WOLF POPULATION STATUS IN THE ALPS: PACK DISTRIBUTION AND TRENDS UP TO 2012

7th « Wolf Alpine Group » Workshop
"wolf monitoring over the Alps – towards a unique approach"
2013 March 19th& 20th - JAUSIERS – FRANCE

Author: Wolf Alpine Group (WAG)

Published in LCIE Web site http://www.lcie.org , June 2014

WAG Corresponding people by country: C. Duchamp (ONCFS, France), F. Marucco (Centro Grandi Carnivori, Regione Piemonte - PAM, Italy), R. Manz (KORA, Switzerland), Manfred Wölfl (LFU, Germany), Georg Rauer (Vetmeduni Wien, Austria), Hubert Potočnik (Univ. Ljubljana – Slovenia)

Citation suggestion: Wolf Alpine Group (2014): Wolf population status in the Alps: pack distribution and trend up to 2012. 6p. Available at http://www.lcie.org. 2014 June.

Foreword

Wolves have been naturally recolonizing the south-western Alps since the late 80's (Lucchini et al. 2002; Valiere et al. 2003) through dispersal from the north Apennine wolf subpopulation. A moderate bottleneck occurred during the recolonization process, and gene flow between the Apennines and the Alps was moderated (corresponding to 1.25-2.50 wolves per generation; Fabbri et al. 2007). Bottleneck simulations showed that a total of 8-16 effective founders explained the genetic diversity observed in the Alps (Fabbri et al. 2007). So far the genetic diversity of the Alpine population shows a separation of the Italian haplotype from the other subpopulations of Eastern Europe and Caucasus area (Pilot et al. 2014). Therefore, the levels of genetic diversity in the current expanding Alpine wolf population may depend on future successful migrants from the Apennines, as well as those coming from the Dinaric, Carpathian and central Europe wolf populations (Fabbri et al. 2013).

Following the Guidelines for Population Level Management Plans for Large Carnivores, the wolf population in the Alps has been identified as a unique population segment (Linnell, et al. 2008). Although it is only slightly genetically connected to the Italian wolf population in the Apennines (Fabbri et al. 2007), the population segment of wolves in the Alps is functionally autonomous enough as a demographic entity to produce a positive rate of increase (Maresco et al. 2011; Marucco et al. 2009). The level of habitat suitability in the Alps (Marucco et al. 2010; Falcucci et al, 2013) and the single narrow corridor allowing wolves to disperse from the Apennines to the Alps (and reciprocally) defines the two different population segments (Kaczensky et al. 2013), along with the ecological and socio-economic contexts (Linnell et al. 2008) that strongly differ between the two regions.

Because they live at low density over large territories of about 300 km^2, packs may extend beyond administrative borders, and dispersers are able to move over hundred kilometres. The need for standardized monitoring techniques among countries to monitor wolves at the population level is therefore obvious.

The information provided in this report on the wolf population over the Alps is provided by the work of the Wolf Alpine Group (WAG). The WAG (see Appendix 1) gathered research and management experts from Italy, France, Switzerland, and Germany who are in charge of wolf monitoring in the Alpine area. Since 2010, based on documented long distance dispersals occurring in the Eastern Alps and associated molecular tracking results (WAG, 2011), wolf monitoring experts from Austria and Slovenia are also now permanent members of the group. Therefore, the WAG is now represented by experts from each country of the alpine range. Associate research groups such as the labs in charge of genetic analysis in each country, also regularly contribute to the WAG. The present dataset comes from Centro Gestione e Conservazione Grandi Carnivori - Regione Piemonte, Parco Nazionale Gran Paradiso, Provincia Autonoma di Trento, Regione Veneto for Italy; from the Office National de la Chasse et de la Faune Sauvage (ONCFS) for France; from KORA for Switzerland; from Bavarian Environment Agency (LFU) for Germany; from the Veterinary Medicine Vienna for Austria; and from University of Ljubljana for Slovenia.

The aim of the WAG is firstly to exchange scientific knowledge on wolf distribution and demography over the Alps. Secondly, we evaluate and implement minimum standards to assess wolf population status according to available data sources. Finally, the WAG aims at continuously improving methodological approaches to monitoring distribution and demography of the alpine wolf population (WAG, 2008 sensus Linnell et al. 2008).

Methods

Monitoring techniques

Similar monitoring techniques are applied over the Alpine countries, which consist of sign surveys, snow-tracking sessions in winter and wolf howling sessions in summer, all of which are associated with standardized non-invasive molecular tracking. According to the levels of wolf occurrence, the combination of these monitoring tools varies between countries.

In France and the western Italian Alps, the wolf range expands all along the mountain chain from the Mediterranean sea to Leman Lake. In both countries, intensive and systematic monitoring protocols are implemented using a network of experts to perform snow tracking in winter and monitor wolf howling in summer. Genetic investigations are also conducted on 600 to 800 samples per year, mainly scats (see Duchamp et al. 2012; Marucco et al. 2012 for details). Research studies using GPS marked wolves are also locally implemented to investigate wolf habitat selection (Italy, Slovenia) and predator-prey dynamics (France). Recently, the LIFE project "WOLFALPS" (2013-2018) began developing a unified wolf monitoring strategy and network for the Italian Alps from west to east, together with Slovenia.

Due to the lower wolf occurence in Switzerland, Germany (Alpine part) and Austria, genetic analysis mostly relies on saliva collected from prey carcasses rather than fecal or urines samples (n=200-250 samples/year in Switzerland; see Fumagalli et al, 2013). Howling surveys are conducted to document reproduction, but only when a pack is established. In Slovenia, intensive and systematic monitoring has been applied since 2010 in the SE part of the Alpine area (~700 km^2), including snow tracking, wolf howling and molecular tracking. In the rest of the Alpine area, only opportunistic sampling for DNA analyses and recording of signs of presence are performed (Potočnik et al. 2014). In the framework of the LIFE Project "SLOWOLF" (2010-2013) three wolf dispersals from the Dinaric population into the alpine area were documented through GPS monitoring.

Mapping wolf occurrence

European wolf occurrence is updated every 5 years by LCIE. All validated signs of wolf presence are projected on an EU 10*10 grid cell dispatching regular vs occasional wolf presence within 5-year temporal windows (see Kaczensky et al. 2013 for details). This validated dataset on wolf occurrence is reported in the WAG map (Fig. 1).

Appendix : The Wolf Alpine Group

In 2001, a first workshop was organized in France by gathering experts from France, Italy and Switzerland concerned with the recent recolonization of the wolf population over the Alpine areas. The main objective was to establish an effective collaboration among the three countries in order to exchange scientific data to effectively monitor the wolf population in the Alps as a whole. Since then, the Wolf Alpine Group was established. Since then, a strong collaboration among experts has been set up from which significant progresses have been made over time, especially regarding information exchanges and shared methodologies (WAG, 2003). Monitoring standards (e.g. definitions of wolf packs, minimum requirements to document pack presence), common genetic approaches and practical exchanges of basic data have been defined, taking into account differences between countries in data collection, specific objectives, institutional organisation, and levels of monitoring. The WAG has to be considered a independent scientific group, which can address specific scientific requests from different platforms (see WAG, 2008 for an example) dealing with large carnivore management (e.g. WISO Platform of the Bern Convention, European Commission). Twelve years after the first workshop, the Wolf Alpine Group met for the 7th time in Jausiers (France) on the 19-20th of March, 2013, with the main goal of updating the wolf population status in the Alps within the different countries. Monitoring standards and exchanges of genotyping results have been further discussed to solve issues related to technological changes and result updates. After defining the population segment of interest and according on previous results and future goals, experts from Austria, Germany and Slovenia joined the group. Therefore, the WAG is now represented by experts from each country of the alpine range. A WAG logo has been adopted in April 2014.

The wolf Alpine Group in Jausiers (France) during the 7th WAG meeting 2013 March, 19-20th.

from left to right: R. Manz (CH); AL. Plisson (FR), F. Zimmerman (CH); G. Delacour (FR); M. Wanner (FR); E. Marboutin (FR); P. Taberlet (FR); G. Millisher on behalf A. Moran (FR), F. Truc on behalf P. Oreiller (IT); C. Stöffel on behalf L. Fumagalli (CH); V. Harms (DE); A. Voulaz (IT), C. Nienhuis (CH); H. Potočnik *(SLO); G. Rauer (AT); F. Marucco (IT) & people unavailable to attend but who participated E. Avanzinelli (IT); L. Boitani (IT); C. Groff (IT); C. Miquel (FR) ; M.K. Schwartz (USA); M. Wölfl (DE).*

Wolf packs, distribution and population trends

We considered changes in the number of "wolf packs" as the biologically meaningful measure of population trend and distribution, similar to other wolf population monitoring systems worldwide (Mech and Boitani 2003). The biological year is defined from May 1st to April 31st, corresponding to the wolf reproduction period.

Wolf distribution is represented by three categories: a pack, a pair, and a solitary wolf, all based on temporal recurrences that depict evidence existing for longer than 1 year. A pack is defined as the main wolf reproductive unit and is identified by either pup occurrences or by at least ≥ 3 individuals travelling together holding a territory within, at least, two consecutive biological years (i.e. potential reproductive units). A pair is defined as at least one male and one female travelling together and holding a territory, as documented by non-invasive molecular tracking, also within at least, two consecutive biological years. A solitary wolf is considered to have settled its territory if detected within two consecutive biological years in the same area. Therefore, dispersers are not reported in the territories of the map or in the population trend evaluation, but can be included in wolf occurrences. Packs are defined as "transboundary" (Tr) once hard evidence is documented with genetic matches, or as "likely transboundary" (LTr) without hard facts but based on the interpretation of the sign presence spatial distribution.

In this report, we update the data until 2012 and subsequently analyse the wolf population structure with data recorded from 2010 May 1st up to 2012 April 31th.

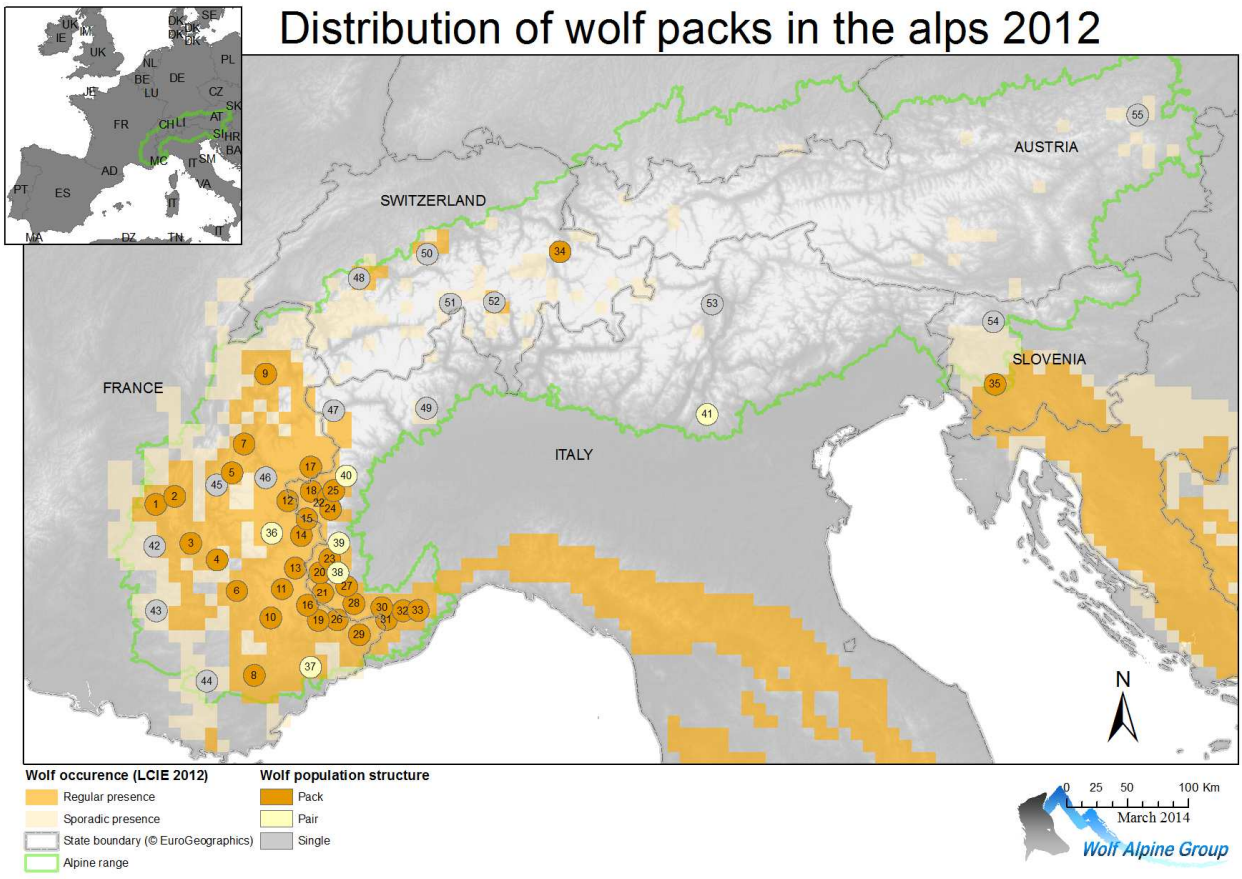

Figure 1 : Distribution of packs, pairs and single wolves in 2012 over the Alpine range that hold a territory for at least two years (from April$_{n-1}$ to April$_n$) – *Packs are documented either by previous summer reproduction records or by records of at least 3 individuals travelling together in the same area; Pairs are defined as one male and one female holding a territory for 2 or more consecutive winters (e.g. potentially reproductive units) as recorded by non-invasive tracking. Details on wolf territories are described in Table 1.*

Results and discussion

The last population status update in 2009 recorded 32 wolf packs scattered over the western part of the French and Italian Alps (WAG, 2011). Despite regular occurrences reported in Switzerland since the

90s, and more recently documented in Germany, Austria, and the Eastern Italian Alps, no evidence of wolf pack formation had been detected within any of these countries.

In 2012, 35 wolf packs and 6 pairs have been documented over the Alps, the great majority of them located in the western part between Italy and France (Fig. 1). Only two packs do not appear in this region, but in Switzerland and Slovenia. Respectively, the swiss one established its territory in 2011 (N° 34 in the map), in the central part of the Alps in Switzerland together with 4 other lonely wolves holding a territory close to the Italian border, all belonging to the Italian genetic lineage (single W14 haplotype, Randi et al. 2000).

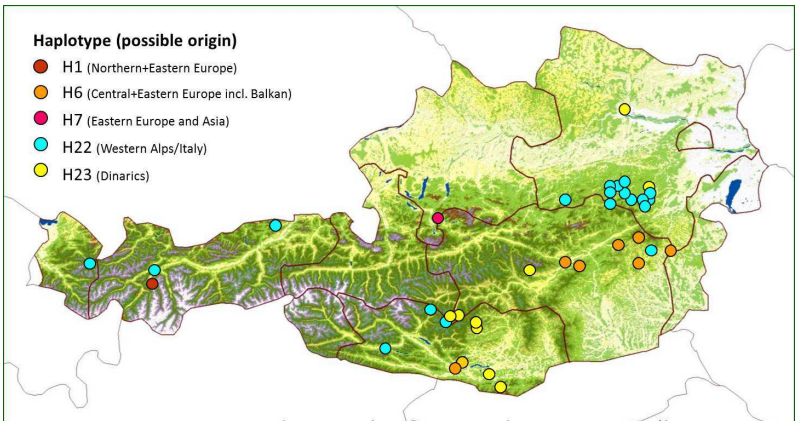

Figure 2 : Identification of haplotypes diversity in Austria based on DNA_{mt} sequencing

The Dinaric population is also expanding northward (Kaczensky et al. 2013). In 2011, a first reproducing pack (N° 35 on the map) was detected in the Slovenian part of the Alps. Eight individuals were genetically identified in that pack during winter 2011-2012, all from the Dinaric genetic lineage (Potočnik et al., 2014).

Molecular tracking indicates the international nature of the population as documented by several transboundary packs between France and Italy and by several long distance dispersal movements recorded over the Alpine range through re-sampled genotypes among the different countries. For example, a dead wolf recorded in Bavaria (Germany) was previously sampled in the Italian Alps. Another wolf male with a Italian genetic lineage was sampled in 2008 in the northern part of the French Alps, passed through the canton of Grisons (CH) to finally move northern Tyrol (AT) and to Bavaria (D) in 2009. An additional dispersal wolf from the Italian Alps passed through Switzerland and is currently monitored in Trentino province (N°53 on the map). Lastly, the dispersal of one male from Slovenia (Dinaric genetic lineage) to the eastern part of Italy was documented by means of GPS/GSM collars. This male wolf left his natal pack five months after collaring and dispersed in December 2011 (Potočnik et al, in prep.). During dispersal, he crossed Slovenia, a large part of Austria, and the Italian Alps before settling in the Lessinia Regional Park in Italy, where he, together with a female from the Italian population, established a pair in Verona province (N°41 in the map). Dispersal lasted 100 days during which the wolf crossed several anthropogenic and natural barriers (highways, railways, urbanized and cultivated areas, river dams, large rivers and mountain ridges). The total cumulative straight line distance between the GPS locations was 1176 km and the straight line distance between natal and new home range was approximately 230 km.

These data along with the study conducted on genetic structures of Alpine *vs* Dinaric populations (Fabbri et al. 2013) and DNA_{mt} investigations in Austria (Fig. 2), indicates the reconnection between the three European populations (Italian, Dinaric, Carpathians) in the Central-Eastern Alps. Indeed, haplotypes which were previously known as region dependant are now occasionally documented within the same area. This may in the future improve the genetic diversity of the overall Alpine population segment.

A positive trend in the number of wolf packs is documented from 1993 to 2012 (Fig. 3) mainly tacking place in the western Alps of Italy and France, where wolf pack density is increasing (Fig. 1).

Population size has also been evaluated using “capture recapture” models based on non-invasive genetic samples analysed both in France (Cubaynes et al. 2010) and Italy (Marucco et al. 2009). However, this approach is not yet applicable to the entire population due to incongruities in datasets and constraints on genetic procedures across labs. Efforts in collaboration between labs have been done to define a common set of microsatellite markers and to standardize ways of analysing genetic results. But the standard technologies rely so far on relative comparisons of allele lengths, thus preventing direct comparisons without dynamic calibrations. A research project conducted in the framework of the WAG by the reference genetic labs tried to solve this issue by sharing a set of reference tissues and allele DNA sequences of the Western Alpine wolf population (Fumagalli and Ströffel, unpublished). Although technically available from 2012, the process faced the strong limitation of maintaining the bridges any time a new allele is documented in the

population. An approach based on new generation sequencers and DNA massive sequencing is being developed to solve those discrepancies and enable large scale molecular tracking comparisons (Taberlet et al. in prep).

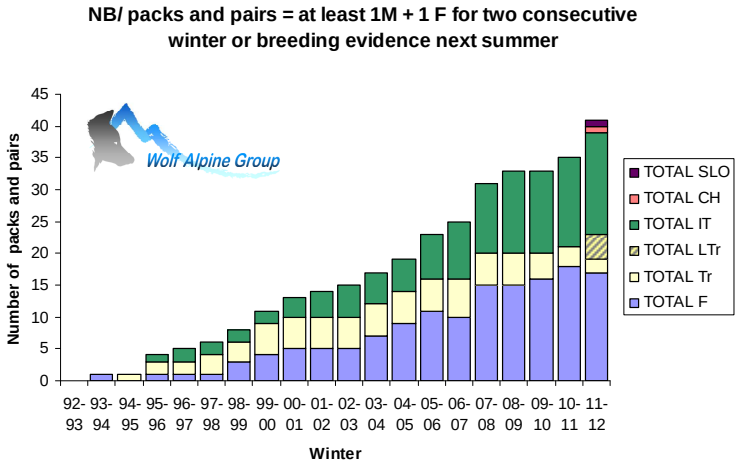

Figure 3 : Temporal trend of the number of wolf packs and pairs across the Alpine range. F : France; IT : Italy, CH: Switzerland; SLO: Slovenia, Tr: transboundary, LTr: likely transboundary (see text for details)

Aknowledments

We are grateful to all field people who are actively participating to the data collection through the network among each country. B. Rahsford kindly reviewed the first draft of the manuscript thus improving english language. We thank the *Villa Morelia* (Jausiers – France) for his kind welcome and facilities for the meeting organisation. Financial support for the meeting was provided by the Office National de la Chasse et de la Faune Sauvage (France).

References

Cubaynes S. et al. 2010. Importance of Accounting for Detection Heterogeneity When Estimating Abundance: the Case of French Wolves. Conservation Biology 24(2):621-6.

Duchamp C. et al. (2012). A dual frame survey to assess time- and space-related changes of the colonizing wolf population in France. Hystrix 23: 14-28

Fabbri E. et al. (2013). Genetic structure of expanding wolf (Canis lupus) populations in Italy and Croatia, and the early steps of the recolonization of the Eastern Alps. Mammal. Biol. http://dx.doi.org/10.1016/j.mambio.2013.10.002

Fabbri E. et al. 2007. From the Apennines to the Alps: colonization genetics of the naturally expanding Italian wolf (Canis lupus) population. Molecular Ecology 16:1661–1671.

Falcucci A. et al (2013). Modelling the potential distribution for a range-expanding species: wolf recolonization of the Alpine range. Biological Conservation 158 (2013) 63–72

Fumagalli L., 2013 Non-invasive genetic monitoring of wolves in the Swiss Alps – a survey of the last 16 years. WISO meeting, Schaan (LI), 2011 June available at http://www.alpconv.org/fr/organization/groups/WGCarnivores/default.html

Kaczensky P, et al. (eds.) (2013) Status, management and distribution of large carnivores – bear, lynx, wolf & wolverine – in Europe. Document prepared with the assistance of Istituto di Ecologia Applicata and with the contributions of the IUCN/SSC Large Carnivore Initiative for Europe under contract N°070307/2012/629085/SER/B3 for the European Commission.

Linnell J. et al. (2008). Guidelines for Population Level Management Plan for Large Carnivores. LCIE report for EC (cont.070501/2005/424162/MAR/B2)

Lucchini F. et al. (2002). Non invasive molecular tracking of colonizing wolf (Canis lupus) packs in the western Italian Alps. Molecular Ecology 11, 857–868

Maresco L. et al. (2011). Capture–recapture population growth rate as a robust tool against detection heterogeneity for population management. Ecological Applications, 21(8), pp. 2898–2907

Marucco F. et al. (2012) Non-invasive integrated sampling design to monitor the wolf population in Piemonte, Italian Alps. Hystrix 23: 5-13

Marucco F. et al. 2009. Wolf survival and population trend using non-invasive capture-recapture techniques in the Western Alps. Journal of Applied Ecology 46:1003-1010.

Marucco, F., and E.J.B. McIntire. 2010. Predicting spatio-temporal recolonization of large carnivore populations and livestock depredation risk: wolves in the Italian Alps. Journal of Applied Ecology **47**:789-798.

Mech, L. D., and L. Boitani 2003. Wolves: behavior, ecology, and conservation. The University of Chicago Press, Chicago.

Pilot M.. et al. (2014) Genome-wide signatures of population bottlenecks and diversifying selection in European wolves. Heredity 112(4): 428-42

Potočnik et al. 2014. Surveillance of conservation status of the wolf population in Slovenia (3) 2010/11, 2011/12 and 2012/13. Project report prepared within LIFE+ project (LIFE08 NAT/SLO/000244 SloWolf): 63 pp. [In Slovenian, original title: Spremljanje stanja populacije volka v Sloveniji 3 – 2010/11, 2011/12 in 2012/13]

Randi, E. et al. 2000. Mitochondrial DNA variability in Italian and East European wolves: detecting the consequences of small population size and hybridization. Conservation Biology 14:464-473.

Valière et al. (2003). Long-distance wolf recolonization of France and Switzerland inferred from non- invasive genetic sampling over a period of 10 years. Animal Conservation 6:83–92

Wolf Alpine Group (2012). Wolf monitoring in the alps. First WISO Conference, Innsbruck, 26th-28th April 2012 available at http://www.alpconv.org/fr/organization/groups/WGCarnivores/default.html

Wolf Alpine Group (2011): Wolf population status in the Alps: pack distribution and trend from 1993 to 2009. 3p. Available at http://www.lcie.org. 2012 February.

Wolf Alpine Group (2008). Wolves in the western Alps: Monitoring and Conservation Status. First report to the Permanent Committee of European Commission. 9p. Available at http://www.protectiondestroupeaux.ch/fileadmin/doc/International/Rapport_Alpen/First_report_to_the_Permanent_Committee_-_english.pdf

Wolf Alpine Group. (2003). Wolf monitoring in the Alps. KORA Bericht. N°18 , 1-29. Muri bei Bern. Weber JM. (Ed).

Table 1: Description of the wolf population structure over the Alps in 2012 (see Fig. 1 for correspondances). *Tr: transboundary wolf territory documented by genotype match; "LTr" refers to a likely transboundary wolf territory based on presence sign distribution; **Genetic lineage based on DNA_{mt} reverse sequencing: It= Italian (haplotype W14); Din: Dinaric (various haplotypes but not W14)

N°	*Country*	*Transb.*	*Pack_Name*	*Status*	*Genetic lineage **
1	FR		Vercors Ouest	Pack	Italian W14
2	FR		Vercors Hts plateaux	Pack	Italian W14
3	FR		Durbon Jocou	Pack	Italian W14
4	FR		Ceuse-Aujour	Pack	Italian W14
5	FR		Oisan-Grdes Rousses	Pack	Italian W14
6	FR		Monges	Pack	Italian W14
7	FR		Belledonne	Pack	Italian W14
8	FR		Canjuers	Pack	Italian W14
9	FR		Les Bornes	Pack	Italian W14
10	FR		Grand Coyer	Pack	Italian W14
11	FR		Trois Eveches-Bachelard	Pack	Italian W14
12	FR-IT	Tr	Clarée-Bardonecchia	Pack	Italian W14
13	FR		Parpaillon Ubaye	Pack	Italian W14
14	FR		Beal-Traversier	Pack	Italian W14
15	FR-IT	LTr	Val Ripa-Queyras	Pack	Italian W14
16	FR-IT	LTr	Merc Hte Tinée	Pack	Italian W14
17	FR-IT	LTr	Hte Maurienne-Cenishia	Pack	Italian W14
18	IT		Gran Bosco	Pack	Italian W14
19	FR		Merc Moy Tinée	Pack	Italian W14
20	IT		Alta Valle Maira	Pack	Italian W14
21	IT		Bassa Valle Stura	Pack	Italian W14
22	IT		Val Chisone	Pack	Italian W14
23	IT		Val Varaita	Pack	Italian W14
24	IT		Val Germanasca	Pack	Italian W14
25	IT		Orsiera	Pack	Italian W14
26	FR-IT	Tr	Merc Vesubie-Tinée-Gesso	Pack	Italian W14
27	IT		Valle Grana	Pack	Italian W14
28	IT		Valle Gesso	Pack	Italian W14
29	FR		Merc Vesubie-Roya	Pack	Italian W14
30	IT		Valle Pesio	Pack	Italian W14
31	IT	LTr	Alta Val Tanaro	Pack	Italian W14
32	IT		Val Casotto	Pack	Italian W14
33	IT		Bassa Val Tanaro	Pack	Italian W14
34	CH		Calanda	Pack	Italian W14
35	SLO		Vremscica-Nanos	Pack	Dinaric
36	FR		Ecrins-vallouise	Pair	Italian W14
37	FR		Cheiron	Pair	Italian W14
38	IT		Bassa Val Maira	Pair	Italian W14
39	IT		Valle Po	Pair	Italian W14
40	IT		Valli Lanzo	Pair	Italian W14
41	IT		Lessinia	Pair	Italian +Dinaric
42	FR		Diois-Baronnies	Single	Italian W14
43	FR		Lure Ventoux	Single	Italian W14
44	FR		Ouest Var	Single	Italian W14
45	FR		Taillefer-Luitel	Single	Italian W14
46	FR		Galibier-Thabor	Single	Italian W14
47	IT		Aosta	Single	Italian W14
48	CH		Schwarzsee-Kaiseregg	Single	Italian W14
49	IT		Val Sessera	Single	Italian W14
50	CH		Flühli-Sörenberg	Single	Italian W14
51	IT-CH	LTr	Reckingen-Oberwald	Single	Italian W14
52	CH		Leventina	Single	Italian W14
53	IT		Trento	Single	Italian W14
54	SLO		Jelovica	Single	Dinaric
55	AT		Schneeberg	Single	Italian W14