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Standards for the monitoring of the Central European wolf population in Germany and Poland

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Content

Summary

Germany and Poland share a joint wolf population - the Central European population. For a joint assessment of the status of transboundary populations, the underlying data must be comparable. In 2012, the members of the Polish-German wolf working group decided to commission the development of joint monitoring standards as a prerequisite to allow a robust population-level evaluation of population size, area of occurrence and their respective trends.

The proposed joint German-Polish monitoring standards presented here are based on the SCALP criteria, which classify wolf observations according to their verifiability. Population size and area of occurrence assessments are based on hard facts (C1) and confirmed observations (C2) only. There are still minor differences in data evaluation between Germany and Poland, which we aim to overcome in coming years as we gain experience applying the criteria. Wolf scientists from both countries should meet once a year to report national monitoring results, jointly determine the status of possibly transboundary territories and estimate the effect of deviations that still exist in data evaluation.

The output of these meetings should be an annual status report on the Central European wolf population, with joint assessment of population size and a transboundary distribution map. The meetings should also be used to review and refine the standards, taking into account the expected increase in population size and concomitant increase in range. It is recommended that other countries sharing the same population, like the Czech Republic and in future perhaps Denmark and the Netherlands, too, should join these meetings and adopt the same monitoring standards.

Zusammenfassung

Deutschland und Polen teilen sich dieselbe Wolfspopulation, die Mitteleuropäische Population. Um den Populationsstatus grenzübergreifend einschätzen zu können, müssen die zugrunde liegenden Daten vergleichbar sein. 2012 gaben die Mitglieder der deutsch-polnischen Wolfsarbeitsgruppe daher die Entwicklung gemeinsamer Monitoringstandards in Auftrag. Diese sind die Voraussetzung, um robuste Schätzungen der Populationsgröße, des Vorkommensgebietes und der Trends dieser beiden Faktoren auf Populationsebene durchführen zu können.

Die hier vorliegenden Vorschläge für deutsch-polnische Monitoringstandards basieren auf den SCALP- Kriterien, anhand derer Wolfshinweise nach ihrer Überprüfbarkeit klassifiziert werden. Schätzungen bezüglich der Populationsgröße und des Vorkommensgebietes beruhen ausschließlich auf Nachweisen (C1) und bestätigten Hinweisen (C2). Noch gibt es kleinere Abweichungen in der Datenevaluierung zwischen beiden Ländern, die in den nächsten Jahren mit zunehmender Erfahrung bei der Anwendung dieser Standards überwunden werden sollten. Wolfswissenschaftler beider Länder sollten sich jährlich treffen, um die nationalen Monitoringergebnisse zu präsentieren, den Status möglicherweise grenzübergreifender Territorien zu bestimmen und die Auswirkungen der noch vorhandenen Unterschiede in der Datenevaluierung abzuschätzen.

Als Ergebnis dieser Treffen sollte ein jährlicher Statusbericht der Mitteleuropäischen Wolfspopulation erstellt werden, der eine gemeinsame Populationsgrößenschätzung und eine grenzübergreifenden Verbreitungskarte enthält. Die jährlichen Treffen sollten auch

dazu genutzt werden, die gemeinsamen Monitoringstandards zu überarbeiten und weiterzuentwickeln, auch in Hinblick auf das zu erwartende weitere Wachstum und der damit einhergehenden Ausbreitung der mitteleuropäischen Population. Wir empfehlen, dass weitere Staaten, die dieselbe Population teilen, wie die Tschechische Republik und in Zukunft möglicherweise auch Dänemark und die Niederlande, an den jährlichen Treffen teilnehmen und die Standards übernehmen.

Streszczenie

Niemcy i Polska dzielą tą samą populację wilka, nazywaną populacją środkowoeuropejską. Aby móc wspólnie oceniać status populacji gatunków o zasięgach trans granicznych zebrane na ich temat dane powinny być porównywalne. W 2012 r. członkowie Polsko-Niemieckiej grupy roboczej ds. wilka zaleciła opracowanie wspólnych standardów monitoringu, które umożliwiłyby ocenę liczebności, obszaru występowania oraz trendów zmian tych parametrów na poziomie całej populacji.

Standardy monitoringu przedstawione w niniejszym opracowaniu opierają się na zmodyfikowanych kryteriach SCALP (Status and Conservation of the Alpine Lynx Population), w których dane o obecności wilków są klasyfikowane zgodnie z ich weryfikowalnością. Ocena wielkości populacji i obszaru występowania gatunku są oparte wyłącznie na stwierdzeniach pewnych (C1) oraz odpowiednio zweryfikowanych (C2). Istnieją wciąż niewielkie różnice w zaproponowanej ocenie danych pomiędzy Niemcami i Polską, które w przyszłych latach chcielibyśmy stopniowo eliminować wraz ze wzrastającym doświadczeniem w monitoringu i zachodzącymi zmianami w wielkości i zasięgu populacji. Specjaliści zajmujący się badaniami nad wilkami z obu państw powinni się co roku spotykać, aby przedstawić wyniki przeprowadzonego monitoringu w każdym z krajów, wspólnie ocenić status transgranicznych terytoriów wilków oraz oszacować wpływ różnic w metodyce na uzyskane wyniki.

Wynikiem tych spotkań powinien być roczny raport na temat sytuacji środkowoeuropejskiej populacji wilka oraz wspólna ocena wielkości populacji wraz z mapą rozmieszczenia gatunku. Spotkania powinny również zmierzać do stopniowego doskonalenia i ujednolicenia standardów monitoringu. Zaleca się by pozostałe kraje dzielące tą samą populacją, np. Czechy a w przyszłości prawdopodobnie również Dania i Holandia, włączyły się w te spotkania i również zastosowały zaproponowane standardy.

1. Introduction

Wolves in Germany and the western half of Poland (west of the 18° 08' meridian) belong to the Central European Lowland population (KACZENSKY et al. 2013), short Central European wolf population (CEWP). This population is one of the fastest growing wolf populations in Europe today. Several dispersers have already reached Denmark and the Czech Republic. The rapid expansion of this population presents a clear challenge for its conservation and monitoring.

In 2009, a first official Polish-German meeting on wolves took place. Attendees included members of federal ministries and authorities, regional (Länder, Provinces) ministries and authorities, as well as wolf biologists from both countries. At this meeting, it was agreed that Germany and Poland share a common wolf population, and the decision was taken to establish a transboundary wolf working group. Since then, the German-Polish wolf working group has met on average once a year. In 2011, the members of the working group decided to commission a feasibility study for joint management of the common Polish-German wolf population. The study, was concluded in 2012 (REINHARDT et al. 2012), and, among other things, recommended to develop common monitoring standards for the shared population. The purpose was to provide a uniform basis for data analysis and interpretation, including units of data collection (e.g. individuals or packs / pairs for population size, grid size for area of occurrence); furthermore, to define monitoring methods. Such standards are a prerequisite to permit a population level evaluation of population size, area of occurrence and respective trends.

In 2012, the members of the Polish-German wolf working group decided to commission the development of such standards. The German Federal Ministry of Environment, Nature Conservation and Nuclear safety (BMU) gave LUPUS – German Institute for Wolf Monitoring and Research a mandate to develop "Joint monitoring standards for the wolf in Poland and Germany" with regard to the Central European wolf population to condition that Polish wolf scientists were engaged as a co-authors. Since Dr. Sabina Nowak from the Association for Nature "Wolf" and Dr. Robert W. Mysłajek from the University of Warsaw had been monitoring wolf recovery in Western Poland since 2001, and Dr. Nowak is a member of the German-Polish wolf working group and Large Carnivore Initiative for Europe (LCIE), they were invited to co-author this report.

National monitoring standards for large carnivores (LCs) have been established in Germany since 2009 (KACZENSKY et al. 2009). Thesestandards are accepted by all the German Länder and were reviewed in 2014 (REINHARDT et al. in prep). Obviously, the joint wolf monitoring standards were to accord with these already existing national standards and ideally to be comparable with those of other European countries with established cross- border monitoring programmes.

Against this background, a two - day workshop on cross border monitoring of wolf populations was held in in Neustadt / Germany in May 2013. Wolf monitoring experts from France, Piedmonte / Italy, Sweden, Poland and Germany participated. The results of this workshop were compiled in a draft report of joint wolf monitoring standards for Poland and Germany. This draft was then circulated among Polish wolf scientists for further discussion and review. In Germany, this step was omitted since the joint standards drafted accorded

with existing national monitoring standards. The comments of the Polish wolf scientists were then used to finalise this paper.

This final report is based on the standards for monitoring large carnivores in Germany (KACZENSKY et al. 2009, REINHARDT et al. in prep), which received strong input from European experts on wolf monitoring. National monitoring experts from Poland and Germany gave it its final shape. These experts are asked to give their input in future too, since the standards should be refined and adapted to the new knowledge gathered and experience gained through working with the standards.

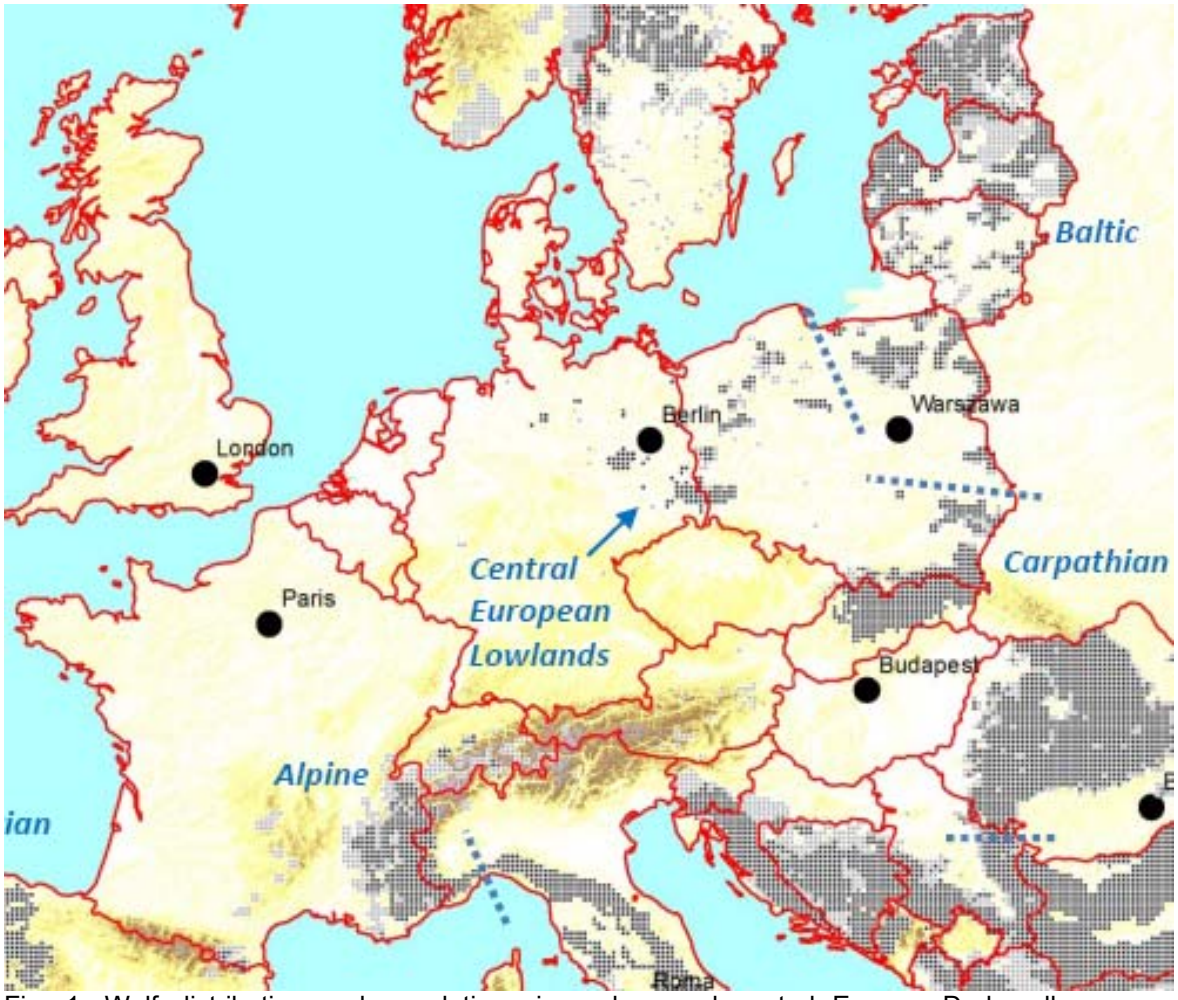

Fig. 1: Wolf distribution and populations in and around central Europe. Dark cells permanent occurrence, grey cells occasional occurrence. Map: KACZENSKY et al. 2013. Data from Poland and Germany are from 2011 / 2012.

2. Background

2.1 Current situation of wolves in Poland

The wolf was persecuted in Poland for centuries, and hunted – at least in some parts of the country – till 1998, when it became strictly protected (NOWAK AND MYSŁAJEK 2011). Wolf numbers increased during wars and uprisings, but were reduced in periods of political stability (JĘDRZEJEWSKA et al. 1996). Large-scale wolf persecution involving direct killing, poisoning and pup extermination was conducted in Poland from 1955-1975. As a result, the population was reduced to several dozen individuals, and wolves disappeared from most of the forests of Poland (WOLSAN et al. 1992). In 1975, the wolf gained the status of a game species, with a short protection season in Western Poland. In following years, the protection season was expanded throughout the whole country. Until the late 90s, wolf numbers and range increased in the eastern part of Poland and the Carpathian Mountains. However, wolves were never permanently present in Western Poland, because whenever they settled there they were quickly eradicated due to intensive trophy hunting.

In 1998, as a result of a national-wide campaign of non-governmental organizations, the wolf was put under strict protection in the entire country. Thus, Poland was the only country in central and eastern Europe to protect its vital population of this large carnivore for several years before joining the European Union.

Data collected during the 2000/2001 National Wolf Census revealed that wolves mainly inhabited the Carpathian Mountains, and the large forests of the north-eastern and eastern parts of Poland, while Western Poland comprised only a few individuals. The number of wolf packs was estimated at about 110, and the total number of wolves at about 550 individuals for the whole country (JĘDRZEJEWSKI et al. 2002). In the following years, thanks to strict protection, wolves gradually resettled in the remaining suitable habitats east of the River Vistula and started to re-colonize forests west of this river, where they had been extirpated many years before. (NOWAK AND MYSŁAJEK 2011).

Currently, based on monitoring data collected by the Association for Nature “Wolf” in Western Poland, at least 30 resident wolf family groups and pairs were present there in 2013 (S. NOWAK AND R. W. MYSŁAJEK, UNPUBL.).

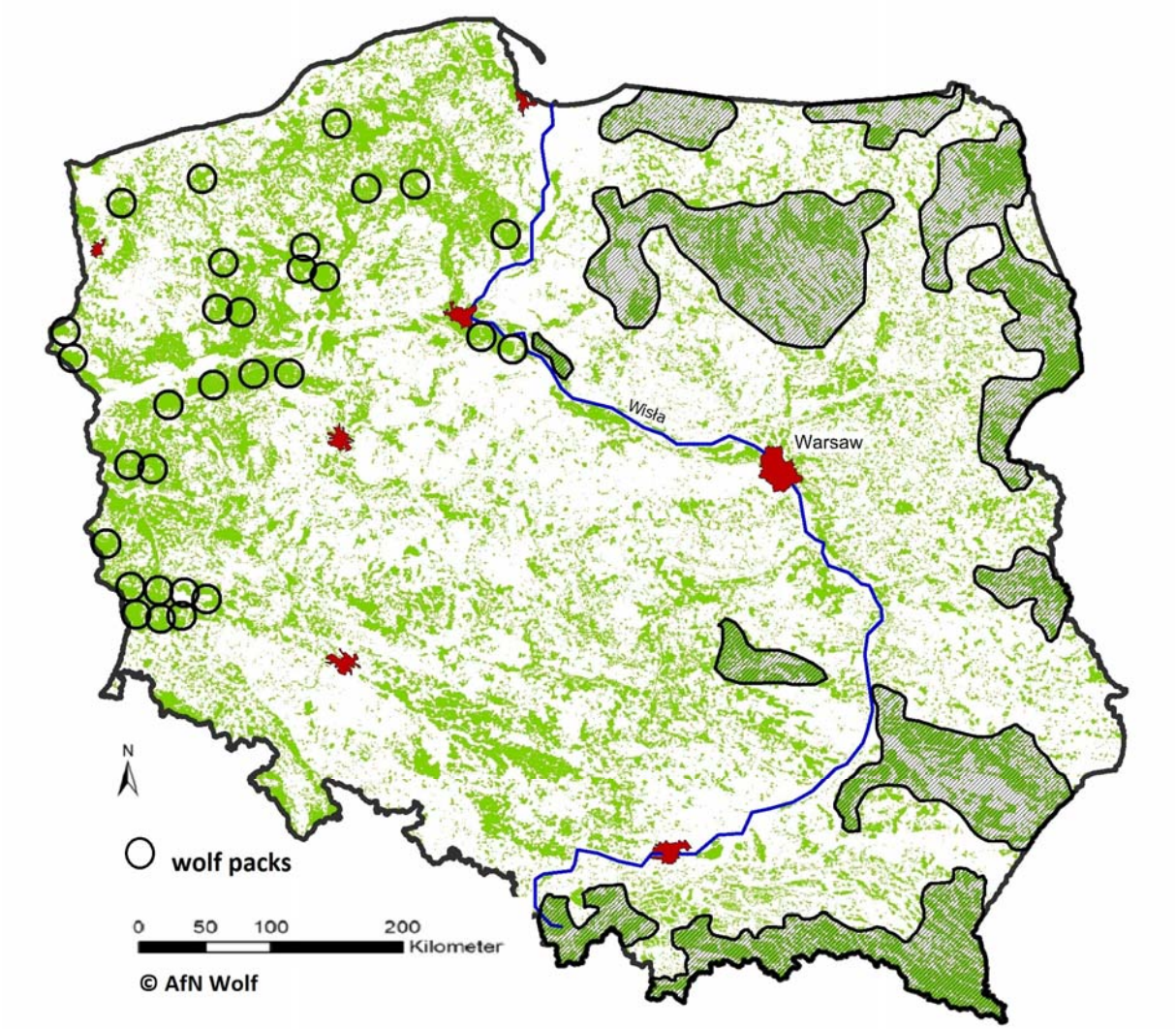

Fig. 2: Wolf packs and pairs distribution in Western Poland in the monitoring year 2012 / 2013. Note that packs and pairs are not distinguished yet in this map. In East and South-East Poland areas occupied by wolves are shaded.

2.2 Current situation of wolves in Germany

In Germany, wolves were eradicated in the 19th century. However, wolves have a large potential for rapidly spreading into and colonising new areas, or areas of their old distribution range. Dispersing animals can wander hundreds of kilometers from their natal packs and re-colonize areas where wolves disappeared a long time ago. In the second half of the 20th century, more than 40 wolves came to Germany, from Poland. They mainly appeared in the north-east of Germany. Most were shot, while others were killed by road or railway traffic (REINHARDT & KLUTH 2007). Preventing resettlement of the wolf was the pronounced goal of the German Democratic Republic, while in the Federal Republic of Germany; the species, albeit absent, had been strictly protected since 1980 (REINHARDT & KLUTH 2007).

After German reunification, the wolf became a protected species in the whole country. Although legally protected, at least six wolves were shot in the 1990s. It was not until the late 90s that two wolves succeeded in establishing a territory in Germany. In 2000, the first

litter of wild born wolf pups was confirmed on active military grounds in Saxony, close to the Polish border (REINHARDT & KLUTH 2007). This was the starting point for re-colonisation.

Establishment of a second wolf pack in 2005 marked the beginning of rapid population growth. In 2013 / 2014, the presence of 25 packs, eight pairs of wolves as well as several single resident individuals was confirmed in Germany. The territory of one pack lies partly in the Czech Republic. Reproduction was proved in four Länder, while in recent years single individuals have been confirmed in five others.

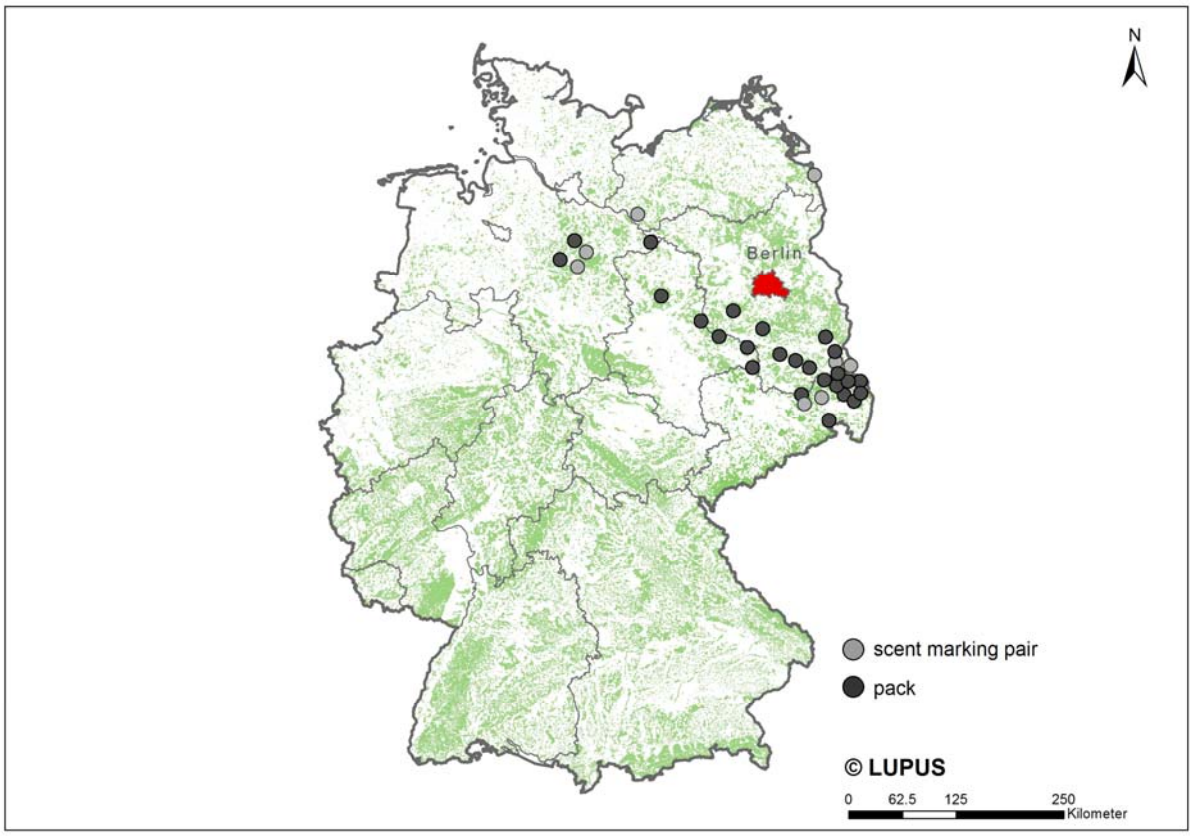

Fig. 3: Wolf distribution in Germany in the monitoring year 2013 / 2014.

2.3 Requirements pursuant to the Habitats Directive

The overarching aims of the Habitats Directive are to achieve and maintain a "favourable conservation status" (FCS) for all habitats and species of European importance, and to protect the biodiversity of natural habitats and of wild fauna and flora in the Member States (DocHab 04-03/03-rev.3). To determine whether these aims are being reached in individual cases, the Member States are called on to "undertake surveillance of the conservation status of the natural habitats and species referred to in Article 2, with particular regard to priority natural habitat types and priority species" (Art. 11, Habitats Directive). Since the wolf is listed in Annexes II and IV in Germany, and in Poland it is included in Annexes II and V of the Habitats Directive, monitoring of their conservation status is an obligation that follows directly from Art. 11 of that Directive.

2.3.1 Required data

In the "Guidelines for Population Level Management Plans for Large Carnivores in Europe" (LINNELL et al. 2008), the term "favourable conservation status" (FCS) is defined as follows (while these guidelines are not legally binding, they are viewed by the Commission as best practice):

A population is considered to have a favourable conservation status if all of the following eight conditions are fulfilled:

1 – The population is stable or increasing in size.

2 – It has a sufficiently suitable habitat.

3 – The habitat in question will retain its quality.

4 – The population size for the "Favourable Reference Population" (FRP) has been achieved (according to the IUCN's Red List criteria D or E).

5 – The population size is equal to or greater than it was at the time the Directive came into force.

6 – The "Favourable Reference Range" (FRR) has been occupied.

7 – Connectivity within and between populations is being maintained or enhanced (at least one genetically effective immigrant per generation).

8 – An effective, robust monitoring programme has been established.

Thus, to determine whether the aims of the Habitats Directive have been achieved for a given population, we require data on the population's size and trends; on its distribution (area, and connectivity with other populations); on the availability of suitable habitat and on the quality of the habitat; as well as on the threats to the population. To obtain such data, an effective, robust programme of monitoring must be carried out.

2.3.2 Reporting obligations

Key findings from monitoring are to be reported to the Commission every six years (Art. 17 Habitats Directive). For a detailed explanation of reporting obligations, we have relied on the following supporting texts for the Directive: *"Assessment, monitoring and reporting under Article 17 of the Habitats Directive: Explanatory notes and guidelines for the period 2007-2012. Final Version 2011 and DocHab-04-03/03 rev.3"*.

Favourable Reference Values (FRV) are key concepts in the evaluation of conservation status. Member states are required to identify threshold values for range and population size in order to evaluate whether the actual range or population are sufficiently large to qualify as “favourable”. Favourable Reference Values should be based purely on scientific grounds. They may be changed between reporting cycles as our understanding of a species changes.

Practicable definitions of Favourable Reference Population (FRP) and Favourable Reference Range (FRR) were developed by LINNELL et al. (2008) for large carnivores.

Favourable Reference Population (FRP): in order to qualify for a favourable conservation status the population size has to ensure the long-term viability of the species (same unit as population size). A FRP must fulfill the following criteria:

1 – The population must be at least as large as it was at the time the Habitats Directive came into force. AND

2 – The population must be at least as large as (preferably, considerably larger than) the minimum viable population (MVP) as defined by the IUCN viability criteria D (>1000 mature animals) or E (extinction risk based on a quantitative PVA – population viability anylysis – <10 % within a period of 100 years). AND

3 – The population is being continually monitored via a robust monitoring programme.

Favourable Reference Range (FRR): the area required to sustain a population that has reached favourable conservation status (in km², if possible with GIS-map). A FRR must fulfill the following criteria:

1 – be larger than the minimum area for maintenance of the reference population (because within a FRR not all areas are equally suitable),

2 – ensure the continuity of distribution within a given population,

3 – ensure connectivity between populations.

The importance of trend information is stressed in the actual texts supporting the Directive, since trend is regarded as one of the most important components of parameters like range or population size. To improve the quality of trend information, attention should be paid to the methodology of the surveillance systems. *Trend* is the directed change of a parameter over time. In reality, it can be difficult to assess whether there is a real trend in the short-term, or whether there is simply a fluctuation or population cycling effect. To distinguish between fluctuation and trend, more frequent sampling is required. To ensure frequent sampling as basis for trend information, trends should be reported over a 12-year period.

The *area of occurrence* is a subset of the range, and shows the area actually occupied. It is shown as occupied 10 × 10 km grids on a map (ETRS LAEA 5210 10 km grid). One way of measuring the area occupied is by the sum of the grid cells that are occupied by the species.

The *range* may be understood as a polygon that comprises the areas actually occupied. However, in many cases, a species will not occur throughout its entire range. The range is formed by filling in the gaps between the grids that are occupied. Nonetheless, range boundaries must not be drawn so widely around the actual areas of occurrence that range changes can no longer be detected. The choice of gap distance used to exclude major discontinuities from the range should reflect the ecological characteristic of the species. For large terrestrial mammals a gap distance of 40 – 90 km is recommended.

At present, there is no agreement between the member states on which population units should be used for each species to denote population size. It is recommended whenever possible and meaningful to use the unit “mature individuals”.

While information on population structure and genetics is not explicitly required for reports, it is understood that a "certain knowledge" of the pertinent population structure is a

requirement for assessment of conservation status. It is noted that such factors as lacking or very slow population growth, unnaturally high mortality and the lack of any young are all signs of unfavourable population structures. It may also be meaningful to consider the genetic structure of a population for assessment.

At the national level, distribution and population maps are to be prepared. The maps are based on 10 × 10 km ETRS grids projected in ETRS LAEA 52 10. For each biogeographic region in which the species in question occurs, a report must be prepared that contains the following information:

- Range within the biogeographically region concerned
  - surface area range [km²]
  - method (inventory or statistically robust estimate / extrapolation / expert assessment)
  - short-term trend period (rolling 12-year time window)
  - short-term trend direction (stable / increasing / decreasing / unknown)
  - short-term trend magnitude (optional)
  - Favourable Reference Range (in km² with GIS file if available)
  - reason for change

- Population
  - population size estimation (unit, minimum, maximum)
  - year or period (when data for population size was recorded)
  - method (inventory or statistically robust estimate / extrapolation / expert assessment)
  - short-term trend period (rolling 12-year time window)
  - short-term trend direction (stable / increasing / decreasing / unknown)
  - short-term trend magnitude (optional; minimum, maximum, confidence interval)
  - Favourable Reference Population
  - reason for change

- Habitat for the species
  - area estimate [km²]
  - year or period (when data for population size was recorded)
  - method (inventory or statistically robust estimate / extrapolation / expert assessment)
  - quality of the habitat (good / moderate / bad / unknown)
  - short-term trend period (rolling 12-year time window)

- short-term trend direction (stable / increasing / decreasing / unknown)
- area of suitable habitat for the species [km²] (area thought to be suitable but from which species may be absent)
- reason for change

- Main pressures (actual pressures; list available under http://biodiversity.eionet.europa.eu/article17/reference_portal)

- Threats (future threats; list available under http://biodiversity.eionet.europa.eu/article17/reference_portal)

- Complementary information

For instance, where two or more member states have made a joint conservation status assessment for a transboundary population of a (usually wide-ranging) species, this should be explained here. Note clearly the Member States involved, how the assessment was carried out and any joint initiatives taken to ensure a common management of the species (e.g. population management plan).

- Conclusions

In a final section, the species' conservation status in the relevant biogeographic region, at the end of the reporting period, is estimated (pursuant to Annex C, notes & guidelines – Reporting under Article 17).

Scale

The scale of assessment for the Directive is clearly the biogeographical region and reporting has to be done for each of the biogeographical regions. The guidelines highly recommend a population level assessment, since the unit for conservation planning should be the entire biological unit; that is the population. This is in accordance to the Directive as stated in the guidance documents: Populations should be seen as biological populations irrespective of political borders. In cases where populations are transboundary, member states are encouraged to undertake a common assessment but to report separately (DocHab 04-03/03-rev.3).

Conclusions for monitoring

According to Art. 17 of the Directive, reports should be submitted every six years. Monitoring efforts themselves must be undertaken continuously and systematically, however, if they are to yield clear views of conservation status and of any relevant trends.

To permit analysis at the EU level, the final report submitted to the Commission should be comparable to, and compatible with, those of other countries. As a result of these

requirements, monitoring efforts need to be standardised, and interpretation of their results need to be standardised as well, at both the national and international levels.

2.4 Current monitoring of wolves in Poland

Currently, there is no nation-wide system for monitoring the wolf population in Poland; however, efforts are being made to establish such a system. Every year, official information on the population size of protected species is published by the Central Statistical Office. In the past several years, these estimates have been done on the basis of annual reports provided by regional directorates of environmental protection (RDEPs) on population size of protected species. These reports are prepared in the RDEPs based on information obtained from local NGOs, scientists, environmentalists, forest divisions and hunters. In some areas, the population numbers are based on data collected within well-conducted census or monitoring projects, in others on guestimates or simply by summing up of numbers reported by forest divisions or hunting clubs. In the past, when the National Census of Wolves and Lynx (described below) provided information on wolf numbers in the whole of Poland, these figures were published as official estimates by the Central Statistical Office.

The government office responsible by law for the monitoring of protected species - the General Inspection of Environmental Protection (GIEP) - commissioned and provided funds for monitoring wolves in three Natura 2000 sites from 2006-2008, and in 10 Natura 2000 sites from 2012-2014 (of which 3 sites were the same as 2006-2008). Currently, Poland has 73 Natura 2000 sites designated for the protection of wolves, which cover 22% of the areas in the country inhabited by this species. Monitoring activities conducted by GIEP from 2006-2008 covered about 5% of habitats occupied by wolves, however monitoring was only done in the continental bioregion. In the second period from 2012-2014, monitoring will cover roughly 12% of the species habitat.

The only project to cover the whole of Poland was the National Census of Wolves and Lynx, a project financed by non- governmental funds. The Census was initiated in 2000 by the Mammal Research Institute of the Polish Academy of Sciences (MRI PAS), the Association for Nature „Wolf" and the General Directorate of State Forests, and was continued up to 2009 with large effort from hundreds of foresters, national park staff and scientists (for details see: JĘDRZEJEWSKI et al. 2002, REINHARDT et al. 2012). Over 28,000 sets of information were collected during this period. Analyses and reporting of results for the whole of Poland were done on a yearly basis. In the past three years, information on wolf and lynx presence has still been collected and MRI PAS has analysed the distribution of wolves, but with less intensity and with lower participation from the forest service. Nonetheless, 1,000-2,000 records are still provided on various regions each year, and results with current maps of wolf and lynx distribution are published regularly on a special website (http://www.zbs.bialowieza.pl/artykul/526.html). The methodology developed within the project was published by GIEP in a methodological handbook describing the recommended methods of wolf population monitoring, indicators of population status, indicators of habitat status within Natura 2000 sites and other forest tracts (JĘDRZEJEWSKI et al. 2010).

Additionally, censuses are conducted and financed in some regions by non-governmental organisations, regional directorates of State Forests, national parks or regional directorates of environmental protection. Most of these projects use similar methods of data gathering

as prepared for the National Census. This allows to add the information collected to the database of the National Census to fill the gaps and assess changes in wolf occurrence in the whole of Poland. For example, surveys of wolves were conducted in February 2011 and 2013 by the Regional Directorate of State Forests in Olsztyn in the North Eastern part of Poland. Collected data were added to the database of the National Census and analysed together with MRI PAS. In Western Pomerania Province (NW Poland)a winter census of wolves was conducted in the past two years by the Regional Directorate for Environmental Protection in Szczecin, together with local national parks and two regional directorates of state forests. The collected data were also provided to MRI PAS.

Since 2001, long-term monitoring of the recovering wolf population has been conducted in Western Poland by the Association for Nature „Wolf" using the same methods as the National Census with the addition of genetic analysis (NOWAK AND MYSŁAJEK 2011). Assessments of population size and distribution in Western Poland have been added to reports from the National Census.

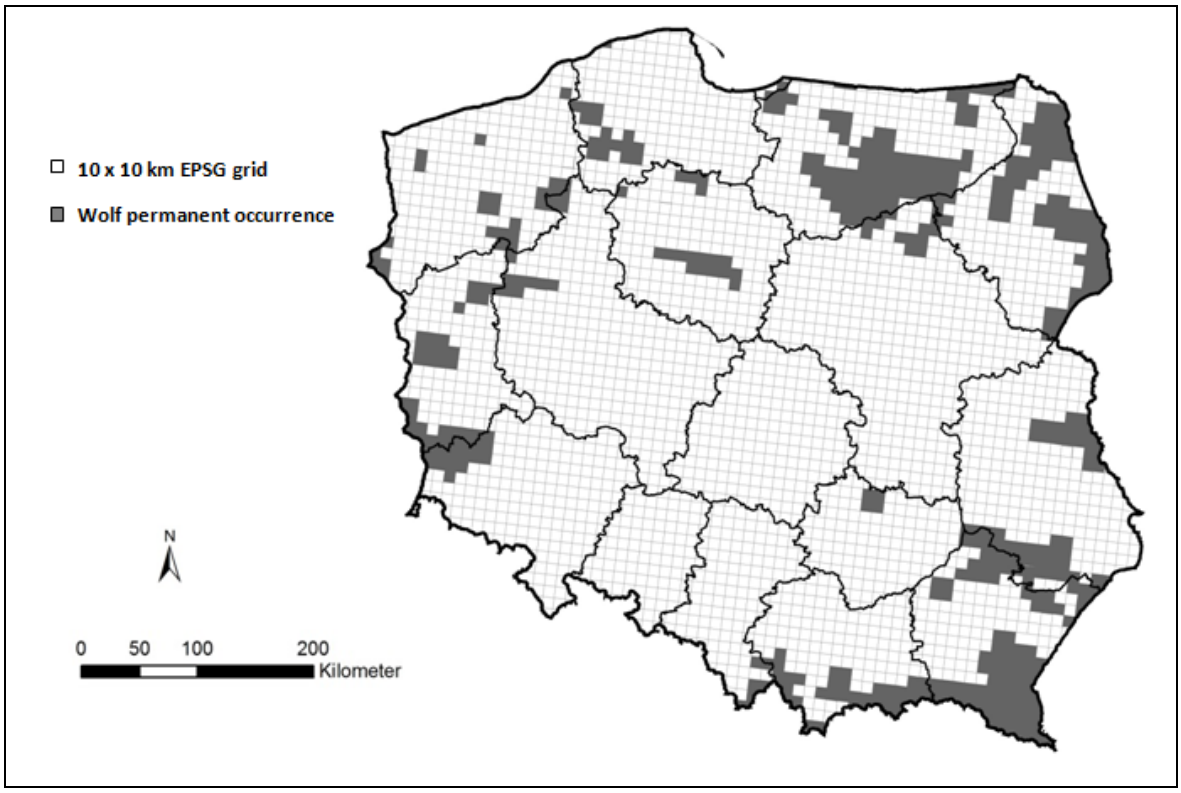

Fig. 4: Area of occurrence of wolves in 2012 / 2013 in Western Poland. Data on wolf distribution in the eastern part of the country is based on the SPOIS report from 2012.

2.5 Current monitoring of wolves in Germany

The Federal Republic of Germany is a federalist system with a Federal Government and 16 federal states or Länder. The Federal Government defines the basic legal framework, and the Länder implement it. Large carnivores are protected by federal laws (as well as by EU laws), and the Federal Government reports to the EU Commission. However, since implementation of large carnivore conservation is under the jurisdiction of the Länder, they are also responsible for the monitoring of large carnivores.

National monitoring standards for large carnivores accepted by all the Länder (KACZENSKY et al. 2009) have been in place in Germany since 2009. These standards take into account EU requirements on reporting for the Habitats Directive and enable comparability of monitoring data within Germany. They are designed to make documentation and assessments of large-carnivore observations comparable and transparent.The standards define how population size and area of occurrence are estimated on a national basis. They describe monitoring methods suitable for LC monitoring and define how large carnivore signs must be evaluated. To do so, LC signs are classified according to their verifiability into hard facts, confirmed observations and unconfirmed observations. To estimate the area of occurrence and the population size, only data from hard facts and confirmed observation are used. The standards contain a monitoring manual that describes in detail under what conditions what signs of large carnivores can qualify as hard evidence, confirmed observation or unconfirmed observation, and how hard evidence and confirmed observations must be documented.

These monitoring standards were reviewed in 2014 (REINHARDT et al. in prep.). The data used for area of occurrence and population size estimation are presented and jointly evaluated at annual meetings of persons responsible for LC monitoring in the various Länder. The results of these yearly meetings, are maps of the actual area of occurrence (figure 5) and population size estimations for wolf and lynx for the previous monitoring year, harmonized on a national level. This process is facilitated by the Federal Agency for Nature Conservation.

Overall mortality data on the wolf and new occurrences of packs and pairs are collected year round by LUPUS. These data are provided to Länder authorities upon request. This service allows for more recent information on the actual wolf situation between the annual meetings.

Responsibility for engaging institutions or individuals for monitoring services rests with the Länder. The monitoring effort and funds allocated differ largely between the Länder as does the monitoring structure. As a rule, data are still collected and evaluated on the level of the Länder. Sometimes one or two experts are in charge. Besides taking care of their own field work, these experienced persons coordinate the activities of trained persons and carry out the data evaluation and analysis. In other areas, most of the data are collected by trained persons alone without much coordination and guidance. Not always are experienced persons for data evaluation and analysis available. Several Länder have created structures allowing for the provision of expertise across administrative borders and use the expertise of experienced persons for transboundary data evaluation. The annual national meetings described above serve as calibrating process to gain robust national population size estimations despite the existing monitoring fragmentation.

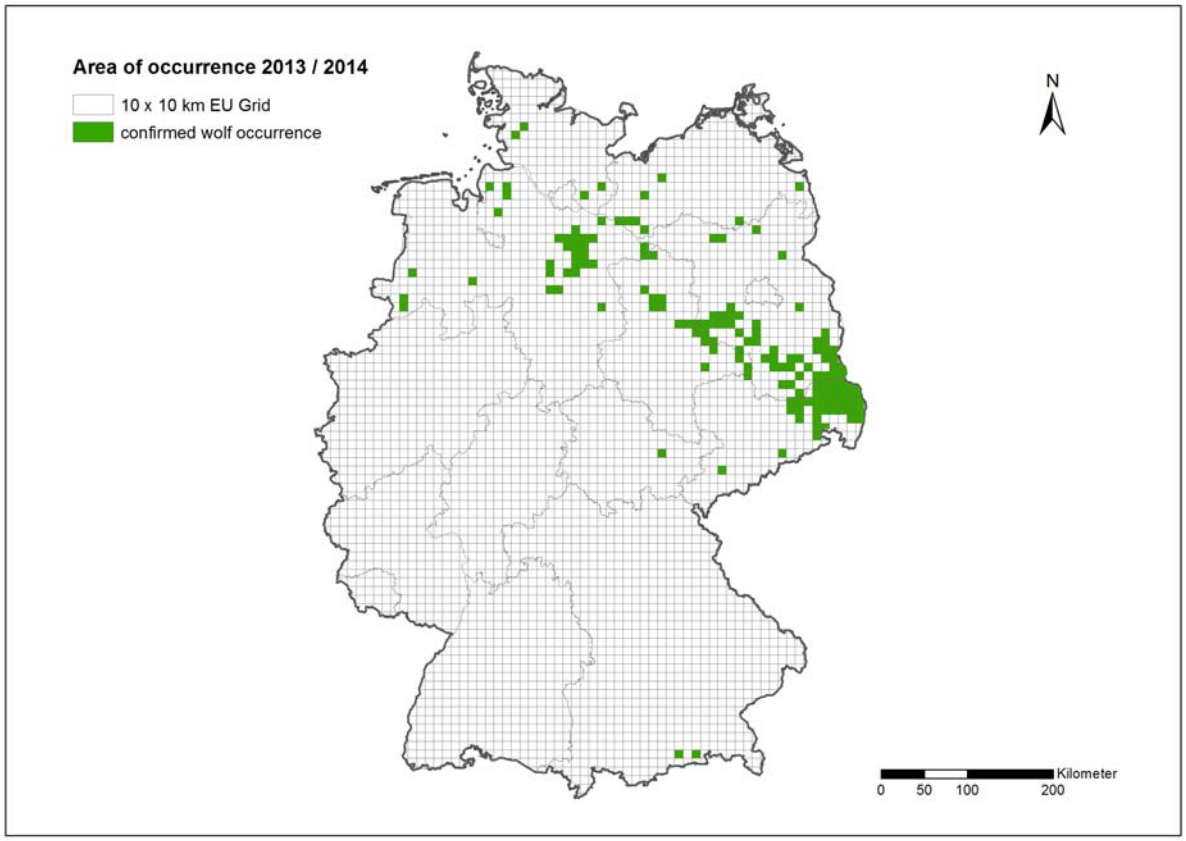

Fig. 5: Area of confirmed occurrence of wolves in 2013 / 2014 in Germany.

3. Monitoring basics and suggestions

3.1 Terminology and aims

Although everyone seems to be familiar with the term monitoring, it is often confused with census or survey. Whereas a survey is defined as a collection of quantitative or qualitative information through standardized procedures in order to define a status at one time step, monitoring means "a regular and structured surveillance [series of surveys] in order to ascertain the compliance of a measure with an expected goal to be reached (e.g. recovery of an endangered population to a viable status", HELLAWELL 1991 *fide* BREITENMOSER et al. 2006).

Monitoring is a process where the results are continuously compared with the desired goal. Before designing a monitoring programme the objective has to be defined first. Second, the accuracy and precision required to assess whether the monitoring goal has been attained must be known. Both the question to be answered and the accuracy needed will finally determine the monitoring methods to be used. The analysis and interpretation of monitoring results in comparison with the objective will determine the adjustment of the actions needed in order to reach the monitoring goal (LINNELL et al. 1998, BREITENMOSER et al. 2006).

In regard to the Habitats Directive, the conservation goal is to achieve and maintain favourable conservation status of wolves. The parameters suitable for assessing the attainment of this goal are given by the reporting format like population size, population trend, range and range trend, habitat, etc.

Monitoring of population development does not require keeping track of every single wolf. However, for other reasons, this may still be necessary because a single individual may cause a whole host of problems. Surveying a single wolf may therefore be essential from a management and/or public relation point of view.

3.2 Methods for monitoring wolves

According to BREITENMOSER et al. (2006) passive and active monitoring can be distinguished. Passive monitoring requires no original field work but mainly means the collection, evaluation and analysis of information that is provided by the public through chance encounters. This may include wolves found dead, damage reports or direct observations. When populations are hunted, this would also involve harvest data. Care has to be taken when analyzing and interpreting this information since these methods can produce biased results. For example, some causes of mortality may be easier to detect (traffic kills) than others (illegal killing, natural diseases). Additionally, the data collected by passive monitoring might not be appropriate for all monitoring questions, e.g. the number of depredation events is not closely linked to wolf population size, but depends more on the husbandry method being used (KACZENSKY 1996). The existence of an animal killing a disproportionate number of livestock strongly biases the data (LINNELL et al. 1998).

Active monitoring means collecting data specifically for the purpose of a monitoring programme (BREITENMOSER et al. 2006, GESE et al. 2012). This includes field work, but also special inquiries or habitat analyses. Data are collected in a targeted and systematic way to minimize the bias, and the monitoring results can directly answer the questions asked.

3.3 Monitoring methods feasible for the Central European Wolf Population

Obviously *snow tracking* is the most common monitoring method for wolves. However, the climate conditions in Germany and Western Poland often do not allow systematic application of this method. Thus, snow tracking cannot become a principle method for the Central European population. However, whenever snow conditions allow tracking, the opportunity should be used to gain as much information as possible (pack size, marking animals, new occurrences, etc.).

Genetic analyses are standard nowadays in LC monitoring. The collection of genetic material (faeces, hairs, saliva collected at kills) can be done all year round. Snow is appropriate to collect samples of marking individuals (urine or oestrus blood). Genetic methods should be applied widely in monitoring the Central European population.

Presence sign survey – the search for signs left by large carnivores like tracks, scats, scratch marks or kills – is probably the most common monitoring method for LCs (see KELLY et al. 2012, LINNELL et al. 1998). It can be done all year round under almost all environmental conditions and should be used as a basic monitoring method for this population. Applied randomly it produces presence / absence data for distribution maps.

Elicited howling is used for the detection of wolf reproduction in summer in many wolf areas. So far, the method has been applied with little success in Germany and moderate success in Poland (NOWAK et al. 2007). However, the success (answering) rate is generally low with this method (FULLER et al. 1988). Meanwhile, other methods like camera trap surveys or genetic analyses have proven successful for confirmation of wolf reproduction (FABBRI et al. 2007, GALAVERINI et al. 2012). Nevertheless, cases using elicited howling might still be reasonable (LLANEZA et al. 2005). A recent study shows that when analyzing recorded wolf howling individual identification is possible (ROOT-GUTTERIDGE et al. 2013).

Camera trapping has proven successful for monitoring wolves (GALAVERINI et al. 2012). By means of this method, most reproductions are confirmed in Germany and Western Poland. In addition, data on minimum pack size, discrimination between neighbouring packs and the area of occurrence can be gained with camera trapping. Some information on individual body conditions and disease symptoms like mange can also be obtained with this method.

Telemetry in itself is not a monitoring method. However, it can provide valuable information on territory size, habitat use or reasons for mortality that is otherwise difficult to obtain. Telemetry studies are often used to calibrate the results of a monitoring program. For instance, without knowledge about the territory sizes in a certain area, it is difficult to distinguish between neighbouring pairs or family groups. Radio telemetry studies provide the most accurate data, but are mostly limited to small areas and few individuals (BREITENMOSER et al. 2006, FULLER AND FULLER 2012). BREITENMOSER et al. (2006) recommend telemetry to calibrate local monitoring programs. Since territory size data collected from just a few individuals can vary widely (REINHARDT AND KLUTH 2011), an adequate sample size is necessary.

Data and information obtained without original field work like chance observations reported by the public, animals found dead, livestock killed by wolves should also be collected in a standardized way.

3.4 Stratified monitoring

Monitoring large carnivores is a difficult task because top predators are always rare and roam over large areas. In practice, these constraints make it almost impossible to monitor wolves with the same intensity over their whole distribution area; especially when populations grow larger than that of the current range of the Central European wolf population. In consequence, many countries use so-called stratified monitoring programmes (see BREITENMOSER et al. 2006 and GREENWOOD AND ROBINSON 2006 for detailed introduction). This means monitoring may differ with regard to intensity and methods on the various scales in space and time. Whereas on a broad, long-term scale more general questions have to be answered like distribution, trends in range and population size, on smaller scales more detailed information is ascertained like home range size and pack size (needed to estimate density), habitat use, the proportion of floaters or data on reproduction.

The precise data gained in comparatively small study areas are needed to calibrate and interpret the information obtained with less expensive methods and less intensive effort over a larger area (BREITENMOSER et al. 2006, BOITANI et al. 2012).

Monitoring coordination across administrative levels is a prerequisite for a stratified monitoring approach.

4. Proposed standards for the monitoring of the Central European wolf population

During an international workshop in May 2013 in Germany, we aimed to harmonize as many details as possible of the methodology used by Poland and Germany to monitor the wolf (regarding the Central European population), while drawing heavily from the experience and solutions provided by wolf experts from the Alps (France / Piedmont) and Scandinavia (Norway / Sweden). As a result, we were able to agree on common definitions, parameters (e.g. sampling units, sampling frequency) and how different units (e.g. packs, pairs, area of occurrence) must be confirmed.

In a second consultation process, wolf scientists from both countries agreed on using the SCALP criteria, where observations are classified according to their verifiability into C1 = hard facts (pictures, genetic records, dead animals, etc.), C2 = confirmed observation (e.g. tracks, scats, kills, etc. confirmed by an experienced person) and C3 = unconfirmed observations (all observations that cannot be confirmed) as recommended by Linnell et al. (2008).

In the following, we explain in detail how data will be assigned to different categories. Wherever the approach differs between Poland and Germany this is stated. The consequences of differences in data evaluation are discussed in chapter 4.3.3. The German part refers to KACZENSKY et al. (2009), revised by REINHARDT et al. (in prep).

4.1 Assessment of wolf observations

The SCALP criteria were developed in the framework of SCALP (Status and Conservation of the Alpine Lynx Population), a conservation initiative (www.kora.ch) that among other things developed standardised criteria for interpretation of lynx-monitoring data. In the following, we define the SCALP criteria required for standardised monitoring of wolves in the Central European Population.

A few preconditions apply:

- For the evaluation of field data at least one experienced person must be available.
- "Experienced" in this regard means having extensive field experience with the large-carnivore species concerned (cf. 4.2).
- All observation must be checked for genuineness (i.e. the possibility of intentional deception must be ruled out).

The letter "C" stands for "category". The numbers 1, 2 and 3 below have nothing to do with the observer's qualifications; they are used to denote the level of validation for an observation.

C1: Hard evidence = Hard fact, i.e. evidence, that unambiguously confirms the presence of a wolf (live capture, dead animal find, genetic proof, photo, telemetric location).

C2: Confirmed observation = Indirect signs like tracks, scats, kills and wolf dens confirmed by an experienced person as being caused by a wolf. The experienced person can either confirm the signs himself in the field, or based on documentation by a third party.

In Poland, a wolf sighting by an experienced person under good conditions may be counted as C2.

C3: Unconfirmed observation = All observations that are not confirmed by an experienced person or observations which by their nature cannot be confirmed. Examples in Germany include all sightings without photographic proof (in Poland sightings by an experienced person may be counted as C2); all signs that are too old, unclear or incompletely documented; signs that are too small in number to provide a clear picture (for example a single track); signs that, for other reasons, do not suffice to provide confirmation; and all signs that cannot be verified. Category C3 can be divided into the sub-categories "likely" and "unlikely".

False: false observations = observation for which a large carnivore can be ruled out as the cause.

Evaluation not possible = signs that cannot be evaluated because of lack of minimum information needed (e.g. reports of visual observations of tracks or kills).

4.2 Criteria that characterize an "experienced person"

A person is considered "experienced" if he or she has already had extensive experience in the collection of field data on wolves, meaning that he or she is practised in recognising and interpreting signs left by the species in the field. In other words, such a person must have recently taken part over a considerable period of time in relevant field work in the framework of national or international recognised scientific wolf projects or monitoring done with methods recommended for the monitoring of wolves in Germany or Poland. Furthermore, such a person must be familiar with wolf biology and its prey animals (both wild animals and livestock). To maintain his or her skills in recognising and classifying signs of wolves, such a person must have the opportunity to see and evaluate signs of this carnivore on a regular basis. In addition, frequent exchange of experience with other persons active in the monitoring of wolves is of great value.

4.3 Data analysis, interpretation and methods recommended

In the following chapter, we explain how monitoring data should be analyzed and results interpreted in order (1) to meet the monitoring requirements under the Habitats Directive and (2) to enable authorities to answer questions which might become important for management and conservation needs. Analysis of data regarding the area of occurrence differs slightly between Germany and Poland (table 1). The main difference is that Poland aims only to generate data on permanent occurrence for the yearly assessment, while in Germany sporadic occurrences are included. Differences between permanent and sporadic occurrence in Germany are shown when maps from consecutive monitoring years are placed on top of each other. Grid cells occupied only once represent sporadic occurrence.

4.3.1 Spatial analysis – area of occurence

Two spatial population indices (occurrence and range) and their trends describe the spatial extent of a population. *Occurrence* refers to the area that is actually occupied by the species in question. It is described in terms of occupied 10 × 10 km grid cells. In **Germany,** a grid cell is considered occupied if at least one observation classified as C1 has been provided for it. Where no C1 has been provided, at least three C2 signs are needed.

In **Poland**, where the aim is to confirm permanent wolf occurrence, a grid cell is only considered occupied if at least two C1 have been provided for it. If only one C1 has been provided, at least two additional C2 signs are needed. If no C1 is available, a minimum of four C2, but not only sightings (see, 4.1) must be provided. If wolf reproduction has already been confirmed in one grid, one C1 or C2 suffices in neighbouring grids to classify them as occupied. If occurrence of more than one wolf was confirmed in a cell during the previous monitoring year, only one C1 or C2 is needed in this cell the following year to classify it as occupied.

The C2-signs provided to occupy single grid cells have to be independent from each other. Cells with C3 signs only are considered unoccupied.

Telemetry locations of non-resident wolves can occupy a grid cell as long as the animal has not dispersed yet and stays in the immidiate vicinity of its parental territory. The grid cells crossed during dispersal are not displayed on the annual distribution maps. They will be on the national German maps compiled every six years where permanent and sporadic occurrence is dipicted.

The area of occurrence is estimated annually. The trend is estimated by a linear regression over all data available (number of occupied cells over time).

Table 1: Determining wolf occurrence in a grid cell in Germany and Poland (green = occurrence confirmed = occupied cell; **?** = occurrence not confirmed).

conditions	Germany	Poland
1 x C1		?
≥2 x C1		
1 x C1 & ≥2 x C2		
1 x C1 & ≥2 wolves confirmed in previous year		
1 x C2 & ≥2 wolves confirmed in previous year	?	
1 x C1 & reproduction confirmed in neighbouring cell		
1 x C2 & reproduction confirmed in neighbouring cell	?	
3 x C2		?
≥4 x C2		
≥1 x C3	?	?

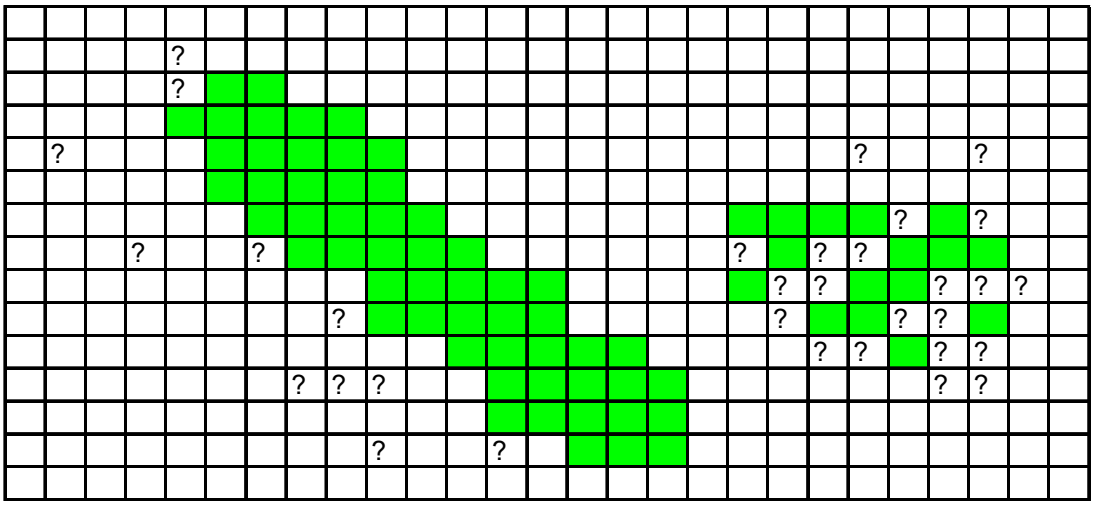

Fig. 6: Example for determining wolf occurrence (green). For conditions for occupying a grid cell in Germany and Poland see table 1. Left: continuous distribution with possible extension to the west. The western extension is speculative. Right: distribution with gaps. The gaps could be real, i.e. gaps in actual occurrence, or they could be the result of inadequate monitoring.

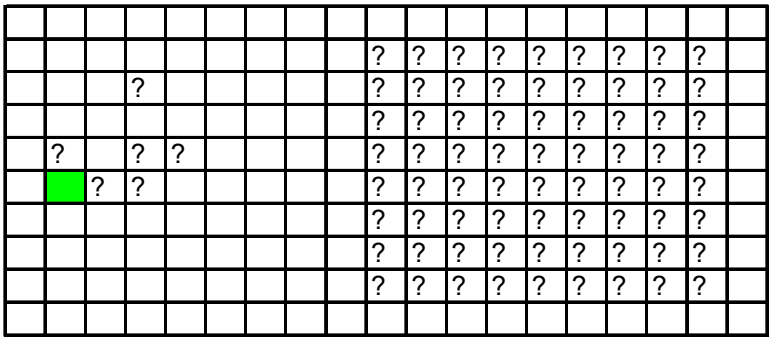

Fig. 7: Left: Probably the occurrence of a single animal. Right: possible presence of a species without supporting data. Clarification is required. This situation could be the result of (1) deficient monitoring (for example, as carried out by inexperienced persons) or (2) reports by "enthusiasts" who simply suppose the species is present.

4.3.1.1 Recommended methods for surveying the area of occurence

In a first step, collection of chance observations (passive monitoring) requires no field work. It involves collection, assessment and analysis of information that has been obtained by chance – for example, examination of wolves found dead, assessment of damage to livestock, collection of direct sightings reported by the public, and carrying out of questionnaire surveys. Data obtained in this way must be interpreted with caution, since they can be affected by systematic discrepancies.

When unconfirmed records accumulate from an area where wolves have not been confirmed yet, an active search for wolf signs should be carried out. At the same time, there is always a risk of confusing wolves with dogs. Furthermore, wolves tend to trigger strong emotions, and media reports can therefore lead to waves of "wolf sightings". Repeated sightings can then prove "contagious". Given the many dogs in our respective countries, it is obvious that many dogs – especially wolf-like breeds such as huskies or German shepherd

mixes – will be mistaken for wolves. In each case, it is up to the relevant experienced person to decide whether an observation that seems doubtful should be pursued.

Questionnaires are rather problematic because sightings, tracks or other types of observations are often not interpreted correctly as a result of inexperience (ELGMORK et al. 1976, VAN DYKE AND BROCKE 1987a, b, *cited in* LINNELL et al. 1998).

Every wolf found dead should be examined in accordance with a standardized procedure, because these wolves are sources of important information. It is recommended to establish national reference institutes for complete analyses of wolves found dead. In this respect, the Leibnitz Institute of Zoo- and Wildlife Research (IZW) is responsible in Germany. When interpreting data such as cause of death or age-class distribution, one must be aware that these data will almost certainly not show a random distribution.

In the most widely used method for confirming the presence of wolves, transects (forest roads, terrain lines, grid-network lines, etc.) or certain areas selected in advance are searched for traces of wolves (tracks, scat). **Presence sign survey** provides data relative to the presence or absence of wolves. Since wolves like to use and drop scats on forest roads, forest roads and paths should be repeatedly searched on foot, by bicycle or car.

Snow provides an ideal medium for confirming the presence of wolves. However, in the lowland areas of Germany and Western Poland, the snow cover is often inadequate for purposes of systematic **snow tracking.** Whenever the opportunity does present itself, it should be exploited immediately. When a moderate snow cover is present, forest roads/pathways can be patrolled by car. For purposes of confirmation, wolf tracks should be followed back for at least 500 m. In mountain areas, winter tracking is only possible on foot or on skis, which means more persons will normally be required to search an area than would be required for a lowland area.

Wherever the situation is unclear, **camera-traps** can be useful tools for confirming the presence of a wolf. Such traps can be set up at watering holes, at possible wolf kills or along roads and pathways where tracks or scats have been found that could not be positively identified. Only in rare cases can use of camera-traps alone replace wolf confirmation by other means. It is unlikely that a wolf will be caught on a camera-trap without having previously left tracks or scat. Therefore, use of camera traps only makes sense in combination with regular presence sign survey.

In sum: Passive monitoring alone does not suffice for the purpose of reliably delimiting areas of occurrence. Nonetheless, “second-hand” information provided by chance should be included in the monitoring records, but care must be taken when interpreting these data because they are often biased. As a rule, confirmation of wolves in a given area will only be possible through active monitoring. Presence sign survey (either with or without snow) is the most suitable method for such confirmation. It is labour intense, but requires few resources.

4.3.2 Demographic analysis – population size

An accurate estimation of population size is very difficult to obtain for wolves. Wolves live in family groups (packs) consisting in general of the parents and their offspring. The number of packs is not only easier to assess than the number of individual wolves, but also more meaningful with regard to conservation status. Therefore, we recommend working with

population indices like the number of packs and scent marking pairs. The LCIE also recommend using packs instead of number of individuals for wolf population size.

For the Directives report (reporting period 2007 – 2012), the population size was to be given in mature individuals. In general, regarding the wolf, this means doubling the number of wolf pairs and packs and adding the number of mature single resident wolves known. In individual cases, when it is known that more or less than two mature individuals live in a pack the number may be corrected.

Table 2: Definitions.

	Definition
Wolf presence type in the area:	
Single resident wolf	Single wolf living in an area for at least 6 months.
Scent marking pair	Male and female wolf marking together but not (yet) having reproduced.
Pack (family group)	A group of more than two wolves living in a territory.
Reproductive pack (family group)	Consists of at least one mature wolf with confirmed reproduction.
Age class of wolves:	
Mature	≥ 22 month
Pup	Wolf in its first year of life. Since most pups are born at the beginning of May the transition from pup to yearling takes place on 1st May.
Yearling	Wolf in its second year of life
Monitoring year	1st May – 30th April.

For small to middle size populations (about 50 packs per management / monitoring unit), we recommend a combination of presence sign survey (including snow tracking whenever possible), camera trapping and genetic analyses to estimate the area of occurrence and population size. From a population size of about 50 – 100 packs, a stratified monitoring approach seems reasonable. However, for such an approach coordination and data analysis across intra-national administrative boundaries is required. Furthermore, it must be assured that the reference areas are representative for the whole area.

A rolling system could be applied to estimate the size of larger populations with more than 100 packs per management / monitoring unit, provided that the range is known. A robust range estimation over a large area seems feasible with an active network engaged in opportunistic monitoring. On the understanding that such an extensive network of trained persons providing year-round observations over the whole area of occurrence exists, a (95%) Kernel density estimation of C1 and C2 data points could be used as *range* for spatially stabile populations. In areas where the population is still expanding, more active sign survey might be needed like in small and middle sized populations.

A rolling system to estimate the population size covers the whole area within the range every three (or six) years. For this purpose, the range is divided into three (six) parts and the population size (minimum number of packs / pairs) is sampled each year in one of the three (six) compartments. During the six year reporting period, each area is sampled twice (or once). A three - year sampling frequency will allow for a calculation of trend over a 12 – 24

year period. Another way to estimate population size in large populations could be by a stratified approach (see above).

The methods used to evaluate population size and to differentiate between neighbouring territories do not distinguish between smaller and larger populations. An active monitoring approach is necessary for both. However, with respect to larger populations it will no longer be possible (or necessary) to sample every detail over the whole area. Here, the stratified approach will be applied.

As much information as possible should be collected on a number of packs on a yearly basis (pack size, territory size, number of pups), even for larger populations. These data help to understand population dynamics and are necessary to calibrate data in a more stratified approach.

4.3.2.1 Recommended methods for determining the population size and confirming reproduction

Reproduction

In many countries, the number of animals snow tracked together within a pack's territory in winter is used to confirm reproduction. However, most of the yearlings in these areas have already dispersed by their second winter. In Germany, presence of at least some yearlings in a pack during winter time is quite normal (REINHARDT & KLUTH unpubl.). However, this makes interpretation of tracks more difficult. Therefore reproduction has to be confirmed in the summer and fall. An active search for wolf-pup signs begins in the middle of June in areas where at least two adult wolves have been confirmed.

An accumulation of wolf scat from April – September within relatively confined areas can point to reproduction. Near *rendezvous sites*, wolf scats can accumulate on forest roads and pathways that wolves use more intensively during this period than the rest of their territory (ZUB et al. 2003). In recent years, use of **camera traps** in combination with presence sign survey has been the most successful method for confirming reproduction in Germany and Western Poland. Camera traps are placed along forest roads or intersections where wolf signs accumulate and / or pup tracks (e.g. at water ponds) have been found. With increasing age, the pups become more and more active increasing the possibility that they are using the same paths as the adults. Some parents change locations with their pups several times during the summer in which case the search for centres of activity may have to be repeated several times and camera trap locations adapted accordingly.

Recognizing pups becomes increasingly difficult during the monitoring year and requires special experience. In their first winter, most pups have an especially fluffy pup fur. For some individuals it may still be difficult to assign them correctly as pup or yearling on the basis of photographs alone. To distinguish pup tracks in late winter from the tracks of older wolves, very good tracking conditions are needed. In deep snow this is hardly possible.

Another method to confirm reproduction in summer is **howling stimulation**. For this purpose, recordings of wolf howls are played or persons emit howls of their own, in an attempt to elicit an answer from wolves. Often, pups will be quicker to respond to such stimuli, and they can be identified as young animals on the basis of their high-pitched calls (NOWAK et al. 2007). In general, however, stimulating howling has a low success rate, and its

success can vary even in one and the same region (MARBOUTIN 2008). Therefore, care must be taken in relevant interpretation. A lack of any response does not necessarily means a lack of reproduction.

Reproduction can also be confirmed by **genetic analyses**, albeit with some time delay. Again, this method relies on **presence sign survey**, including snow tracking to collect enough genetic samples to clarify kinship relations within a pack. However, with this method, too, there are always some cases where it remains unclear whether an individual was a pup or a yearling when sampled.

In Poland, freshly excavated or renovated dens found in summer or early autumn can also be considered as confirmation of reproduction. In Germany, a den alone does not suffice to confirm reproduction even if the den shows recent signs of digging. There have been several cases where wolves have dug or inspected dens, but have not reproduced (see 4.3.3).

In sum: Confirming reproduction is usually a work-intensive process. Presence sign survey in combination with use of camera traps during summer has become the most promising combination of methods under conditions prevailing in the lowlands of Western Poland and Germany. Genetic analysis can also help to confirm reproduction, albeit with some time delay. Genetic methods too involve extensive field work for sampling.

Minimum population size

Packs can be detected through sign survey, including snow tracking, camera traps or genetic analysis. The signs found must confirm clearly the presence of either more than two animals together or reproduction. To prove presence of a pair of wolves they must be confirmed together marking or repeatedly with an interval of at least four weeks between individual signs. Hereby an attempt is made to exclude cases where two wolves have been confirmed together that do not actually form a pair.

In recent years, it has become clear that it is becoming increasingly difficult to distinguish one pack from another when an area becomes saturated with wolf territories. This requires intensive camera trapping and / or application of genetic methods. In individual cases, telemetry may be helpful; however, it is not reasonable to radio collar wolves in all territories. To facilitate assignment to different territories we have developed rules based on the experiences from the past few years (table 3). With growing knowledge, these rules should be adapted.

For this kind of analysis, it is crucial to assess and interpret all the data from the area in question together, regardless of administrative boundaries. Even if all existing data are known it may take several months or even a year until the picture is pieced together. The more details are missing, the more difficult analysis of the overall picture becomes.

Surveying for the number of packs / pairs in this way renders an estimate of the minimum population size. The combination of presence sign survey, camera traps and genetic analyses appears to be feasible even with an expected further population increase in coming years.

For some populations, a minimum – maximum estimate is given of the actual numbers of wolves present. The minimum pack size can be determined based on snow track or sand track surveys, camera trapping or intensive genetic monitoring.

In many countries, the pack size is determined in late autumn / winter by snow tracking. In Germany / Western Poland this is difficult because of uncertain snow conditions. However,

reasonable data is often available from the summer half year. To guarantee data comparability with other countries, we recommend to determine summer and winter pack size whenever possible in order to develop a robust correction factor. At least the sample time should be mentioned when referring to pack size.

To estimate the population size in number of individuals, capture-mark-recapture analyses based on genetic data would be most suitable. This method yields population estimates (minimum, maximum) with confidence intervals based on the proportion the same individuals are repeatedly "captured" and new individuals are discovered. With the development of new genetic methods, lab prices may drop considerably over the next few years, making CMR more feasible. However, the effort involved in collecting sufficient genetic samples remains high. The sampling effort per territory should be comparable over the area of occurrence.

The questions addressed using genetic analyses may differ between the two countries (REINHARDT et al. 2012). However, we strongly recommend conducting joint genetic monitoring in border areas in order to be able to identify cross border territories. This should include all the territories on the Oder-Neisse border. To do so, about 5 - 10 samples per territory and year should be collected and analysed on each side of the border. Until 2013, samples from both Germany and Western Poland were analysed in the same lab, i.e. the Senckenberg Institute (Gelnhausen, Germany). To ensure data comparability, we recommend using a common lab in future, too. If this is not possible, the different labs should use the same protocols and ensure calibration that allows for joint data analysis.

In sum: The combination of survey methods (presence sign survey, camera traps, genetic analyses) has proved sufficient to determine the minimum population size in Germany and appears to be feasible in spite of the further increase in population expected in the years ahead.

If an estimation of population size in number of individuals is requested, it would require intense genetic monitoring across the whole area of occurrence

4.3.3 Standardisation of data interpretation

Table 3: Parameters, recommended methods and accuracy needed to estimate the area of occurrence and population size for wolves in the Central European wolf population.

Parameter	Method	Precision and scope of required data	
		Germany	Poland
Area of occurrence	Presence sign survey, camera trapping, genetic analyses	One C1, or three independent C2* signs per 10×10 km cell and year;	Two C1, or one C1 and two C2, or 4 C2*, ** signs per 10×10 km cell and year. If presence of more than one wolf was confirmed in this cell the previous year, or if reproduction has already been confirmed in a neighbouring cell, fewer C1 or C2 are needed.
Population size	Presence sign survey, camera trapping, genetic analyses, snow tracking	A pack must be confirmed by C1 or at least two independent C2* data. If a min. 2 km C2-track is documented, this one C2 suffices.	A pack must be confirmed by C1 or at least two independent C2*, ** data. If a min. 2 km C2-track is documented, this one C2 suffices.
		To confirm a pair one C1 or C2* is required showing territorial marking or without marking at least two C1 or C2* ,with an interval of at least four weeks.	To confirm a pair one C1 or C2* is required showing territorial marking or without marking at least two C1 or C2*, ** with an interval of at least four weeks.
		Single resident individuals must be confirmed over at least six months by two C1 or three independent C2*.	Single resident individuals must be confirmed over at least six month by two C1 or four independent C2*, **.
Distinguishing between adjacent territories	Genetic analyses, camera traps, telemetry, presence sign survey	Reproduction is confirmed in both areas *simultaneously* OR	Reproduction is confirmed in both areas *simultaneously* OR
		reproduction is confirmed in May – July at least 10 km apart OR	reproduction is confirmed in May – July at least 10 km apart OR
		one of the territories is known by telemetry OR	one of the territories is known by telemetry OR
		distinction possible because individuals are clearly identifiable (camera traps) OR	distinction possible because individuals are clearly identifiable (camera traps) OR
		by means of genetic analyses	by means of genetic analyses

Pack size	Presence sign survey (focus on tracks), snow tracking, genetic analyses, camera trapping	The minimum number for pack size can be confirmed by one C1 or C2***.	The minimum number for pack size can be confirmed by one C1 or C2***.
Reproduction	Presence sign survey (focus on pup tracks), snow tracking, genetic analysis, camera traping, howling survey	At least one pup must be confirmed by C1 or two independent C2* signs OR a lactating female is confirmed by C1.	At least one pup must be confirmed by C1 or two independent C2* signs OR a lactating female is confirmed by C1 OR a new or renovated wolf den in summer was confirmed by C2*.

* note the different meanings for C2 and C3 in Germany and Poland (see chapter 4.1).
** C2 sightings alone do not suffice.
*** If the presence of a pack has already been confirmed, one C2 may suffice to determine the minimum pack size.

This report suggests joint monitoring standards for the Central European Wolf population that allow for a common assessment of the shared population. The remaining differences between Poland and Germany in data assessment (table 3) are of minor consequence and will not, in our opinion, hinder a robust population assessment. However, in the following we list these differences, describe exemplarily which deviations will be seen in the results and propose remedial measures.

- In Poland, a wolf sighting by an experienced person under good conditions may be counted as C2, while in Germany all sightings - including those by experienced persons - are C3. The SCALP criteria categorize signs according to verifiability, and not according to their reliability. This strict form of data assessment was accepted by all large carnivore experts in Germany during the process of developing the national monitoring standards. Since 2009, assessment of wolf and lynx signs is done according to these criteria. Of course, nobody doubts that under good conditions experienced persons can recognize a wolf as a wolf, but a sighting cannot be verified per se. However, it takes some time to become familar with the strict categories of verifiability. Although Poland has a long tradition in wolf monitoring and has many more people experienced in this field than Germany, the system of applying SCALP-criteria is new. We believe that this single difference in application of the SCALP-criteria will not alter the outcome of the population assessment, particularly with regard to the fact that C2 sightings alone do not suffice to confirm a pack / pair or to occupy a grid cell. We are not aware of any wolf sightings by experienced persons in Germany outside otherwise confirmed wolf areas. Therefore, this difference will probably not affect the population assessment. However, for future assessments, we recommend to check whether categorizing sightings by experienced persons as C2 in Poland has any influence on the emerging results. We would preferably like to overcome this difference in the next few years.
- In Poland, reproduction can be confirmed by signs of a freshly used wolf den, while in Germany there is evidence that non- reproducing wolves can dig dens, too. In winter

2006 / 2007, three freshly dug wolf dens were found in the territory of the Zschorno pair (Brandenburg). This pair consisted of two siblings that from 2007 to 2013 have not reproduced successfully. In spring 2011, two wolf dens from the previous year belonging to the Seenland pack (Saxony) were monitored with automatic cameras. One of these dens was repeatedly checked by a two year old female from this pack, who did not reproduce. The reproducing female of this pack raised her pups in another den instead.

This shows there might be dens that are checked / excavated by wolves that do not reproduce. Applying the Polish approach in Germany would so far have meant one false confirmation of reproduction (in 2007). In future, we recommend keeping track of how often wolf reproduction in Poland is confirmed by the presence of a wolf den alone. Furthermore, we recommend to collect data on how often fresh wolf dens are found in territories of non-reproducing wolves, for instance in territories inhabited by pairs that aren't reproducing yet. However, we also wish to point out that it in future it will become more and more difficult to confirm reproduction in every single pack every year. It may well be that with a further increase in population size we will no longer be able to accomplish this for the whole population; rather, we will have to focus on selected areas / packs. When using this stratified monitoring approach we recommend applying more strict criteria to confirm reproduction than a freshly excavated den.

- Poland aims to map yearly the area with permanent wolf occupancy and therefore places more strict requirements on occupation of a grid cell than Germany does, where both permanent and sporadically occupied grid cells are mapped. The differences between permanent and sporadically occupied grid cells become apparent when maps from consecutive years are overlaid. In Germany, sporadic occurrence is also regarded as valuable information, especially in areas without regular wolf presence. In Poland, it is not regarded as necessary to survey for sporadic occurrence of wolves nor is it required underHabitats Directive reporting.

  In Poland, at least two C1 or four C2 are nessecary to occupy a grid cell, while fewer C2 are nessecary for grid cells surrounding a cell with confirmed wolf reproduction. In Germany, only one C1 or three C2 are required regardless of whether reproduction has been confirmed or not. The approach to lower the requirements around areas where reproduction has been confirmed was recommended by the German authors of this report but turned down at the yearly monitoring meeting held in September 2013 in Germany. Applying the Polish approach to the monitoring data for Saxony for 2012 / 2013, two more grid cells would have been occupied (32 rather than 30). Under the German standards, too few C2 signs were documented in the two grid cells. Since these cells are adjacent to cells where reproduction was confirmed, fewer C2 would have been necessary in Poland. On the other hand, all grid cells occupied in 2012 / 2013 in Saxony had more than one C1 (only one would have been enough), none was occupied with C2 alone. Therefore, applying the Polish approach, under which more than one C1 is necessary to occupy a grid cell, would not have influenced the outcome. This means that the differences in the two approaches are of minor consequence in areas with intense monitoring and permanent wolf occupancy. However, the differences would be larger where monitoring is less intense and in areas where wolves only show up occassionally. We believe these differences will

likely be resolved while working with and refining the joint monitoring standards in the years ahead. However, for better comparabilty between the areas of occurrence in Poland and Germany we recommend to mark grid cells as sporadic on the German side where it is known or very likely that these are only occupied occasionally.

In future, we recommend yearly meetings at which the monitoring data from both countries should be presented. As a precondition, the standards must be applied in both countries. The outcome should be a joint population assessement especially with regard to possible transboundary territories. For these territories the data should be presented and compared at the meetings in order to assess their status – transboundary or not. In this regard, it is essential that geneticists working on the CEWP attend these meetings. The focus should also be on the existing differences in data evaluation discussed above and on whether these differences impact on the results obtained. These meetings must be scheduled after the national data compilations. We recommend these yearly meetings for the current Habitats Directive reporting period. After this period, it should be decided whether the yearly cycle should be maintained or extended.

The outcome of this yearly joint assessment should be a short status report on the Central European wolf population with joint distribution maps and population size estimates. For the distribution maps, circles of 200 km² are drawn for packs. For pairs, another symbol / collar should be used for differentiation.

During the yearly meetings, possible changes to the joint monitoring standards should be discussed upon demand and included if agreed. Thus, this should be an active paper that is subject to constant improvement asnew knowledge is gained based on the experience gathered at the yearly joint assessments. We highly recommend to invite wolf experts from all countries sharing the CEWP to these meetings. The aim should be for these countries to contribute to and adapt these joint monitoring standards.

4.3.4 Data storage and evaluation

Poland

A database containing all the evidence collected on wolf presence has existed in Poland since 2000. It was designed by the Mammal Research Institute of the Polish Academy of Sciences to compute data on wolves from the whole of Poland within the frame of the National Wolf and Lynx census (see chapter 2.4). Thus, it covers all the defined populations of wolves existing in the country: Central European, Carpathian and Baltic. Today, the database comprises over 28,000 sets of information about wolf presence with geographical coordinates. The same database template is used to monitor wolf recovery in Western Poland. The template is created in Excel, is easy to operate, analyse, compare in term of time regions, type of information and allows export to most popular GIS software in order to make GIS layers (e.g. ArcView “shp” or MapInfo “tab”). The Excel database template is also easy to share with co-workers by e-mail, which allows to compute findings collected by the most experienced persons directly to the template and send it back to the person responsible for maintaining the database for the whole country. Having ten years of experience with this template, we recommend using the same database, but with a few improvements and simplifications to monitor wolves in Western Poland.

Germany

In Germany, the Länder are responsible for wolf monitoring; thus, the data collected are the property of the Länder and are generally stored in various regional data bases. Once a year, the persons responsible for wolf and lynx monitoring meet under the umbrella of the BfN for a joint assessment of the data. The output from these yearly meetings are assessmentsof the population size and the area of occurrence for both wolf and lynx in Germany harmonized on a national level.

An exception are data collected on federal land (mostly active or former military training grounds). These federal areas belong to the Federal Ministry of Defence (BMVG) and are managed by the Federal Office for Real Estate Affairs (BImA). All wolf monitoring data from these areas are sent to LUPUS for evaluation and archiving ,where they are stored in an SQL-database allowing for fast analyses. Once a year, these data are compiled into a nationwide report for the BImA and the BMVG on the situation regarding the wolf on federal land

Data confirming existing and new packs and pairs, as well as data on mortality cases are collected by LUPUS all year round to obtain a more up-to-date picture of the fast spreading population of wolves in Germany. To date, these data were provided to the Länder authorities upon request and in future they will be made available on an own website.

CEWP

Since monitoring will in the long-term be conducted “to ascertain compliance of a measure with an expected goal” (see chapter 3.1), all data collected during annual surveys should be computed and stored in a well-designed database that allows for easy evaluation and between-year comparison. Since the CEWP is already shared by four countries (Poland, Germany, Czech Republic, Denmark) which use different languages, having different legal systems regarding environmental data and different monitoring structures, it will be difficult to run a joint database containing all the raw data for the entire population. However, it is highly recommended that each country has a national database, where data on the development of population size (number of packs, pairs and how they were confirmed), the area of occurrence, mortality cases, etc. is stored. From this, cumulative data could be generated and shared with other CEWP countries after having jointly assessed the data for each monitoring year at the annual expert meetings.

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Appendix 1. Funding sources and costs of wolf monitoring in different European countries

As table 1 shows, the cost of monitoring wolves differs greatly between European countries. As a rule, countries to which wolves have recently returned tend to invest considerably more money in the monitoring of this species than countries where wolves have always been present. Populations in new wolf areas are mainly smaller and public interest in the recovery of this species, both in population size and distribution area, is generally high.

The structure, coverage and quality of wolf monitoring varies considerably from country to country, sometimes also within countries. It must be pointed out that the monitoring costs listed in table 1 are difficult to compare. In some countries / regions with precise and scientifically robust monitoring programmes, a large part of the field work is done by state employees (i.e. France, Piedmonte). Their salaries do not show up in the calculation (they are paid regardless of whether a wolf monitoring programme is run or not). It also depends on what aspect of monitoring the focus lies. For instance, in France, the field network of trained persons is endeavoured to detect even dispersing and single individuals in order to map a robust population distribution range (on a yearly basis) including sporadic occurrence. Thus, the effort put into these single individuals is generally much higher than that for a wolf pack, which is usually easily detected (Eric Marboutin pers. communication). Sometimes the amount indicated also covers wolf-related issues other than monitoring. In Saxony (Germany), where two professionals are employed part-time to conduct monitoring surveys, their tasks also include consulting to conservation authorities, the provision of data for public relations work, and 24- hour standby services to collect dead and handle injured wolves or individuals showing undesired behavior.

There is no general formula for the costs required per pack, and table 1 cannot be used to translate the listed finances into cost / pack. It depends on the monitoring structure and the possibility to use synergistic effects (covering several species; cooperation across intranational borders, the possibility to use state employees), the desired information (genetic analyses and telemetry are generally quite costly) and the robustness of data considered necessary. The latter two will at least partly be a result of public interest, which is generally much higher in areas newly colonized by wolves.

In the new wolf countries, financial resources for wolf monitoring activities are usually provided from state or regional budgets, sometimes in combination with EU funding. In traditional wolf countries, monitoring often relies more or less on the commitment of NGOs and / or scientific institutions, both in form of manpower and finances.

Table 1: Funding sources and cost of wolf monitoring in different European countries.

Country	Source of funding	Cost/year (€)	Costs include	No. wolf territories	Comments	Source of information
Austria	State Governments	35,000	Field work, DNA analyses, personal costs of LC managers	0 (few loners)		Georg Rauer
Bulgaria	State budget, Ministry of Agriculture and Food (National Forests Agency)	unknown	Year-round observations collected together with other game	~170 - 200		Dana Zlatanova
Croatia	Mainly through scientific programs and some state budget.	12,000 - 16,000	12,000 - 16,000 for telemetry (2 – 3 wolves) and other field work (camera trapping + snow tracking, year-round signs recording, howling sessions) + mortality monitoring + genetic analyses of tissue from dead wolves	50	Agencies responsible ask for data from scientific institutions, but scientific programs do not cover the whole wolf range. Lack of financing from State budget which does not cover field work. In 2014 , the nationwide wolf monitoring group was established, but monitoring has not started yet.	Djuro Huber & Josip Kusak
Czech Republic (lynx + wolf)	Various sources: state budget + EU funds + NGO (foreign environmental funds + donations)	147,000 (roughly 30% for the wolf) + 10,000 NGO' wolf project	Field work (winter tracking, year round observations, camera trapping), DNA analyses	(few loners)		Miroslav Kutal
Estonia	State budget: Estonian Environmental Agency (Wildlife Monitoring Department) + Estonian Environment Investment Centre	60,000	~ 15,000 field data analyses 45,000 DNA analyses + telemetry	~20	Hunters are obliged to report wolf observations	Peep Mannil
Finland	Ministry of Agriculture and Forestry, Finnish Game and Fisheries Research Institute, Finnish Wildlife Agency	350,000	GPS-tracking, DNA-analyses, snow-tracking	20	yearly routine	Ilpo Kojola

France	State budget / Ministry of Environment	300,000	135,000 for 3 fulltime state employees mainly for management of national field work net (protocols, data gathering and evaluation, data base management, synthesis, training of field staff) + 120,000 for DNA analyses + field work (incl. snow tracking, howling sessions in summer)	24	Field work is done mainly by state employees	Eric Marboutin
Germany (Brandenburg)	Government of Brandenburg	85,000 – 105,000	65,000 – 85,000 for field work of professionals and allowance of volunteers + 20,000 for DNA analysis	7 (2013)		Ekkehard Kluge
Germany (Mecklenburg Vorpommern)	Government of Mecklenburg-Vorpommern	9,800 (2013)	7,300 coordination, cost of materials & allowance for volunteers + 2,500 for DNA analysis	2		Kristin Zscheile
Germany (Saxony)	Government of Saxony	108,300 (2013)	74,000 for 2 part-time employees for field work (sign survey, camera trapping), data evaluation and management issues + 34,300 for DNA + scat analysis	12	In the past few years, additional funds for telemetry has come partly from the Government of Saxony, partly from NGOs.	Bernd Dankert
Greece	In 2014-2015 State budget, Hellenic Ministry of Environment (in 2009-2012 Ministry of Environment+ highway & railway investors - 220 000 Euro for 4 years)	20,000 (nationwide monitoring) + 27,000 (Kalmas NP)	Field work (snow tracking, camera trapping, howling sessions, genetics, telemetry)	~90-100		Giorgos Mertzanis & Yorgos Iliopoulos
Italy (Piedmont)	State budget and Piedmont Region, until 2012 (in 2013-2018 Life+)	100,000	field work + DNA analyses	16 - 18	Cost per pack reduced within 10 years in line with the increase in number of packs; Field work is done mainly by state employees (Forestry Service and Park Service).	Francesca Marucco

Latvia	State budget & EU Funds: Ministry of Agriculture + Ministry of Science and Education (European Social fund)	8,300 + 120,000	8,300 for field work 120,000 for DNA analyses,	~50	360 game wardens (state employees) involved in livestock damage investigation.	Janis Ozolins
Lithuania	State budget, National Forests Agency	unknown	2 x ½ day of winter tracking per year, + analyses / estimates	~60 - 70		Vaidas Balys
Norway (all LCs)	State budget	1,000,000	6 fulltime employees: A unit at NINA (independent research institute) is funded to coordinate the design, analysis and publication of monitoring – consists of six full time positions – a coordinator, a geneticist, a communicator, a database person, a scientist full time and part of a lab person for autopsies and another genetics lab person	5 - 6?	Field work is either conducted by rangers from the State Nature Inspectorate, or under subcontracts with the Hunters Association (lynx transects), Hedmark College (for wolves) and Svanhovd Environmental Center (bear genetics). In addition, the public provide many observations.	John Linnell
Poland	In W-Poland: NGOs (foreign environmental funds, NGO's sources) + General Directorate of National Roads and Motorways; in whole of Poland: National Fund for Environmental Protection and Water Management - monitoring in 10 Natura 2000 sites	20,000 (West Poland) + 6,000 for 10 Natura 2000 sites (whole Poland)	West Poland: 2 part-time employees, field work (winter tracking, year round signs recording, camera trapping, howling sessions) + DNA analyses.	30 (W-Poland)	Regular surveys only in W-Poland. In whole of Poland monitoring only in 10 Natura 2000 sites, the nationwide monitoring system is currently under discussion.	Sabina Nowak
Portugal	Motorway investors (to prepare EIA for dams, wind farms and motorways on local wolf populations)	unknown	Costs of employees and field work (detection of breeding packs by sign and howling surveys, camera-trapping	~60	Currently only regional monitoring. Last nation-wide survey in 2002/2003.	Francisco Alvares
Romania	State budget (Forest Research Institute + Forest Faculty of Brasov and Carpathian Foundation)	100,000	100,000 + unpaid work by staff of environmental agencies, national parks, foresters, hunting organisations, NGOs	~500	Every 6 years an additional survey is done to prepare the report for EC (art.17 of HD).	Ovidiu Ionescu

Slovakia	State budget (Ministry of Agriculture and Rural Development, National Forestry Centre in Zvolen) & some national parks) NGOs	unknown	Data assessment + in some protected areas field work including camera trapping	~40	No state monitoring; hunters report their estimations to the National Forestry Centre	Robin Rigg
Slovenia	EU funds (LIFE+) until 2014 since 2014 - State budget	85,000	Field work (incl. regular howling sessions) + DNA analyses	10		Aleksandra Majić
Spain	Regional Governments	unknown	Census coordination by experts	260?	No coordination between the regions; in some regions, census is done every year or every second year, in others, every ten years. Field work is usually done by state employees (forestry / wildlife service).	Juan Carlos Blanco
Sweden	State budget	500,000 (3.8 million Euro for wolf, lynx and wolverine in 2014)	Fulltime employees, field work, DNA analyses	70		Olof Liberg & Guillaume Chapron
Switzerland	State budget (Federal Office for the Environment)	70,000	Field work, DNA analyses	1 (+ 12 - 15 loners)	Field work is mainly done by the game wardens (paid by the cantons).	Urs Breitenmoser
Ukraine	No funds for wolf monitoring					Maryna Shkvyrya