	Management plans with prescriptions of measures possibly with precise and spatially explicit targets (e.g. increase area by 10 ha)
Assessments	Art 17 report: Conservation Status parameters range, population/area, habitat/structure & function, future prospects, aimed at favourable (FV) status	Standard Data Form: Representativity and Degree of conservation, aimed at excellent (A) performance
Objectives	Top down	Bottom up

The Birds Directive requires that Member States shall take the requisite measures to maintain the population of the species (referred to in BD Article 2) at a level which corresponds in particular to ecological, scientific and cultural requirements, while taking account of economic and recreational requirements, or to adapt the population of these species to that level. Article 3 also includes the equivalent of the concept of favourable reference value for range ('*area and diversity of habitat*'), with diversity understood in the geographical extent. In defining and applying FRVs the terms and definitions used under the HD should be used for birds as well (see Preface of this report).

[3] Based on a presentation by Doug Evans (ETC-BD) at the Natura 2000 Atlantic Seminar, October 2016, Ireland.

3.1.2 Favourable reference values

Favourable reference values consider the long-term viability of a species or habitat in their natural range including ecological variations. Definition are given in Table 3.2.

Table 3.2. Definitions of favourable reference values by the Habitats Committee in 2004 (European Commission, 2005).

FRV	Definition
FRR	Range within which all significant ecological variations of the habitat/species are included for a given biogeographical region and which is sufficiently large to allow the long term survival of the habitat/species; favourable reference value must be at least the range (in size and configuration) when the Directive came into force.
FRP	Population in a given biogeographical region considered the minimum necessary to ensure the long-term viability of the species; favourable reference value must be at least the size of the population when the Directive came into force.
FRA	Total surface area of habitat in a given biogeographical region considered the minimum necessary to ensure the long-term viability of the habitat type; this should include necessary areas for restoration or development for those habitat types for which the present coverage is not sufficient to ensure long-term viability; favourable reference value must be at least the surface area when the Directive came into force.

The functional unit that responds to environmental changes and human pressures is the population for species and the vegetation (or corresponding ‘stand’ in marine environments) and its corresponding species composition, typical species, structure and processes for habitats. In setting FRP and FRA, requirements on the viability of a species/habitat type in its natural range will result in constraints on densities/numbers/areas and on spatial aspects such as exchange, connectivity, (meta)population structure, risk spreading and restoration of ecological variations within the natural range.

This means that data on the spatial configuration of populations and habitats (spatial distribution) will be necessary to set FRP and FRA.

Next, given the dependence of setting FRP and FRA on spatial distribution and configuration, setting FRP/FRA and FRR are interdependent and asks for an iterative process such that the FRR includes the extra distribution required for restoring the FRP/FRA in the natural range of the species/habitat. The FRR acts as a distributional envelope for FRP and FRA, determined by the range tool for a given distribution.

3.1.3 Current and directive value, short and long term, recent and historical past

The term 'current value' (CV) is the value for range, population size or area covered by habitat reported by the Member State for the present reporting period, which is to be compared to the favourable reference value as part of the assessment of conservation status.

A favourable reference value must be at least the value when the Directive came into force (see Table 3.2) for which in this report we use the term 'directive value' (DV), defined as the population size, area or range of a species or habitat at a time as close as possible to the date when the Directive (Birds or Habitats) came into force.

In reporting, short term has been defined as 12 year (two reporting periods) and long term as at least 24 year (four reporting periods). In using historical information for setting FRVs, we need a broader perspective and consider the recent past, i.e. the last 50 years before the relevant Directive came into force, and the historical past, i.e. up to the last two or three centuries, depending on occurrences of major (irreversible) impacts on distribution, population size and area.

3.1.4 Other terms and aspects of scale

The HD articles which define a FCS for species and habitats use terms and phrases which in their turn need definitions and guidance, such as 'long-term basis' and 'viable'. Clearly, defining FRVs will depend on the interpretation of these terms and we include literature on this subject in § 3.2.

Another important aspect in defining FRVs is selecting an appropriate spatial scale for the assessment of the conservation status of features. However, this is much less discussed because until now all FRVs have been defined at the biogeographic level within Member States. The concepts of spatial management unit (or assessment unit) and flyway population are included in the literature review but a more detailed view on spatial aspects is presented in chapter 4.

3.2 Literature review of relevant concepts

3.2.1 Understanding FCS

Epstein et al. (2015) presented a comprehensive discussion of legal-ecological aspects of Favourable Conservation Status (FCS). They discuss (1) whether FCS should be measured at the species, population or national level, (2) what it means for a species to be a 'viable component of its natural habitat', (3) how long is a 'long-term basis', (4) what it means for a species to 'maintain itself', (5) whether FCS should be measured from extinction or carrying capacity, and (6) whether FCS requires that a population approaches historical levels. Although of course they don't give definite answers, their summary of discussions on these subjects is thought provoking. For example, the last point on historical levels highlights an important difference between the Bonn Convention and the Habitats Directive. The former includes the criterion: '*the distribution and abundance of the migratory species approach historic coverage and levels to the extent that potentially suitable ecosystems exist and to the extent consistent with wise wildlife management*'. The HD didn't incorporate this criterion. Epstein et al. conclude on this point: '*Although the use of historical distribution and potential range in determining FCS is recommended by both the 2006 and 2011 Article 17 Reporting Guidelines, it would seem to be a good management practice but not legally required that species populations approach historical levels and utilize potential habitat*'.

The interpretation of species 'to maintain itself' is elaborated by many authors in a broader context of conservation planning and management. Redford et al. (2011) express their concern that '*the avoidance of extinction has in certain quarters become synonymous with successful species conservation'*. They present and discuss six 'attributes' of species conservation: demographically and ecologically self sustaining, genetically robust, healthy populations, representative populations, replicate populations and resilience across a range. Likewise, Wolf et al. (2015) discuss '*Why recovery under the* [US] *Endangered Species Act is more than population viability*'.

3.2.2 Population viability analysis (PVA)

PVA is a quantitative model-based method that uses genetic, demographic and abundance data of species and incorporates identifiable threats to population survival to estimate the probability of extinction and/or loss of genetic variation (Beissinger & McCullough, 2002). PVA uses models of population dynamics which incorporate causes of fluctuations in population size in order to predict probabilities of extinction and maintenance of genetic variation, and to help identify the processes which contribute to a population's vulnerability. Which of the various deterministic and stochastic factors are important to consider in a PVA will depend on the species biology, the present population size and distribution, and the threats a population faces. Several software packages perform PVA, such as Vortex (www.vortex10.org/Vortex10.aspx).

Linnell et al. (2008) discuss the use of PVA in the context of management plans for large carnivores and explicitly include its relationship with defining FRPs. They '*strongly recommend that FRP be defined at significantly higher levels than the minimum levels predicted by a PVA. This recommendation is based both on the best available science and on the intention of the Habitats Directive as clarified in (1) the various guidance documents that underline that FCS is intended to* *represent a positive goal, not just a minimum, (2) that true long term consideration requires attention to genetic issues, and (3) the Directive's statement that species should be viable components of their habitat, which implies some degree of ecological functionality'.*

PVA requires a lot of biological data which are not only species specific but necessarily site specific as well. Radchuk et al. (2016) conclude that '*for threatened and poorly-known species, there is no short-cut when developing models: investments to collect appropriately detailed data are required to ensure PVA models can assess extinction risk under complex environmental conditions'*. Linnel et al (2008) note that many PVAs, instead of field data, use a range of 'reasonable values', or values taken from other study sites or from captive animals. Despite these objections and its demanding nature, PVA is an important tool in exploring and planning population management including setting FRVs when data are available or can be obtained.

Some recent examples of applied PVA are available for Scandinavian wolf, bear, lynx and wolverine (Nilsson, 2013; Bruford, 2015; Puranen-Li et al., 2014). Brambilla et al. (2011) provided FRPs based on PVA for populations of Italian breeding birds with less than 2,500 pairs. For species with more than 2,500 pairs and a wide, more or less continuous range, the FRP was expressed in terms of breeding density at different spatial scales for non-colonial species. Out of the 88 species considered, they were able to formulate PVA-based FRPs for 47 populations belonging to 21 species, and breeding density for 15 further species. This approach was modified by Tye et al. (2014).

The use of PVA in plant conservation is reviewed by Harrison & Ray (2000), Brigham & Schwarz (2003) and Zeigler (2013). The relative importance of genetic factors in driving extinction of plant species is discussed by Kim et al. (2015).

3.2.3 Minimum viable population (MVP) and generalised genetic rules

'*The idea of a MVP has its foundation in efforts to capture, in population viability analyses (PVA), the many and interacting determinants of extinction risk. In this original context, MVP is defined as the smallest number of individuals required for a population to persist in its natural environment. The likelihood of success is measured on a probability scale (0–1), and projections into the future can be scaled to years or generations*' (Traill et al., 2010).

MVPs estimated through PVA depend on population growth rate and therefore not only on the species' life-history characteristics but on environmental conditions as well (e.g., habitat, resources and external pressures). Hence, these PVA-based MVPs have a short temporal validity and are context dependent (Hilbers et al., 2016).

Generalised genetic rules, derived from population genetic analyses and PVA, recommend general thresholds for viable population sizes. A much used and debated generalisation is the '50/500-rule' which states that an effective population size $N_e > 50$ is sufficient to prevent inbreeding depression in naturally outbreeding species in the short term ('demographic MVP') , and $N_e > 500$ to retain evolutionary potential ('genetic MVP'). Frankham et al. (2014) give a recent review on this subject, including discussion on how N_e-thresholds relate to census population sizes N and MVPs. Palstra & Fraser (2012) and Wang et al. (2016) discuss the N_e/N-relationship in more detail. The observed ratio N_e/N has been found to be about 10–20% on average in meta-analyses across many species and populations. However, this average N_e/N ratio may be an overestimate, as marine species are under-represented in these analyses and can have extremely low N_e/N ratios (Wang et al., 2016). As noted by Brook et al. (2011) the genetic arguments alone are sufficient to embrace MVP generalisations, because there is substantial evidence that inbreeding does indeed matter profoundly for extinction risk.

MVP size refers to the number of individuals required for a high probability of population persistence in the long term. Based on the meta-analysis by Traill et al. (2007), the MVP for 99% persistence for 40 generations for a typical outbreeding species is of the order of several thousand (N) (Frankham et al., 2014: 6.3).

Frankham et al. (2014) further present revised recommendations including a '100/1000-rule' and thresholds for population size used by the IUCN red List criterion C: Critically Endangered <500, Endangered < 5000 and Vulnerable < 20,000 (instead of 250, 2500 and 10,000).

Generalised genetic rules have been applied in setting FRPs e.g. by BE-VLG and NL (see § 2.4) and further analysed e.g. by Laikre et al. (2016) for the Fennoscandian wolf.

3.2.4 MVP-targets derived from body size relationships

Hilbers et al. (2016) present an approach to estimate MVP targets which differs from the PVA-based method in being context independent i.e. based only on intrinsic characteristics of the species. Furthermore, these targets differ from fixed nonspecific targets ('generalised rules', see previous paragraph) in being tailored to a species' biology. They found that body mass is a good predictor of a number of life-history traits related to survival, reproduction and spatial behaviour. The influence of environmental stochastic effects on animal populations is related to body mass as well, with larger species being less susceptible to fluctuations in environmental conditions. Given that animal demographic rates and their susceptibility to environmental stochasticity depend on body size, it can be expected that MVP targets are, at least partly, dependent on body size too. These targets have been derived for a range of body masses of mammals, from 2 g to 3825 kg, by using allometric relationships for intrinsic growth rate and stochastic effects in models of population dynamics (for more guidance see § 4.2.2 FRP assessment).

3.2.5 Potential range and distribution modelling

Information on the potential range of a species or habitat can be used to constrain the reference range and the area and population size within this range. Several sophisticated approaches are available to estimate the potential range of species and habitats, based on statistical relationships between distribution and physical, climatological and other conditions. Species distribution models (SDMs) now include former niche models and habitat suitability models and are used to understand the relationship between a species and its (a)biotic environment and to predict the occurrence of a species for locations where survey data are lacking (Franklin, 2010).

Most studies rely on a few methods (MAXENT, Generalized Additive Methods, Boosted Regression Trees; see Franklin, 2010) which model distribution patterns using presence-absence, presence-only or relative abundance data. Methodological issues concerning these models are much debated (e.g. Yackulic & Ginsberg, 2016). False absences (detection bias) reduce the predictive accuracy of conventional SDMs. (Dynamic) occupancy modelling is used to avoid this bias (e.g. Comte & Grenouillet, 2013).

Di Marco et al. (2016) use habitat suitability models to scale up population targets to the species level including conditions reflecting species persistence (number, size, location of the populations to be protected), uniqueness (e.g. evolutionary potential) and representativeness (e.g. presence in different ecosystems).

3.2.6 Spatially structured populations: management units (assessment units) and flyway populations

In defining appropriate spatial scales for FRVs, sometimes a species range needs to be spatially stratified within or across Member States, based on ecological criteria. The concept of management unit is important in this respect. Management units (MUs) are functionally independent population segments i.e. exhibit distinct demographic processes and show reduced exchange (migration/dispersal) rates over a few generations. MUs can be characterized by genetic markers, life history parameters, distribution, behaviour, movements (i.e. connectivity) and morphology, and are appropriate short-term targets for conservation. The concept is used in conservation management (e.g. Olea et al., 2014) but especially well-developed for migratory or otherwise mobile, marine species such as turtles, cetaceans and seals (Palsbøll et al., 2007; Evans & Teilmann, 2009; Wallace et al., 2010; Olsen et al., 2014; Sveegaard et al., 2015). Managers commonly use the term 'assessment unit' as equivalent to management unit.

Another important spatial stratification of populations results from the flyway approach, well-developed for migratory birds. A flyway encompasses the entire range of a migratory population, including the breeding and non-breeding areas and the resting and feeding sites in between, as well as the area within which a bird migrates. The flyway approach to conservation requires that all key sites along a flyway are in good condition and are able to carry out their functional role in the migratory cycle (Dodman & Boere, 2010). In fact, the Habitats Directive requires the same for the range of migratory species[4] and therefore the flyway approach is not only relevant for birds but e.g. for migratory fish and bats as well. The stepwise approach for setting FRVs for species (§ 4.2) explicitly deals with FRVs for non-reproductive 'populations' occurring in wintering or passing areas.

[4] See Chapter 5 (Range) in: Reporting under Article 17 of the Habitats Directive. Explanatory Notes and Guidelines for the period 2013–2018.

4 Setting FRVs

This chapter presents the considerations and building blocks used to construct the general approach for setting FRVs as given in the Explanatory Notes and Guidelines for the period 2013–2018. The approach is based on the MS questionnaires (chapter 2), an overview of literature and methods (chapter 3) and opinions and reviews by the authors of this report as well as discussions with the Ad hoc group on FRVs.

4.1 General considerations

4.1.1 Guidance on the interpretation of FRVs and feasibility aspects

'*Establishing favourable reference values must be distinguished from establishing concrete **targets**: setting targets would mean the translation of such reference values into operational, practical and feasible short-, middle- & long-term targets/milestones. This obviously would not only involve technical questions but be related to resources and other factors'* (EC, 2005).

This clearly stated relationship between FRVs and conservation targets can be summarized as follows[5]:

- FRV = ecologically determined threshold value for the assessment of a FCS;
- FRV = amount/number required for a viable conservation of the habitat type/species;
- FRV ≥ value when the HD came into force;
- FRV > minimum viable population (MVP);
- FRV ≠ national target (see above), but may be chosen as such;
- FRV ≠ accountable; it is possible to deviate from a FCS with good arguments;
- FRV ≠ linked to a fixed reference year (unless year when the Directive came into force);
- FRV ≠ historical value which can however be used as inspiration;
- FRV ≠ potential value which can however be used to understand restoration possibilities and constraints.

The presented stepwise approach for setting FRVs (see § 4.1.4) starts by selecting an appropriate spatial scale and historical perspective for the species or habitat type. This is necessary to understand how historical processes and major impacts shaped current ranges, areas and numbers and, based on this, what can be considered as ecologically and technically feasible. These feasibility considerations should include irreversibility of developments e.g. major infrastructure, urban development or water safety measures. Socio-economic considerations should be left out.

Historical considerations and major impacts on the distribution and population size of species groups and habitat types differ between environments and often between species groups and land use categories as well. Some major historical changes and impacts are given below:

- For coastal environments the main period of land claim/enclosure and therefore habitat loss was in the 18th century. Some offshore habitats also significantly depleted long before this time period e.g. oyster reefs in the southern North Sea.

  Baleen whales like blue, fin, and humpback whale were first hunted intensively from 1850s onwards, with the most intense period (in eastern North Atlantic) being between 1900 and 1960s. Protection became widespread in mid-1980s. Bottlenose dolphin appears to have been more widespread (particularly in estuaries and semi-enclosed bays) before 1900, and may also have experienced declines between 1960s and 1980s. Harbour porpoise also appear to have experienced declines during the twentieth century, particularly the latter half (1960s-1980s). In both cases, increased pollution may have played a role; in the latter case,

[5] Based on a note by the Ministry of Economic Affairs in the reports on Dutch FRVs: see § 2.4.3.

additionally, by-catch almost certainly has done, whilst prey depletion from over-exploitation of fish stocks may well have a role as well.

- For the terrestrial enviroment of large mammals, the collapse of socialism in Russia in 1991 had a major impact. The large socioeconomic shock, including a drastic increase in poverty, resulted in major land-use changes, like widespread farmland abandonment, and steep declines in livestock numbers and forest harvesting, which offered opportunities for conservation. In the ex-Soviet Union, wild boar, brown bear and moose had lower per-capita population growth rates, while wolves increased in the 1990s. This rapid increase in wolves after 1991 was likely due to the cessation of control measures. The increase in poaching, low enforcement of protection laws, loss of crops as forage, the increased wolf numbers and other factors associated with the fall of the Soviet Union together likely caused the rapid population changes. In the period 2001–2010, wild boar populations increased significantly, together with brown bear, moose, roe deer, and red deer, while the Eurasian lynx continued to decline. In some post-Soviet countries large mammals rebounded after initial declines (e.g. wild boar in Czech Republic, brown bear in Romania, wolf in Estonia, Latvia, Lithuania; Bragina et al., 2015).
- The 'normalization' of river systems and lakes started already in the 19th and early 20th century with large river works e.g. dams, weirs, summer dykes. Important pressures in the fresh water environment are water pollution, strong over fishing, habitat loss, invasive alien species and diseases (e.g. crayfish, amphibians).
- Forest cover steadily declined in most parts of Europe to very low values, starting from 1000 BC up to about 1850, a process linked to increasing population density (Kaplan et al., 2009). After this low, forest cover generally increased as a result of plantation forestry (often with non-native tree species). Therefore, historical references for area and viability of forest ecosystems doesn’t make much sense in Europe.
- Semi-natural habitats depending on extensive agricultural management experienced severe declines in quantity and quality and in numbers of associated species in most parts of Europe after World War II due to cultivation, hydrological ‘improvement’, agricultural intensification including ammonia emissions, water pollution, fragmentation and urbanisation (e.g. Fuller, 1987; Cousins et al., 2007; Ridding et al., 2015).
- Industrialisation starting in the mid-19th century resulted a.o. in high (acidifying) SO_2 emissions in the first half of the 20th century with maximum levels in the 1970s and 1980s; since 1990 a strong reduction in SO_2 emissions has been achieved by a combination of measures.
- For countries in which urbanisation caused large declines, the second half of the 20th century may be the period of main losses in coastal dune areas.

4.1.2 Relationships with other CS parameters

Setting FRVs for Range, Area and Population must be independent from the assessment of the other CS parameters Habitat for the species, Specific structure & functions (incl. typical species) and Future prospects. However, requirements e.g. on spatial configuration, connectivity, (meta)population structure and population density used for setting FRVs, will probably be assessed as aspects of habitat quality as well. The FRV definitions given in § 3.1.2 include requirements of connectivity, population density and ecological and genetic variations in setting FRP and FRA and this will have consequences for the methodology used to assess the other parameters. In fact, this procedure will contribute to a better understanding of the conservation status of quality parameters. For example, in the case of assumptions on population density in setting FRPs, an environment must provide the conditions which enable such a density; quality indicators are needed to evaluate these conditions. Another subtle relationship exists between FRA and Structure & Functions of habitats regarding the conservation status of typical species. It seems logical to include requirements of characteristic species of a habitat in setting a FRA; however, the evaluation of typical species is part of the assessment of Art 17 Structure & Functions and both uses of characteristic/typical species need to be independent and consistent.

4.1.3 Reference-based and model-based methods

This paragraph introduces two approaches for setting FRVs: reference-based and model-based. See § 4.2.2 (step 2.1 FRP assessment) or § 4.3.2 (step 2.1 FRA assessment) for further implementation.

The reference-based method
The reference-based approach for setting FRVs considers the historical distribution/area of a habitat type or the historical distribution/population size of a species in a period when the habitat type or species was supposed to be in a (stable) favourable condition. Empirical numbers, areas or densities corresponding to a particular historical baseline are used to set FRVs.

In selecting a reference period we suggest to use the recent past, i.e. from about the last 50 years before the relevant Directive came into force (see § 3.1.3), depending on occurrences of (irreversible) major impacts on distribution and population size/area.

Only rarely will reference values be available for populations and habitats throughout the entire relevant range. In this case we suggest to use regional studies with good data and interpolate to areas without or with poor data.

Generally, the FRA/FRP is derived from a historical reference (baseline) by downscaling, depending on the decline rate in area/population size. The question is: How much of the baseline needs to be restored to reach a favourable area or population size?

A special case of the reference-based approach applies to setting FRVs for non-reproductive 'populations' such as passing or wintering bird populations.

Model-based methods
Model-based approaches use species-specific information on required viable population size or species-specific or habitat type-specific features such as habitat suitability or required area for proper functioning. The following methods can be used:

- The **population-based method** uses population viability analysis (PVA) or more often literature sources to estimate a minimum viable population (MVP) size, followed by upscaling to FRP level using knowledge of potential range, suitable habitat, average density, historical trends and (historical) ecological and genetic variations within the natural range and considers spreading of risk. This approach is valid for species with individuals as population unit and which reproduce in the member state (instead of e.g. just wintering).

  In applying MVPs we use 'genetic MVPs' i.e. accounting for evolutionary potential (see § 3.2.3) or similar concepts resulting in upscaled 'demographic MVPs'.

  Translating (upscaled) MVPs to the FRP and FRR level inevitably requires knowledge of reference conditions for ecological/genetic variations in the species' natural range. Generally, several 'long-term viable populations' will be necessary to account for all the significant ecological variations of the habitat/species within its range (see FRV definitions, Table 3.2).

- The **potential-range method** uses distribution modelling or habitat suitability measures to constrain the FRP/FRA and FRR within the potential range (see § 3.2.5). Next, FRVs are determined by identifying and applying favourable reference densities (for FRPs) or environmental conditions (for FRAs) in 'optimal' and 'average' habitats within the potential range, given considerations on ecological and technical feasibility; see § 4.1.1).

- The **area-based method** uses assumptions on the area requirement of a good functioning habitat at the landscape level, followed by upscaling to FRA level by considering risk spreading and ecological variations within the natural range. This approach is based on the 'minimum dynamic area' concept (e.g. Poiani et al., 2000) and is valid for 'macro habitats' (see § 4.3.1 Table 4.2).

Combined methods and using proxies for population numbers
For terrestrial mammals and birds fairly good estimates are available for MVPs or can be derived using body size relationships. In these cases, a reference-base method can be used with the additional requirement that the FRP must be at least the size of an upscaled MVP.

For some marine species, for widespread terrestrial (including bird) species and invertebrates for which population numbers are difficult to assess, FRPs may be derived from proxies for population numbers such as the number of km-squares or occupancy and by using a reference-based or potential-range based method to set FRPs.

4.1.4 A general approach for setting FRVs

The most obvious general conclusion emerging from chapter 2 is the need for defining and structuring criteria and indicators for setting FRVs at appropriate spatial and temporal scales into practical methods. The criteria and scales to be considered must have an ecologically relevant relationship with the long-term viability of the features.

Chapter 3 presented definitions and available concepts, building material and methods relevant for the structuring of criteria into practical methods. The previous paragraphs provide guidance on general aspects in setting FRVs. Now, all these elements are brought together in a stepwise approach for setting FRVs. Apart from guiding the process, this approach enables careful early decisions about data deficiency (FRV is unknown) or clearly favourable conditions (FRV is current value) after which the process is finished. Figure 4.1 presents the necessary steps (and see Figure 10 in Explanatory Notes and Guidelines for the period 2013–2018). These steps are elaborated in § 4.2 for species and in § 4.3 for habitat types.

In setting FRVs we consider three levels of data availability and knowledge :

- low: sparse data on actual distribution and ecological requirements; hardly historical data;
- moderate: good data on actual distribution and ecological requirements but limited historical distribution data (only trends);
- high: good data on actual distribution and ecological requirements and good historical data and trends.

These levels will determine which approach (reference-based and/or model-based) can be used and how confident FRVs can be presented: as unknown, by expert opinion, as operator or real valued.

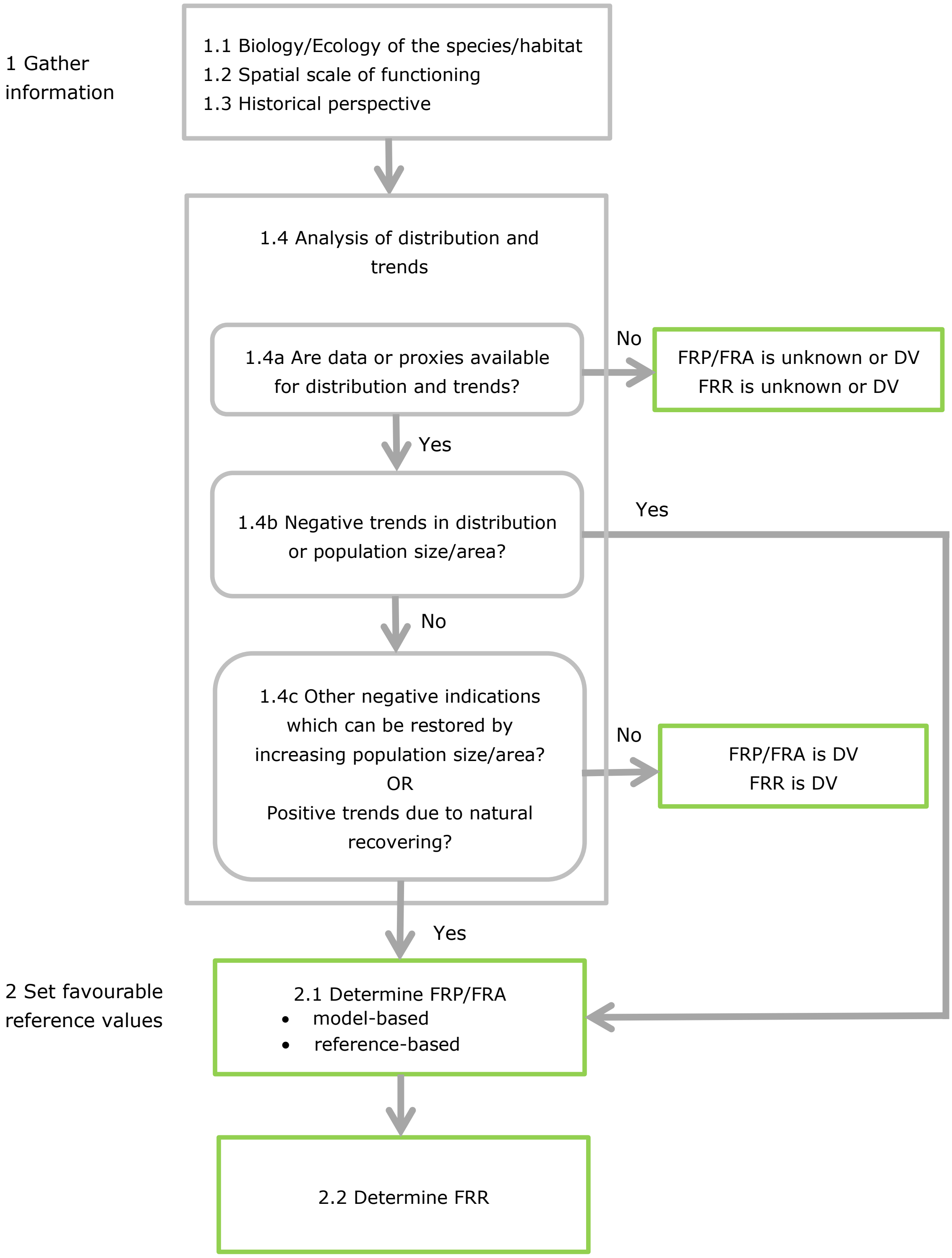


Figure 4.1. Flowchart for the stepwise process of setting FRVs for species and habitat types.

4.2 The stepwise approach for species

Refer to Figure 4.1 for the overall process of setting FRVs and its relationship with the steps elaborated below.

4.2.1 Step 1 - Gather information

Step 1.1 - Biology of the species
Differences in species attributes and requirements will result in different population processes and different methods for setting FRVs. Consider:

- Life history strategies; body size; dispersal capacity
- Genetic structure of the population: subpopulations, meta-populations, management units
- Geographical variation (differentiation) in habitat requirements, migration routes
- Habitat requirements for reproduction, foraging, resting, migration, wintering
- Potential range
- Unit for defining population size including proxies (e.g. occupancy)

Step 1.2a - Spatial scale of functioning: how many populations?
For a given species, the first question is how many isolated (meta)populations have to be considered. Next the viability of each population must be assessed at an appropriate spatial scale (step 1.2b).

However, this approach requires much region-specific data and knowledge and therefore is only feasible for a limited number of already well-studied species.

The identification of reproductive populations for which it is very likely that they are isolated, i.e. have insufficient exchange of individuals with neighbouring populations to consider them part of one coherent population network or metapopulation, requires region-specific data and knowledge and therefore is only feasible for a limited number of already well-studied species. We propose a shortcut by considering the distribution of a species, e.g. from national atlases, and defining separate 'populations' only in the case of clearly disjunct distributions. In order to work this out, information is needed on:

- the species' current distribution in Europe or the distribution of management units;
- the species' distribution in Europe in a reference period and/or a species' potential distribution to evaluate the possible impact of historical pressures and to identify possible relict occurrences;
- the species' reproductive dispersal distance (see step 1.1 Biology of the species); Box 4.1 provides guidance in estimating the median dispersal distance for birds and mammals and in using this distance to decide whether populations are isolated or not.

Generally, we expect distinct populations in the EU for habitat specialists which naturally occur only locally, e.g. in mountain areas or calcareous regions, or for species with artificially fragmented distributions. For widespread species, Europe may contain just one large population.

Although a population approach formally does not apply to non-reproductive populations, we propose to use the same procedure as for reproductive populations: separate non-reproductive populations which are supposed not to exchange individuals. With respect to waterbirds, their flyways might be useful for this purpose, also in linking wintering and passage populations to breeding populations.

Step 1.2b - Spatial scale of functioning: population categories
Species are highly diverse in their mobility and spatial requirements and dynamics. Therefore, FRVs make only sense when the appropriate spatial scale is explicitly taken into account. Populations functioning at different spatial scales may require different methods in setting FRVs. This step determines an appropriate spatial scale for setting FRVs by considering different population categories related to the behaviour of individuals and features of species groups.

The following aspects have been used to define population categories (and see Table 4.1a en 4.1b):

- **Sedentary (resident) versus migratory species**

  This distinction is useful in setting FRVs because sedentary (resident) and migratory species face different pressures and threats and generally require different measures to maintain or reach a favourable conservation status. Migratory species are defined here as having individuals showing large cyclic, directed movements between reproductive and non-reproductive areas. Despite this high mobility, reproductive populations can be small and confined to specific locations (predictable) or large and more or less continuous and dynamically responding to variations in available habitat (covered by the categories MR1-MR4).

  Most migratory species to be considered belong to birds, cetaceans and turtles; fish and mammals include migratory species as well. Annex 2 presents lists of the migratory species of the Birds and Habitats Directive.

  For partial migratory species, the non-reproductive (staging and wintering) population can occur in the same spatial configuration as for the resident or breeding population. In this case a population can be considered as resident.
- **Reproductive versus non-reproductive populations**

  Several migratory species including birds, several whales, turtles and some bats occur only as non-reproductive populations in some or all Member States. Setting non-reproductive FRVs (nrFRVs) for these species requires other approaches and methods than for reproductive populations, e.g. MVPs and population-based methods can't be used. The categories MNR1-MNR4 characterize non-reproductive populations similar to the way reproductive populations for resident species are presented.
- **Home range, mobility and predictability of habitat**

  Species with large home ranges, e.g. large carnivores and several cetaceans, require FRVs at the supranational level (categories S4, MR4).

  For small, more or less immobile invertebrate species often occurring in locally high densities (assigned to category S6), both population numbers and historical references are not or hardly available and in this case only an area-based approach or potential-range based method can be used.

  Some invertebrates (e.g. bufferflies) use several types of habitat during their life span which must lie within the mobility range of the species during one generation. Other small and mobile species require extra attention as well in terms of metapopulation dynamics and/or required combinations of habitats (see § 5.5). For these cases population category S5 applies.
- **Animal versus plant species**

  Most population categories apply to animals to describe their diversity in spatial behaviour. Only three categories are used for plants as well to differentiatie between more or less continuous distributions with exchange by seeds or pollen often crossing member state boundaries (S1), clearly disjunct distributions of uncommon species with isolated or genetically differentiated populations (S2) and an intermediate category with scattered (often fragmented) distribution (S6).
- **National versus supranational assessment**

  The supranational level must be considerd for species when

  1) the minimal value for a sustainable population size on the population level ('upscaled MVP') is not or just met and

  2a) the biology of the species allows for long-distance exchange (large home range or large dispersal distance)(categories S4, MR4) or

  2b) individuals have small home ranges and occur in only one or a few isolated populations at supranational level (categories S3, MR3).

  This means that assessment at the national level (within biogegraphic regions) is appropriate when the minimal value for a sustainable population size on the population level is clearly exceeded in the current situation (category S1 for resident species and MR1 for migratory species). In this case, define a FRP at MS level only, e.g. by considering the potential range within the MS (which could be current population size).

Given the number of populations, determined as described in step 1.2a, and the appropriate population category (or categories) from step 1.2b, FRPs can be defined for each population separately, resulting in partial FRPs (pFRPs; see Table 4.1 categories S2 and MR2) within a Member State. The overall FRP (at national level) results from adding all pFRPs. However, the evaluation of current value must consider all pFRPs on a one-out-all-out basis: overall population size will be favourable (FV) only when all partial population sizes are favourable.

For small countries, species with populations showing substantial trans-boundary dynamics the same reasoning applies. In this case it is important to decide between categories S1/MR1 (sustainable population to be assessed at national level) and S3/MR3 (isolated population to be assessed at supranational level).

From an ecological point of view, distinct FRVs may be necessary or not at the biogegraphic region-level within the national level. Likewise, the supranational level will often be above the biogeographic region-level as well, especially for bird species and large carnivores.

Box 4.1. Guidance on evaluating isolation between populations for birds and mammals using distribution maps

Although distribution patterns of clearly disjunct species suggest isolated populations, this must at least be evaluated relative to the species' dispersal distance. The distribution of (natal) species dispersal distance (dispersal density) can be used for this purpose. This density describes the probability of settling (breeding, reproducing) at a particular distance from the site of origin (birth, parent). Several authors discuss relationships between dispersal distance and species traits, such as adult body mass (e.g. Sutherland et al., 2000; Santini et al., 2013; Whitmee & Orme, 2013).

Hilbers et al. (2016a) provide allometric relationships for birds and mammals between body mass and size of home range and between the latter and median dispersal distance which can be used to evaluate whether a species is likely to colonize distant habitat or not. We assume that habitat at larger distance than five times the median dispersal distance will not be colonized and therefore that populations more than five times the median dispersal distance apart can be considered as isolated.

The allometric relationships for given body mass m (in kg) are as follows (from Hilbers et al. 2016a, Table 1):

Variable & unit	**Estimate**			
	carnivorous birds	non-carnivorous birds	carnivorous mammals	non-carnivorous mammals
HR home range size (km^2)	$2.1 \times 10^{2} \times m^{1.13}$	$3.7 \times 10^{1} \times m$	$3.8 \times 10^{--1} \times m^{1.13}$	$5.4 \times 10^{-2} \times m$
d_m median natal dispersal distance (km / generation)	$12 \times HR^{0.5}$		$5.6 \times HR^{0.5}$	

Example: The smew (*Mergellus albellus*), a diving duck, has body mass m 0.5-0.9 kg, an estimated home range size HR=37 x 0.9=33 km^2 and an estimated median dispersal distance d_m=12 x $33^{0.5}$=69 km per generation. This means that populations more than about 350 km apart can be considered as isolated.

Table 4.1a. Population categories for sedentary/resident species and migratory species (reproductive populations) of the habitats and birds directive with reproductive populations in one or more Member States (MS a-d). See Table 4.1b for the legend.

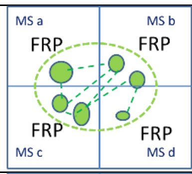
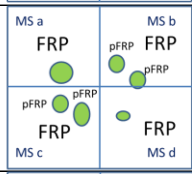
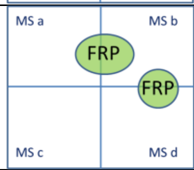
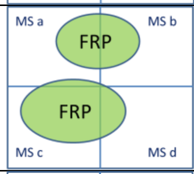
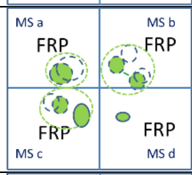
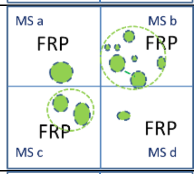
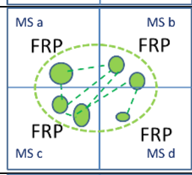
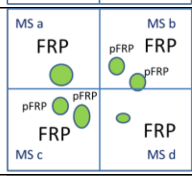
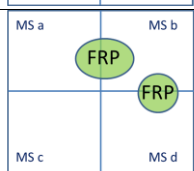
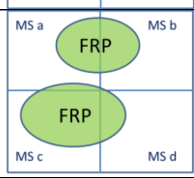
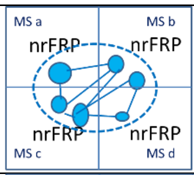
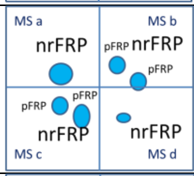
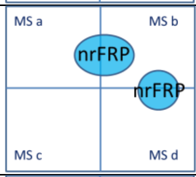
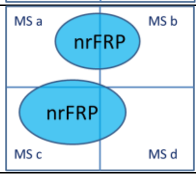
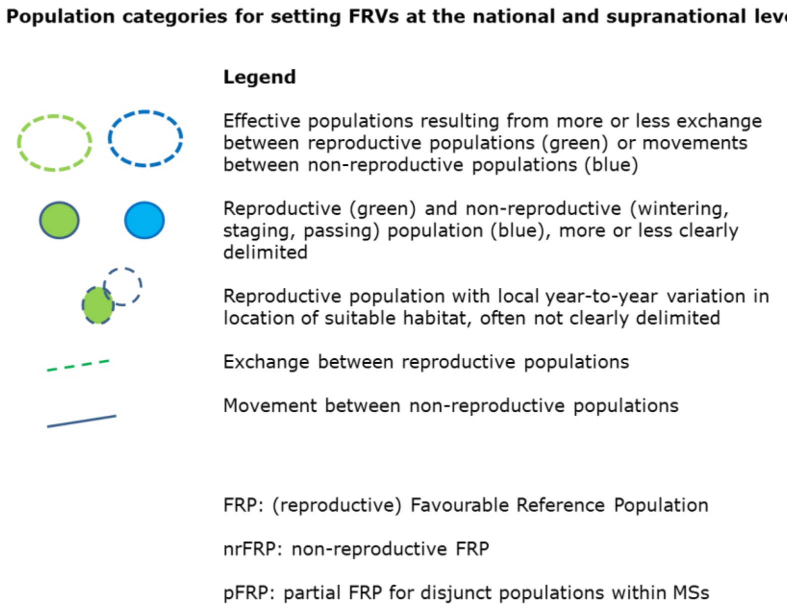
Category	Subcategory	Animals /Plants	FRV assessment level	Picture
S Sedentary/ resident species	S1 widespread species with more or less continuous distribution (often crossing national boundaries) and populations (assessment units) with more or less exchange at or below national level	A/P	National	
	S2 species with clearly disjunct distributions and one or a few isolated (often genetically differentiated) populations at the national level	A/P	National	
	S3 animal species with individuals with small home ranges and one or a few isolated populations at supranational level	A	Supra-national	
	S4 animal species with individuals with large home ranges (>100 km2 up to >1000 km2)	A	Supra-national	
	S5 small, mobile animal species with year-to-year variation in occurrence of suitable habitat or with metapopulation dynamics	A	National	
	S6 small animal species with low mobility and uncommon plant species with scattered (often fragmented) distribution	A/P	National	
MR Migratory species (reproductive populations)	MR1 widespread species with more or less continuous distribution (often crossing national boundaries) and populations (assessment units) with more or less exchange at or below national level	A	National	
	MR2 species with clearly disjunct distributions and one or a few isolated (often genetically differentiated) populations at the national level (corresponding to S2)	A	National	
	MR3 species with individuals with small home ranges and one or a few populations at supranational level (corresponding to S3)	A	Supra-national	
	MR4 species with individuals with large home ranges (>100 km2 up to >1000 km2) and one or a few populations at supranational level (corresponding to S4)	A	Supra-national	

Table 4.1b. Population categories for migratory species of the habitats and birds directive with non-reproductive populations in one or more Member States (MS a-d)

Category	Subcategory	Animals /Plants	FRV assessment level	Picture
MNR Migratory species (non-reproductive populations)	MNR1 widespread species with more less continuous non-reproductive (wintering/staging) distribution (often crossing national boundaries)	A	National	
	MNR2 species with one or a few isolated non-reproductive (wintering/staging) populations (sites) at national level	A	National	
	MNR3 species with one or a few isolated non-reproductive (wintering/staging) populations at supranational level	A	Supra-national	
	MNR4 species with individuals with large home ranges (>100 km2 up to >1000 km2) and one or a few non-reproductive populations at supranational level	A	Supra-national	



Step 1.3 - Historical perspective: what happened to the species?
Current size and configuration of a species' range are strongly shaped by historical pressures. The viability of populations within their range can only be understood and evaluated from a broad historical perspective on FCS. However, while many populations and habitats were more abundant in the past than nowadays, this does not necessarily have direct implications on their probability to persist and play a role in the environment. This step must provide a proper historical perspective.

Deducing this perspective could involve the generation of a narrative, for example to articulate an overarching principle of restoring the natural range of species in viable populations in robust and viable ecosystems. This in turn helps clarify a high level context of both the extent and natural levels of biodiversity, under recent climatic conditions, for example looking at pre-industrialisation or pre-agricultural intensification levels of human impact. Thus it rationalises the range and likely geographical extent of species and habitats. This could cover a timespan of anything from 10- 10,000 years BP (e.g. for considering species that could be reintroduced) but with much more recent times scales for considering the potential and relevance of restoration.

Present a narrative about what happened to the species. Consider:

- Recent and historical distribution and population size;
- Distribution and population size when the HD came into force;
- Major impacts on overall distribution and population size; when did they occur? See § 4.1.1 for an overview of major historical changes;
- Changes in configuration of the range (connectivity, fragmentation);
- Loss of ecological variations in habitat of the species, e.g. in particular regions;
- Main causes of trends;
- Restoration potential; (ir)reversibility of major impacts and measures.

Step 1.4 - Analysis of distribution and trends
Given an appropriate spatial scale and historical perspective, step 1.4 proceeds with the analysis of distribution and trends based on historical and recent data. If current population numbers are below or just reach MVP size or when negative trends are found or can be inferred from the historical perspective, subsequent analyses must reveal the causes of low viability or decline, e.g. decreased connectivity, land use change or overexploitation. Generally this results in setting FRVs greater than CV. If this kind of signals is not found or can't be inferred, we assume that FRV=DV and the process of setting FRVs is finished. Step 1.4 is also meant to decide about data deficiency and to avoid the process of setting FRVs in the case of a clearly favourable conservation status.

Step 1.4a - Are data or proxies available for distribution and trends?
Only in the case of a total lack of data or proxies on current distribution or any indications of historical distribution and trends, FRVs are considered as data deficient (X). For common species FRV=DV is more appropriate in this situation.

Step 1.4b - Negative trends in distribution or population size?
This step requires an appropriate historical perspective and estimates or indications of a species' historical range including spatial configuration. The relevant time scale depends on historical impacts specific to the particular environment (step 1.3). Trends are assessed for both the recent past (up to about 50 years before the HD came info force) and the historical past (up to two or three centuries). The spatial resolution in marine enviroments is generally 10x10 km (but preferably lower), on land below 10x10 km, preferably 1x1 km. Factors/indicators to consider are grid-based presence/occupancy and spatial configuration.
If a negative trend in distribution or population size is found, proceed with step 2.1 (FRP assessment).

Step 1.4c - Other negative indications which can be restored by increasing population size OR Positive trends due to natural recovering?
This extra step is to ensure first, that small and isolated populations with apparently stable distributions and population sizes are indeed viable in the long term. When this is not evident (e.g. regarding reproduction) a FRP must be assessed according to step 2.1, probably corresponding to

population category S2 (species with clearly disjunct distributions and one or a few isolated populations at the national level; see Table 4.1a).

Secondly, the situation where range and population show positive trends due to natural recovering needs explicit consideration. For several species population sizes in the recent and even historical past were very low caused by overexploitation, hunting etc. As a result of changes in land use or legislation, some of these species now recolonize their natural range spontaneously, e.g. large carnivores. This process needs to be assessed relative to the natural (potential) range including ecological variations according to step 2.2 (FRR assessment).

Otherwise, FRV = DV and the process of setting FRVs has been finished. Note that this decision is only made when 1) the historical distribution is smaller than or similar to the actual distribution in size and configuration, AND 2) trends in distribution AND in size are not negative in the recent and historical past, AND 3) after evaluating two special, apparently favourable cases.

4.2.2 Step 2 - Set favourable reference values

Step 2.1 - FRP assessment
The FRP is assessed in two cases detected in step 1.4:

1. Negative trends in current or historical distribution and/or population numbers;
2. Positive trends in current distribution and/or population numbers for species recovering from a deep low, e.g. after cessation of hunting or whaling or as a result of legislation, land use change or improvement of air or water quality. Although in this case current population size can be higher than DV, it needs to be determined what values for population size and range are sufficient for long-term viability.

In both cases a population-based method can be used to asses the FRP (see Box 4.2). When a population-based approach can not be performed, e.g. for species with other population units than individuals or when proxies have been used (e.g. occupancy), a reference-based or another model-based approach can be applied (see Box 4.4). For species with a more or less stable or still decreasing population size all these approachs depend on considerations about restorable suitable habitat. Note that the use of historical information does not mean that the FRP must or will be restored up to the historical population size or range.

In case 2, when a species is already recolonizing its natural range succesfully, instead of using the outcome of a population-based analysis, we suggest to use operators until population size and distribution have been stabilized for a sufficient long time (‘wait-and-see’). This is particularly useful for naturally expanding, (formerly) threatened species. In this case FRP > DV (or FRP >> DV) and generally FRR > DV (or FRR >> DV) as well, depending on how much the species expanded already in its (former) natural range.

After a FRP has been determined, including the additional range necessary to restore population size up to FRP-level, proceed with step 2.2 FRR assessment.

Step 2.2 - FRR assessment
The FRP-assessment explicitly included considerations to restore required ecological variations and configuration within the natural range of the species. Therefore, the FRR must be derived from DV and additional range to include the FRP in the case FRP > DV.

Box 4.2. Guidance on using a population-based method in setting FRPs

A. Determine or infer the minimum viable population size (MVP).

- high data quality: perform Population Viability Analysis (PVA) for a given population and context (see § 3.2.2)
- moderate/low data quality: use MVP-estimates from
    - species (and context) specific literature
    - generalised genetic rules corresponding to an effective population size $N_e \geq 500$ ('genetic MVP'; see § 3.2.3)
    - (for mammals) body size relationships (see Box 4.3 for further guidance)
    - (for birds) body size relationship with 'rule of thumb' (see § 5.4.2).

B. Translate MVP-size to the FRP level
The number of required more or less isolated (minimum viable) populations will at least depend on ecological and genetic variations within the natural range of the species and often on known trends as well. Several (not always independent) approaches are available for upscaling a MVP estimate to FRP level.

For all approaches: take into account 1) ecological/genetic variations within the (historical) natural range i.e. geographical, climatological, geological and altitudinal gradients as well as siginificant differences in historical land use and 2) technical feasibility.

Approaches:

- high data quality: use models for potential range and habitat suitability (see § 3.2.5) or available estimates of population density, amount of suitable area and maximum dispersal distance to constrain the number of required populations or the spatial extent of one mixing population
- low data quality: consider ecological/genetic variations within the historical range and find the minimum number of populations needed to cover this variation
- for migratory species and species with large home ranges: consider structured populations according to management units (marine mammals and turtles) or flyway populations of migratory birds (see § 3.2.6)

C. Determine the FRP

- if the scaling factor can be estimated with sufficient confidence:
  FRP = MVP * scaling factor (=number of required populations or muliplier)
  if this FRP < DV then FRP = DV
- if the scaling factor can only be estimated qualitatively, use operators:
  if MVP << DV then FRP=DV
  if MVP ~ or > DV and the scaling factor is relatively low: FRP > DV
  if MVP ~ or > DV and the scaling factor is relatively high: FRP >> DV

D. Consider consequences for setting the FRR
In case of FRP > DV or FRP >> DV determine how much additional range is necessary (or not) to include the FRP.

Box 4.3. Guidance on calculating MVP targets according to Hilbers et al. (2016)

Refer to § 3.2.4 for the rationale behind estimating minimum viable population targets based om body size relationships (and see Hilbers et al. 2016).

MVP targets related to the body mass (m in kg) of mammals for six different intrinsic growth rates (rm of 80%, 60%, 40%, 20%, and 0% of rm) are obtained by the regression equation

$$\log MVP = a - b * \log m + c * \log^2 m \text{ } (\log_{10}\text{-based})$$

with coefficients a, b and c given in the tables below.

model	Mean			Mean + 2SD		
	a	b	c	a	b	c
100% rm	1.51	0.38	0.06	1.78	0.49	0.10

The mean value corresponds to a population with 95% chance to withstand environmental stochasticity for 100 years.

The model is based on the assumption that threats are abated by protection. The influence of alleged unfavourable conditions on the MVP targets, which represent habitats of relatively low quality or external factors (e.g., human pressures or predation) affects the growth rate of species, and can be quantified as fractions of the intrinsic population growth rate rm. Since favourable reference values represent favourable conditions, we propose to use the 100% rm model only. Refer to Hilbers et al. (2016) for coefficients of regression models for fractions of rm. They also present 'cautionary MVPs' using the upper bound at 2 SD of the estimates, for which coefficients have been included in the table above (Mean + 2SD)*.

Example: For the Eurasian red squirrel with body mass 0.33 kg, model mean gives MVP=51 and the 'cautionary model' (mean + 2SD) MVP=109.

*Provided by Jelle Hilbers, Radboud University Nijmegen, the Netherlands.

4.3 The stepwise approach for habitat types

Refer to Figure 4.1 for the overall process of setting FRVs and its relationship with the steps elaborated below.

4.3.1 Step 1 - Gather information

Step 1.1 - Ecology of the habitat
Differences in species composition and requirements will result in different functioning of habitat types and in different methods for setting FRVs. Consider:

- Physical and ecological conditions (potential extent of range)
- Variation in species composition across geographical regions, altitudes and historical land use
- Stability and dynamics of area, including units to define FRA (e.g. km^2 or detailed distribution as a proxy)
- Features of a favourable structure & function
- Typical species and their range and conservation status

Step 1.2 - Spatial scale of functioning
Habitat types have been defined by each MS independently based on a common interpretation manual at the EU level (EC, 2013). National interpretations and definitions may therefore differ between countries.

The requirement that a FRA must be sufficiently large to include the ecological variations in the natural range (see § 3.1.2) does not necessarily imply that supranational FRVs have to be considered. In fact, this requirement is met already when, in setting FRVs for habitats, each MS includes all ecological conditions resulting from geological, altitudinal, climatic variation and historical land use, within its national boundaries. Indeed, many habitat types show considerable turnover in species composition along geographic gradients within their ranges. For species considered at the supranational level, e.g. for large carnivores, a change in area or quality of the habitat in one MS will affect the functioning of the supranational population and that's why this scale level makes sense in setting FRPs. For habitat types, changes in area or quality in a particular MS mostly won't affect the functioning of that habitat type in an adjacent MS.

In conclusion, we propose to set FRAs for all marine and terrestrial habitat types at the national level only.

As noted already, habitat types differ considerably in extent and scale of ecological processes and therefore in requirements for proper functioning (viability). A useful distinction to address differences in functioning of habitat types including the spatial scale of key processes involved, is between a macro- and meso-habiats as given in Table 4.2. According to this table each habitat type can be assigned to one out of four categories, exemplified by habitat types of group 31 'Standing waters':

- Macro-habitats (category 1a): e.g. 3160 Natural dystrophic lakes and ponds, 3170 *Mediterranean temporary ponds, 3180 *Turloughs, 3190 Lakes of gypsum karst;
- Macro-habitat components (category 1b): e.g. 3260 Rivers with muddy banks with Chenopodion rubri p.p. and Bidention p.p. vegetation
- Meso-habitats (category 2a): e.g. 3110 Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae), 3140 Hard oligo-mesotrophic waters with benthic vegetation of Chara spp.;
- Meso-habitat components (category 2b): 31A0 *Transylvanian hot-spring lotus beds.

Table 4.2. Categories of habitat types functioning as ecosystems at different spatial scales and generally requiring different considerations and approaches for setting FRVs.

Category	Characteristics	FRV approach	Example habitats
1a macro-habitat	• ecosystem with broad abiotic range and natural dynamics, resistant against extreme events (robust); • comprising a diversity of qualifying vegetation types and successional stages (with characteristic species and structure) in gradients or mosaics; • minimum area of functioning from 10s to 100s of hectares, not very dependent on specific (localized) conditions; • optimal functioning is main criterion for high quality;	FRA based on the minimum area needed for optimal functioning of the ecosystem with all its successional stages AND the required number of sites with an optimal functioning ecosystem; area can be related to potential occurrence	H1330 H2180 H2330 H3260 H7110 H9160
1b component of macro-habitat (macro-component)	• small and specific abiotic range, as part of the broader range of the ecosystem, high-dynamic; • representing one successional stage (with characteristic species and structure) in a gradient or mosaic ; • minimum area of functioning can be small or large, dependent on specific but spatially dynamic conditions; • functioning as part of the broader ecosystem is main criterion for good quality	FRA based on percentages (between limits) of FRA of the (successionally) related, optimal functioning ecosystem in the same landscape OR (proxy) based on a percentage of grid squares of the related ecosystem OR area of physical conditions required by the component	H1310 H2110 H2160 H2170 H5130
2a meso-habitat	• small and specific abiotic range, either high- or low-dynamic, often determined by historical land use (semi-natural habitats); • low differentiation in succession stages and structure due to specific management or specific natural (localized) conditions; • minimum area for functioning from several to 10s of hectares, dependent on specific locations that are part of an abiotic gradient or mosaic; different locations are needed for risk spreading; • species composition, structure, site conditions and spatial configuration (connectivity) are criteria for good quality	FRA based on a historical reference and on functioning of characteristic species; spatial configuration (connectivity) of the habitat should be taken into account	H2130 H2140 H3130 H4030 H6410 H6510 H7230 9330
2b component of meso-habitat (meso-component)	• defined by one or a few (dominant) species • abiotic range determined by (part of the) condition required by these species, either high- or low-dynamic; • hardly any differentiation in succession stages and in structure; • no minimum area for functioning; • no criteria for good quality in terms of species composition or structure (no typical species); dominant species population structure may be used as quality criterion	Like meso, but focused on the dominant species OR proxy based on the historical number of occupied grid squares OR proxy derived from the potential area of required physical conditions	H31A0 H7210

Considerations on gene flow, isolation and viability don't apply directly to habitats, and therefore (meta)population theory can't be applied either. However, these theories can be used to describe requirements of the typical, diagnostic or key species of a habitat type. The HD requires that a habitat with FCS must have its typical species in favourable condition as well, and theoretically this may determine the area and spatial configuration of habitats, and therefore the FRA and FRR. So, although the reporting format evaluates typical species as part of the assessment of the Structures & Functions parameter, this doesn't theoretically exclude using species and their FRPs in the process of setting FRAs. Note however the increasing insight into factors and species attributes resulting in considerable extinction debts of characteristic species (e.g. Piessens & Hermy, 2006; Cousins & Vanhoenacker, 2011; Dullinger et al., 2013).

Step 1.3 - Historical perspective: what happened to the habitat?
Current size and configuration of a habitat's range are strongly shaped by historical pressures and viability of habitats within their range can only be understood and evaluated from a broad historical perspective on FCS (see step 1.3 for species).

Present a narrative about what happened to the habitat. Consider:

- Recent and historical distribution and area
- Distribution and area when the HD came into force
- Major impacts on overall distribution and area; when did they occur?
- Changes in configuration of the range (connectivity, fragmentation)
- Loss of ecological variations, e.g. in particular regions
- Changes in species composition and structure & function
- Main causes of trends
- Restoration potential; (ir)reversibility of major impacts and measures

Since setting FRVs for habitat types will strongly depend on reference-based methods, a historical perspective for a FCS is important. Although much literature exists on historical land use change which can be used to infer trends in area and quality of habitat types, direct data (surveys) on corresponding changes in species composition of the vegetation are scarce and at most available from the early 20th century onwards. Modelled potential distribution (potential-range method; see § 4.1.3) may help to assess historical area for climax habitats, like most forest types.

As for species, reference periods for setting FRVs for habitat types must be deduced by considering common threats and pressures in particular environments as well as major impacts resulting in irreversible changes in landscapes and seascapes (see § 4.1.1 for major changes and impacts).

Step 1.4 - Analysis of distribution and trends
Given an appropriate spatial scale (macro- or meso-habitat or component) and historical perspective, step 1.4 proceeds with the analysis of distribution and trends based on historical and recent data. If negative developments are found or can be inferred from a general historical perspective, subsequent analyses must reveal their nature and causes, e.g. decreased connectivity or land use change. Generally this results in setting FRVs greater than CV. If this kind of signals is not found or can't be inferred, we assume that FRV=DV and the process of setting FRVs is finished. Step 1.4 is also meant to decide about data deficiency and to avoid the process of setting FRVs in the case of a clearly favourable conservation status.

Step 1.4a - Are data or proxies available for distribution and trends?
Only in the case of a total lack of data or proxies on current distribution or any indications of historical distribution and trends, FRVs are considered as data deficient (X). For common habitats FRV=DV is more appropriate in this situation.

Step 1.4b - Negative trends in distribution or area?
This step requires an appropriate historical perspective and estimates or indications of a habitats historical range including spatial configuration. The relevant time scale depends on historical impacts specific to the particular environment (step 1.3). Trends are assessed for both the recent past (up to about 50 years before the HD came info force) and the historical past (up to two or three centuries).

The spatial resolution in marine enviroments is generally 10x10 km (but preferably lower), on land below 10x10 km, preferably 1x1 km. Factors/indicators to consider are grid-based presence/occupancy and spatial configuration.
If a negative trend in distribution or area is found, proceed with step 2.1 (FRP assessment).

Step 1.4c - Other negative indications which can be restored by increasing area OR Positive trends due to natural recovering?
This extra step is to ensure first, that habitats with apparently stable distributions and areas are indeed viable in the long term regarding their function & structure. The special case where distribution and area appear more or less stable but favourable functioning requires additional area occurs in habitats showing large-scale aging and decline in typical species when large-scale suitable habitat for rejuvenation or pioneer stages is absent (e.g. salt marshes, drift sands). An area-based approach can be used to assess FRA (see step 2.1). Negative trends in structure & function without clear relationship with area and distribution have to be assessed under the parameters Structure & Function and/or Future Prospects.

Secondly, the situation where range and area show positive trends due to natural recovering needs explicit consideration. For some habitats areas in the recent and even historical past were very low caused by cultivation or overexploitation. As a result of changes in legislation or land use, some of these habitats now spread spontaneously into their natural range again, e.g. some forest types. This process needs to be assessed relative to the natural (potential) range including ecological variations according to step 2.1.

Otherwise, FRV = DV and the process of setting FRVs has been finished. Note that this decision is only made when 1) the historical distribution is smaller than or similar to the actual distribution in size and configuration, AND 2) trends in distribution AND in area are not negative in the recent and historical past, AND 3) after evaluating two special, apparently favourable cases.

4.3.2 Step 2 - Set favourable reference values

Step 2.1 - FRA assessment
The FRP is assessed in two cases detected in step 1.4:
1. Negative trends in current or historical distribution and/or area;
2. Positive trends in current distribution and/or area for habitats recovering from a deep low, e.g. as a result of legislation, land use change or improvement of air or water quality. Although in this case current area can be higher than DV, it needs to be determined what values area and range are sufficient for long-term viability.

For habitats with a more or less stable or still decreasing area (case 1) FRA assessment depends on considerations about restorable suitable habitat. Note that the use of historical information does not mean that the FRP must or will be restored up to the historical population size or range.

In case 2, when a habitat is already spreading into its (former) natural range succesfully we suggest to use operators until area and distribution have been stabilized for a sufficient long time (‘wait-and-see’). This is particularly useful for naturally expanding, (formerly) threatened habitats.

Alternatively, an area-based approach can be used: determine the minimum area (MA) needed for the good functioning of a habitat at the landscape scale and decide on the minimum number of occurrences in its natural range considering natural variations. Then, FRA = HDV + (MA * number of occurrences needed). An area-based approach is relevant e.g. for natural forest types with only scattered remaining occurrences and for which a reference-based approach clearly makes no sense. Area requirements for natural functioning of woodlands at the scale of gap dynamics can be derived form the concept of ‘minimum structure area’ (MSA; e.g. Bücking, 2003; Parviainen, 2005), based on the more general concept of ‘minimum dynamic area’ (e.g. Poiani et al. 2000). To allow large-scale disturbance events and functioning at the scale of stand dynamics (e.g. see Angelstam & Kuuluvainen, 2005; Hahn et al., 2007) the MSA must be increased by at least a factor of five (Parviainen, 2005).

This estimate does not include considerations about species composition. Generally, an even larger area is needed to obtain 'compositional equilibrium' (e.g. Busing & White, 1993).

After a FRA has been determined, including the additional range necessary to restore area up to FRA-level, proceed with step 2.2 FRR assessment.

Step 2.2 - FRR assessment

The FRA-assessment explicitly included considerations to restore required ecological variations and configuration within the natural range of the species. Therefore, the FRR must be derived from DV and additional range to include the FRA in the case FRA > DV.

BOX 4.4. Guidance for assessing the level of restoration needed when using a reference-based approach (species and habitats)

A. Determine a reference value (RefValue)

- Find a historical reference period for which the habitat/species is supposed to be in favourable condition, based on the narrative of what happend to the habitat/species including considerations about major impacts (see stepwise approach). Estimate the corresponding area of habitat, population size or occupancy (=RefValue) for this period
- Alternatively (requiring high data quality and knowledge), use a species/habitat distribution model for potential range, based on statistical relationships between occupancy and physical and climatological factors and underpin a desired minimum occupation threshold to infer a RefValue (e.g. by considering historical distribution). For species, use estimates of favourable density to find reference population size and for habitats use estimates of favourable conditions to find reference area within potential range.

Define 'distance to reference value' RV1 = RefValue - DV. Note: use min-max values to express confidence.

B. Determine how much of RV1 can be restored, considering ecological and technical feasibility and knowledge of suitable/potential habitat. This is the restorable amount RV2. Note that the magnitude of the negative trend determines the amount of RV2: the more negative, the larger RV2 will be.

C. Determine FRA/FRP

- if RV2 can be estimated with sufficient confidence:
  - FRA/FRP = DV + RV2 (or use min-max-values to express confidence)
- if RV2 can only be estimated qualitatively, use operators:
  - FRA/FRP > DV when RV2 is relatively small
  - FRA/FRP >> DV when RV2 is relatively large

D. Consider consequences for setting the FRR

When RV2 is relatively large due to loss of variations or configuration: determine how much additional range is necessary to include the FRA/FRP.

5 Additional guidance for selected groups of species and habitats

5.1 Migratory species and species with large home ranges

Annex 2 lists alle migratory species and species with large home ranges of the Habitats and Birds directives:

- terrestrial mammals (Table A2.1);
- seals and turtles (Table A2.2);
- cetaceans (Table A2.3);
- fishes and lampreys (Table A2.4);
- birds (Table A2.5).

Additional guidance in setting FRVs is provided for selected species groups and habitats in the next paragraphs.

5.2 Marine mammals (cetaceans)

5.2.1 General remarks

Thirty-eight species of cetaceans have been recorded in European seas (Table 5.2.1), representing more than 40% of the 90 species currently recognised in the world. Of those thirty-eight species, 15 are common or regular, whilst the remaining 23 are rare or vagrant.

Table 5.2.1. List of cetacean species recorded in Europe

Common or Regular Species	Rare or Vagrant Species
Harbour Porpoise *Phocoena phocoena*	Rough-toothed Dolphin *Steno bredanensis*
Short-beaked Common Dolphin *Delphinus delphis*	Spinner Dolphin *Stenella longirostris*
White-beaked Dolphin *Lagenorhynchus albirostris*	Atlantic Spotted Dolphin *Stenella frontalis*
Atlantic White-sided Dolphin *Lagnorhynchus acutus*	Fraser's Dolphin *Lagenodelphis hosei*
Striped Dolphin *Stenela coeruleoalba*	Melon-headed Whale *Peponocephala electra*
Common Bottlenose Dolphin *Tursiops truncatus*	False Killer Whale *Pseudorca crassidens*
Risso's Dolphin *Grampus griseus*	Pygmy Killer Whale *Feresa attenuata*
Long-finned Pilot Whale *Globicephela melas*	Short-finned Pilot Whale *Globicephala macrorhynchus*
Killer Whale *Orcinus orca*	Beluga *Delphinapterus leucas*
Northern Bottlenose Whale *Hyperoodon ampullatus*	Narwhal *Monodon monoceros*
Cuvier's Beaked Whale *Ziphius cavirostris*	Sowerby's Beaked Whale *Mesoplodon bidens*
Sperm Whale *Physeter macrocephalus*	True's Beaked whale *Mesoplodon mirus*
Minke Whale *Balaenoptera acutorostrata*	Blainville's Beaked Whale *Mesoplodon densirostris*
Fin Whale *Balaenoptera physalus*	Gervais' Beaked Whale *Mesoplodon europaeus*
Humpback Whale *Megaptera novaeangliae*	Gray's Beaked Whale *Mesoplodon grayi*
	Pygmy Sperm Whale *Kogia breviceps*
	Dwarf Sperm Whale *Kogia sima*
	Blue Whale *Balaenoptera musculus*
	Sei Whale *Balaenoptera borealis*
	Bryde's Whale *Baaenoptera edeni*
	Gray Whale *Eschrichtius robustus*
	Bowhead Whale *Balaena mysticetus*
	Northern Right Whale *Eubalaena glacialis*

Species diversity is greatest for those countries bordering the Atlantic, and lowest for semi-enclosed seas like the Baltic and Black Seas (Evans, 2010, 2011; see Fig. 5.2.1). For a list of species by European country, see Waring *et al*. (2009).

All the species of cetaceans recorded in European seas are highly mobile, and none has a range confined to a single country or even to Europe. The only species with relatively restricted ranges are northern bottlenose whale, Atlantic white-sided dolphin and white-beaked dolphin, and all three of these occur across the North Atlantic. Although the status of particular species may vary between countries' EEZs, the majority of species are rare or vagrant, largely because their main distributions are outside European waters. It is therefore recommended that FRVs be assessed only for the 15 common or regular species. All European cetaceans are European Protected Species (requiring 'strict protection'), but only the harbour porpoise and bottlenose dolphin are listed on Annex II of the Habitats Directive, requiring Natura 2000 sites for their protection.

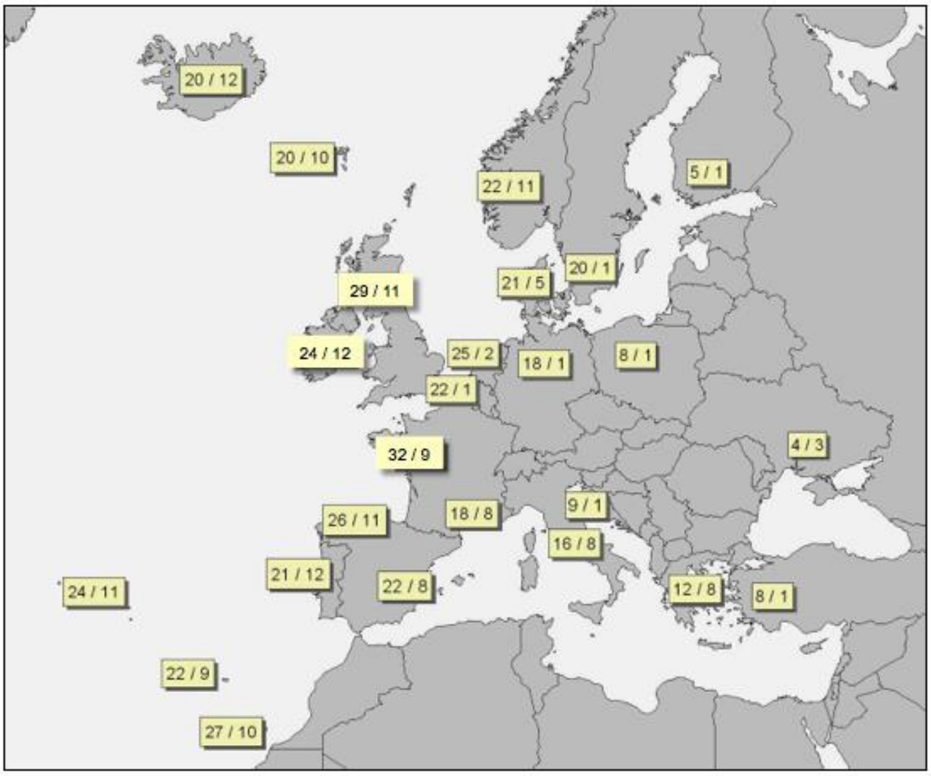


Figure 5.2.1. Cetacean species diversity by country. The first value is the total number of species recorded in that country; the second value is the number of regular species (adapted from Evans, 2010).

Building upon the criteria for identification of FRVs proposed by the Article 17 Reporting Guidelines the following are proposed for setting FRPs and FRRs for cetaceans.

5.2.2 Setting FRPs for cetaceans

Population trends. Large-scale systematic surveys to estimate cetacean abundance only started in the North Atlantic in the late 1980s. Part of the Northwest European continental shelf was surveyed in July 1994 (SCANS survey – Hammond et al., 2002) and a larger area of the shelf in July 2005 (SCANS II survey – Hammond et al., 2013), whilst there was a survey along and beyond the West European shelf edge in July 2007 (CODA, 2009). A third SCANS survey took place in July 2016. The SCANS surveys have allowed trends to be determined for harbour porpoise, white-beaked dolphin, and minke whale (abundance estimates exist also for bottlenose dolphin and common dolphin but these have not been sampled sufficiently widely in both years to determine trends). Tables of existing abundance estimates for different species in NW Europe may be found in ICES (2016b). North Atlantic Sightings Surveys have also been undertaken mainly to the north of the British Isles, involving Norway, Faroe Islands, Iceland, Greenland, and in the early years, Spain, with surveys occurring during the summers of 1987, 1989, 1995, 2001, 2007 and 2015, yielding population trends for blue, fin and minke whale as well as sperm whale (Lockyer & Pike, 2009). Inshore populations of bottlenose dolphin are best monitored using photo-identification of individuals and capture-mark-recapture analytical techniques. However, for only six such populations (in the Sado Estuary, Moray Firth, Cardigan Bay, Shannon Estuary, Gulf of St Malo, and Ile de Sein) has it been possible to examine trends (over periods ranging from 5 – 29 years) (ICES, 2016a). Indices of abundance (as opposed to actual abundance estimates) exist for a number of species in UK waters, using data from a range of effort-based surveys extending back to the early 1980s (Evans et al., 2003; Paxton et al., 2016). Although some areas within the Mediterranean Sea have been surveyed systematically on occasions, there have not been surveys over the entire region, and no trends have been assessed (Notarbartolo di Sciara & Birkun, 2010).

A recommended approach for cetacean species where there is little past information on population parameters is to use genetics as an indicator of population health and decline (see, for example, Hoban et al., 2014). With improved techniques for genetic analyses, it is now possible to examine entire genomes and, even with small sample sizes, to investigate genetic variability in space and time using RAD (restriction site associated DNA) sequencing. This can provide measures of effective population size (Ne) comparing that to the censused population size (Ne/N ratio), genetic diversity and variability (observed and predicted heterozygosities, haplotype and nucleotide diversities). These provide insights into the extent to which present day populations have experienced contractions in size and loss of genetic diversity. Genetic analysis enables one to estimate the effective population size (Ne) for management units prior to major human impacts, as has been undertaken for large whale populations pre-whaling (Roman & Palumbi, 2003; Alter & Palumbi, 2009; Ruegg et al., 2013). Because there tend to be fine-scale divisions among coastal populations (e.g. of the common bottlenose dolphin), regional populations are often less diverse (lower Ne) than offshore, but coastal populations will also be the most impacted by human activities. Using metrics that reflect Ne, connectivity, and population dynamics, one could establish FRPs that are diverse, connected and stable, the three key population parameters to aim to attain. For guidance on how to approach these issues, see the decision-making tools developed from the EU CONGRESS Project (http://www.congressgenetics.eu/Default.aspx).

Management Units (see also § 3.2.6). Cetacean species rarely exhibit obvious discontinuous distributions and yet populations may be demographically, if not genetically, distinct and thus should be treated separately where those differences can be detected. Management units have been tentatively defined for harbour porpoise and bottlenose dolphin (Evans & Teilmann, 2009; ICES, 2013). Although generally difficult to determine with accuracy, there is scope to identify these for several species (Evans & Teilmann, 2009) and to set FRVs at the level of management units (see FRV-sheet common bottlenose dolphin).

Genetic Variation & Diversity. With improved techniques for genetic analyses, it is now possible to examine entire genomes and, even with small sample sizes, to investigate genetic variability in space and time using RAD (restriction site associated DNA) sequencing. This can provide measures of effective population size (Ne) comparing that to the censused population size (Ne/N ratio), genetic diversity and variability (observed and predicted heterozygosities, haplotype and nucleotide diversities). These provide insights into the extent to which present day populations have experienced contractions in size and loss of genetic diversity, and can be calculated for harbour porpoise, bottlenose dolphin, common dolphin, Risso's dolphin, killer whale, and long-finned pilot whale, and possibly other cetacean species.

Life History Changes. Other approaches to assessing the characteristics of a favourable reference population include measures of life history parameters: age structure, age at sexual maturity, pregnancy rates, and calving intervals. These can then be compared over time or with populations in other geographical regions. Examples of their uses can be found for harbour porpoise (Murphy et al., 2015), common dolphin (Murphy et al., 2013) and bottlenose dolphin (Feingold and Evans, 2014).

Population Viability Analysis. This has been conducted on a wide range of terrestrial birds and mammals but upon relatively few cetacean species because of lack of input data. One of the best-studied species is the bottlenose dolphin, and an example of a PVA analysis on the Moray Firth dolphin population can be found in Thompson et al. (2000).

5.2.3 Setting FRRs for cetaceans

Present Range. The present ranges of all fifteen cetacean species regularly occurring in European seas, are reasonably well known and have been described in a number of publications (see, for example, Reid et al., 2003; Culik, 2004; Jefferson et al., 2008; Notarbartolo di Sciara & Birkun, 2010).

Historic Range. Historic ranges, on the other hand, are not known for any cetacean species, and there is only fragmentary information of range changes before the 1950s. Some evidence exists for historical reductions in the occurrence of bottlenose dolphins in a number of coastal estuaries and semi-enclosed bays around Europe (Evans & Scanlan, 1989; ICES, 2016a), possibly as a result of pollution. And harbour porpoises appear to have experienced declines in several parts of Europe between the 1960s and 1990s (Evans, 1980, 1990, 2010).

Potential Range in Relation to Available Suitable Habitat. Through habitat modelling of present datasets it is now possible to determine the potential range of each of the fifteen common or regular species in relation to available suitable habitat, and to use this to better assess FRR.

Occupancy. Occupancy can be calculated, but only in the present and for the range of the fifteen common or regular species. Nevertheless, it would be useful to apply this to those species where robust estimates of population sizes and trends are not available. Occupancy-abundance relationships have been described in a number of taxa but have scarcely been investigated with cetaceans. This is an area of research that could usefully be developed further.

5.2.4 In summary

For cetaceans, some of the criteria proposed by the Article 17 Reporting Guidelines are more appropriate than others given their trans-boundary characteristics and for most species, relatively poor data on population sizes and trends, migration routes and dispersal. Some species (e.g. the great whales – blue, fin, sei, humpback, and northern right whale as well as sperm whale) have populations whose current sizes in the North Atlantic are clearly much diminished on what they were historically before commercial whaling, although pre-exploitation population size estimates are difficult to obtain, and both population modelling and genetic analytical attempts have given variable results (Roman & Palumbi, 2003; Holt & Mitchell, 2004; Punt et al., 2006; Alter & Palumbi, 2009; Smith & Reeves, 2010; Ruegg et al., 2013). However, new generation genetic approaches can address FRPs for the majority of cetacean species; they have the potential to provide a historical estimate before the bulk of anthropogenic related impacts, as well as various measures of genetic variability, and an estimate of migration rates.

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5.3 Migratory fish

5.3.1 General remarks

Migratory fish species that are using large areas comprising both freshwater and marine habitats to complete their life cycles are referred to as 'diadromous' species. They need not only both freshwater and marine habitats but also corridors in between making them vulnerable to multiple human pressures such as overfishing, pollution, habitat loss and migratory barriers. Within the diadromous fish species different life history traits are present. An often used division is between catadromous species spawning at sea and realising growth in freshwater (such as European eel *Anguilla anguilla*) and anadromous species spawning in freshwater and realising their main growth in marine habitats (such as Atlantic salmon *Salmo salar*, European sturgeon *Acipenser sturio*, North Sea Houting *Coregonus oxyrhinchus*, shads and lampreys).

The Habitats Directive lists 12 migratory species of fish and lamprey, the latter belonging to the order of Cyclostomata or jawless fishes (see Annex 2, Table A2.4). All of these migratory species are anadromous and many are endangered or locally extinct. The European sturgeon that used to be present in a large part of Europe now only occurs in the Gironde basin of France. The North Sea Houting that was endemic to the River delta of the Scheldt, Meuse and Rhine and the rivers entering the Wadden Sea, was close to global extinction. In both cases rearing in captivity was developed, followed by reintroduction programs using reared individuals.

The catadromous European eel is considered critically endangered by the IUCN but not listed on Annex II, IV, V of the habitat Directive. This species spawns in the Sargasso Sea in the Atlantic and realises most of its growth in freshwater on the European continent (individual life span range of ~6000km) and is dealt with within a separate EU trajectory (Council Regulation (EC) 1100/2007, 'establishing measures for the recovery of the stock of European eel').

5.3.2 Spatial scale of functioning

The spatial scale of the ranges that individuals use to complete their life cycle, varies highly among and within these species, both during their freshwater and marine phases (Table 5.3.1).

Table 5.3.1. Spatial scales of different life stages/habitats occupied by migratory fishes and lampreys that are listed on the Habitats Directive Annex II, IV, V.

species (scientific name)	species (English name)	Spawning dispersal within river basin	Homing to natal river?	Marine dispersal
L. fluviatilis	River Lamprey	Middle reaches of small-large rivers-tributaries	No	Unknown, limited coastal distribution?
P. marinus	Sea Lamprey	Middle and upstream reaches of large rivers	No	Unknown, larger dispersal sea basin?
A. naccarii	Adriatic Sturgeon	Restricted to the middle reaches of the Po (It)	Yes	Limited to (Northern) Adriatic Sea
A. sturio	European Sturgeon	Restricted to the middle reaches of Gironde (Fr)	Yes	Large over entire continental shelf
H. huso	Beluga Sturgeon	Restricted to lower-middle reaches Danube	Yes	Black Sea basin
A. nudiventris	Ship Sturgeon	Restricted to lower-middle reaches Danube	Yes	Black Sea basin
A. gueldenstaedtii	Russian Sturgeon	Restricted to lower-middle reaches Danube	Yes	Black Sea basin
A. stellatus	Stellate Sturgeon	Restricted to lower-middle reaches Danube	Yes	Black Sea basin
A. alosa	Allis Shad	Middle reaches of large rivers-tributaries	Yes	Coastal waters of up to several MSs

species (scientific name)	species (English name)	Spawning dispersal within river basin	Homing to natal river?	Marine dispersal
A. fallax	Twaite Shad	Lower reaches of large rivers (tidal freshwater sections)	Yes	Coastal waters of up to several MSs
S. salar	Atlantic Salmon	Upstream reaches of small-large rivers	Yes	Very large, North Atlantic Greenland-Faroer-Norway, more restricted in Baltic
C. oxyrhynchus	North Sea Houting	Lower-middle reaches of small-large rivers South Eastern part of North Sea (Scheldt – Wadden Sea)	Yes	Limited to estuaries and adjacent coastal waters in close vicinity of rivers

Most anadromous species perform strong natal homing to the rivers they were born and therefore populations in rivers are reproductively isolated with limited gene flow between populations. The lampreys form an exception to this, with much more mixing between populations in adjacent rivers as a consequence (Bergstedt et al., 1995). Lampreys use pheromones excreted by larvae ('ammocoetes') that live in the middle and upstream sections for spawning, not necessarily the river they were born. The pheromones are an important cue to select spawning rivers and therefore go to rivers proved suitable for the species rather than returning to where they were born (Buchinger et al., 2015). As a result, the migratory fish species have fairly separated spawning populations per river basin, whereas lampreys show more mixing between river basins and thus form larger regional populations at a larger scale than individual river basins.

When combining the freshwater and marine phase, individuals for most migratory fish species use spatial scales that encompass more than one MS. When considering only the freshwater stages of river basin populations, most are confined to a single MS, except for some large river basins like the Rhine (NL, DE, FR, Switzerland), Meuse (NL, BE-WAL, LU, FR, DE) and Danube (DE, AT, CZ, SK, HU, BU, RO) or rivers forming borders like the Oder (DE, PL).
Potentially, species that complete their life cycle within large river basins like the Rhine, Meuse or Danube can have individuals with home ranges that encompass several MS's. Even though data and knowledge on the scale of movement patterns of most freshwater species is limited, there are examples of individuals may move over several hundreds of kilometres within a river basin. However, these appear to encompass only a smaller proportion of the populations. As of yet, no species are known where the majority of the population has home ranges that exceed MS scales.

For some endangered marine fish species this is different, e.g. different shark species or Bluefin tuna, where the majority of individuals of a population may perform movement patterns at scales of several 1000s km. However, no marine species are included in the Habitat Directive Annexes and therefore not considered here.

5.3.3 Setting FRPs

Minimum viable populations
For fish, minimum viable population size can vary between species and depending on the different life history traits and degree of mixing between populations. Thompson (1991) reviewed the various methods available, to determine the MVP for fish stock. Depending on the degree of precision desired, the conclusion of the analysis was that most rules of thumb fall within an order of magnitude of each other, giving a generic MVP of 1,000 to 10,000 adults. Also Traill et al. (2007) list much higher numbers for MVP for fish than for other taxa. PVAs are possible, e.g. Wildhamer et al. (2017) for pallid sturgeon in the Mississippi, but they require extensive datasets on parameters that are rarely available for endangered fish species and often very hard to measure in practice.

Population trends and management units
For most species river basins are the appropriate 'population' scales and/or management units. Especially for the diadromous fishes that show strong homing to natal rivers. Because diadromous fish populations rely on very different habitat types ranging from freshwater to marine, are highly dependent on corridors linking these habitats (estuaries and mainstem rivers) that are often densely populated and used by humans, they are highly vulnerable to anthropogenic impact. Diadromous fish populations have decreased dramatically in most of the river basins throughout Europe (Limburg & Waldman, 2009) due to a combination of severe overfishing, migratory barriers like dams and weirs, water pollution and habitat loss. This lead to many local extinctions or strong decreases in population numbers in river basins in the course of the 19th and first half of the20th century. European Sturgeon, Adriatic Sturgeon and North Sea Houting were close to global extinction (hence the priority status for these species within the Habitat Directive). Due to captive breeding programs these species were safe guarded against extinction, though for European Sturgeon and Adriatic Sturgeon natural reproduction in the wild has been lacking for tens of years. North Sea Houting has been successfully reintroduced in different Danish, German and Dutch rivers and nowadays forms self-sustaining populations that do not rely on stocking anymore. The Atlantic Sturgeon (*Acipenser oxyrhinchus*) that historically occupied the Baltic, and there is growing evidence that it also lived in sympatry with the European sturgeon along the Atlantic and North Sea coasts of western Europe, became extinct in Europe in the 19th and first half of the20th century and is now only found in the western Atlantic in North America.

5.3.4 Setting FRRs

Present range
Some migratory species have very restricted ranges of occurrence during their freshwater stages due to extensive local extinctions well before 1992. European sturgeon is now only limited to the Gironde basin. Beluga, Ship and Stellate Sturgeons are confined to the lower reaches of the Danube. The Adriatic Sturgeon is confined to the Po. North Sea Houting was confined to a single small river in southern Denmark, the Vida Aa, in 1992. After successful reintroduction programs they re-occurred in the lower reaches of the Elbe and the Rhine. Other species, namely Atlantic Salmon, Allis and Twaite Shad maintained a wide distribution with some local extinctions in some river basins (mainly in western Europe, e.g. Seine, Thames, Meuse, Rhine), where several reintroduction efforts are being carried out especially for Atlantic salmon (Thames, Seine, Meuse, Rhine) and to a lesser extent Allis shad (Rhine). The range of the River and Sea Lamprey has maintained comparable to historical times.

Historical range (19th-early 20th century)
For many species, historical ranges were substantially larger than the present ranges, both in terms of river basins occupied as well as the range occupied within a river basin. M barriers like dams and weirs often restricted the range of occurrence, especially for species that used the upstream reaches and tributaries for spawning, such as Atlantic Salmon and the different sturgeon species in the Danube. The most dramatic decrease in range took place for the European sturgeon that was distributed throughout Europe ranging from river basins around the Black Sea, Mediterranean, Atlantic coasts, North Sea and Baltic Sea, whereas nowadays it is confined to the Gironde in France. The Adriatic Sturgeon was present throughout the Adriatic Sea, and is now confined to the Po and northern part of the Adriatic Sea. The North Sea Houting already had a limited historical distribution ranging from the lower reaches of the Scheldt, the Meuse, Rhine up to the the small Danish rivers discharging into the Wadden Sea (South-Eastern North Sea endemic), but became extinct in all but one small Danish river (Vida Aa).

5.3.5 Taxonomic controversies

Freyhof & Schöter (2005) claimed that the North Sea Houting was confined to the Scheldt, Meuse and Rhine basins and that this was a different species than found in the Elbe and Danish Wadden Sea area based on morphological differences (number of gill rakers) between museum houtings from the Scheldt, Meuse and Rhine basins and the houtings from the Vida (which they claimed were in fact *C. maraena*). This view was adopted by the IUCN and therefore the North Sea Houting *C. oxyrhinchus* is listed as globally extinct by the IUCN. Other scientists dismissed this claim due to the lack of genetic evidence and the strong morphological plasticity that is found in many of the Coregonid species (e.g. Hansen et al., 2006, 2008; Jacobsen et al., 2012).

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5.4 Birds

5.4.1 General remarks

Two methods are generally available for setting FRVs for reproductive populations (see § 4.1.3):

- the combined population-based and reference-based method which starts by identifying the upscaled minimum viable population (MVP) size (see § 5.4.2) and by identifying the historical trend in numbers, in particular since the start of the Bird Directive;
- the potential-range method which uses information on habitat requirements and suitability (see § 5.4.3).

Both methods, as applied to birds, require that the FRP must exceed the upscaled MVP-value. Furthermore, the FRP should not be smaller than at the start of the Bird Directive (DV: 'directive value')(see § 5.4.2 step 2). Note that the potential-range method is constrained by MVP size as well (as applied to birds).

Generally, reference-based methods are the only option in setting FRVs for non-reproductive 'populations' in key areas for wintering or passing (§ 5.4.4). In the case of working with distribution or occupancy data as proxies for population numbers, a reference-based method should be used as well. SOVON has tested this approach in a case of the lapwing (*Vanellus vanellus*) in the province of Friesland (the Netherlands)(Teunissen et al., 2015) and this was supported by the State Attorney. They used distribution data (km-squares) to define a period in which this distribution was considered favourable and defined the regional favourable reference population as the population index in that period. If data on the exact rate of change are lacking because there is no yearly change index then operators can be used to describe the population status relative to the reference period.

5.4.2 The MVP-concept in setting FRVs for birds

Refer to § 3.2.2 (Population viability analysis) and 3.2.3 (Minimum viable populations and generalised genetic rules) for introductory information and compare § 3.2.4 (MVP-targets derived from body size relationships).

A MVP-body size relationship for breeding populations of birds
The number of bird species for which MVPs have been calculated is limited (Traill et al., 2007) and for many European breeding birds MVPs are not available. Following Hilbers et al. (2016) who derived relationships between MVP and body size for terrestrial mammals using population modelling (see § 3.2.4), we investigated the more simple approach of a direct allometric relationship between MVP and body size in birds. Although there are some outliers, generally light weighed birds (<1 kg) have MVPs around 2500 individuals and heavy birds (>1 kg) have MVPs around 500 individuals (Figure 5.4.1).

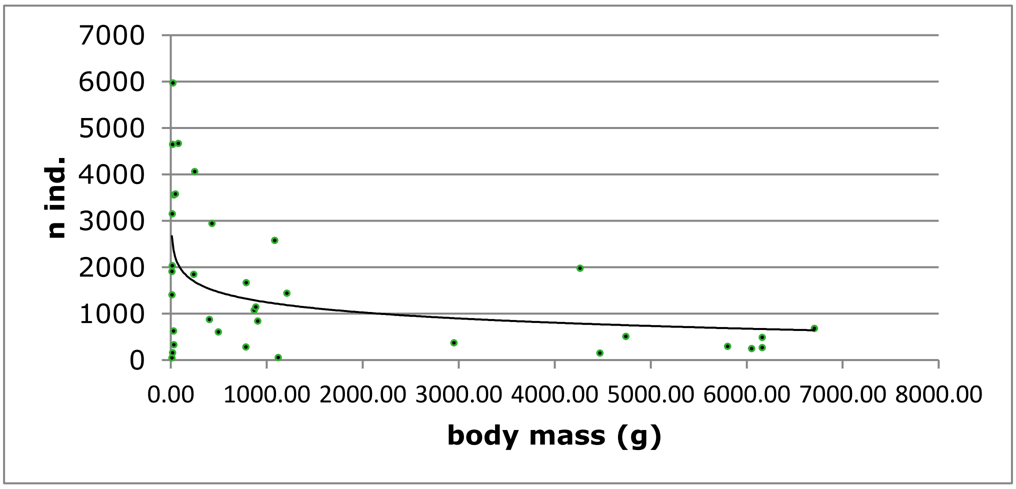

Figure 5.4.1. Relation between the MVP-values of birds (n individuals; based on Traill et al., 2007) and body mass (g) (Foppen unpubl.).

Guidance in setting FRPs for birds using MVPs and reference values
Step 1. Setting and upscaling MVPs

1. Preferably use a published MVP (e.g. Traill et al., 2007).
2. If a published MVP is not available use the relationship between MVP and body size presented above (Figure 5.4.1).
3. As a first FRP estimate, apply a multiplier to account for the risk of a large magnitude decline. This step is part of ongoing research by the Royal Society for the Protection of Birds (RSPB) and Durham University on defining favourable conservation status for birds in the UK[6]. Awaiting further guidance, we agreed to use a factor 10 as a rule of thumb (Table 5.4.1). In cases where this results in unrealistically high FRPs, an appropriate historical value should be considered (e.g. for the Great Bustard population in the German-Polish plain and for the Baltic Sea population of Dunlin; see FRV-sheet Great Bustard)
4. Continue the stepwise process by considering additional population possibly needed to take into account ecological/genetic variations within the (historical) natural range (see Box 4.2).

Table 5.4.1. Rule of thumb values of upscaled MVPs as dependent on body mass to be used in setting FRPs for birds.

body mass (g)	upscaled MVP (breeding pairs)
≤ 1000	12500
> 1000	2500

[6] by Rhys Green, Jerry Wilson, Gillian Gilbert (RSPB) and Tom Mason, Steve Willis, Phillip Stevens (Durham University).

Step 2. Considering reference values
Population numbers should not be lower than at the start of the Bird Directive (DV); this is a requirement of the Bird Directive. Generally, quantitative data on the population status of bird species are available for that period. Of course this does not necessarily mean that that DV is a favourable situation for a bird population:

1. A species' population size might have declined before the BD came into force. In that case the upscaled MVP value always serves as a threshold to prevent setting a FRP that might lead to extinction. If the DV exceeds the MVP, the FRP should be at least equal to DV. A higher FRP value should be set if the species is known to have declined as a result of unnatural conditions that could be reversed given the current human presence and its needs.
2. A species' population size might have been above MVP level when the BD came into force although it was depleted at that time. However it has shown recovery since, because of restoration of natural conditions. In that case a more recent population level should be set as FRP such as current value (CV) or use an operator and wait till population size has been stabilized.
3. A species' population size can have increased after the BD came into force not as a consequence of restoration/improvement of natural conditions but due to a substantial increase in artifical habitat. We suggest to set DV as FRV (if it exceeds upscaled MVP), despite a higher CV in this case. An example is the increase of geese in the Netherlands as a result of agricultural intensification leading to an increase and improvement of foraging habitat.

5.4.3 The potential range method in setting FRVs for birds

The LIPU (Lega Italiana Protezione Uccelli)/BirdLife Cyprus-method is a model-based approach for setting FRVs for large populations of breeding bird species (more than 2500 pairs). The method works by identifying favourable reference densities in 'optimal' and 'average' habitats within a potential range. Whenever possible, the availability and relative suitability of a species' habitat is modelled. A FRP is derived by applying habitat-density relationships. When feasible a future vision is then developed, which results in estimates of future habitat extent and suitability including restoration opportunities, which in turn can contribute to defining the favourable reference value for population. The resulting FRP value should be definitely higher than the (upscaled) MVP.

The method was developed and applied by Brambilla et al. (2011, 2013) and Tye et al. (2014). The FRV-sheet for Wood Warbler demonstrates the process of setting FRVs. In summary the method includes the following steps:

1. Define favourable density
    a. Assess what constitutes 'optimal' and 'average' habitats or mosaics of these for the species at relevant spatial levels (local to landscape level).
    b. Identify favourable reference densities in 'optimal' and 'average' habitats or mosaics.
2. Assess the FRP based on current habitat
    a. Whenever possible, assess the potential and current spatial distribution of habitat extent and suitability (e.g. by species distribution or habitat suitability modelling).
    b. Derive a FRP based on habitat extent and suitability and density values previously obtained.
    c. Check whether the FRP is higher than the (upscaled) MVP (see § 5.4.2). If not, the upscaled MVP must be used.
    d. Adjust the FRP on the basis of the habitat extent and quality resulting from a future vision on restoration opportunities and foreseen macro-habitat changes (e.g. due to climate change, land abandonment, habitat restoration, etc.) and potential conflicts between and within macro-habitats/habitat types, taking into account ecological requirements of the different species and whether this prevents reaching favourable reference densities.

5.4.4 Setting FRVs for flyway populations of migratory birds

Why a special approach for migratory birds?
In migratory birds the conservation status (population size, trend, range, distribution) will be the combined result of conditions during breeding, migration and wintering and the interactions between

these annual cycle phases. In many migratory birds these phases occur large distances apart often in different countries or even continents with rather contrasting environments. Bottlenecks in population development can be caused by factors in one or a combination of these annual cycle phases. Many examples exist of causes of unfavourable conservation status connected to either breeding, migration or wintering without evidence that one of these phases is more dominant in causing population limitation than the other (Newton, 2008). On the other hand evidence exist that migratory bird populations have in general a less favourable conservation status than resident populations showing that this lifestyle is extra demanding with respect to current habitat conditions and requires extra conservation effort (Vickery et al., 2014).

Table A2.5 in Appendix 2 lists all European (partially) migratory birds with indications whether species breed or winter in Europe.

FRVs for flyway populations including breeding, staging and wintering
Given the framework of favourable reference values under the Birds Directive these references must be defined for all components of the flyway population i.e. the reproductive phase and the migration and wintering phases of the annual cycle (see also guidance on the interpretation of Favourable Conservation Status under AEWA, 4 sept 2017 (AEWA Technical Committee, 2017)). The conservation status of the flyway population is considered favourable only when all phases are in good condition. Several member states have designated Nature 2000 sites for the occurrence of important concentrations of specific bird populations during migration and or wintering.

As a consequence the evaluation of the conservation status of flyway populations needs FRVs for the staging and wintering annual phases besides FRVs for the breeding phase. Important steps in setting these FRVs are similar to the general stepwise approach but require additional considerations:

1. agreement on the definition and delineation of a flyway population for a particular species;
2. gathering information about the population status of a flyway population;
3. assessment of the FRP and FRR for components of the flyway population including the breeding, migration and wintering phases.

Step 1. Define and delineate flyway populations
A flyway population is a ‘distinct’ population of a single species within its flyway. A flyway is the entire range through which the population moves on an annual basis including the breeding grounds and wintering grounds and the area in between used for feeding, resting and migration (Boere & Stroud, 2006). A distinct flyway population can be the entire population of a monotypic species or of a subspecies. In most cases flyways are defined by knowledge of connectivity between breeding, staging and wintering ranges in a rather crude way and on a relatively large geographical scale (Figure 5.4.2 and 5.4.3). Within the breeding, staging and wintering ranges of a species, more or less discrete geographical units can be distinguished. Examples within the European-African migration system are: East Canada and Greenland, Iceland, Scandinavia, West Russia, Siberia, British isles, West continental Europe, East Europe for the breeding range and NW Europe, West Mediterranean, East Europe, East-Mediterranean, West Africa, East Africa, South Africa for the wintering and staging range. Between the breeding, staging and wintering geographical units, connectivity is investigated using information from ringing of individual birds or other marking and tracking data or based on biometrics, isotopes and DNA signature. Patterns in connectivity between breeding, staging and wintering units reveal boundaries between flyway populations. If such patterns are not found, mostly the entire population in the African-Palearctic region is considered as one flyway population which in itself can be a subdivision of a more worldwide occurrence of the species.

Within a flyway and therefore within a flyway population of a migratory bird species, truly migratory individuals breeding in the northern parts may mix during migration and or wintering with more sedentary individuals in the southern part of the breeding range. Both kinds of individuals are considered part of the same flyway population.

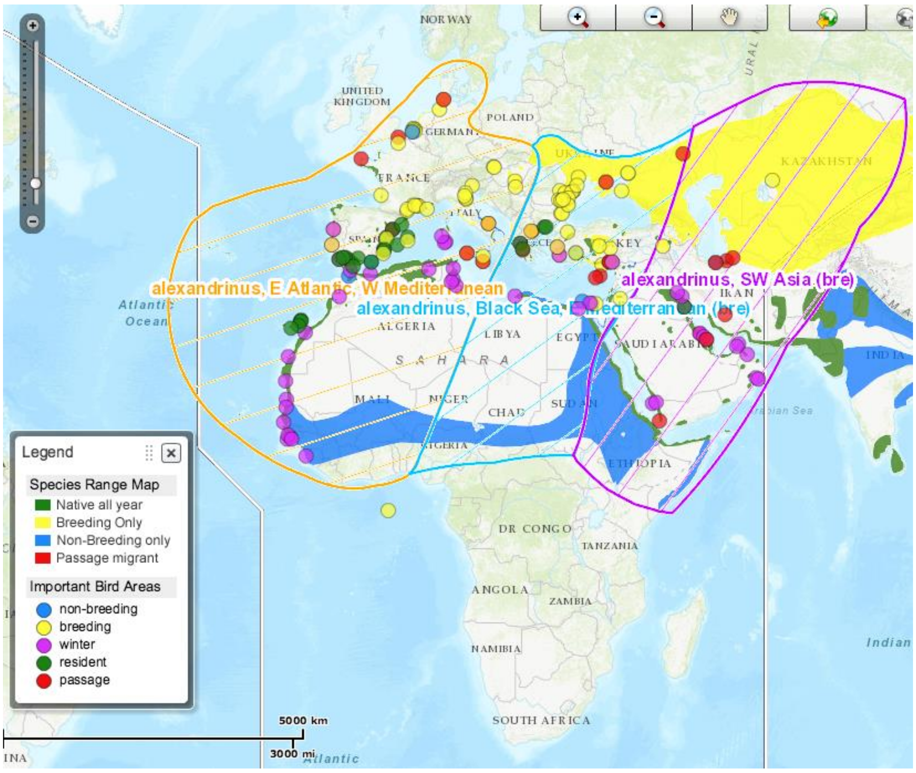

Figure 5.4.2. Waterbird example showing distinct flyways. Delineation of Flyway populations of Kentish Plover Charadrius alexandrines in the African-Eurasian region (http://csntool.wingsoverwetlands.org).

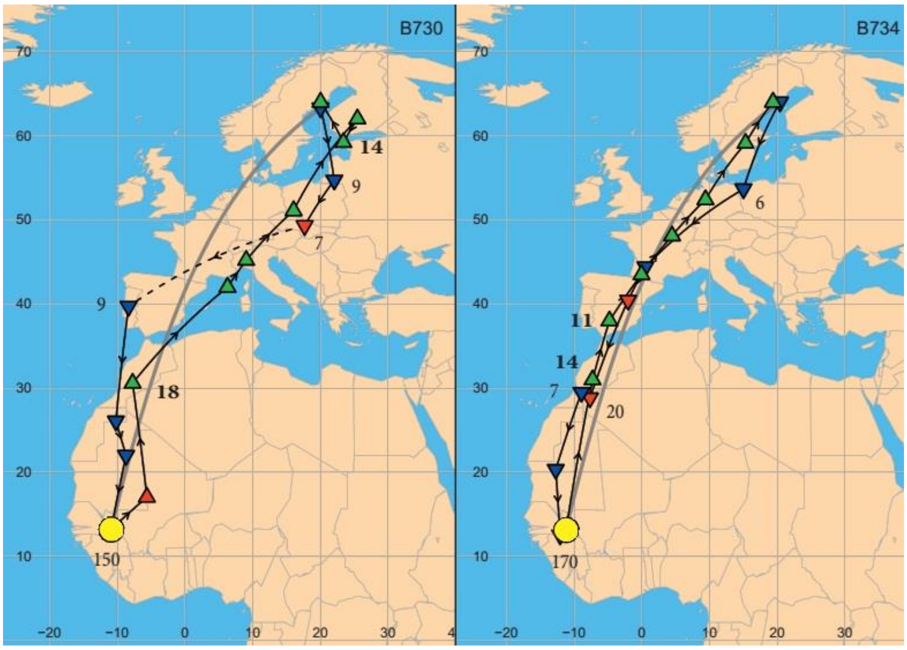

Figure 5.4.3. Passerine example showing distinct flyways. *Migration routes for Ortolan Buntings (*Emberiza hortulana*) between Sweden and sub-Saharan Africa. Longer stays are indicated with numbers (equalling the number of days spent there). Figures given with regular font represent autumn; bold figures represent spring periods (based on Selstam et al., 2015).*

This concept of flyway populations is at present well developed for waterbirds (Scott & Rose, 1996; Delany et al., 2009; Critical Sites Network tool - http://csntool.wingsoverwetlands.org) but can also be applied to seabirds (Brooke, 1990; Nelson, 1997) and passerines (Zwarts et al., 2009). As an underpinning of these flyways a summary of connectivity information should be made. Many references with data from individual countries (ringing atlases) exists already and an European/African integration should be made to use this data to define flyway populations.

Defining the breeding ranges requires information available from breeding bird atlases and other information about evidence of breeding (Hagemeijer & Blair, 1997; Lappo et al., 2012). Up to date breeding ranges are also indicated in recent field guides and handbooks (Svensson et al., 1999; del Hoyo et al., 1999-2011). The wintering range can be loosely defined as the geographical range were the population is between the end of their autumn migration and the start of their spring migration. In practice population specific choices need to be made based on knowledge of behaviour and timing of movements. Wintering ranges can also be found in del Hoyo et al. (1999-2011). The staging range is the geographical area where migratory birds make stop-overs for some days or weeks to restore energy reserves. This range is part of the overall migration range. The direct use (staging) at sites and habitats during migration is most appropriate for defining FRVs. Sometimes the difference between wintering and staging range is less clear and the two are better taken together.

Step 2. Gathering information about the population status of the flyway population
In this step information is gathered about size and trend of population numbers and range of the flyway population, preferably including historical data in connection with major pressures and threats. Estimates of population size should be based on either wintering or breeding phase or sometimes migration, based on the best estimate available, but should be cross checked if estimates from more than one phase are available. Estimates can be the result of a more or less complete surveys or combinations of surveys and extrapolations. Trends should be based on monitoring programmes. Information about ranges needs to be based on atlases and records of occurrence. Regular occurrence (on a yearly basis in a certain minimum number during breeding, staging and wintering) should be considered as part of the range contrary to irregular or vagrant occurrences.

Step 3. Assessment of the FRP and FRR for components of the flyway population.
For a given flyway population, assessment of the conservation status must be based on the population size of the breeding phase (relative to the reproductive FRP) and wintering and or staging phases (relative to corresponding non-reproductive FRPs). Corresponding FRRs can be derived by following the general stepwise approach (see § 4.2).

> *Step 3.1. Breeding populations (reproductive FRPs)*
> Paragraph 5.4.2 addresses how MVP-based FRPs for breeding bird populations can be defined and this applies to the breeding phase of flyway populations as well.
>
> *Step 3.2. Wintering and/or passing populations (non-reproductive FRPs)*
> Population numbers in wintering and passing areas can not be assessed by a MVP-based method but must of course be consistent with estimates of breeding populations. However, a particular wintering area can be used by different flyway populations (e.g. see FRV-sheet Dunlin). For this kind of wintering 'populations' four non-reproductive population categories have been established: MNR1 - MNR4 (see Table 4.1). Targets for wintering must consider the carrying capacity of the (national or supranational) wintering areas using time series over several years from which peak numbers can be used as a proxy for the non-reproductive FRP and a reference value can be derived for the population size in 1980 (DV).

The FRV-sheets of Smew and Dunlin demonstrate the process of setting FRPs and FRRs for components of their flyway populations.

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5.5 Invertebrates

5.5.1 General remarks

All invertebrate species together cover a tremendous diversity in size, life history and habitats. With respect to setting FRPs, some of the larger species, like octopuses, may be comparable with mammals in methodology. Large as a reproductive unit are wood ant colonies, which may be treated in the same way. At the other end of the size spectrum, the very small individuals may be assessed by an area-based approach as a proxy. The challenge is to tackle the large group in between: the small and mobile species. Migrating dragon flies, butterflies and moths may be treated like migrating birds, as distances are often comparable as in the butterflies *Vanessa cardui* and *Vanessa atalanta* and the dragon flies *Anax parthenope* and *Sympetrum fonscolombei*. Species migrating or commuting on smaller scales require larger areas than just the area where they forage. Ground breeding bees such as *Andrena vaga*, require open soil and their main food source, flowering willows, in short distances (less than a couple of 100 m, for smaller species even closer). Dragon flies and damselflies develop in fresh water and forage as an adult in sometimes extended landscapes: *Sympetrum sanguineum* develops in soft water lakes, where eggs are deposited on the banks and rain in the water next season, whereas the emerged adults use the vast heathland landscape to hunt. These are just a few examples of many species that require more than one habitat type in close range.

A number of species appear to need much larger areas than previously understood: ground beetle species such as *Poecilus versicolor* at the Dwingelderveld and *Brachinus crepitans* at the Wrakelberg (both in the Netherlands) occupy as a moving population a much larger area than the few acres around fixed pitfall traps, resulting in an apparently fluctuating number in the traps, while the population is fairly constant in sizes but moves around in the area. This makes the area to conserve thus bigger than presumed. In another example, a butterfly *Melitaea cinxia* at the Bemelerberg (the Netherlands), the area needs to cover larger differences in moisture gradients, as the population moved in a very dry year to the extended part (reclaimed from agriculture just a few years before) of the area (which was moister) and recolonized the original reserve the year after again. A nice example of metapopulation movement; without the reclaimed extension of the original reserve, the reintroduced species would have been gone extinct again (see also Van Noordwijk et al., 2012).

Another problem to tackle, typically in invertebrates, is that of the very vast fluctuations in numbers. However, in most species numbers are fairly high, thus no extinction problems are to be expected in terms of loss of genetic variation. Loss of habitat will usually be the largest threat. Nevertheless, some species occurring in lower densities may show these high fluctuations, for instance in the butterfly *Callophrys rubi*: in transect studies annual densities vary from 10-350. In PVA studies this variance is used to estimate the chance of extinction (less than once in 100 generations). In this methodology one assumes a mirroring of fluctuations downward and upward, while from ecological literature it is known that downward fluctuations are much lower in magnitude than the upward ones. Even several kinds of life history features exist to cope with detrimental seasons, such as prolonged diapause, resting eggs, etc. Taking the log of the numbers before calculating the PVA may help here to prevent overestimates of required surfaces to keep a population in a sustainable state.

So, in summary, for larger invertebrates methodology as proposed for mammals may be used, for the vast majority of the small and less mobile ones, habitat preservation is of most importance, thus following an area-based approach. Only the small and mobile species require extra attention in terms of metapopulation dynamics, combination of habitats were required, and rescaling the fluctuations in numbers when PVA are to be calculated.

5.5.2 Population categories for species groups based on mobility, body size and density

As argued above, for invertebrates as a group one may need several methodologies to proper estimate a FRP. We will start with a short key based on just mobility, body size and density of the species:

1. a. Larger species, usually in low density with a high to moderate mobility (e.g. octopuses, colonies of carpenter bees and larger ants, N.B. the colony here is the unit of reproduction, not the individual, so mobility, size and density refers here to colonies): **Group I**
   b. smaller species, or having higher mobility and/or density -- 2
2. a. Species less mobile in most of their life stages, usually in high densities in the habitat they live in, size is mostly small (e.g. soil inhabiting mites and springtails, plant specific herbivores as aphids, all kinds of leaf mining insects, etc.): **GROUP II**
   b. Species having a higher mobility and sometimes a lower density --------------------------------- 3
3. a. Species using several types of habitats during their life span, these types of habitat lie within the mobility range of the species during one generation, or species having a higher mobility that allows for fast (re)colonization of new spots -- 4
   b. Species being much more mobile, with individuals dispersing over large distances, even crossing MS borders (e.g. migrating butterflies and dragonflies): **GROUP III**
4. a. Species having a high mobility that allows for fast (re)colonization of new spots: **GROUP IV**
   b. Species using several types of habitats during their life span, these types of habitat lie within the mobility range of the species during one generation: **GROUP V**

These groups are decribed in more detail below in relation to the populatuion categories defined in Table 4.1 (main text).

Group I: Species having a moderate to high mobility, large size and usually lower densities. FRPs for these species may follow the methodology for vertebrates (mammals, birds, fish etc.) with population category S1.

Group II: Species in this group have small-sized individuals, usually in high densities and with a limited mobility (population category S6). Populations are not often subject to extinction threats, nevertheless, if the local habitat becomes too small or deteriorated, recolonization may be very difficult due to local adaptations of these species. Local adaptation can be seen as a trade-off to mobility: either a species is more mobile and hence less adapted to specific local environmental conditions, or a species is very well adapted and is consequently less mobile (higher mobility and colonization would give rise to a higher mortality rate, due to experienced less favourable conditions elsewhere).

Group III: For species in this group the same methodology as in birds may be followed (mostly population category S1 or MR1 for truly migratory species). However, for calculating growth rates of populations a log transformation on numbers may be used as argued above.

Group IV: Species having a higher mobility that allow for fast (re)colonization of new spots are typically the species with metapopulation dynamics (population category S5). This concept was introduced in a study of an endangered butterfly, the Glanville fritillary (*Melitaea cinxia*) (Hanski et al., 1995). In setting FRPs not only the number of individuals per site is important, but also the number of potentially suitable sites and their connection. Based on the metapopulation dynamics (frequency of (re)colonisations and local extinctions) one can calculate the number of sites needed for a sustainable metapopulation (see Mills, 2007 Chapter 10).

Group V: Species using several types of habitats during their life span require that these types of habitat lie within the mobility range of the species during one generation. Population can mov around in vaste areas, e.g. for *Poecilus versicolor*, a ground beetle. Sampling these populations on fixed spots (for instance with pitfall traps) may give rise to fluctuating numbers on such a spot, whilst the population as such has much less fluctuation. This kind of dynamics is included in population category S5 as well.

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5.6 Marine habitats

5.6.1 General remarks

Nine habitat types on Annex 1 are included under marine reporting requirements of the Habitats Directive (Table 5.8.1). With the exception of Posionia beds, they are all physiographic features, albeit at various scales. Estuaries and inlets and bays can extend over many square kilometres for example, while sea caves and submarine structures made by leaking gases are typically much smaller features. Reporting on the status of coastal lagoons (habitat code 1150) is usually grouped with terrestrial habitat types.

Most of the habitat types occur in many coastal Member States and are present across all the marine biogeographical regions. The main exception is Boreal Baltic narrow inlets, which only occurs in the Baltic biogeographical marine region. Posidonia beds, a priority marine habitat type, also has a more limited distribution, being found mainly in the Mediterranean but also in the Macaronesian marine region.

Table 5.8.1. Marine habitat types.

Habitat code	Habitat Type
1110	Sandbanks which are slightly covered by sea water all the time
1120	Posidonia beds (Posidonion oceanicae)
1130	Estuaries
1140	Mudflats and sandflats not covered by seawater at low tide
1160	Large shallow inlets and bays
1170	Reefs
1180	Submarine structures made by leaking gasses
1650	Boreal Baltic narrow inlets
8830	Submerged or partially submerged sea caves

The Interpretation Manual of EU habitats describes some of the variability within these habitat types. Some of the descriptions have been modified (cf. sandbanks) and additional changes made for accession countries since the first version of the Manual was published (EC, 1995; EC, 2007; EC, 2013) and consequently shifted potential values of FRV and FRA between the first and subsequent reporting periods

The list of marine habitat types is far less comprehensive than that for the terrestrial environment, particularly in relation to shelf and open ocean ecosystems (e.g. EEA, 2015). Guidance on determining FRVs could therefore usefully be framed with a potentially expanded Annex 1 list of marine habitats in mind.

5.6.2 Setting FRR and FRA for marine habitats

Current range. The current range of what are often large intertidal/coastal marine habitat types (1130, 1140, 1160 and 1650) is generally well known across the marine biogeographical regions. The situation is less clear for permanently submerged/offshore features primarily due to lack of information or mapping on a detailed enough scale to distinguish such habitat types. This is being addressed through marine survey work and inventories frequently driven by the requirements of the Habitats Directive (e.g. Barratt et al., 2014) and supported by INTERREG projects (e.g. MESH, and PANACHE). A recent 'Red List' assessment, using a network of marine scientists, has also brought together information to provide an overview of the character, extent and status of benthic marine habitats across the European Union (Gubbay et al., 2017). The knowledge base for determining current range of marine habitats, including Annex 1 habitat types is therefore improving and consequently the baseline, even working on 10 x 10km grid squares, is likely to change for these lesser known habitat types at least over the next reporting period.

Potential extent of range. Given that the majority of Annex 1 marine habitats are physiographic features, the underlying geological, physical and oceanographic processes are especially important influences on their potential range. Understanding and mapping these influences has been used to scope the potential range of some offshore habitat types (e.g. sandbanks and reefs). The use of proxies is a reasonable and realistic approach to determining potential range of such marine habitat types and therefore also informative where there is an absence of current range data. Indeed, in the absence of historical data and current range information, this is potentially the most significant factor to focus on when setting FRR.

A valuable source in this regard at European level is EUSeaMap, although working at a more detailed level than Annex 1 habitat types (see Figure 5.8.1). A combination of survey data and predictive modelling is being undertaken in phases by the European Marine Observation and Data Network (EMODnet). Work to date has provided benthic habitat layers across the Celtic Seas, Greater North Sea and Baltic Sea, as well as undertaking broad-scale mapping of the western Mediterranean for the first time. The coverage of the maps is currently being extended to all European seas.

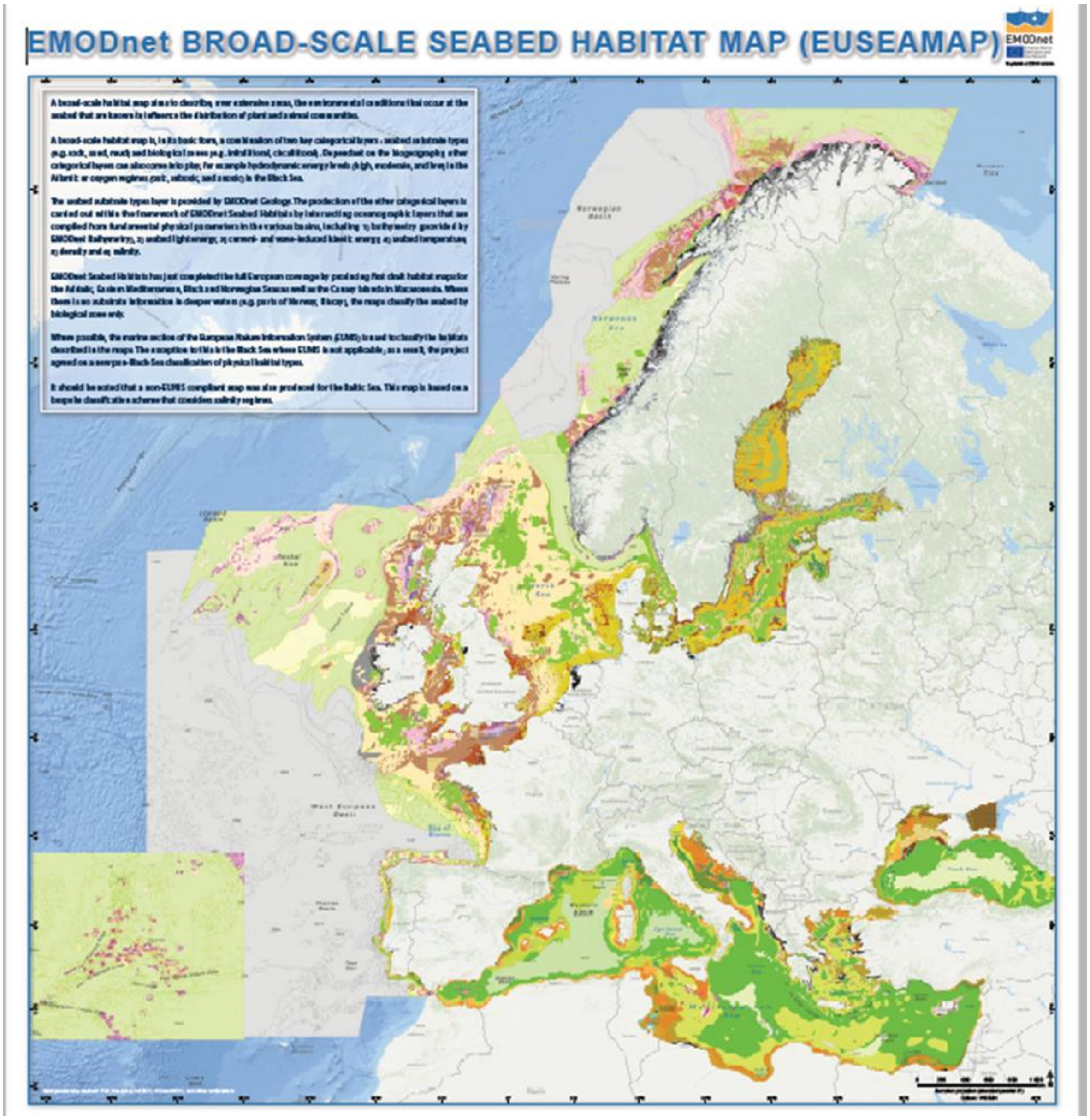

Figure 5.8.1. EUSeaMap.

Historical range. The timescale over which historical range is considered will determine the potential for FRR to be informed by this parameter. For example, there is good historical information on changes in the extent of the some of the Annex 1 habitat types. This is most likely the case for 1130 and 1140 but with the most substantial changes in extent having taking place in the 18th and 19th centuries. More recent (decadal) changes have been reported for Posidonia beds (1120) based on species distribution (e.g. RAC/SPA, 2014), while for physiographic features such as 1160 and 1650 historical range may be similar to current range, as substantive changes may take place over geological time scales. There is unlikely to be detailed historical mapping of the extent of habitat types where they occur far from the coast or in deeper waters, although some point source data and small scale maps are available, for example from 19th century scientific surveys, fishing logbooks and historical charts.

Area required for variability of the habitat. For Annex 1 marine habitat types that are physical features, such as Boreal Baltic inlets and estuaries, their variability is usually known and described in general terms. Despite this the associated biotopes/marine communities may not be known and even where this is the case, they may be poorly understood. This precludes a good understanding of whether the full variability of the habitats is present within the FRR. It is also the case that such variation is unlikely to be 'captured' at a national scale (e.g. submerged and semi-submerge caves which support different characteristic communities depending on the predominant rock time).

Nevertheless, if the variability is accounted for within each Member State, then when taken in combination, this factor should be adequately addressed.

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under construction

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Annex 1 Questionnaire sent to Member States

QUESTIONNAIRE ON SETTING REFERENCE VALUES

This inquiry results from a service contract by the European Commission for *Defining and applying reference values for species and habitats under the EU birds and habitats directive* (ENV.B.3./SER/2015/0009). The contracting authority works closely together with the EEA and its ETC-BD who are leading on the whole review process.

The questionnaire has been sent to all Member State representatives involved in Article 12 and 17 reporting. The results of this inquiry will become available spring 2016 in the CIRCABC-website on Favourable Reference Values (https://circabc.europa.eu/w/browse/951a6763-c409-4f66-9fce-c7e9b6ed80c2).

The deadline for filling in the questionnaire is **31 December 2015**. Please send the completed document to Angelika.Rubin@ec.europa.eu with copies to rienkjan.bijlsma@wur.nl and Carlos.Romao@eea.europa.eu.

General			
Member State:			
Contact details of persons involved in setting Favourable Reference Values (FRVs)	name*	e-mail*	FRR/ FRA/ FRP**
Documentation of methods used to set FRVs	reference*	link*	language*
Documentation of definitions for habitat types including typical species	reference*	link*	language*
Did you set reference values for bird populations under the Birds Directive?	no/ yes**; if yes: please give name and e-mail address of contact person***:		
Methods for features of the Habitats Directive only			
When did you report reference values as unknown (x)?	lack of actual distribution data/ lack of historic distribution data/ lack of trend data**/ other reasons:***		
When did you report operators instead of real values?	***		
How did you decide whether FRVs are different from levels when the HD came into force?	***		
Which factors did you consider in setting FRVs? From: Evans & Arvela 2011, Explanatory Notes & Guidelines for reporting under Article 17 for the period 2007-2012	FRR** • current range • potential extent of range taking into account physical and ecological conditions • historic range and causes of change • area required for viability of habitat connectivity and migration use • variability including genetics other: ***		
	FRA** • historic distribution • potential natural vegetation • natural variation • actual distribution and variation (including quality of habitat) • dynamics of the habitat type • requirements of typical species (including gene flow) other: ***		
	FRP** • historic distribution and abundances and causes of change • potential range • biological and ecological conditions • migration routes and dispersal ways • gene flow or genetic variation including clines • populations should be sufficiently large to accomodate natural fluctuations and allow a healthy population structure other: ***		
What method(s) did you use in the assessment of connectivity aspects of FRP and/or FRR?	none/ GIS analysis of habitat coverage in the landscape/ ecological dispersal studies (marked animals)/ direct genetic method (unique markers for individuals or subpopulations)/ indirect genetic method (e.g. Fst analysis, BayesAss, Assignment test)**/ other:***		

Methods for HD features and birds with reference values	
Did you use historic references for setting reference values?	no/ fixed general baseline e.g. a particular year as used in red lists/ species or habitat specific reference e.g.a year when a feature was supposed to have FCS**
Did you use trend data for setting reference values?	no/ habitat types/ HD species/ birds**
For FRP/birds: did you use or include estimates of minimum viable population size?	no/ yes: based on literature/ yes: based on specific analyses**
Did you consider feasibility in setting reference values?	no/ technical/ financial/ social**
How did you assess references values for mobile species with dynamic ranges crossing national boundaries or going beyond EU territories?	***
Did you otherwise differentiate in methods between groups of species or habitats?	standardized approaches for species and for habitats/ marine versus terrestrial incl. aquatic/ migrating versus non-migrating species/ central versus peripheral position in range**/ other groupings:***
Which species or habitat types are good illustrative examples for the methods used?	***
Application/translation	
Are your current conservation targets based on reference values?	***
Are you defining milestones in reaching the set values?	***
Problems, suggestions	
Which (kind of) species or habitats require biogeographic or population based reference values and why?	***
Which species (groups) or habitat types were otherwise problematic and why?	***
Do you have suggestions to improve the process of setting reference values?	***

* expand/repeat when necessary; ** delete/strike out options, *** add free text

Annex 2 Lists of migratory species and species with large home ranges

Table A2.1 Terrestrial mammals

Michela Pacifici, Carlo Rondinini & Luigi Boitani

References: Bats (Chiroptera) with disjunct breeding and wintering ranges: McGuire & Ratcliffe (2011), Voigt et al. (2015). Other terrestrial mammals (Cetartiodactyla, Carnivora): Jones et al. (2009).

Taxonomic group	Scientific name	English name	HD Annex	Functional units*
Chiroptera	*Barbastella barbastellus*	Barbastelle	II, IV	B, W
Chiroptera	*Miniopterus schreibersii*	Common Bentwing bat	II, IV	B, W
Chiroptera	*Myotis dasycneme*	Pond bat	II, IV	B, W
Chiroptera	*Myotis myotis*	Greater mouse-eared bat	II, IV	B, W
Chiroptera	*Myotis daubentonii*	Daubenton's bat	IV	B, W
Chiroptera	*Nyctalus leisleri*	Leisler's bat	IV	B, W
Chiroptera	*Nyctalus noctula*	Noctule	IV	B, W
Chiroptera	*Pipistrellus nathusii*	Nathusius' pipistrelle	IV	B, W
Chiroptera	*Pipistrellus pygmaeus*	Pygmy Pipistrelle	IV	B, W
Chiroptera	*Vespertilio murinus*	Particoloured bat	IV	B, W
Cetartiodactyla	*Rangifer tarandus fennicus*	Finnish forest reindeer	II	B, W
Cetartiodactyla	*Cervus elaphus*	Red deer		B
Carnivora	*Canis lupus*	Wolf	II, IV, V	B
Carnivora	*Ursus arctos*	Brown bear	II, IV	B
Carnivora	*Gulo gulo*	Wolverine	II	B
Carnivora	*Lynx lynx*	Eurasian lynx	II, IV	B

* Functional units: B (breeding) population, W (wintering) population.

Table A2.2 Seals and turtles

Susan Gubbay

Reference: IUCN Red List of threatened species (http://www.iucnredlist.org/search)

Taxonomic group	Scientific name	English name	HD Annex	Functional units*
Pinniped	*Cystophora cristata*	Hooded seal	V	NB -vagrant
Pinniped	*Erignathus barbatus*	Bearded seal	V	NB -vagrant
Pinniped	*Halichoerus grypus*	Grey seal	II, V	B, NB
Pinniped	*Monachus monachus*	Mediterranean monk seal	II, IV	B, NB
Pinniped	*Phoca (Pagophilus) groenlandica*	Harp seal	V	NB -vagrant
Pinniped	*Phoca (Pusa) hispida botnica*	Ringed Seal	II, V	B,NB
Pinniped	*Phoca vitulina*	Harbour seal	II, V	B,NB
Reptile	*Caretta caretta*	Loggerhead turtle	II, IV	B,NB
Reptile	*Chelonia mydas*	Green turtle	II, IV	B,NB
Reptile	*Dermochelys coriacea*	Leatherback turtle	IV	NB
Reptile	*Eretmochelys imbricata*	Hawksbill turtle	IV	NB
Reptile	*Lepdochelys kempii*	Kemps's Ridley turtle	IV	NB -vagrant

* Functional units: B (breeding) population, NB (non-breeding) population

Table A2.3 Cetaceans

Peter Evans

References: Jefferson et al. (2008), Waring et al. (2009).

Taxonomic group	Scientific name	English name	HD Annex	Functional units*
Cetacean	*Balaena mysticetus*	Bowhead whale	IV	NR - Vagrant
Cetacean	*Eubalaena glacialis*	N Atlantic right whale	IV	NR? - Vagrant
Cetacean	*Balaenoptera acutorostrata*	Minke whale	IV	R
Cetacean	*B. borealis*	Sei whale	IV	R? - Macaronesia
Cetacean	*B. edeni*	Bryde's whale	IV	NR? - Vagrant
Cetacean	*B. musculus*	Blue whale	IV	R
Cetacean	*B. physalus*	Fin whale	IV	R
Cetacean	*Megaptera novaeangliae*	Humpback whale	IV	R – Macaronesia NR
Cetacean	*Physeter macrocephalus*	Sperm whale	IV	R - Macaronesia NR
Cetacean	*Kogia breviceps*	Pygmy sperm whale	IV	R - Macaronesia
Cetacean	*K. sima*	Dwarf sperm whale	IV	R? - Macaronesia
Cetacean	*Hyperoodon ampullatus*	Northern bottlenose whale	IV	R
Cetacean	*Mesoplodon bidens*	Sowerby's beaked whale	IV	R
Cetacean	*M. densirostris*	Blainville's beaked whale	IV	R - Macaronesia
Cetacean	*M. europaeus*	Gervais' beaked whale	IV	R - Macaronesia
Cetacean	*M. grayi*	Gray's beaked whale	IV	NR - Vagrant
Cetacean	*M. mirus*	True's beaked whale	IV	R
Cetacean	*Ziphius cavirostris*	Cuvier's beaked whale	IV	R
Cetacean	*Delphinapterus leucas*	Beluga whale	IV	NR
Cetacean	*Monodon monoceros*	Narwhal	IV	NR
Cetacean	*Delphinus delphis*	Short-beaked common dolphin	IV	R
Cetacean	*Feresa attenuata*	Pygmy killer whale	IV	NR?
Cetacean	*Globicephala macrorhynchus*	Short-finned pilot whale	IV	R - Macaronesia
Cetacean	*G. melas*	Long-finned pilot whale	IV	R
Cetacean	*Grampus griseus*	Risso's dolphin	IV	R
Cetacean	*Lagenodelphis hosei*	Fraser's dolphin	IV	NR?
Cetacean	*Lagenorhynchus acutus*	Atlantic white-sided dolphin	IV	R
Cetacean	*L. albirostris*	White-beaked dolphin	IV	R
Cetacean	*Orcinus orca*	Killer whale	IV	R
Cetacean	*Peponocephala electra*	Melon-headed whale	IV	NR?
Cetacean	*Pseudorca crassidens*	False killer whale	IV	R?
Cetacean	*Stenella coeruleoalba*	Striped dolphin	IV	R
Cetacean	*S. frontalis*	Atlantic spotted dolphin	IV	R? - Macaronesia
Cetacean	*S. longirostris*	Spinner dolphin	IV	R? - Macaronesia
Cetacean	*Steno bredanensis*	Rough-toothed dolphin	IV	R? - Macaronesia
Cetacean	*Tursiops truncatus*	Common bottlenose dolphin	II, IV	R
Cetacean	*Phocoena phocoena*	Harbour porpoise	II, IV	R

* Functional units: R (reproductive) population, NR (non-reproductive) population

Table A2.4 Fishes and lampreys

Erwin Winter

Reference

Taxonomic group	Species (scientific name)	Species (English name)	HD Annex	Functional units*
Petromyzonidae	*Lampetra fluviatilis*	River Lamprey	II, V	S
Petromyzonidae	*Petromyzon marinus*	Sea Lamprey	II	S
Acipenseridae	*Acipenser naccarii*	Adriatic Sturgeon	II, IV	S
Acipenseridae	*Acipenser sturio*	European Sturgeon	II, IV	S
Acipenseridae	*Huso huso*	Beluga Sturgeon	V	S
Acipenseridae	*Acipenser nudiventris*	Ship Sturgeon	V	S
Acipenseridae	*Acipenser gueldenstaedtii*	Russian Sturgeon	V	S
Acipenseridae	*Acipenser stellatus*	Stellate Sturgeon	V	S
Clupeidae	*Alosa alosa*	Allis Shad	II, V	S
Clupeidae	*Alosa fallax*	Twaite Shad	II, V	S
Salmonidae	*Salmo salar*	Atlantic Salmon	II, V	S
Coregonidae	*Coregonus oxyrhynchus*	North Sea Houting	II, IV	S

* Functional units: S(pawning) population in river basin

Table A2.5 Birds

André van Kleunen, Marc van Roomen & Ruud Foppen

The table lists the EU (partially) migratory bird species. Scientific and Englisg names according to 2014 BirdLife/Handbook of the Birds of the World/IUCN.

M/PM: Migratory (M), partially migratory (PM); NotW: species not wintering in Europe; NotB: species not breeding in Europe.

Scientific name	English name	M/PM	NotW	NotB	Comment
Coturnix coturnix	Common Quail	PM			sedentary parts of Southern Europe
Oxyura leucocephala	White-headed Duck	PM			
Cygnus olor	Mute Swan	PM			
Cygnus cygnus	Whooper Swan	M			
Cygnus columbianus	Tundra Swan	M			
Branta bernicla	Brent Goose	M			
Branta leucopsis	Barnacle Goose	M			
Branta ruficollis	Red-breasted Goose	M			
Anser anser	Greylag Goose	M			
Anser fabalis	Bean Goose	M			
Anser brachyrhynchus	Pink-footed Goose	M			
Anser albifrons	Greater White-fronted Goose	M			
Anser erythropus	Lesser White-fronted Goose	M			
Clangula hyemalis	Long-tailed Duck	M			
Somateria spectabilis	King Eider	M			
Somateria mollissima	Common Eider	M			
Polysticta stelleri	Steller's Eider	M			
Melanitta fusca	Velvet Scoter	M			
Melanitta nigra	Common Scoter	M			
Bucephala clangula	Common Goldeneye	M			
Mergellus albellus	Smew	M			
Mergus merganser	Goosander	M			
Mergus serrator	Red-breasted Merganser	M			
Tadorna tadorna	Common Shelduck	M			
Tadorna ferruginea	Ruddy Shelduck	M	y		
Marmaronetta angustirostris	Marbled Teal	PM			resident in parts of Spain
Netta rufina	Red-crested Pochard	M			
Aythya ferina	Common Pochard	M			
Aythya nyroca	Ferruginous Duck	M			
Aythya fuligula	Tufted Duck	M			
Aythya marila	Greater Scaup	M			
Spatula querquedula	Garganey	M	y		
Spatula clypeata	Northern Shoveler	M			
Mareca strepera	Gadwall	M			
Mareca penelope	Eurasian Wigeon	M			
Anas platyrhynchos	Mallard	M			
Anas acuta	Northern Pintail	M			
Anas crecca	Common Teal	M			
Tachybaptus ruficollis	Little Grebe	M			
Podiceps grisegena	Red-necked Grebe	M			
Podiceps cristatus	Great Crested Grebe	PM			
Podiceps auritus	Horned Grebe	M			

Scientific name	English name	M/PM	NotW	NotB	Comment
Podiceps nigricollis	Black-necked Grebe	M			
Phoenicopterus roseus	Greater Flamingo	PM			
Columba oenas	Stock Dove	PM			
Columba palumbus	Common Woodpigeon	PM			
Streptopelia turtur	European Turtle-dove	M	y		
Streptopelia decaocto	Eurasian Collared-dove	PM			
Spilopelia senegalensis	Laughing Dove	PM			
Pterocles orientalis	Black-bellied Sandgrouse	PM			
Pterocles alchata	Pin-tailed Sandgrouse	PM			
Caprimulgus ruficollis	Red-necked Nightjar	M	y		
Caprimulgus europaeus	European Nightjar	M	y		
Tachymarptis melba	Alpine Swift	M	y		
Apus caffer	White-rumped Swift	M	y		
Apus affinis	Little Swift	M	y		
Apus pallidus	Pallid Swift	M	y		
Apus apus	Common Swift	M	y		
Clamator glandarius	Great Spotted Cuckoo	M	y		
Cuculus canorus	Common Cuckoo	M	y		
Rallus aquaticus	Western Water Rail	M			
Crex crex	Corncrake	M	y		
Porzana porzana	Spotted Crake	M	y		
Zapornia parva	Little Crake	M	y		
Zapornia pusilla	Baillon's Crake	M	y		
Gallinula chloropus	Common Moorhen	PM			
Fulica atra	Common Coot	PM			
Anthropoides virgo	Demoiselle Crane	M	y		
Grus grus	Common Crane	M			
Tetrax tetrax	Little Bustard	PM			
Otis tarda	Great Bustard	PM			
Gavia stellata	Red-throated Loon	M			
Gavia arctica	Arctic Loon	M			
Gavia immer	Common Loon	M			
Gavia adamsii	Yellow-billed Loon	M			
Oceanites oceanicus	Wilson's Storm-petrel	M			
Pelagodroma marina	White-faced Storm-petrel	M			
Hydrobates pelagicus	European Storm-petrel	M			
Hydrobates castro	Band-rumped Storm-petrel	M			
Hydrobates leucorhous	Leach's Storm-petrel	M			
Fulmarus glacialis	Northern Fulmar	M			
Pterodroma deserta	Desertas Petrel	M			
Pterodroma madeira	Zino's Petrel	M			
Ardenna grisea	Sooty Shearwater	M			
Ardenna gravis	Great Shearwater	M			
Calonectris diomedea	Scopoli's Shearwater	M			
Calonectris borealis	Cory's Shearwater	M			
Puffinus puffinus	Manx Shearwater	M			
Puffinus yelkouan	Yelkouan Shearwater	M			
Puffinus mauretanicus	Balearic Shearwater	M			
Puffinus lherminieri	Audubon's Shearwater	M			
Bulweria bulwerii	Bulwer's Petrel	M			
Ciconia nigra	Black Stork	PM			
Ciconia ciconia	White Stork	PM			
Platalea leucorodia	Eurasian Spoonbill	PM			
Geronticus eremita	Northern Bald Ibis	M	y		

Scientific name	English name	M/PM	NotW	NotB	Comment
Plegadis falcinellus	Glossy Ibis	M			
Botaurus stellaris	Eurasian Bittern	PM			
Ixobrychus minutus	Common Little Bittern	M	y		
Nycticorax nycticorax	Black-crowned Night-heron	PM			
Ardeola ralloides	Squacco Heron	M	y		
Bubulcus ibis	Cattle Egret	M			
Ardea cinerea	Grey Heron	PM			
Ardea purpurea	Purple Heron	M	y		
Ardea alba	Great White Egret	M			
Egretta garzetta	Little Egret	M			
Pelecanus crispus	Dalmatian Pelican	M	y		
Pelecanus onocrotalus	Great White Pelican	M	y		
Morus bassanus	Northern Gannet	M			
Microcarbo pygmaeus	Pygmy Cormorant	PM			
Phalacrocorax carbo	Great Cormorant	M			
Burhinus oedicnemus	Eurasian Thick-knee	PM			
Haematopus ostralegus	Eurasian Oystercatcher	M			
Recurvirostra avosetta	Pied Avocet	M			
Himantopus himantopus	Black-winged Stilt	PM			
Pluvialis squatarola	Grey Plover	M			
Pluvialis apricaria	Eurasian Golden Plover	M			
Eudromias morinellus	Eurasian Dotterel	M			tiny wintering area in southern Spain
Charadrius hiaticula	Common Ringed Plover	M			
Charadrius dubius	Little Ringed Plover	PM			
Charadrius alexandrinus	Kentish Plover	PM			
Charadrius leschenaultii	Greater Sandplover	M	y	y	not a European breeding bird
Vanellus vanellus	Northern Lapwing	M			
Vanellus spinosus	Spur-winged Lapwing	M	y		
Numenius phaeopus	Whimbrel	M			
Numenius tenuirostris	Slender-billed Curlew	M	y		
Numenius arquata	Eurasian Curlew	M			
Limosa lapponica	Bar-tailed Godwit	M			
Limosa limosa	Black-tailed Godwit	M			
Arenaria interpres	Ruddy Turnstone	M			
Calidris canutus	Red Knot	M			
Calidris pugnax	Ruff	M			
Calidris falcinellus	Broad-billed Sandpiper	M	y		
Calidris ferruginea	Curlew Sandpiper	M			
Calidris temminckii	Temminck's Stint	M			
Calidris alba	Sanderling	M			
Calidris alpina	Dunlin	M			
Calidris maritima	Purple Sandpiper	M			
Calidris minuta	Little Stint	M			
Scolopax rusticola	Eurasian Woodcock	M			
Gallinago media	Great Snipe	M	y		
Gallinago gallinago	Common Snipe	M			
Lymnocryptes minimus	Jack Snipe	M			
Phalaropus lobatus	Red-necked Phalarope	M	y		
Phalaropus fulicarius	Red Phalarope	M	y		
Xenus cinereus	Terek Sandpiper	M	y		

Scientific name	English name	M/PM	NotW	NotB	Comment
Actitis hypoleucos	Common Sandpiper	M			
Tringa ochropus	Green Sandpiper	M			
Tringa erythropus	Spotted Redshank	M			
Tringa nebularia	Common Greenshank	M			
Tringa totanus	Common Redshank	M			
Tringa glareola	Wood Sandpiper	M			
Tringa stagnatilis	Marsh Sandpiper	M			
Cursorius cursor	Cream-coloured Courser	?	?		
Glareola pratincola	Collared Pratincole	M	y		
Glareola nordmanni	Black-winged Pratincole	M	y		
Hydrocoloeus minutus	Little Gull	M			
Xema sabini	Sabine's Gull	M	y		
Rissa tridactyla	Black-legged Kittiwake	M			
Larus genei	Slender-billed Gull	M			
Larus ridibundus	Black-headed Gull	M			
Larus ichthyaetus	Pallas's Gull	M	y		
Larus melanocephalus	Mediterranean Gull	M			
Larus audouinii	Audouin's Gull	M			
Larus canus	Mew Gull	M			
Larus fuscus	Lesser Black-backed Gull	M			
Larus argentatus	European Herring Gull	M			
Larus armenicus	Armenian Gull	M			
Larus michahellis	Yellow-legged Gull	M			
Larus cachinnans	Caspian Gull	M			
Larus glaucoides	Iceland Gull	M			
Larus hyperboreus	Glaucous Gull	M			
Larus marinus	Great Black-backed Gull	M			
Sternula albifrons	Little Tern	M	y		
Gelochelidon nilotica	Common Gull-billed Tern	M	y		
Hydroprogne caspia	Caspian Tern	M	y		
Chlidonias hybrida	Whiskered Tern	PM			
Chlidonias leucopterus	White-winged Tern	M	y		
Chlidonias niger	Black Tern	M	y		
Sterna dougallii	Roseate Tern	M	y		
Sterna hirundo	Common Tern	M	y		
Sterna paradisaea	Arctic Tern	M	y		
Thalasseus sandvicensis	Sandwich Tern	M			
Stercorarius longicaudus	Long-tailed Jaeger	M	y		
Stercorarius parasiticus	Arctic Jaeger	M	y		
Stercorarius pomarinus	Pomarine Jaeger	M			
Catharacta skua	Great Skua	M			
Fratercula arctica	Atlantic Puffin	M			
Cepphus grylle	Black Guillemot	M			
Alca torda	Razorbill	M			
Alle alle	Little Auk	M			
Uria aalge	Common Murre	M			
Surnia ulula	Northern Hawk-owl	PM			
Aegolius funereus	Boreal Owl	PM			
Otus scops	Eurasian Scops-owl	M			
Asio otus	Northern Long-eared Owl	M			
Asio flammeus	Short-eared Owl	M			
Bubo scandiacus	Snowy Owl	M			

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Pandion haliaetus	Osprey	M			
Pernis apivorus	European Honey-buzzard	M	y		
Neophron percnopterus	Egyptian Vulture	M	y		
Circaetus gallicus	Short-toed Snake-eagle	M			
Clanga pomarina	Lesser Spotted Eagle	M	y		
Clanga clanga	Greater Spotted Eagle	M			
Aquila adalberti	Spanish Imperial Eagle	PM			
Aquila heliaca	Eastern Imperial Eagle	M	y		
Aquila chrysaetos	Golden Eagle	PM			
Hieraaetus pennatus	Booted Eagle	M			
Circus aeruginosus	Western Marsh-harrier	M			
Circus cyaneus	Hen Harrier	M			
Circus macrourus	Pallid Harrier	M	?		has shown spectacular increase in Western Europe on passage, some birds might winter at Iberian Penninsula
Circus pygargus	Montagu's Harrier	M	y		
Accipiter brevipes	Levant Sparrowhawk	M	y		
Accipiter nisus	Eurasian Sparrowhawk	PM			
Accipiter gentilis	Northern Goshawk	PM			
Haliaeetus albicilla	White-tailed Sea-eagle	M			
Milvus milvus	Red Kite	M			
Milvus migrans	Black Kite	M			
Buteo lagopus	Rough-legged Buzzard	M			
Buteo buteo	Eurasian Buzzard	PM			
Buteo rufinus	Long-legged Buzzard	M			
Upupa epops	Common Hoopoe	M			
Merops apiaster	European Bee-eater	M	y		
Coracias garrulus	European Roller	M	y		
Alcedo atthis	Common Kingfisher	PM			
Jynx torquilla	Eurasian Wryneck	M			
Dryocopus martius	Black Woodpecker	PM			
Picoides tridactylus	Three-toed Woodpecker	PM			
Dryobates minor	Lesser Spotted Woodpecker	PM			
Dendrocopos major	Great Spotted Woodpecker	PM			
Falco naumanni	Lesser Kestrel	M			
Falco tinnunculus	Common Kestrel	PM			
Falco vespertinus	Red-footed Falcon	M	y		
Falco eleonorae	Eleonora's Falcon	M	y		
Falco columbarius	Merlin	M			
Falco subbuteo	Eurasian Hobby	M	y		
Falco biarmicus	Lanner Falcon	M			
Falco cherrug	Saker Falcon	M			
Falco rusticolus	Gyrfalcon	M			
Falco peregrinus	Peregrine Falcon	M			
Lanius collurio	Red-backed Shrike	M	y		
Lanius minor	Lesser Grey Shrike	M	y		
Lanius excubitor	Great Grey Shrike	M			
Lanius senator	Woodchat Shrike	M	y		
Lanius nubicus	Masked Shrike	M	y		
Oriolus oriolus	Eurasian Golden Oriole	M	y		
Garrulus glandarius	Eurasian Jay	PM			

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Pica pica	Black-billed Magpie	PM			
Corvus monedula	Eurasian Jackdaw	PM			
Corvus frugilegus	Rook	PM			
Corvus corone	Carrion Crow	PM			
Corvus corax	Common Raven	PM			
Bombycilla garrulus	Bohemian Waxwing	M			
Parus ater	Coal Tit	PM			
Parus major	Great Tit	PM			
Parus caeruleus	Blue Tit	PM			
Remiz pendulinus	Eurasian Penduline-tit	M			
Riparia riparia	Sand Martin	M	y		
Hirundo rupestris	Eurasian Crag-martin	M			
Hirundo rustica	Barn Swallow	M	y		
Hirundo daurica	Red-rumped Swallow	M	y		
Delichon urbicum	Northern House-martin	M	y		
Aegithalos caudatus	Long-tailed Tit	PM			
Melanocorypha calandra	Calandra Lark	M			
Calandrella brachydactyla	Greater Short-toed Lark	M	y		
Calandrella rufescens	Lesser Short-toed Lark	M			
Galerida cristata	Crested Lark	PM			
Lullula arborea	Wood Lark	M			
Alauda arvensis	Eurasian Skylark	M			
Eremophila alpestris	Horned Lark	M			
Cisticola juncidis	Zitting Cisticola	M			
Cettia cetti	Cetti's Warbler	M			
Locustella naevia	Common Grasshopper-warbler	M	y		
Locustella fluviatilis	Eurasian River Warbler	M	y		
Locustella luscinioides	Savi's Warbler	M	y		
Acrocephalus melanopogon	Moustached Warbler	M			
Acrocephalus paludicola	Aquatic Warbler	M	y		
Acrocephalus schoenobaenus	Sedge Warbler	M	y		
Acrocephalus agricola	Paddyfield Warbler	M	y		
Acrocephalus scirpaceus	Eurasian Reed-warbler	M	y		
Acrocephalus dumetorum	Blyth's Reed-warbler	M	y		
Acrocephalus palustris	Marsh Warbler	M	y		
Acrocephalus arundinaceus	Great Reed-warbler	M	y		
Hippolais caligata	Booted Warbler	M	y		
Hippolais pallida	Eastern Olivaceous Warbler	M	y		
Hippolais opaca	Western Olivaceous Warbler	M	y		
Hippolais olivetorum	Olive-tree Warbler	M	y		
Hippolais polyglotta	Melodious Warbler	M	y		
Hippolais icterina	Icterine Warbler	M	y		
Phylloscopus trochilus	Willow Warbler	M	y		
Phylloscopus collybita	Common Chiffchaff	M			
Phylloscopus ibericus	Iberian Chiffchaff	M	y		

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Phylloscopus bonelli	Bonelli's Warbler	M	y		
Phylloscopus sibilatrix	Wood Warbler	M	y		
Phylloscopus inornatus	Inornate Warbler	M	y		
Phylloscopus borealis	Arctic Warbler	M	y		
Phylloscopus trochiloides	Greenish Warbler	M	y		
Sylvia atricapilla	Blackcap	M			
Sylvia borin	Garden Warbler	M	y		
Sylvia communis	Common Whitethroat	M	y		
Sylvia curruca	Lesser Whitethroat	M	y		
Sylvia nisoria	Barred Warbler	M	y		
Sylvia hortensis	Orphean Warbler	M	y		
Sylvia rueppelli	Rueppell's Warbler	M	y		
Sylvia melanocephala	Sardinian Warbler	M			
Sylvia melanothorax	Cyprus Warbler	M	y		
Sylvia cantillans	Subalpine Warbler	M	y		
Sylvia subalpina	Moltoni's Warbler	M	y		
Sylvia conspicillata	Spectacled Warbler	M			
Sylvia sarda	Marmora's Warbler	M	y		
Panurus biarmicus	Bearded Parrotbill	PM			
Regulus regulus	Goldcrest	PM			
Regulus ignicapilla	Firecrest	M			
Troglodytes troglodytes	Winter Wren	PM			
Tichodroma muraria	Wallcreeper	M			
Certhia familiaris	Eurasian Treecreeper	M			
Sturnus roseus	Rosy Starling	M			
Sturnus vulgaris	Common Starling	M			
Turdus torquatus	Ring Ouzel	M			
Turdus merula	Eurasian Blackbird	PM			
Turdus pilaris	Fieldfare	M			
Turdus iliacus	Redwing	M			
Turdus philomelos	Song Thrush	M			
Turdus viscivorus	Mistle Thrush	M			
Erithacus rubecula	European Robin	PM			
Luscinia luscinia	Thrush Nightingale	M			
Luscinia megarhynchos	Common Nightingale	M			
Luscinia svecica	Bluethroat	M			
Tarsiger cyanurus	Orange-flanked Bush-robin	M	y		
Erythropygia galactotes	Rufous-tailed Scrub-robin	M	y		
Phoenicurus ochruros	Black Redstart	M			
Phoenicurus phoenicurus	Common Redstart	M	y		
Saxicola rubetra	Whinchat	M	y		
Saxicola torquatus	Common Stonechat	M			
Oenanthe oenanthe	Northern Wheatear	M	y		
Oenanthe finschii	Finsch's Wheatear	M			Breeds in Caucasus
Oenanthe hispanica	Black-eared Wheatear	M			
Oenanthe pleschanka	Pied Wheatear	M	y		
Oenanthe cypriaca	Cyprus Wheatear	M	y		
Oenanthe isabellina	Isabelline Wheatear	M	y		
Monticola saxatilis	Rufous-tailed Rock-thrush	M	y		
Monticola solitarius	Blue Rock-thrush	M			
Muscicapa striata	Spotted Flycatcher	M	y		
Ficedula hypoleuca	European Pied Flycatcher	M	y		

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Ficedula albicollis	Collared Flycatcher	M	y		
Ficedula semitorquata	Semi-collared Flycatcher	M	y		
Ficedula parva	Red-breasted Flycatcher	M	y		
Cinclus cinclus	White-throated Dipper	M			
Passer hispaniolensis	Spanish Sparrow	M			
Passer moabiticus	Dead Sea Sparrow	M	y	?	Breeds in Asian part of Turkey
Passer montanus	Eurasian Tree Sparrow	M			
Montifringilla nivalis	White-winged Snowfinch	PM			
Prunella collaris	Alpine Accentor	M			
Prunella modularis	Hedge Accentor	M			
Motacilla alba	White Wagtail	M			
Motacilla citreola	Citrine Wagtail	M	y		
Motacilla flava	Yellow Wagtail	M	y		
Motacilla cinerea	Grey Wagtail	M			
Anthus richardi	Richard's Pipit	M	y	y	
Anthus campestris	Tawny Pipit	M	y		
Anthus trivialis	Tree Pipit	M	y		
Anthus pratensis	Meadow Pipit	M			
Anthus cervinus	Red-throated Pipit	M	y		
Anthus petrosus	Rock Pipit	M			
Anthus spinoletta	Water Pipit	M			
Fringilla coelebs	Eurasian Chaffinch	M			
Fringilla montifringilla	Brambling	M			
Serinus serinus	European Serin	M			
Carduelis chloris	European Greenfinch	PM			
Carduelis spinus	Eurasian Siskin	M			
Carduelis carduelis	European Goldfinch	PM			
Carduelis flammea	Common Redpoll	M			
Carduelis flavirostris	Twite	M			
Carduelis cannabina	Eurasian Linnet	M			
Carpodacus erythrinus	Common Rosefinch	M	y		
Pinicola enucleator	Pine Grosbeak	M			
Loxia pytyopsittacus	Parrot Crossbill	M			
Loxia scotica	Scottish Crossbill	M			
Loxia curvirostra	Red Crossbill	M			
Loxia leucoptera	White-winged Crossbill	M			
Pyrrhula pyrrhula	Eurasian Bullfinch	PM			
Coccothraustes coccothraustes	Hawfinch	PM			
Miliaria calandra	Corn Bunting	M			
Emberiza citrinella	Yellowhammer	PM			
Emberiza leucocephalos	Pine Bunting	M			
Emberiza cia	Rock Bunting	M			
Emberiza cineracea	Cinereous Bunting	M	y		
Emberiza hortulana	Ortolan Bunting	M	y		
Emberiza caesia	Cretzschmar's Bunting	M	y		
Emberiza pusilla	Little Bunting	M	y		
Emberiza rustica	Rustic Bunting	M	y		
Emberiza aureola	Yellow-breasted Bunting	M	y		
Emberiza melanocephala	Black-headed Bunting	M	y		
Emberiza schoeniclus	Reed Bunting	M			

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Calcarius lapponicus	Lapland Longspur	M			
Plectrophenax nivalis	Snow Bunting	M			