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Research Article

Monitoring of wolves in Scandinavia

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Abstract

The Scandinavian wolf population is jointly monitored by Norwegian and Swedish authorities. Monitoring is made annually. Wolves are classified in different categories. Family groups ($\geq$ 3 animals sharing a territory), territorial pairs, other stationary wolves, and vagrants. Also number of reproductions are determined each year, and has the highest priority as national management goals for the wolf population in both countries are expressed as number of reproducing units. Three methods are used in combination. Tracking on snow is the basic method. Around 100 field workers are employed full time or part time to find and follow tracks of wolves during the monitoring season Oct. 1 – Feb 28. The second method is DNA-analysis, mainly based on wolf scats collected during tracking. DNA-analysis help verifying reproductions, identifying newly established pairs, differentiating between neighboring territories and for identifying new immigrants from the Finnish/Russian population. The third method is radio telemetry. 10-20 wolves are equipped with GPS-collars each year, and used for determining of territory extents and differentiating between neighboring territories. All monitoring data are recorded in national databases, and compiled each year in an annual monitoring reports. Annual budget for large carnivore monitoring in the two countries combined in 2011 was approximately 5.8 million Euro, of which approximately 1.5 million was spent on wolves.

Background

The Scandinavian Peninsula (hereafter Scandinavia) consists of Sweden and Norway and covers in total 835000 km^2. Most of this land is considered suitable habitat for wolves from a biological perspective (Karlsson et al., 2007). However, due to cultural, economic and social limitations for wolf establishment (reindeer husbandry in the north, extensive Norwegian open land sheep husbandry in the west, and agricultural plains and high human densities in the south) there is probably not more than approximately 200000 km^2 of suitable habitat that could be utilized by wolves. There is a national minimum goal of 3 annual reproductions in Norway and 20 in Sweden, corresponding to approximately 230 individual wolves (based on an average ratio of 10:1 between total counts of wolves and counts of reproductions during 20 years, for methods see below). Since 2009, Sweden also has a temporary (until 2012) maximum goal of 210 wolves, but Sweden is presently in a political process with EU to revise both the minimum and the maximum goals. By winter 2010/11 the Scandinavian wolf population consisted of 286–335 wolves (preliminary data), with 31 reproductions recorded in 2010 and the wolf range covering 100000 km^2 (Fig. 1). Approximately 85% of the wolf population occurred in Sweden.

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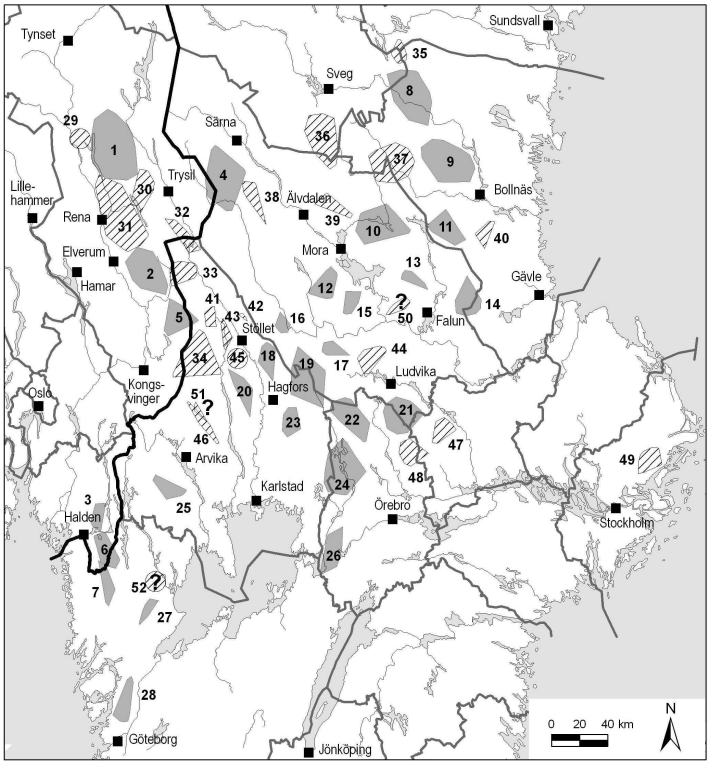

Figure 1 – Wolf territories in central Scandinavia in winter 2009/10. Dark shading is family groups (> 2 wolves), striped shading is pairs. Figures refer to territory identity. In most cases the true extent of a territory is much larger than the one shown on the map.

Organization, directions for the monitoring work and classification of wolves

In Sweden, county (Swedish "län", the next level of administration below the state) authorities are responsible for performing annual monitoring of all large carnivores, including wolves. The present wolf range involves 9 out of Sweden's 21 counties. In each county a varying number (5-15) of rangers are employed, on full or part time, to perform the field work. In Norway, the University of Hedmark has the responsibility for monitoring stationary wolves, whereas vagrant wolves are monitored by a special governmental organization (Norwegian "Statens Naturopsyn SNO"). The routines for monitoring wolves are strictly regulated by a set of official "monitoring directions" (Sw. "inventeringsföreskrifter"), issued by the responsible central authorities, (the Norwegian "Directorate for management of nature" and the "Swedish Environment Protection Agency"). The directions for the monitoring program of the wolf population contain criteria for verification of various categories of wolves (reproductions, family groups, pairs, other stationary wolves and vagrants). The most important are criteria for a verified reproduction, as the minimum national goals for both countries are expressed in this unit. These include registration of pups at the den (the Scandinavian Wolf Research Project SKANDULV, (Liberg et al., 2010) is checking dens of GPS-collared parental wolves during spring), visual or acoustic observation of pups during summer and early autumn by authorized field personnel or DNA-analysis of pups from scats collected at rendez-vous sites. The majority of reproductions is however verified by snow tracking (for methods see below). For first time breeders verification of a minimum of three wolves in the same territory is required, including a minimum of three tracking events

during different days with a minimum of three wolves recorded at each event, and with each tracking event being minimum three km long. For packs that have bred before, the number of wolves should be minimum five wolves, or one wolf more than the year before (only applicable when there were 3 wolves in year t and 4 wolves in year t+1), to qualify as a reproduction, with the same minimum requirements for tracking as for first time breeders. Alternatively, a reproduction can be verified with aid of DNA, for example if all pups from the year before were DNA-typed, and the following year a new offspring from the same parents is identified in the territory, or if more pups are identified by DNA in one year than the maximum number of individuals tracked in the same territory the year before. For first time breeders, it is enough if only one offspring is identified with aid of DNA. A prerequisite for using these types of verifications is that the DNA-profiles of the parents are known. As partners within pairs might disappear and be replaced between years, it is important to DNA-type all potential parental wolves each year. These criteria are not a 100% guarantee to be correct, but they standardize the classifications making time trends reliable, and it is judged that overestimates and underestimates will be of approximately the same magnitude.

As the national goals in both countries are expressed in number of reproductions, recording of these has the highest priority. Further, number of family groups (minimum 3 wolves, of which at least one should be territorial by scent marking, travelling together and sharing a territory), territorial pairs, and "other stationary wolves" (usually single wolves that have recently settled, or remnants of split family groups), are recorded. In Norway, also vagrant wolves are recorded, whereas this segment of the population in Sweden is calculated according to an assumed proportion of the population. This proportion (18-22%) is based on earlier census estimates involving also this category when the population was smaller and therefore easier to differentiate between different categories of wolves. Possibly, this proportion might have changed with higher density of wolves, and will be revised in the near future, using population modeling, based on our radio tracked wolves.

Monitoring methods

General

The monitoring of wolves in Scandinavia is based on three main methods which are used in combination. The basic method is tracking of wolves on snow (Wabakken et al., 2001). For this reason the "monitoring period" is defined as October 1 – February 28. Even if there often is a snow cover long after the closing date of the period, this date is set to avoid the problem of pups starting to disperse and thereby breaking up the rather stable state of the population composition during winter and increasing the risk of double-counting. The field workers are actively searching for tracks all through the winter, but is also getting information about fresh tracks from the public. Tracks found, especially groups consisting of two or more wolves, are followed, usually backwards, to avoid disturbance of the animals, for as long distances as possible, depending on time available and competition with other work tasks, but at minimum 3 km when possible. During tracking, number of animals in the group tracked is determined, territorial scent markings and oestrus bleedings are recorded, and found scats are retrieved for DNA-analysis. Hunting efforts and carcasses are recorded, as are all unusual behavior, like playing and mating. Wolf tracks are mapped using a handheld GPS. During the winter 2008-2009 a total of 950 different tracking events were registered including a total distance of 5487 km of wolf tracks followed (Wabakken et al., 2009).

Snow tracking

Determining number of animals in a pack (family group) from snow tracking might seem to be simple and straightforward. However, our experiences show that this a rather tricky task, depending on several characteristics of wolf pack travelling. One is that wolves when travelling in snow, especially in deep snow, move in single file, carefully stepping in each other foot prints, presumably to save energy. When tracking a short distance it is usually impossible to tell how many wolves have moved in the track, sometimes even seven wolves travelling together can

make it look like just one or a couple has moved there. To avoid underestimation of group sizes, the "monitoring directions" therefore strongly recommend the trackers to follow the track for a minimum of three km to get a reasonable probability to reach sections of the track where the group has fanned out enough to disclose their number. Also tracking in the same territory has to be done repeatedly each winter to further minimize this bias. A second characteristic which causes a worse problem is the tendency of a pack to frequently split up in subgroups. This tendency increases with the progression of the winter (Fig. 2). The pattern of group sizes varying in both directions over time, down and up again repeatedly, as well as many simultaneous trackings of different subgroups in the same territory, shows that there indeed is a constant splitting up and re-uniting again, and not just groups becoming smaller due to a progressing winter mortality.

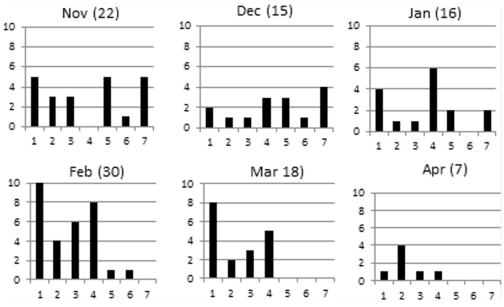

Figure 2 – Number of wolves counted at different tracking events in one specific territory during the different months in one single winter. Number within brackets indicate total number of tracking events in respective month. Number of wolves travelling together are on the x-axis, frequency on the y-axis.

Again, the solution to this problem is to revisit the territory and track the wolves there many times to increase the chance of finding them when they are all together. To make things even more complicated, it is not unusual that vagrant wolves passing through a territory, takes up a track of the resident wolf/wolves and follow it for a varying distance. A fourth problem is that wolves sometimes make loops and come back to their own track and then follow it for a while. If a tracker follows just that section of a track, he might easily get the impression that there has travelled double as many wolves as is the truth. The most important lesson of all this is to make as long trackings as possible, and to repeat them many times at different occasions during the winter. If there still is uncertainty of number of animals in a group at the end of the monitoring period, a minimum and a maximum number is given. Even taking the precautions discussed here there remains an unknown degree of uncertainty, but it likely is relative small, and will likely be similar in different years, thus not compromising the possibility to detect significant changes in density.

DNA analyses

The second method is DNA-analysis. DNA is extracted from blood or other tissue from live wolves during capture and from retrieved dead wolves, but the majority of DNA-samples are sampled from faeces found during tracking (Liberg et al., 2005). The DNA-analyses are valuable for verifying reproductions, for identifying newly established pairs, for differentiating between neighbouring territories and for identify new immigrants from the Finnish/Russian population. The objective is to identify all territorial wolves to the individual level each season (parents in packs, territorial pairs and singles). Analyses are based on 30 diploid micro satellites, and one haploid used as a sex marker (for details of the method, see Supplements in Liberg et al. 2011). The recent DNA program is designed and financed to process 400 samples per year for monitoring, and another 100 for urgent cases, e.g. to check identity of depredators and potential immigrants. As a consequence of this DNA-typing program, by June 2011 we have in our DNA-database genotype profiles of approximately 750 different wolf individuals, corresponding to between 75 and 90% of all wolves that have ever lived in this population since it was founded by a couple of immigrants in the 1980s (since practically all reproductions since the founding event are known, including approximate number of pups recruited for each reproduction, see Liberg et al. 2005, 2011, this number could be calculated). A near complete pedigree of the whole population has been constructed (Liberg et al., 2005).

Radio tracking

The third method finally is radio telemetry. The Scandinavian Wolf Research Project SKANDULV perform captures and fit some 10 and 20 wolves each winter capture wolves with GPS-GSM collars, mainly territorial wolves in pairs and packs (alpha animals). These wolves are valuable for distinguishing between neighbouring territories, and provide information on territory sizes and the occurrence of reproduction in spring. Although the territorial nature of wolves is a great help in the monitoring work, a problem is the huge variation in territory sizes. In Scandinavia, territory sizes ranges between 200 and 4360 km^2 (based on data from GPS-collared wolves) with an average of 1000 km^2. This variation excludes using some type of "distance rule" when differentiating between neighbouring territories. Even tracks found 80 or 90 km apart can belong to the same territory. This variation also must be borne in mind when trying to map territories from a scant material of snow tracking. It is not unusual that territory sizes based on only snow tracking have tripled or more when data from collared wolves from the same territory became available.

The Scandinavian monitoring of wolves is heavily dependent on good snow conditions for tracking wolves. However, as a consequence of the progressing climate change, winters are getting warmer with shorter periods of snow cover. In southern Scandinavia this is already a problem. Therefore trials are made for a new monitoring system, more dependent on DNA-analysis of faeces. In a first step, time and work effort (costs) to collect an enough number of scats on bare ground without snow, to be able to verify at least all reproductions annually, is evaluated. Due to the fact that political goals in both Sweden and Norway are expressed as number of annual reproductions, it has not yet been tried to use DNA-samples in a Catch-Mark-Recapture model, as this only gives total number of individuals and not number of reproductions, but in the future this is also a possibility.

Documentation and financing

All monitoring data are recorded in national databases (in Norway "Rovbasen", and in Sweden "Rovdjursforum"). Access to the databases is partly open, but surrounded by a certain amount of secrecy regulations to safeguard the security of the wolves. Hedmark University College, the Swedish Wildlife Damage Center and SKANDULV jointly produce an annual report on the status of the whole Scandinavian wolf population (e.g. Wabakken et al. 1999, 2010). These reports are in Norwegian or Swedish, but with an English abstract, and all tables and figures also have captions in English.

The financing for monitoring of wolves and other large carnivores is provided by the governments in Norway and Sweden. The total annual budget for monitoring of all large carnivores in 2011 in Norway was 2.9 million Euro, while for Sweden it was 2.7 million Euro for field work and around 0.2 million Euro for wolf DNA-work. A rough estimate of the wolf's share of the total amount for whole Scandinavia in 2011 was 25%, or 1.5 million Euro.

Lessons learned

- The Scandinavian wolf population is small, still more than 100 people are engaged in the monitoring work, indicating how resource-demanding high quality wolf monitoring is.
- Combination of several methods improves the results of a wolf monitoring system un-proportionally.
- Even if DNA-analyses is a "high-tech" method compared with snow-tracking, the latter provides so much extra information that is very difficult to do without it.
- When snow tracking to determine number of animals in a group, it is important to repeat the tracking many times during the season in each territory, and to track the animals as far as possible, minimum 3 km.
- Territory sizes vary enormously, cautioning against using distance between different tracks to differentiate between neighbouring territories.

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