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This report provides an overview of the favourable reference values for population size and range of the wolf in the Netherlands listed in the European Habitats Directive. These favourable reference values are necessary to assess the conservation status of the wolf on the basis of Article 17 of the Habitats Directive. This report does not provide further explanation of what these reference values could mean in social and economic terms in the Dutch context.

Key words: Article 17 report, FRP, FRR, Favourable Reference Values, FRV, Habitats Directives species, population, range, reference values, conservation status, wolf (*Canis lupus*)

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Cover photo: four wolf cubs next to their den. Photo: Marielle van Uitert©.
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Management summary

The Ministry of Agriculture, Fisheries, Food Security and Nature (LVVN) commissioned Wageningen Environmental Research (WENR) to determine the Favourable Reference Population (FRP) and the Favourable Reference Range (FRR) for the wolf in the Netherlands. In this report, we describe the methods applied to determine the Favourable Reference Values (FRVs) for the wolf in the Netherlands.

As the European Court of Justice has not yet issued full and final clarification, there are still some uncertainties with regard to the appropriate method(s) for assessing conservation status. Despite this, our report reflects the European Commission guidelines, including those recently published on the conservation status of large carnivores (Linnell & Boitani, 2025).

Having extended its natural range, the wolf recently reappeared in the Netherlands and re-established itself after an absence of 150 years. We were unable to use historical data to determine the FRVs as only limited data are available and, partly as a result of this, it is unclear which reference period should be chosen. For this reason, we determined the FRVs using model studies, substantiating them with additional scientific insights.

A sustainable wolf population consists of more than 500 packs. Our findings show that the Netherlands alone cannot accommodate a favourable population size – with corresponding favourable range – of a sustainable wolf population. However, the Netherlands can contribute to a sustainable wolf population in a European context as part of the Central European population. According to the guidelines issued by Linnell & Boitani (2025), it should be possible for the Netherlands, as a small to medium-sized country, to at least accommodate a *minimum viable population* (MVP) and possibly also an Effective Population Size (Ne, the number of individuals contributing to reproduction within a population) of more than 50 packs.

According to a model study, the Netherlands can contribute to the Central European population with a favourable population size for the member state (FRPms) of 23-56 packs. A strictly applied scenario of 23 packs would require an favourable range within the member state (FRRms) of 32 10x10 km cells and a lenient scenario of 56 packs would require an FRRms of 181 10x10 km cells.

The wolf is still extending its range in the Netherlands (colonisation phase) and it appears that the potential habitat of the lenient scenario (181 10x10 km cells) is being used for this purpose. The recent establishment of the pack on the Utrecht Hill Ridge falls within this scenario, for example. The 181 10x10 km cells have the potential to achieve an Ne of more than 50 packs, enabling the Netherlands to make a substantial and realistic contribution to the Central European population. The minimum scenario (strict) involves the wolves using 32 10x10 km cells of a potential suitable habitat. Although this would achieve an MVP, the Netherlands would only contribute to around half of an Ne larger than 50 packs. The FRP values currently lie between the minimum and maximum scenarios.

These findings provide input to discussions on both scenarios with surrounding countries regarding the Central European wolf population. The choice of having fewer wolves in the Netherlands would then require larger numbers in other countries if an FRP of at least 500 packs in this region is to be achieved.

This report does not provide further explanation of what these reference values could mean in social and economic terms in the Dutch context.

1 Introduction

Background

The Habitats Directive is European legislation for the protection of species and habitats in Europe. The aim of the Habitats Directive is "to contribute towards ensuring biodiversity through the conservation of natural habitats and of wild fauna and flora in the European territory".

In accordance with Article 17 of the Habitats Directive, EU member states must report on the Conservation Status (CS) of Habitats Directive Annex II, IV and V species every six years. Making a judgement on the different aspects of conservation status requires what are known as Favourable Reference Values (FRVs). These are necessary in order to assess the population size and range of a species. Member states have a duty to determine reference values for the Favourable Reference Population (FRP) and the Favourable Reference Range (FRR) for Habitats Directive Annex II, IV and V species. These FRVs must be based on scientific insights. For any species where insights are unavailable, 'best professional judgement' can be applied.

Research questions

The Ministry of Agriculture, Fisheries, Food Security and Nature (LVVN) commissioned Wageningen Environmental Research (WENR) to determine the Favourable Reference Population (FRP) and the Favourable Reference Range (FRR) for the wolf in the Netherlands. In this report, we describe the method(s) applied to determine the FRP and FRR. The potential societal and economic significance of these reference values within the Dutch context is outside the scope of this research.

Reading guide

Chapter 2 describes the method applied to determine the FRVs. Chapter 3 reviews the legal framework, Chapter 4 explores the wolf's biology and ecology, and Chapter 5 describes trends, shifts and pressure factors. Chapter 6 explores the current and historical distribution of the wolf, including numbers. Chapter 7 outlines in more detail how FRVs are determined for population and distribution in the Netherlands, and Chapter 8 closes with conclusions and recommendations.

2 Methodology

Favourable reference values for species' population size and range
Kuiters et al. (2024) provide an update on the FRVs for population size and range for Habitats Directives (HD) Annex II species, previously compiled by Ottburg & Van Swaay (2014) and Kuiters et al. (2024). FRVs are required in order to determine the Conservation Status (CS) of HD species in the Netherlands. The FRVs are reference values, above which a favourable conservation status is guaranteed.

In 2017, the European Commission (EC) published the 'Explanatory notes and guidelines' for the six-yearly Article 17 report (DG Environment, 2017). This includes revised guidelines for determining FRVs. These guidelines were further refined in 2023 (*DG Environment 2023. Reporting under Article 17 of the Habitats Directive: Guidelines on concepts and definitions – Article 17 of Directive 92/43/EEC, Reporting period 2019-2024*). The most recent guidelines are based on the recommendations of Bijlsma et al. (2019a and 2019b).

The basic principle is that all important ecological variation within the range of a species must be covered by one or more sustainable populations. This requires an iterative procedure in which the FRV for the population size (FRP) and the FRV for the range (FRR) are mutually aligned: the FRR must be large enough to contain the FRP and the FRP must be large enough to encompass the ecological variation within the range. The step-wise plan for determining FRVs (FRP and FRR) for the species is shown in Figure 1 (DG Environment, 2023). This procedure was also used for the wolf in this report.

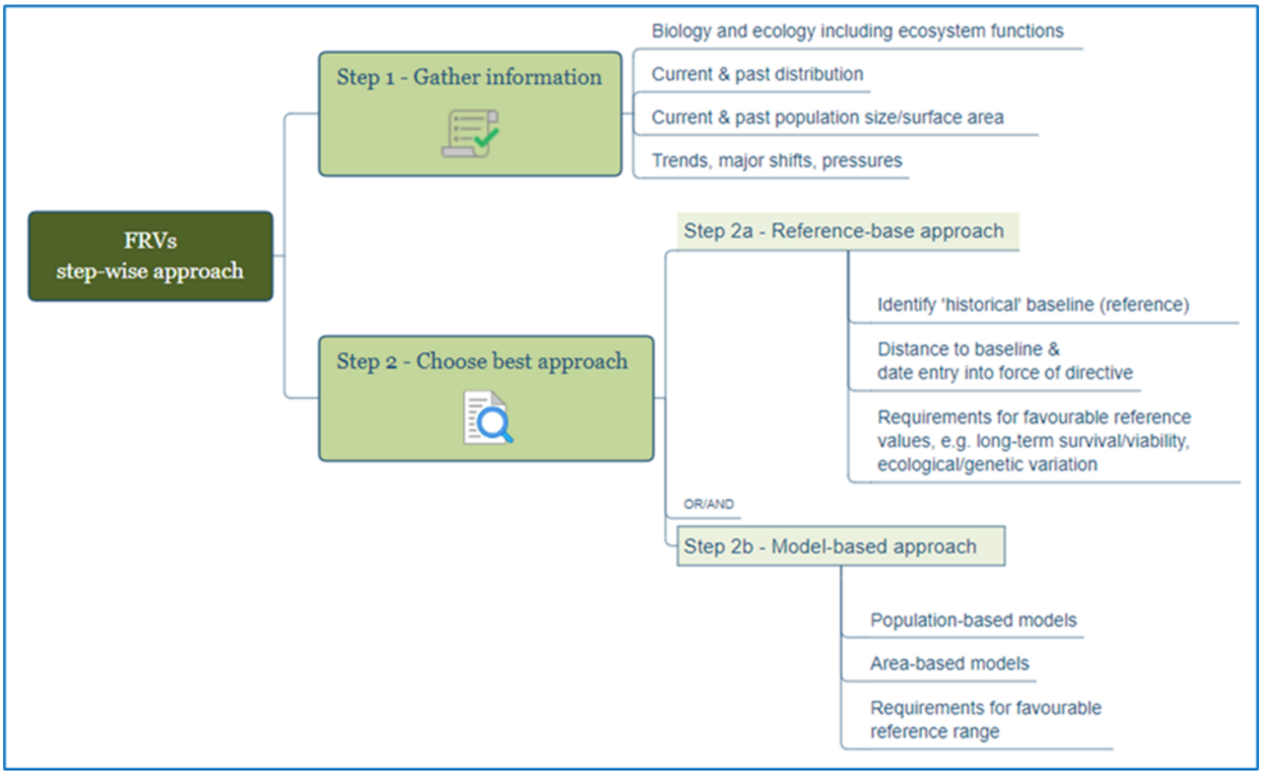

Figure 1 *Schematic representation of step-wise plan for determining FRVs.*

Step 1 Gather information concerning:
- Biology/ecology of the species
- Current and past distribution
- Current and past population size/densities
- Trends, major shifts, pressure factors

Step 2 Choose best approach: Reference-based or Model-based
At the appropriate scale level, it is necessary to determine what constitutes a sustainable population. For this purpose, a model-based approach is preferred for species, based on knowledge of the genetic Minimum Viable Population (MVP), taking account of the genetic variation present and the population's evolutionary potential. This generally means that the population size is a multiple of the necessary size if genetic processes are disregarded and only demographic stochasticity is modelled. For the wolf, we conducted a review of the literature of MVP studies in Europe.

An alternative approach is reference-based, involving the use of an historical reference to estimate the sustainable population size or density, derived from a period when the species concerned had a favourable conservation status. Given that the wolf disappeared from the Netherlands long ago, that there have been significant changes to the landscape in the last 150 years, that it is not possible to determine a baseline reference year with any objectivity, and that there are only limited historical data about the wolf, this method cannot easily be applied to the wolf.

As far as both approaches are concerned, a key precondition is that the (historical) ecological variation is guaranteed within the range and must, as far as possible, be reinstated. This requirement results in a lower threshold for the number of sustainable populations (model-based) or a desirable pattern of distribution that reflects the historical range (reference-based). This also determines the FRR. Both approaches therefore require knowledge of the historical range. In order to choose between these two approaches, we conducted a literature study of the distribution and trend in wolf numbers in the Netherlands based on historical and current data, predicted through modelling.

The wolf has recently reappeared in the Netherlands as a result of natural expansion of its range and has re-established itself after an absence of 150 years. There are no clear European guidelines for compiling FRVs for 'new species' of this kind. However, to determine the FRVs to be 'current value' (CV) in the case of natural expansion, it would be safe to assume that the positive trends in distribution and population size suggest a favourable conservation status. Bijlsma et al. (2019a) state that positive trends of this kind do not (yet) directly indicate favourable conservation status, especially if populations were decimated as a result of years of overhunting and the historical range has largely disappeared. For this category, the use of operators (> CV) is recommended for both FRP and FRR until such time that the range and population size become stabilised ('wait & see'; Bijlsma et al., 2019a; Bijlsma et al., 2019b). In the view of the fact that operators create confusion in the interpretation of 'wait-and-see' (such as > as opposed to >>), the FRVs concerned are considered unknown, but larger than the current population size and range (CV). A literature study concerning expected habitat suitability and trends in numbers in the Netherlands casts light on the question of how the CV relates to the uncertainties around FRP and FRR based on modelling. Recent studies by Dekker et al. (2024) and Biersteker et al. (2024) concerning the potential habitat suitability and trend in numbers in the Netherlands were considered in this process.

There is also the question of what constitutes a population of wolves. This depends on the spatial scale in which the wolf operates, and requires an assessment of how many more or less isolated populations need to be considered collectively: is there a single national population or several populations that may or may not exchange genes? In the latter case, it is necessary to consider compiling partial FRPs (pFRPs) for populations where there is no such exchange. For the prevalence of the wolf, the Netherlands can be considered as a connected population (Biersteker et al., 2024). This means that, within the Netherlands, there is no need for pFRPs to be determined. In view of the fact that wolves can exchange genes over very large distances, it is necessary to determine which European populations can be distinguished and the extent to which there is sufficient genetic exchange. This involves examining the European regions about which reports must be issued to the EU, and in which regions there is genetic exchange with the Dutch population (Atlantic region versus Central European wolf population).

The wolves currently present in the Netherlands originate from the Central European population from Poland/Germany and have also established themselves in Belgium, Denmark, the Western region of the Czech Republic and North-East Austria. There is a cross-border population with the exchange of individuals between the Netherlands, Germany and Belgium. The (legal) consequences of determining the FRP and FRR (together referred to as the Favourable Conservation Status (FCS) must be considered, even if it cannot be achieved within the Netherlands. In accordance with DG Environment (2023), FRVs for wolves with extensive home ranges must be determined for the entire population (or metapopulation) which implies the need for cooperation between member states.

3 The legal framework for determining conservation status

Determining the conservation status for the Habitats Directive species, including the FRVs that play an important role in this process, is a scientific endeavour. However, this must take place within the legal frameworks of the Habitats Directive. In the same way, the Habitats Directive must be interpreted and applied in the light of overarching treaty obligations and associated decisions. When it comes to the correct interpretation and application of the Habitats Directive and other EU legislation, the EU Court of Justice (CJEU) is the ultimate authority.

There is a degree of uncertainty with regard to some aspects of the term 'conservation status'. Some clarification can be derived from the CJEU on certain other aspects, including recent case law dating from 2024 and 2025. Technical guidelines developed by or intended for the European Commission such as DG Environment (2017), DG Environment (2023) and Linnell & Boitani (2025) can also prove useful for the practical application of the Habitats Directive by member states. However, these documents are not legally binding and in cases where their content has not been confirmed by the CJEU, there is uncertainty as to whether the recommendations included in these documents are correct.

We provide a brief outline of what is certain within this context, primarily based on CJEU case law, and where uncertainty still remains.

The aim of the Habitats Directive is "to contribute towards ensuring biodiversity through the conservation of natural habitats and of wild fauna and flora in the European territory" (Art. 2(1)). The measures that member states must take pursuant to the Directive "shall be designed to maintain or restore, at favourable conservation status, natural habitats and species of wild fauna and flora of Community interest" (Art. 2(2)), including the wolf.

The Habitats Directive defines "the conservation status of a species" as "the sum of the influences acting on the species concerned that may affect the long-term distribution and abundance of its populations within the [European] territory [of the member states]" (Art. 1(i)). Conservation status is considered to be favourable" if (Art.) 1(i)):

- "population dynamics 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 distribution area 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 to maintain its populations on a long-term basis."

The global compass for biodiversity policy and law for 2030 and beyond is shaped by the Global Biodiversity Framework (GBF) agreed in 2022 by parties to the 1992 Convention on Biological Diversity. GBF targets that are relevant in this context include providing more space for ecosystems, starting with the conservation of 30% of land, waters and seas by 2030 and the restoration of degraded ecosystems and managing "human-wildlife conflict" to achieve coexistence (GBF Targets 2-4). The Habitats Directive should also be read in the context of an exacting legal obligation in the Convention on Biological Diversity to repair degraded ecosystems (Art. 8(f)).

Other targets and thresholds of relevance in applying the Habitats Directive derive from the 1979 Bern Convention (Convention on the Conservation of European Wildlife and Natural Habitats). An example of this is the obligation of result to maintain a minimum population level for all species that meets "ecological requirements" (Art. 2). Both the Convention on Biological Diversity and the Bern Convention recognise the “intrinsic value” of flora and fauna, i.e. their distinctive value, irrespective of any potential benefit or detriment for humans (see both preambles).

Building on these general obligations, the new European Nature Restoration Regulation (Regulation 2024/1991) includes an obligation to take measures, where necessary, to restore the habitat of the wolf (and other species) to achieve “sufficient quality and quantity” and thereby contribute to achieving or maintaining a favourable conservation status (Art. 4(7) and 3(9-10). The Regulation also shifts the emphasis from habitats and habitat types to ecosystems. The overarching objective is to contribute to the “long-term and sustained recovery of biodiverse and resilient ecosystems” (Art. 1(1)(a)). The wolf and other species are explicitly considered to be part of well-functioning, dynamic ecosystems that the Nature Restoration Regulation ultimately aims to achieve (Art. 3(1)).

The CJEU has now more or less clarified a key question that long remained unanswered i.e. the question of the level (or levels) at which the conservation status needs to be assessed. In a recent ruling on the management of wolves in Austria, the Court determined that the consequences in terms of conservation status of the culling of a wolf “must be assessed at local and national level” and that assessing the consequences at the level of the cross-border wolf population is more likely to make it more difficult to meet the condition concerned (CJEU, case C-601/22, 11 July 2024, paras. 47-66). The Austrian case concerned the strict protection regime set out in Annex IV, but in an even more recent ruling, concerning the hunting of wolves in Estonia, the Court confirmed that the same approach also applies with regard to the obligation to guarantee an FCS such as that arising from the flexible protection regime set out in Annex V (CJEU, case C-629/23, 12 June 2025).

In the Austrian case, the CJEU was asked to what extent cross-border wolf populations (in this case wolves in countries neighbouring Austria) could or should be taken into account in assessing the expected impact of an envisaged derogation from strict protection on conservation status. The Court’s response was that the cross-border population has a relatively limited role in this context and that the decisive assessment levels – both for assessing whether there is conservation status and assessing the impact of the culling of wolves on that conservation status – are “the level of the local and national territory of the Member State” (C-601/22, para. 66).

According to the Court, the consequences of an envisaged derogation from strict protection must be assessed “in the first place, at local and national level and, in the event of a favourable conservation status at that level, as far as possible, in the second place, at a cross-border level” (para. 60). The ruling makes it clear that taking account of the cross-border population in the assessment does not necessarily make it easier to permit derogations from protection, contrary to what has often been assumed or suggested (Linnell et al., 2008). Indeed, the opposite may even be the case. One example is a scenario in which there is FCS at local and national level, but culling one or several wolves in a cross-border pack may still be unlawful because of an unfavourable conservation status in the neighbouring country concerned.

In a nutshell, even given an FCS at national level, culling wolves can still be ‘wrong’ in light of the cross-border situation. Conversely, in the words of Advocate General Capeta, “the unfavourable national status cannot be remedied through favourable status at the cross-border level” (case C-601/22, Opinion of Advocate General T. Capeta, 18 January 2024, para. 73, which the CJEU refers to specifically in para. 57 of the ruling itself; the Advocate General is an independent adviser to the Court).

In the wake of this ruling, confusion remained about what exactly the criteria are that must or could be used to respond to the question of whether or not a wolf population has an FCS at local and national level – i.e., in the Austrian case, “at the level of the Province of Tyrol and at national level” (para. 65). For example, the question of whether the risk of extinction or ecological carrying capacity, or both, are the most suitable points of departure; and the related question of whether it exclusively concerns demographic and/or genetic viability, or actually (also) ecological functionality (Epstein et al., 2016; Trouwborst, Boitani & Linnell, 2017). What did become clear is that “local” and “national” are the levels that matter. For comparison, the province of Tyrol is the equivalent in size to approximately three Dutch provinces.

The Austrian ruling therefore makes it clear that drawing up and implementing international management plans at cross-border population level – as recommended by the European Commission (European Commission 2008) and the Bern Convention's Standing Committee (Recommendation No. 137 (2008) on Population Level Management of Large Carnivore Populations) – does not mean that the assessment level for conservation status necessarily shifts to the cross-border population. In the case of the Netherlands, that would primarily be the population of the lowlands of Central Europe.

In other words, international management plans of this kind are no panacea. This does not detract from the fact that cross-border segments of the population (may) have some role to play in determining whether there is an FCS *at national or local level*. In that context, 'population-level management plans' could still make it easier, especially in small member states such as the Netherlands, to meet the favourable conservation status requirement. Building on that assumption, guidelines recently drawn up for the European Commission include concrete suggestions for operationalising an approach of this kind (Linnell & Boitani, 2025).

In the long-awaited Estonian wolves ruling (case C-629/23), the CJEU did partially confirm this line. The Court takes the view that, in principle, when determining conservation status at "local and national level", a member state can "take into consideration the exchanges between, on the one hand, the population of the species concerned present within its territory and, on the other, the populations of that species present in the neighbouring Member States or third countries" (para. 66). Especially in "relatively small Member States" – such as the Netherlands – this can "make it possible to establish that the three cumulative conditions for a conservation status to be taken as favourable are satisfied as regards that [national] population" as laid down in Article 1(i) of the Habitats Directive (para. 55).

In determining the relevance to be attached to these kind of cross-border exchanges, "the Member State concerned must take into account, in particular" three factors (para. 66), i.e. (1) "the level of legal protection guaranteed by those other Member States" for the species, (2) "the extent to which the respective competent authorities are cooperating" in monitoring and maintaining the species and (3) "any foreseeable and probable change capable of affecting those exchanges" such as border fencing and factors that affect connectivity.

A second aspect addressed in the Estonian wolves case is the relevance of the Red Lists and the associated methodology developed by the International Union for Conservation of Nature (IUCN). According to the Court, the assessment method differs from the methodology that must be applied pursuant to Article 1(i) of the Habitats Directive (para. 50). On the one hand, the "data, criteria and assessments" that form the basis for the classification of a species on a Red List can "form part of the scientific data which the Member State concerned must take into consideration for the purposes of its own assessment" (para. 51). On the other hand, the classification of a species on a Red List – in this case the wolf's inclusion in the 'vulnerable' category on the Estonian national Red List – "does not, as such, preclude the conservation status of that species, within the territory of the Member State concerned, from still being taken as favourable" if the conditions laid down in Article 1(i) have been met (para. 51).

A third aspect that has significant importance for practical implementation concerns the role of Article 2(3) of the Habitats Directive in this context. This clause reads as follows: "Measures taken pursuant to this Directive shall take account of economic, social and cultural requirements and regional and local characteristics." The Court acknowledges that these kinds of requirements and characteristics can be part of "the influences acting on the species" and can therefore be relevant "for the purpose of establishing whether or not the conservation status of a species... is favourable" (para. 68). "Nevertheless, the conservation status of that species cannot be taken as favourable owing to those requirements and characteristics", the Court continues, "if the three cumulative conditions of Article 1(i) are not satisfied" (para. 71).

What constitutes an FCS is therefore determined exclusively by the criteria laid down in Article 1(i) of the Habitats Directive. In other words, the economic, social and cultural factors and other local circumstances referred to in Article 2(3) can play a role in whether or not the bar for achieving an FCS in the member state is *reached*, but they cannot be allowed to play a role in determining *where that bar lies*. That is the exclusive domain of the ecological requirements laid down in Article 1(i).

A fourth and final clarification, which may also be of major significance, relates to the increased emphasis in international biodiversity policy, referred to earlier, on the functioning of ecosystems. In the Estonian case, the Advocate General explicitly linked the concept of FCS and the ecological function of the species concerned, in this case the wolf (case C-629/23, Opinion of Advocate General J. Kokott, 12 December 2024, para. 37):

"[...] the Habitats Directive does not seek to conserve the protected species only somewhere in the European Union. Rather, [according to Article 1(i)], each species should form a viable component of its natural habitats. In that natural habitat, the species has an ecological function."

After some considerations regarding the wolf's ecological role as a large carnivore (para. 38), the Advocate General then concludes that an FCS in the sense of the Habitats Directive does imply that the species concerned "[can] fulfil its ecological function there... to its full extent" (para 39). The Court confirms this reasoning in its ruling (C-629/23, par. 48):

"As the Advocate General has observed... if the conservation status of a species is not favourable in a Member State that species cannot fulfil its ecological function there, or at least not to its full extent."

The ruling provides no further explanation of the concrete implications of this in terms of requirements, but it appears to set the bar significantly higher than conventional MVP standards.

Finally, in recent case law, the CJEU emphasised the role of the precautionary principle for both the Annex IV and Annex V regimes. In the Austrian case, concerning the strict protection regime from Annex IV, the Court confirms that "if, after examining the best scientific data available, there remains uncertainty as to whether or not a ... derogation" – i.e. the removal of one or several wolves from the population – "will be detrimental to the maintenance or restoration of populations... at a favourable conservation status, the Member State must refrain from granting or implementing that derogation" (para. 64). This uncertainty can relate both to the conservation status as such, and to the effect of the envisaged culling on that conservation status.

In another recent case regarding the hunting of wolves in Spain, the CJEU applied similar reasoning with regard to the flexible protection regime from Annex V. Here too, the precautionary principle applies that the member state in question is not permitted to authorise the "exploitation" of wolves "if, after examining the best scientific data available, there remains uncertainty as to whether the exploitation … is compatible with the maintenance of that species at a favourable conservation status" (case C-436/22, 29 July 2024, para. 72).

Of all the guidelines available for operationalising the concept of FCS, the methodology developed for the wolf and other carnivores in the most recent set of guidelines (Linnell & Boitani, 2025) would appear to most closely reflect recent CJEU case law – although it is not certain that this methodology is in agreement with the case law (and particularly the most recent Estonian ruling on wolves) on all points. In this report, we primarily aim to reflect the guidelines drawn up by Linnell & Boitani.

4 Biology/ecology of the species

The key factors to consider when determining the FCS of the wolf are the species' biological characteristics and ecology. Jansman et al. (2021) includes a detailed description of these and the text below has largely been derived from that.

Wolves are carnivores with a high, narrow chest, long legs and a long torso. The head is large with a wide forehead, slightly slanting eyes and relatively short ears. Wolves have bushy tails around one third the length of their body. In Central Europe, the coat is usually grey-brown with lighter fur in some areas, and some black fur. Adult female wolves weigh around 40kg and male wolves around 45kg. Wolves are habitat generalists and occur in a range of landscapes, providing that cover and food is available. They make their dens, where the cubs are born, in remote places that are less accessible for humans. They primarily hunt wild ungulates and will travel great distances in search of safe and easy food. They tend to select ungulates that present little risk of injury during hunting (young, weaker or sick animals).

Wolves live in a pack that generally consists of the parents and their offspring, and may include several generations. In addition, wolves from outside the pack are occasionally accepted to strengthen the pack (genetically). Living in a pack plays an important role in the shared defence of territory, hunting as a pack, defending food, and the rearing of young. Wolves can be divided into different age groups:

- Cub: 0-10 months
- Yearling: 10-24 months
- Adult: >2 years of age

In addition to the animals living in packs, a wolf population also includes roaming animals in search of their own territories and established solitary animals awaiting a breeding partner.

The population dynamics of wolves are complex and depend on many factors. Wolves have a strong system of territory that results in low wolf densities. Variations in population density occur as a result of variation in territory size, with only very limited variation in the number of wolves per territory. The size of a territory is determined mainly by the availability of food, inter-pack competition, and safe resting areas. An important factor is that the pressure on sources of food or the predation pressure also remain approximately constant. The size and dynamic of populations are determined by factors such as reproduction, mortality, immigration and emigration (figure 2); these depend on both internal factors (territoriality and inter-pack aggression) and external factors (availability of food, climate, diseases).

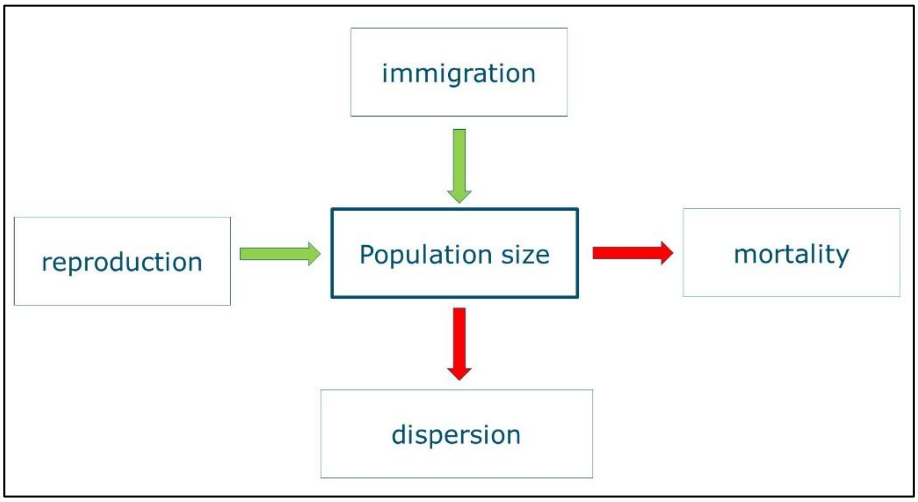

Figure 2 *The main factors that affect population size.*

4.1 Reproduction

Female wolves become fertile at around the age of two years. They are only fertile once a year, around February-March. It is usually only the pack leaders that reproduce and there is only one litter per year. Occasionally there may be multiple litters within a pack, usually fathered by the male leader with female subordinates (polygyny), which can result in inbreeding. The gestation period is approximately 63 days and most young are born in early May. The average litter size of wolves in the Netherlands is around 4.7 cubs, with a maximum of 7 (Dekker et al., 2024). In practice, the litter size may be larger as it is based on camera trap footage, which can potentially miss litter mortality. The litter size in the Netherlands corresponds with data from the Central European population for the period 2005-2022 (Planillo et al., 2024b), which shows an average litter size of 4.04 with a distribution of 4.20 and maximum of 13. If density is high, density dependency can play a role, leading to a lower litter size.

4.2 Mortality

The average life expectancy for wolves is five years (Mergeay et al., 2024; Planillo et al., 2024a) and few make it to the age of ten. In Europe, traffic is an important cause of death for wolves. Extensive research in Yellowstone National Park has shown that approximately 40% of adult wolves are killed by other wolves due to territorial behaviour. In Europe, however, there is no evidence that wolves often kill each other, although this has been observed from autopsies on Dutch wolves. For the Central European population, the human impact on mortality is probably much greater than in Yellowstone due to higher traffic intensity, illegal persecution, and (ungulate) management, which reduce the amount of territorial fighting. If density increases further, density-dependent mortality could become more significant.

Disease also plays a role in the population size and dynamics of wolves. Canine diseases, such as canine distemper virus (CDV) and mange were found to have a significant effect on the population in Yellowstone National Park. CDV is also found in European wolf populations, but it is unclear of the effect of diseases in Europe. Mange and French heartworm have already been found in Dutch wolves, with further information on veterinary aspects in Groot Bruinderink et al. (2012). In the Central European population, the annual survival rate is estimated to be 75% for immature individuals and 88% for adult wolves (Planillo et al., 2024a). However, these figures are high compared to other European populations, probably because this population is still in full expansion. The figures for annual survival rates for each age category of Dutch wolves are not known, but are likely to be similar to those in the rest of the Central European population. There appears to be particular variation in the survival rates of cubs in their first year, dependent on factors like the supply of prey and pack size (Planillo et al., 2024a).

4.3 Dispersal

Most young wolves leave the parental pack sooner or later in order to find their own territory and reproduce. This usually occurs when the young wolf is a yearling (second year of life), but it can be as early as ten months old. A young wolf will live on its own during that phase of life – as a 'lone wolf'. Some look for free territory in the vicinity of the parental pack, but some wolves travel hundreds of kilometres.

4.4 Trends in wolf numbers and range

In practice, the wolf population of a particular region is largely determined by the animal's strongly territorial way of life. This is because no outsiders are tolerated within a pack's territory, and the number of individuals in these exclusive areas is therefore naturally – i.e. with no human intervention – limited to a low density in accordance with the wolves' position in the ecological food web. Thus, a 'local' population is limited to the parents with their young, plus a few young wolves from the previous year. The size of the pack can fluctuate over time depending on the number of young born each year as well as their survival, but largely it remains the same.

Due to the wolf's territorial nature, population changes are manifest in localised spatial patterns of local presence and absence, as with other medium and large predators. Wolves' territories can be seen as pieces in a jigsaw puzzle across the landscape, not necessarily adjacent and often with intervening gaps. The variation in the size of wolf territories can be considerable, and local living conditions such as the availability of food are a factor in this. More abundant food permits smaller territories and vice versa. The minimum territory size in the Central European population currently appears to be around 50 km^2 and the maximum ten times that figure. One consequence is that the predatory pressure on local wild prey species is always of the same order of magnitude, at least when considering that all the available habitat has been taken at regional level.

The density of a wolf population is ultimately determined primarily by the number of territories in a wide region, plus lone wolves roaming within that same area. As the density of wolves increases, negative density-dependent factors come into play (Planillo et al., 2024a). These can include smaller litter sizes, lower survival rates among young wolves, an increase in mortality as a result of aggressive interactions between wolves, and the spread of disease. For the time being, there is still plenty of potential habitat for wolves in the Netherlands, as their numbers remain low. The wolf population in the Netherlands is in a growth phase and is determined mainly by immigration, reproduction and mortality. In the event of increasing numbers, density-dependent factors will curb that rate of growth. Eventually, the population will stabilise and fluctuate around the ecological carrying capacity of the ecosystem, a situation that has now been achieved in the Lusatia region in Eastern Germany.

Most wolves in the Netherlands originate from the German segment of the Central European population. That population is still growing and will probably continue to be a source of immigrants. In addition, due to wolves' high capacity for dispersal and growth in other subpopulations in Europe, such as the Alpine wolf population, individuals may also come to the Netherlands from other regions. Whether these immigrants can find a place to settle will depend, in turn, on the amount of suitable habitat available.

Figure 3 *A pair of wolves. Photo: Marielle van Uitert©.*

5 Trends, major shifts, pressure factors

The pressure factors pursuant to the IUCN Red List identified by Boitani et al. (2022) for the wolf in Europe are (listed in order of frequency of reporting from high to low):

- Infrastructure: roads and railways
- Illegal culling/predator control
- Disturbance from recreational activities
- Spatial developments – tourism and recreation areas
- Agriculture – livestock farming
- Spatial developments, housebuilding and urbanisation
- Logging (large-scale)
- Spatial developments – commercial and industrial areas
- Energy and mining – renewable energy
- Climate change – habitat shifts and changes
- Agricultural – arable farming
- Hunting – hunting for pleasure
- Wildlife management – management of prey animals
- Mining – energy & mining, quarries
- Biosafety measures - fencing
- Agriculture – wood and biomass production
- Oil and gas extraction

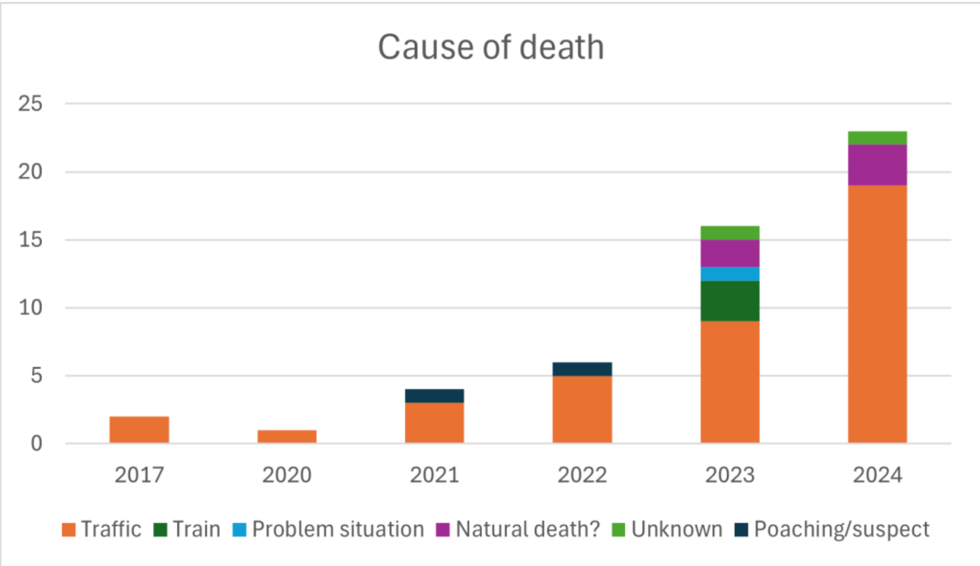

Figure 4 *Causes of death for wolves in the Netherlands (Source: WENR and BIJ12).*

For the Netherlands, the pressure factors especially affecting population development and distribution in recent years are vehicle deaths and illegal culling. Traffic (cars and trains) is by far the greatest cause of death (figure 4). In 2024, at least 19 of an estimated population of 93-113 wolves were killed by traffic i.e. 17-20% traffic mortality. Illegal culling has been reported from autopsies of wolf carcasses. It is not possible to say how often this actually occurs as wolf culling commonly remains unreported. In recent years, several genetically identified wolves in the Netherlands have disappeared in the monitoring of the Central European population. The possibility cannot be excluded that this is (partly) the result of illegal hunting (Jansman et al., 2021). To date, there has been no predator control (deaths resulting from population management) in the Netherlands.

Threats that can ultimately affect the Dutch wolf population trend include:

- Disturbance from recreational activities
- Spatial developments; loss of habitat through housebuilding, industry
- Energy and mining; construction of solar parks
- Fragmentation; roadbuilding, ribbon development (industry)
- Wildlife management
- Climate change
- Biosecurity measures: fencing to combat disease or protect livestock
- Culling of (problem) wolves
- Hybridisation

Disturbance from recreational activities around the den can cause stress, the frequent moving of cubs or can also affect the way wolves use their territory. There is also the chance of habituation to humans if animals are fed by recreational visitors, creating problem situations (Jansman et al., 2021). Recreation can therefore increase mortality and result in more human-animal conflicts. This is an area in which, to date, no research has been conducted in the Netherlands.
Spatial developments (housebuilding, construction of industrial sites and solar parks) can lead to the disappearance of potentially suitable habitat, depending on the location of the construction work. The influence of fragmentation will be minor providing that there are permeable structures, for example ribbon development with openings and/or motorways with appropriate wildlife crossing points. If roads are fenced off to deter wolves and there are no wildlife crossing points, the landscape becomes more resistant and there will be less genetic exchange within the population. Inbreeding depression can result in reduced fitness in the wolf population (Jansman et al., 2021).

Wildlife management (hunting) can impact the supply of prey and therefore the carrying capacity for wolves. This effect depends on the type of prey species and numbers present in a territory and the pressure resulting from hunting as part of wildlife management practices. To date, no studies have been conducted on this aspect; there are no signs that wildlife management practices have a negative impact on the size of territories and/or the trend in wolf numbers in the Netherlands.

Climate change can lead to a loss of habitat or quality as a result of complex interactions between the vegetation and wild ungulates. For example, the demise of oak and beech trees can reduce wild boar carrying capacity, reducing the availability of prey for wolves (Groot Bruinderink & Hazebroek, 1995). On the other hand, grass growth can continue for longer in higher winter temperatures, leading to a resurgence in the wild boar carrying capacity.

Fencing to combat the spread of animal diseases, such as African swine fever, can have an impact if the fences form a (partial) barrier for wolves. This also applies when herds of sheep are fenced off to deter wolves either in or close to areas of nature, preventing further access to wild prey within the fenced-off areas.

The culling of problem wolves can also increase mortality; in recent years this has occurred once. As wolf numbers increase, this human-animal conflicts may increase and culling will play a more significant role.

Hybridisation of wolves with dogs could either result in reduced genetic adaptability or actually increase it. Currently, the aim of policy is to remove hybrids from the population. Hybridisation occurs infrequently (< 1%) in the Central European population, has never been identified in the Netherlands, and is not anticipated in view of the low number of stray dogs (Jansman et al., 2021; Stronen et al., 2024). It is monitored on a European scale, including the Netherlands via Biodiversa+ project WOLFNESS, etc.

6 Current and past distribution and numbers

In the 20th century, the wolf was eradicated in much of Europe, with some small numbers remaining in Western Europe in Spain/Portugal and Southern Italy. (Chapron et al., 2014). In the Netherlands, the species was present sporadically until around 1800 in parts of Brabant and Limburg (De Rijk, 1985). More or less permanent populations continued to exist in difficult-to-access areas, such as de Veluwe, de Peel and Central Drenthe. By the end of the 19th century, the species could be considered extinct in the Netherlands. Precise information about the original range and numbers are not available.

From the end of the 20th century, the wolf has been on the rise from the remaining source areas in Eastern Europe (Chapron et al., 2014) and the current European population is estimated at around 23,000 animals (Di Bernardi et al., 2025). Starting in 1998, the wolf began to reappear in Germany from Poland (Jarausch et al., 2021). After its return to the Netherlands in 2015 and the first pack with cubs in 2019, the population here has also increased in numbers and distribution. From 2020-2025, animals were observed in 554 map cells (5x5 km; figure 5). Based on monitoring data from BIJ12 (BIJ12 voortgangsrapportage-wolf-24-september-2024) there was just one pack in the Netherlands between 2019 and 2021, four in 2022, and nine in 2023. In 2024, eleven packs were reported in the Netherlands, with an estimated >100 wolves including two solitary established adults, 17-26 yearlings, 55-62 cubs, and 8-12 roaming animals.

6.1 Wolf monitoring in the Netherlands

Wolf monitoring in the Netherlands is commissioned by BIJ12. It largely involves the genetic recognition of individuals based on DNA traces taken from scats (faeces), hairs, and traces of saliva on the remains of prey. These DNA traces are then analysed according to the CEwolf-consortium method (https://www.senckenberg.de/en/institutes/senckenberg-research-institute-natural-history-museum-frankfurt/division-river-ecology-and-conservation/cewolf-consortium/). The CEwolf consortium is a collaborative group of genetic experts from Austria, Belgium, the Czech Republic, Denmark, Germany, Luxembourg, the Netherlands and Poland, who all use the same methods to conduct DNA identification of wolves and share these data in a joint database. More than 4,500 different wolves have been identified in this way since 2005, with each wolf being observed more than 20 times on average. This DNA database makes it possible to trace individual wolves throughout their lives, track any journeys roaming wolves make across Europe (Konec et al., 2024), identify family relationships between individuals (Jarausch et al., 2021), obtain detailed information about survival, longevity and population growth (Planillo et al., 2025), and evaluate the conservation status of populations (Mergeay et al., 2024).

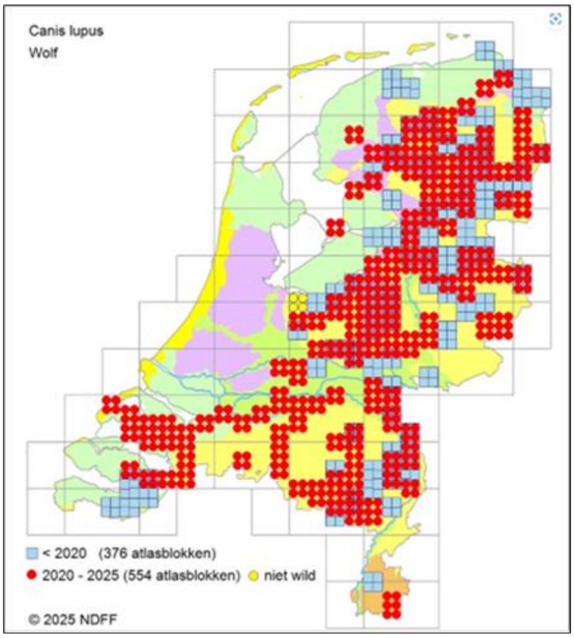

Figure 5 *Observations of wolves from the NDFF (Dutch National Database of Flora and Fauna) (NDFF Verspreidingsatlas | Canis lupus - Wolf).*

7 Determining the FRV values

The central aim of the European HR is to enable identifying the FCS for every protected species. The HR categorises conservation status as favourable when: 1) population dynamics data on the species concerned indicate that the population maintains itself on a long-term basis as a viable component of its natural habitats and is likely to continue to do so over the longer term; 2) the natural distribution range of that species is not declining and is unlikely to decline in the foreseeable future; and 3) sufficient habitat exists and is likely to continue to exist to sustain the populations of that species in the long term. In concrete terms, this means that the populations must be sufficiently large and robust to continue to exist in the long term and that they can fulfil their ecological function in the wider ecosystem. However, this is a wide-ranging qualitative concept that has never been clearly defined in law in quantitative or scientific terms because it can differ according to the species and the country.

In order to translate the concept of FCS into specific, quantitative measurable targets, the derived concept of FRV was introduced. This was then subdivided into a component for population size (Favourable Reference Population, FRP) and a component for geographic range (Favourable Reference Range, FRR). In order to speak of an FCS, both population size and range must be favourable.

The current guidelines generally refer to the need to apply the "best available scientific insights" to determine criteria for the different aspects (populations, range, available habitat). Until recently, these were described for large carnivores in Linnell et al. (2008). At the behest of the European Commission, this recently underwent rigorous scientific revision, which, after several rounds of consultations with the member states, culminated in a new set of "best practices" for large carnivores (Linnell & Boitaini 2025). Their report also incorporates new genetic insights into the conservation of populations, as recommended by previous guidelines and explanatory notes (Art. 17, explanatory notes/Evans & Arvela, 2011) and also account for the fact that large carnivores, such as wolves, have populations spread across several member states.

7.1 At which spatial scale should evaluation and reporting happen?

According to the original concept, FCS focuses on biogeographic regions within member states, and that member states must meet the conditions for FCS within their own territories. This is at odds with the fact that biological populations of many species (e.g. migrating fish species, bats, and large carnivores) can transcend political boundaries of member states and that biogeographical regions are of little biological significance for many species. It therefore makes little sense to regard a population of wolves in the Netherlands as an entity isolated from influences outside the Netherlands and to evaluate it in isolation; there is frequent immigration and emigration of wolves, and Dutch wolves are ecologically part of a coherent Central European population. This should therefore be the basic unit on which long-term viability must be evaluated.

Although the HD makes it possible for member states to determine joint criteria for FCS and therefore to report jointly, this still rarely happens. However, this is currently the case for the Birds Directive. Since FCS is implicitly anchored to biological populations as a unit, this calls for concrete coordination of terms, spatial scales, and conceptual frameworks in order to apply FCS. Bijlsma et al. (2019a) therefore suggested defining FRVs hierarchically on two spatial scales: firstly, FRVs are characteristics of the biological populations (FRV_{pop}), that can be defined both for the population size (FRP_{pop}) and range (FRR_{pop}). In addition, there is the level of the political and administrative units of the member states (FRV_{MS}), which again can be determined for both population and range (FRP_{MS} and FRR_{MS}). For wolves, the level of member states is partly or completely submerged in the level of the biological populations.

We define the term ‘population’ as a group of individuals whose members are regularly connected because they use the same spatial landscape and can therefore also be genetically identified as such. In Europe, nine different wolf populations are currently recognised (Kaczensky et al., 2024), and these are jointly monitored across different member states. The Dutch wolves are part of the Central European population, for which coordinated monitoring of the population size takes place in accordance with the joint criteria of the CEwolf consortium. This population is found in the Netherlands, Belgium, Denmark, Germany and adjacent parts of the Czech Republic and Austria, and to the west of the Vistula in Poland.

Until recently, some of these populations were still clearly different from each other as a result of decades of isolation from the often small remaining group of individuals. However, as a result of the recent growth in the European wolf population (Di Bernardi et al., 2025), we were able to determine that some of these populations have already grown closer to each other and that there is sufficient and frequent exchange between individuals from the different subpopulations to be able to consider them a functional metapopulation: a set of subpopulations that exchange at least one (but preferably more than five) effective migrant or migrants per generation. Mergeay et al. (2024) recognise seven metapopulations in Europe in this way. For the Central European population, there has been anecdotal reporting of occasional mixing with wolves from the Italian Alpine population and the Baltic population, thus this population is still clearly genetically distinct from the other European populations (Szewczyk et al., 2021).

7.2 The favourable reference population, FRP

The HD explicitly states that the criteria for a FCS must be determined based on population-dynamic and genetic data and that the long-term viability of populations must be considered. In the past, the concept of minimum viable population (MVP) was used, which attempts to determine the conditions required to prevent, with 99% certainty, a population becoming extinct within a foreseeable period, generally 100 years. Although 100 years may seem a long time, this concept of MVP has a completely different use in practice than what the HD aims to achieve: ensuring that there are large, robust populations with a long-term sustainable existence. For an FRP, the timeframe has to be significantly longer (Miller & Dussex, 2024). The chosen period of 30-100 years in typical model studies is a limited time horizon in the context of evolutionary processes. An FRP goes further than a population with a slight risk of extinction, and also needs to be longer than an MVP for demographic and genetic viability (DG Environment, 2023).

Recently, several MVP studies have been conducted for different European wolf populations (Miller & Dussex, 2024; Dekker et al., 2024), all of which address relatively small regions dependent on immigration from other member states. In the Netherlands, Dekker et al. (2024) calculated that a population of around 200 wolves (approx. 20 packs) would have a low risk of extinction within 100 years, but would require regular immigration from Germany. This approach can prove useful in determining a reference value at member state level (FRP_{MS}), but needs to be anchored to the situation of the overarching biological population, for which a separate FRP_{POP} reference value needs to be determined.

Through the Convention on Biological Diversity, this concept of long-term population sustainability was recently translated into relative universal criteria for population growth (COP15, 2022) by referring to a genetically effective (meta)population size larger than 500 (for a more detailed technical explanation, see text box 1). Starting from this value, a population has no notable net loss of adaptive genetic diversity that was already present. This effective population size is not in itself a countable number of individuals, but generally translates in concrete terms as being made up of 5,000 (countable) individuals, although this can vary from species to species (Hoban et al., 2020). For wolves, we now know that the effective population size can be effectively approximated based on the number of packs (Mergeay et al., 2024), which means that genetic methods are not needed to determine both the total effective population size (and whether this exceeds 500) and the partial contribution of each member state. Linnell & Boitaini (2025) also recommend defining the FRP at the level of the biological population as $FRP_{pop} > 500$ packs.

7.2.1 FRV at the level of the Netherlands

An important element of the principle of hierarchical FRVs for species with a large dispersal capacity (Bijlsma et al., 2019a) is that member states that share a biological population also have a shared responsibility to achieve favourable conservation status for that population (Linnell & Boitaini, 2025). Ultimately, this has to be based on FRV criteria at the level of the different member states and agreement between them is needed as to how this occurs. table 1 shows the current situation for the Central European population in terms of numbers of packs (effective population size) with the number of packs in each country indicating the current absolute contribution to the overarching target of FRP_{POP} > 500. This shows that the total population size is approximately 64% of the target figure.

One criterion within the HD is that the population must not be smaller than when the HD came into force. As there were no wolves in the Netherlands at that time (there was no Central European wolf population in 1994; Jarausch et al., 2021), this criterion does not apply. However, it is possible to use simulations and models to determine how much suitable habitat is needed as a means of estimating the limits of a member state's ecological carrying capacity. This also provides an estimate of an (ecologically) realistic population size and this is complementary to the need to determine a favourable reference range (FRR_{MS}). This can be used when determining concrete criteria for the FRP_{MS} for each member state, and assessing this against the FRP_{POP}.

Table 1 *The current number of packs per country in the Central European population of wolves and for the total population. Poland has wolves that belong to three genetically distinct populations (Central European, Baltic and Carpathian); some packs to the west of the Vistula are counted as part of the Central European population. Data from CEwolf consortium.*

Country	Number of packs
Belgium	4
Denmark	8
Germany	209
The Netherlands	11
Austria	4
Poland	70
Total	322

The ecological carrying capacity of a member state with regard to wolves has now been determined for various different member states. Using statistical models based on characteristics of the landscape matrix on the one hand and observed ecological preferences of wolves on the other, the suitability of certain zones in the landscape for accommodating a pack of wolves can be assessed. Each 10x10 km cell is given a suitability score (which also depends on the quality of the neighbouring cells) and if a specific score is exceeded, it is assumed that the cell is suitable for wolves. Kramer-Schadt et al. (2020) used this method to calculate that Germany has ecological space to accommodate 700 to 1,400 packs. The range in these calculations is due to the differences in input parameters in the different models. Biersteker et al. (2024) used virtually the same model, with improved granularity at scale level, to conclude that the Netherlands can accommodate between 23 and 56 packs. In Belgium, an analysis has been conducted for Wallonia (Schockert et al., 2020), which suggests that there is space for 20 to 30 packs. In Flanders, saturation is expected to be achieved at 3-5 packs, but a detailed study is under development (J. Mergeay, pers. info.). In Denmark, expectations are that there is space for 11-30 packs (K. Olsen pers. info.) and in Luxembourg 6-8 packs (L. Schley, pers. info.). No estimates are yet available for Northern France, Western Poland, the Czech Republic or Austria.

In order to achieve a favourable population size at population level, the current population (322 packs) needs to increase. Habitat modelling already suggests sufficient ecological space to enable this increase in all member states for which information is available: in the case of the Netherlands, Belgium and Germany, the FRP_{POP} would be significantly exceeded if only the minimum modelled ecological carrying capacity were to be achieved. For Germany and Belgium, however, this would require more than a fourfold increase in the current number of wolves.

It is up to each member state to determine what the FRP_{MS} value is, considering that the total population must ultimately be large enough for a favourable conservation status to apply. For a member state there are four possible scenarios that are combinations of the situation at the level of the total population and that of the member state, and these result in a favourable or unfavourable conservation status (Linnell & Boitaini, 2025):

1. FRV_{POP} unfavourable and FRV_{MS} unfavourable ➔ FRV is unfavourable.
2. FRV_{POP} unfavourable and FRV_{MS} favourable ➔ FRV is unfavourable. The member state may have achieved its local target, but the total population is too small.
3. FRV_{POP} favourable and FRV_{MS} unfavourable ➔ FRV is unfavourable. The total population may be sufficiently large, but the member state does not sufficiently contribute to it.
4. FRV_{POP} favourable and FRV_{MS} favourable ➔ FRV is favourable.

7.2.2 Wolf metapopulations now and in the future

In principle, the FRP_{POP} criterion of at least 500 packs refers to an isolated population that has full internal mixing, but can also relate to a metapopulation (a set of distinct but connected subpopulations). The level of connection necessary between subpopulations within a metapopulation in order to be considered functionally connected is at least one effective genetic migrant per generation over a long period. If subpopulations exchange fewer than one migrant per generation, these subpopulations will largely develop independently of each other. If they exchange more than one migrant per generation, they will evolve as a single large population and therefore also maintain evolutionary potential for variation as a whole. If we plot the fraction of genetic diversity within subpopulations relative to the total population as a function of gene migration, if this is balanced there is a notable tipping point at around one migrant per generation. However, if we are to talk of robustly connected metapopulations, we are likely to need five to ten effective migrants per generation. The HD also requires robust criteria with an ample safety margin. Thus, we recommend aiming for five effective migrants per generation before we consider subpopulations to be functionally connected.

Currently, there are nine recognised wolf populations in Europe (Boitani et al., 2022; Kaczensky et al., 2024). However, based on estimates of increased connectivity between some of these populations, Mergeay et al. (2024) we now consider seven metapopulations, each of which must meet the FRP_{POP} criterion: the Italian and Alpine populations have become one continuous population by default, and the Dinaric-Balkan population also appear to be functionally connected with the Carpathian population. In the event of continued growth of both the Central European and the Baltic and Alpine populations, it would seem plausible that this connectivity will increase to such an extent that we will be able to consider the Central European population as part of a larger metapopulation, which means that the FRP_{POP} criterion can, in theory, be spread over a larger area. However, this may potentially lead member states to do more about population management as a result of the lowering of the protection status within the Habitats Directive to Annex V, causing different subpopulations to shrink and connectivity to fall below the threshold value again, as a result of which the FRP_{POP} criterion may revert to a smaller area. It would therefore seem inappropriate to count on future increases in connectivity in determining the FRP_{POP} and $FRP_{MS.}$

Text box 1 The effective population size and the FRP

We can approximate the size of a population in two complementary ways: the number of countable individuals (N) and the effective (genetic) population size.

The effective population size is a measure of the speed with which genetic diversity is lost and is expressed as a number of individuals of a theoretical ideal population. The main influence on effective population size is the variation in reproductive success throughout a wolf's life. Variation is a measure of distribution, and if that distribution is higher than it is in an ideal theoretical population, the effective size is smaller than the number of individuals in the population: the census size. With regards to wolves, variation in reproductive success is largely caused by differences in adult survival – and the different potential litters associated with that – and by differences in litter size (Mergeay et al., 2024). Again, the latter is a function of the quality of the territory (Planillo et al., 2024a) and of differences in fitness between individuals (Waples, 2024). In the case of wolves, the Ne is around 12% of the total population size and this closely corresponds to the number of packs (Mergeay et al., 2024). Since viability and genetic variation in a small population are mainly determined by the Ne and much less by the number of animals within a population, the effective size is a key concept in determining an FRP.

It has been determined theoretically and empirically that the long-term survival of populations requires a minimum effective size of 500-1,000 individuals (Frankham et al., 2014; Traill et al., 2007; Perez-Pereira et al., 2022). The effective population size can also be calculated by determining variation in reproductive success, however genetic methods can also be applied to estimate how quickly genetic diversity is lost. Generally, the conversion rule of 1/10 (effective versus census size) is considered robust (Hoban et al., 2020) and is accepted as a rule of thumb by the Convention on Biological Diversity. This makes it possible to apply guidelines for conserving genetic diversity without the need for complex genetic research (Mastretta-Yanes et al., 2024).

The threshold value accepted by the CBD of an effective size of 500 therefore generally translates into a concrete countable number of 5,000 individuals. This has been studied empirically for wolves: the recommendation in this case is to approximate the effective size by taking the number of packs, as this appears a good approximation of the effective population size (Mergeay et al., 2024).

Since no FRVs can be determined by means of a reference-based approach, the model-based approach has been applied.

7.3 MVP – Theoretical framework

Linnell & Boitani (2025) state that small to medium-sized countries should accommodate an FRP_{ms}, an MVP, or an Ne>50-100 packs as a contribution to the FRP_{pop}. An MVP is an estimate of the minimum number of individuals needed for a viable population and is the smallest isolated population which maintains an extinction risk of 5% over 100 years (Verboom et al., 2001), despite the envisaged impacts of demographic, environmental and genetic stochasticity, and natural catastrophes.

Commonly, an MVP is determined by using simulation models, and sometimes by rules of thumb or statistical methods to determine population viability by means of a PVA (population viability analysis) (Boyce, 1992). A PVA usually involves stochastic (random) modelling of demographic and genetic processes within populations in order to calculate extinction risks. A PVA's reliability is totally dependent on the reliability of the model parameters chosen and a sensitivity analysis is necessary as many parameter values may be variable over time (e.g. mortality risks, age-dependent dispersal, maximum dispersal distance; Stockland, 2016).

Figure 6 *Wolf family. Photo: Marielle van Uitert©.*

7.4 MVP for the Wolf

Several studies have been conducted in Europe that provide an estimate for an MVP. However, most model studies have been conducted in North America and in order to parameterise such factors as litter size or dispersal, information from outside the study area is commonly used (Dekker et al., 2024).

A recent study using the Vortex model based on field data from the German population shows that around 8,500 wolves can be expected in the basic short-term scenario (30 years) without any decrease in genetic diversity or increase in inbreeding. Depending on how the model is parameterised, this figure varies between 1,500-8,500 wolves. In a number of scenarios, there is a risk of short-term extinction, especially if mortality increases (Hatlauf et al., 2024). In an Italian study using Vortex, mortality of juvenile and adult animals was also identified as the most important parameter value (Merli et al., 2023).

Dussex (2024) and Miller & Dussex (2024) used Vortex and SLiM to carry out a PVA for the Swedish wolf population. In the models, empirical data relating to mortality, reproduction, population size and migration were parameterised. Genetic diversity was also modelled. Based on field data, the extinction risk over 100 years was around 1% for a population of 50 wolves and 0% for a population >100. If the chance of survival and reproductive output of females (litter size) were reduced, the extinction risk would be 22-32% for a population of 50 wolves, and between 1-10% for a population >100. For a population of 170 – 270 wolves in Sweden, 1-3 immigrants per decade would be sufficient to cause < 5% inbreeding. However, Miller and Dussex do note that there is then a risk of the introduction of damaging recessive genes, especially in small populations, even in the case of >8 immigrants per decade. In addition, these models assumed regular immigration from a genetically diverse and large Russian source population, which seems at odds with the current situation: since 1990, only four immigrants have contributed genetically to the Scandinavian population and inbreeding is still around 25%, which would suggest that this population is insufficiently connected to form a buffer against inbreeding in the current population.

A model study was recently conducted for the Netherlands by Dekker et al. (2024). They used an age-/stage-structured population model with density-dependent effects (litter size and mortality) based on the carrying capacity. Where possible, this model used parameter values for the Dutch population, including a sensitivity analysis. After a simulation over 30 years, the default model produces a population of 122 wolves, of which 21 are roaming animals, 43 cubs, 24 yearlings, 10 subdominant and 24 adult wolves in 12 packs. After 100 years, the population could be around 190 animals, with around 75 adult animals. The default model underestimates the number of territories, number of cubs, and the population size compared to Dutch field data. This is probably the result of using parameter values from wolf research conducted outside the Central European population. Based on the model study, there is no expectation that the Dutch population will become extinct. In all of the runs in which the parameter values were varied for the purposes of the sensitivity analysis, the population remains persistent and it is mainly the regular influx of migrants that plays a role. The result of this study therefore indicates that a relatively low number of packs is sufficient to prevent extinction based on demographic stochasticity. However, the model takes no account of genetic aspects.

The above studies indicate that an MVP for wolves will be approximately 100-200 in order to minimise the extinction risk over 30-100 years. In this, it should be noted that the results of a PVA primarily indicate what the uncertainties are with regard to the expected population sizes, extinction risks, and parameter values that influence these (Hatlauf et al., 2024). Above all, it is important to remember that there is a real risk of genetic drift and inbreeding in such a small population/MVP (Miller & Dussex, 2024; Stockland, 2016; Hatlauf et al., 2024). These small populations are also sensitive to variations in pressure factors that can have a negative impact on the population, such as increased mortality. It should also be noted that an MVP is not identical to a FRP_{pop}, but can contribute to it.

7.5 Is the Netherlands large enough for a FCS?

Biersteker et al. (2024) conducted a habitat suitability analysis for wolves in the Netherlands. The model assumes a habitat suitability of 0.17% (lenient) or 0.28% (strict) suitable habitat within a cell and an average home range size of 200 km^2. Based on LARCH (Landscape-Ecological Analysis and Rules for the Configuration of Habitat) modelling, they conclude that the number of cells in which there is suitable habitat for the wolf in the strict scenario is 32 10x10 km cells and 181 10x10 km cells in the lenient scenario (figure 7). This is the equivalent of 20 to 104 packs. However, each cell also contains unsuitable habitat for the wolf that has been wrongly included. For this reason, they applied a refinement using a grid of 100x100 m which shows more cells to be unsuitable. Based on these scenarios determined using a LARCH scan, this results in 32 10x10 km cells in the strict scenario and 181 10x10 km cells in the lenient scenario (figure 8). This scenario appears to be realistic for the range, but includes unsuitable habitat within the cells, resulting in an overestimation of the corresponding number of packs. The scenario with a refined grid provides a better estimate for this (figure 8).

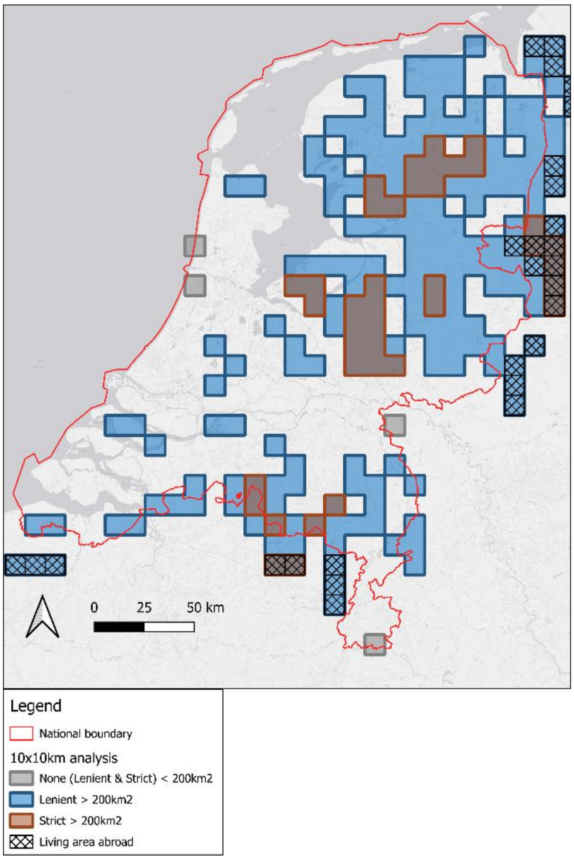

Figure 7 *Habitat suitability for the wolf in the Netherlands.*

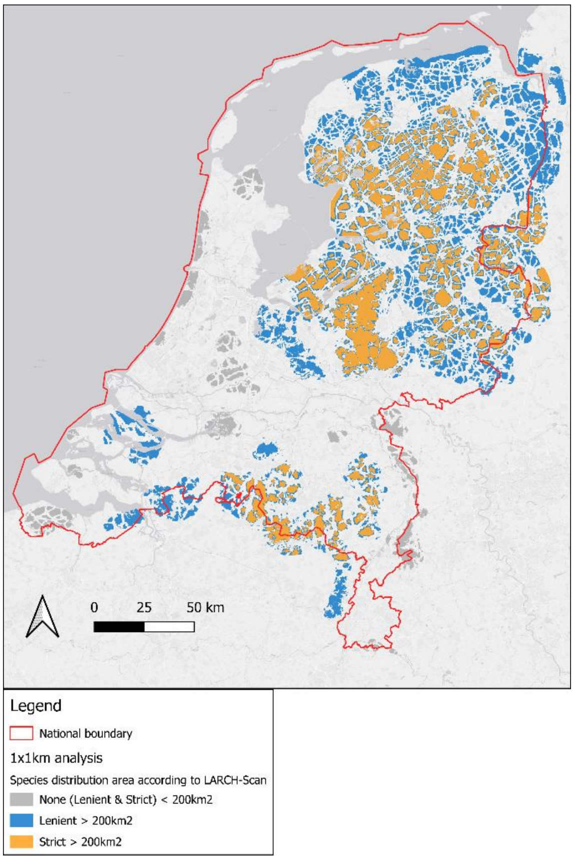

Figure 8 *Habitat suitability for the wolf in the Netherlands.*

Biersteker et al. (2024) estimate that the most realistic estimate for the carrying capacity in the Netherlands in their habitat suitability analysis is 23-56 packs with a range as shown in figure 8. This implies that the Netherlands can be expected to be able to accommodate an MVP, even in the strict scenario, provided that mortality remains low enough and there is sufficient exchange with neighbouring populations. It seems less likely that an Ne >50 can be reached, which means that the extinction risk as a result of genetic processes can be covered in the short term. The model estimates an upper limit in the lenient scenario of 56 packs which means that an Ne of 50 packs could be exceeded. It should be noted that Biersteker et al. (2024) use a territory size of 200 km^2 for their calculation. If this figure is any smaller or larger, the resulting number of packs will be higher or lower. Wolves' home ranges can vary significantly in Europe, ranging between 80-400 km^2 (Jansman et al., 2021, and others). With regard to genetic processes that play a role in reaching a sufficient Ne for the long-term of > 500 packs, the studies by Dekker (2024) and Biersteker et al. (2024) make it clear that this figure cannot be expected. This means that the Netherlands is too small for an FRP. Assuming five animals per pack, the Netherlands could provide space for approx. 20-50 packs, or 100-250 wolves. The highest numbers could be achieved in the area modelled by Biersteker et al. (2024) with an ample upper limit, occupying a great deal of cultivated area.

FRVs for the Netherlands

The wolves currently present in the Netherlands originate from the Central European population of Poland/Germany, and they have also established themselves in Belgium and Denmark. There is a cross-border population that involves the frequent exchange of individuals between the Netherlands, Germany and Belgium. In accordance with DG Environment (2023), FRVs for species with extensive home ranges, such as wolves, are usually determined for the entire population (or metapopulation) which implies the need for cooperation between member states. This view is also supported by Linnell & Boitani (2025) in their advisory report to the European Commission. For the Central European population and the required effort to be made by small to medium-sized countries like the Netherlands, they make the following suggestion:

- FRP_{pop}: all countries together ensure that there are Ne>500 packs with sufficient effective genetic exchange between countries.
- FRR_{pop}: an area that is large enough to accommodate the FRP_{pop} with realistic population densities with sufficient (connected) suitable habitat within the dispersal distance.
- FRP_{ms}: for small to medium-sized countries such as the Netherlands (10,000-50,000 km^2), the proportion within the FRP_{pop} must be an MVP or an Ne>50-100 packs.
- FRR_{ms}: an area that is large enough to accommodate the FRP_{ms} with realistic population densities with sufficient (connected) suitable habitat within the dispersal distance and in line with the FRR_{ms} of adjacent countries, overlapping all Natura 2000 sites designated for the species, in the biogeographical area that is considered to be the natural range, overlapping all relevant ecological conditions, ecosystems and prey communities.

Based on the habitat suitability analysis, the Netherlands could contain between 32 and 181 10x10 km cells with between 23 and 56 packs respectively. In the first case, the Netherlands is a small country with less than 10,000 km^2 of suitable habitat. According to Linnell & Boitaini (2025), wolves would then need to occur in a significant portion of the country. In the second case, the Netherlands is in the small to medium-sized country category with the conditions described above. In view of the fact that the wolf's range in the Netherlands continues to expand (colonisation phase) and there is colonisation outside the modelled 32 10x10 km cells, it seems fair to assume that the range will ultimately be between 32 and 181 10x10 km cells.

For assessing FCS, Linnell & Boitani (2025) suggest the following checklist (table 2 and table 3):

Table 2 *Central European population (CEP). (pop = population. ms = member state).*

		Yes/No
FRP_{pop}		
1	Does the sum of all member state contributions in the CEP result in an Ne>500?	
2	Is the population trend positive or stable?	
FRR_{pop}		
3	Is the FRR in the CEP composed of a continuous and interconnected distribution?	
4	Is the range stable or increasing?	
5	Is there sufficient habitat without barriers that impede exchange within the dispersal distance?	
6	Is the area large enough to accommodate the FRP_{pop} in realistic densities?	
7	Is the prognosis for habitat quality and connectivity positive?	
8	Are there potential connection corridors for neighbouring populations to enable regular dispersal of individuals?	
9	Have all genetically distinct units or subspecies been included in the range?	
FCS_{pop}	If all answers to questions 1 to 9 are yes, FCS_{pop} has potentially been achieved, otherwise not.	

Table 3 *Member state: the Netherlands.*

		Yes/No
FRP_{ms}		
1	Is the FRP_{ms} greater than or equal to when the country gained EU membership?	
2	Is the population trend positive or stable?	
3	Is the population size greater than an MVP or an Ne>50?	
4	Are there reproductive packs in the full range of Natura 2000 sites, biogeographic region under relevant ecological conditions?	
FRR_{ms}		
5	Is the FRR in the CEP composed of a continuous and interconnected distribution or potential distribution?	
6	Is the range stable or increasing?	
7	Is there sufficient habitat without barriers that impede exchange within the average dispersal distance?	
8	Is the area large enough to accommodate the FRP_{pop} in realistic densities?	
9	Is the prognosis for habitat quality and connectivity positive?	
10	Is the FRR sufficiently aligned to neighbouring populations to enable the FCS_{pop} to be attained?	
11	Does the FRR overlap all Natura 2000 sites designated for the species?	
12	Does the FRR overlap the entire biogeographical region in the Netherlands considered to be a natural range?	
13	Does the FRR allow for the presence of the species in all ecological conditions, ecosystems, and prey communities?	
14	Are all subspecies or distinct genetic populations included?	
FCS_{ms}	If all answers to questions 1 to 14 are yes, FCS_{ms} has potentially been achieved, otherwise not.	

The values suggested by Linnell & Boitani (2025) in their advisory report to the European Commission for small countries (MVP and if possible Ne > 50) correspond well to the minimum and maximum number of packs in our country in both the strict and a lenient scenarios. This suggests that the model values can effectively be used to determine the FRV values.

The relevant region

The current requirement is for reporting to be done across biogeographical regions (figure 9). The assessment of species in biogeographical regions is a requirement pursuant to Article 17 of the HD and Resolution No. 8 (2012) of the Bern Convention (Dekker et al., 2024). The Netherlands is in the Atlantic region, whereas the Central European wolf population of which the Netherlands is a part is in the Continental region. This approach (Atlantic region) does not therefore reflect the biology of wolves in the current situation. For an assessment of conservation status, a report would also result in the determination of an unfavourable status in the Atlantic region. For example, within this region, there are wolves in Spain and Portugal that are not connected to the Dutch population, whereas the German population is largely out of scope. In the case of the wolf, it would therefore be more logical to include Dutch reporting in the EU report for the Continental region.

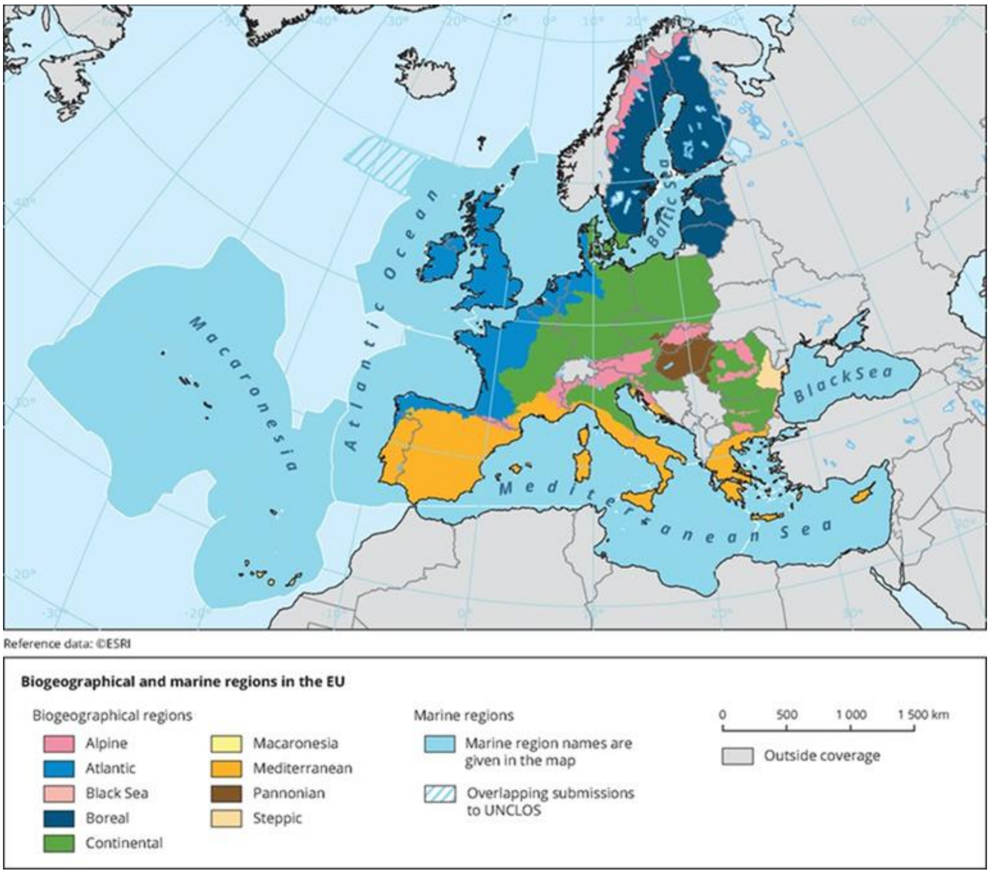

Figure 9 *Biogeographical regions in Europe.*

Recommendations
If the EU were to implement this proposal, agreements will need to be made with all countries within the CEP. Consultations have already been initiated on this issue (Dekker et al., 2024; Letter to Parliament on adoption of National Wolf Strategy, Ministry of LVVN dated 17-12-2024). There needs to be a focus on social, economic and cultural aspects within the FRR. An in-depth analysis that considers the importance of social, economic, and cultural factors in relation to the reference values is beyond the scope of this study. Based on the habitat suitability analysis by Biersteker et al. (2024), it would seem fair to assume that areas will also be colonised outside existing nature areas. There is also uncertainty with regard to the extent to which this study underestimates the habitat suitability of parts of the Netherlands. This is because wolves are flexible species that can adapt opportunistically to new conditions. There are currently no Natura 2000 sites designated for wolves in the Netherlands.

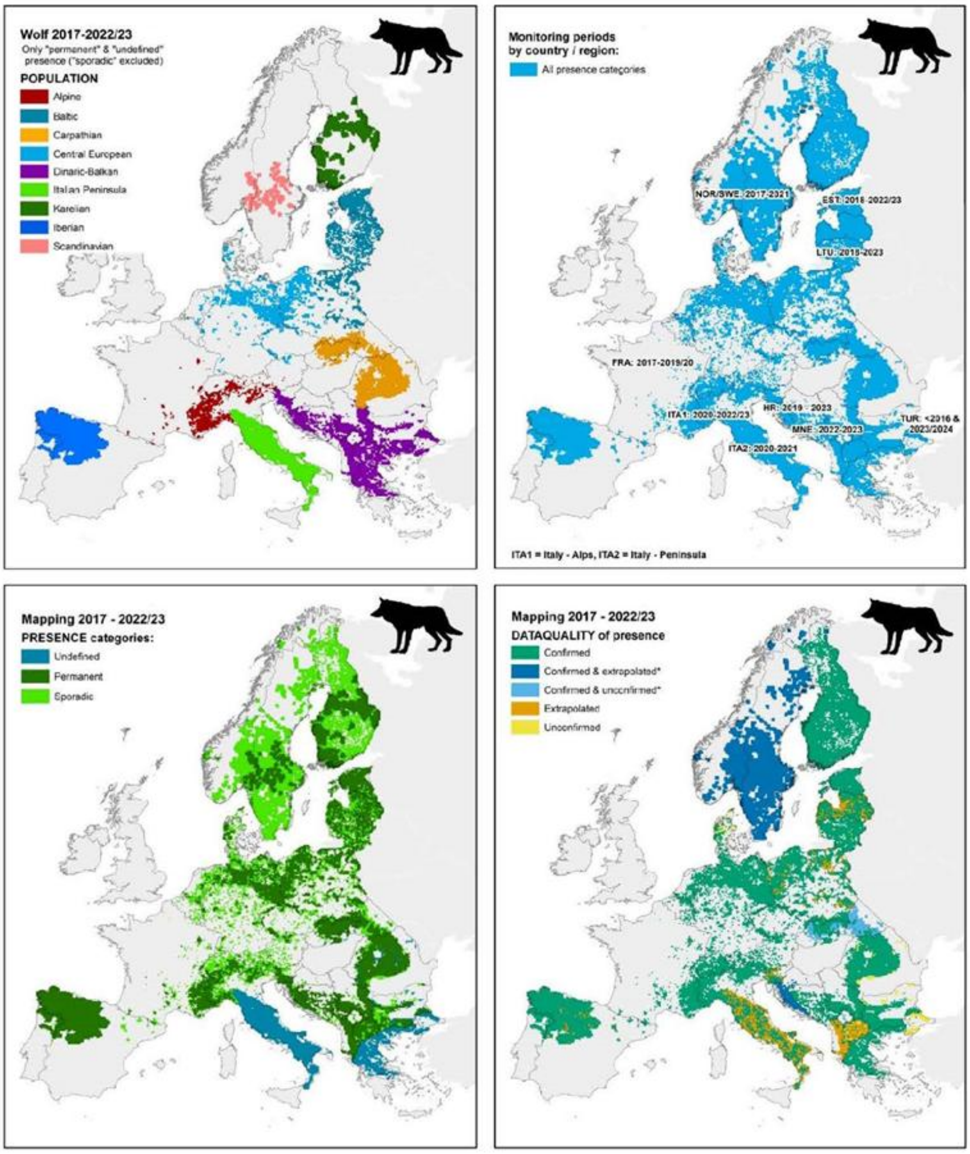

Figure 10 *Distribution of wolves in Europe (Kaczensky et al., 2024).*

In Europe, the wolf population is estimated at 23,000 individuals with nine distinct populations (figure 10; Kaczensky et al., 2024). Between 2016 and 2023, the population grew by 35%, mainly by means of rapid expansion from the Central European and Alpine population. The Netherlands is part of the Central European population (Kaczensky et al., 2024), found primarily in Poland and Germany and increasingly in Belgium, the Czech Republic, Denmark, Luxembourg and the Netherlands. In 2002, the number of wolves in this population was estimated at around 3,000 (table 4). Sporadic exchange with the Alpine, Dinaric-Balkan and Carpathian population is beginning to happen.

Table 4 *Central-European population size. Changes in wolf distribution in the Central European population between 2016 and 2022 based on the number (N) of 10x10 km cells (Kaczensky et al., 2024).*

N 2016			**N 2022**		
Permanent	Sporadic	Total	Permanent	Sporadic	Total
487	520	1007	1169	1703	3372

8 Conclusions: FRVs for the wolf

There are still uncertainties with regard to the appropriate method or methods for assessing conservation status as the European Court of Justice has not yet issued full and final clarification on this matter. Despite this, our report reflects the European Commission guidelines, including those recently published on the conservation status of large carnivores (Linnell & Boitani, 2025).

In order to be able to accommodate a sustainable wolf population (FRP), more than 500 packs are required. This report makes it clear that the Netherlands alone cannot accommodate an FRP with a corresponding FRR of a sustainable wolf population of more than 500 packs. The Netherlands can only contribute to a sustainable wolf population in a European context as part of the Central European population. According to the advisory report by Linnell & Boitani (2025), it should be possible for the Netherlands, as a small to medium-sized country, at least to accommodate a minimum viable population (MVP) and possibly also an Ne (Effective Population Size) of more than 50 packs.

Based on the modelling/habitat suitability analysis, the Netherlands can contribute to the Central European population with an FRP_{ms} of 23-56 packs. A minimum value of 23 packs would require an FRR_{ms} (range) of 32 10x10 km cells (strict scenario) and the maximum value of 56 packs would require an FRR_{ms} (range) of 181 10x10 km cells (lenient scenario). These values correspond to the required MVP (minimum value) and Ne of more than 50 packs (maximum value) and are suggested here as FRVs.

In the first case (strict scenario), the Netherlands is a small country with less than 10,000 km^2 of suitable habitat. Wolves would then need to occur in a significant portion of the country. In the second case (lenient scenario), the Netherlands is a small to medium-sized country with the conditions for an MVP or Ne as described above. In view of the fact that the wolf's range in the Netherlands continues to expand (colonisation phase) and there is colonisation outside the modelled 32 10x10 km cells, it seems fair to assume that the range will ultimately be between 32 and 181 10x10 km cells.

Both scenarios will need to be discussed with the surrounding countries home to the Central European wolf population since the choice of having fewer animals in the Netherlands would require larger numbers in the other countries.

This report does not provide further explanation of what these reference values could mean in social and economic terms in the Dutch context. This reflects the HD, which states that a favourable conservation status is determined exclusively by the criteria laid down in Article 1(i) of the HD. In other words, the economic, social, and cultural factors and other local circumstances referred to in Article 2(3) can play a role in whether or not the bar for achieving favourable conservation status in the member state is reached, but they cannot be allowed to play a role in determining where that bar lies. That is the exclusive domain of the ecological requirements laid down in Article 1(i).

Finally, we recommended that, for the purposes of the Article 17 reporting, the Dutch population be counted as part of the Continental region rather than the Atlantic region.

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The mission of Wageningen University & Research is "To explore the potential of nature to improve the quality of life". Under the banner Wageningen University & Research, Wageningen University and the specialised research institutes of the Wageningen Research Foundation have joined forces in contributing to finding solutions to important questions in the domain of healthy food and living environment. With its roughly 30 branches, 7,700 employees (7,000 fte), 2,500 PhD and EngD candidates, 13,100 students and over 150,000 participants to WUR's Life Long Learning, Wageningen University & Research is one of the leading organisations in its domain. The unique Wageningen approach lies in its integrated approach to issues and the collaboration between different disciplines.

To explore the potential of nature to improve the quality of life

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