Wolf Howling Survey in February 2016 in Zarandul de Est, Drocea, Muresului Defile and Metaliferi Mountains area

- Draft Report -

Prepared by: Cristian-Remus Papp, Iain Trewby, Radu Mot

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1 Introduction

1.1 Context

Management decisions and actions for the conservation of large carnivores and any other species should be based on sound information and the data gathering process should start from knowing and understanding the animal being studied.

Large carnivores usually live in small densities, are difficult to observe and often nocturnal due to human disturbance, they move fast across the landscape and are wide-ranging animals. Territorial species, like the grey wolf (*Canis lupus*), may spread over vast extents, often with clumped distributions in disjoint ranges (e.g. Koen *et al.* 2008). These characteristics make the large carnivores' surveys difficult and daunting. In addition, external factors like climate change can greatly influence data collection when using for instance snow tracking - the most often used method of primary data collection in Romania. Due to large individual home-ranges, especially in territorial species, surveys need to be conducted over large enough areas to produce biologically and statistically meaningful data (Boitani & Powell, 2012).

Often sophisticated techniques and a wide range of skills, time, human and financial resources are needed to collect information on the presence, distribution and dynamics of the local (sub)population of large carnivores.

The techniques available for surveying wolves vary greatly, including in terms of cost, accuracy, and handiness. Some of the most common methods include: transects for a) tracks and signs identification - e.g. imprints in snow, mud, sand or dust, scats, hairs, prey animal carcasses, urine and other scents used for marking the own territory and b) sightings (direct counts) by the rangers, hunters or other field personnel; DNA based analysis from excrements or hairs; camera trapping alongside movement/ dispersal routes; tracking using GPS-GSM/ video collars for observing daily and seasonal movements, favourable habitats, home range, etc.

The present report is showing the results of the first wolf howling survey performed in the area of the most critical ecological corridor from the Carpathians - the corridor between Apuseni Mountains and the SW Carpathians in Romania. The survey was conducted in February 2016.

1.2 Objectives

The 1st survey is creating the basis for providing both qualitative (presence/absence) and quantitative data (potential number of packs and a rough estimation of the number of individuals) by using a bio-acoustic stimulation method.

The specific objectives of this particular survey were to:

• Test the wolf howling survey within the Life Connect Carpathians project as a complementary method for data collection regarding the presence/ absence of wolf packs in Zarand-Metaliferi Mountains-Drocea corridor area.

• Identify the relative number of packs, estimate the density and relative number of wolves in one pilot area of the project by using the howling technique.

• Introduce/ train the field conservation staff of the Life Connect Carpathians project to use the wolf howling technique as a practical tool for identifying wolf packs in the project area.

1.3 Area covered

The survey was conducted (fig. 1) in the following Natura 2000 sites: Zarandul de Est (SCI), Drocea (SCI), Metaliferi Mountains (SCI) and Muresului Defile (SPA). 3 calling stations (out of the 42) fall outside these protected areas, being situated between Zarandul de Est, Drocea and Muresului Defile sites.

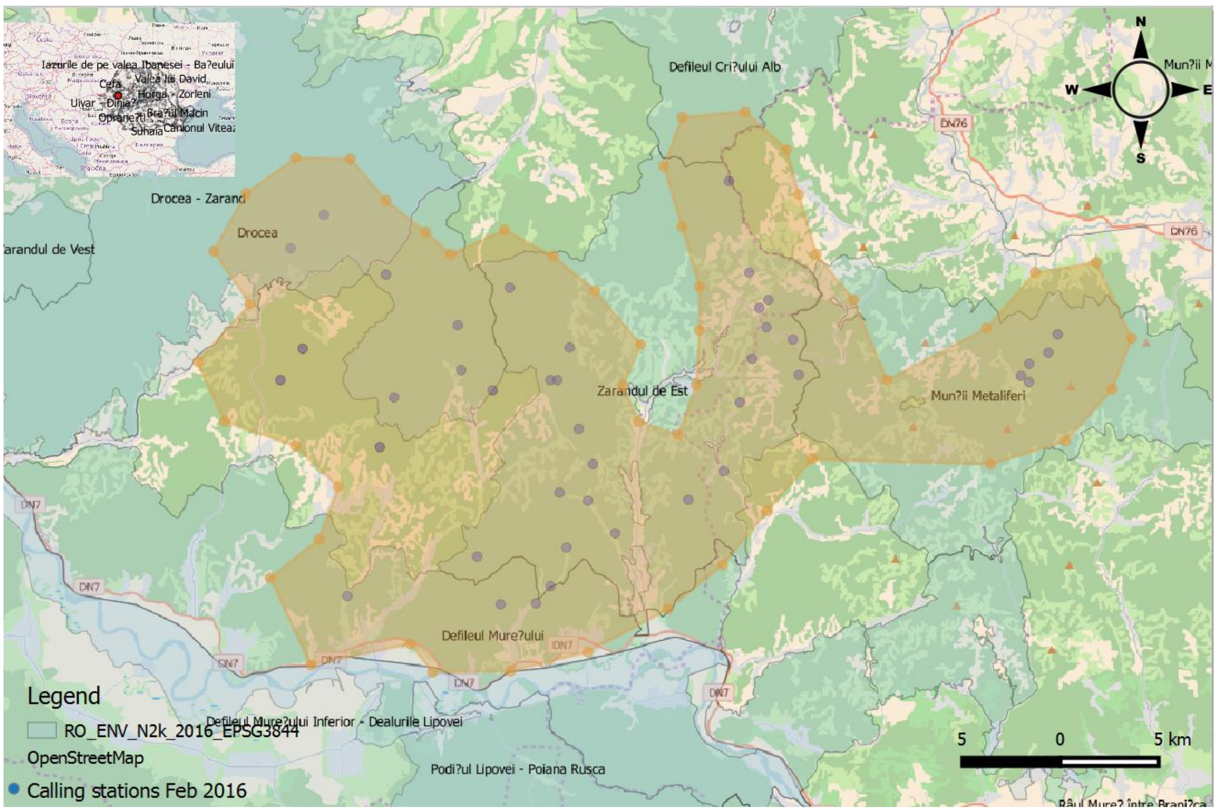

Fig. 1. Map of the surveyed area

The effective surveyed area covered with howls was around 380 km^2 (aprox. 9 km^2 per calling station x 42 stations). However, the extended area can be considered as over 1.000 km^2 (without the non-surveyed areas between Zarandul de Est - Muresului Defile - Drocea and Zarandul de Est - Metaliferi Mountains).

2 Method

Some animal species are hard to see but easy to hear. Standard visual methods for estimating population density for such species are often ineffective or inefficient, but methods based on passive acoustics show more promise (Kidney *et al.* 2016). In addition, for social carnivores that utilize long-range vocalizations (e.g. howls) to communicate, as the wolf and other species, it is possible to use the response rate to simulated vocalizations as an estimate or index of relative animal abundance (Gese, 2001).

Since wolves both hunt and mark their territory as they travel, and since marks are effective for long periods of time (Peters and Mech, 1975), this behaviour allows efficient territory defence. Howling at various locations along their routes, including homesites, complements this defence.

The howling survey is one of the main wolf monitoring techniques at present, which is based on the wolves' tendency to use vocalisations to mark territory ownership in response to howls of unknown individuals (Passilongo *et al.* 2015).

This stimulation technique has been used for a long time in the U.S. for wolves (e.g. Harrington & Mech, 1982; Carbyn, 1982; Fuller & Sampson, 1988). In Europe it started to be successfully used first by Giannatos (2004) and then others (e.g., Krofel, 2008; Szabo *et al.*, 2007; Lapini *et al.* 2009, etc.) for the golden jackal. In Romania, the bio-acoustic stimulation has been introduced by Banea *et al.* in 2012 and used by others as well (e.g. Papp *et al.* 2013).

For this particular survey wolf howling was used to determine the wolf's presence and to start identifying the packs and their home ranges. The rationale behind is that wolves present in the area are stimulated by the recording and tend to respond for letting potential competitors know that the area is included in their territory (Harrington & Mech, 1979).

The acoustic stimulation is a non-invasive and cost-effective method, relatively easy to use by trained staff. The method was taken from Harrington & Mech, 1982 and adapted based on the previous experiences of the team with the golden jackal and wolf acoustic monitoring.

Only a few howling stations were predefined by the team (e.g. roads and valleys' intersections), the other following transect lines along forest roads or ridges where wolf presence was suspected in the area. Each transect should have 3-5 stations, depending on the local conditions and the distance at which they can be placed. The distance between the stations varied from 1.5 to 3 km, depending on the natural habitat/ vegetation layer, distance to the water courses, villages and other human presence (e.g. forest exploitation platforms). Potential environmental or human induced factors that could affect/ influence the propagation of howls have thus been considered - distracting background noises like e.g. dog barking close to the villages, loud water crashing and other natural obstacles for howls like heavily meandered valleys, steep slopes, and thick forest cover have been considered in most of the cases when selecting the individual stations.

The howling was performed at dusk or during night, no later than 1 a.m. when the activity of the target species is decreasing and so is the efficiency of the stimulation. Wolf howls were played, from single individuals or packs, by using a 25-50 W megaphone (fig. 2 & 3). The howls were played from an USB storage disk. Different wolf howls were played although some researchers are using individual vs pack howls depending on the season. However, the variety and different types of howls played at one particular station with wolf presence seems to work and to stimulate the answer. The decoding of the howls would help to better select which howl works better and when, but in the meantime it is better to rely on the individual experiences and past successes. In addition, each wolf subpopulation has its own particularities and the responses differ from one area to another depending on the environmental and other external factors.

Fig. 2. The megaphone type used for the wolf-howling survey.

The howling was performed by 1-3 teams, each team consisting of 2-3 persons. We recommend that the same person is playing the howls while the other 1-2 members should stay at a distance of about 50 m each from the megaphone, to cover a larger area from which potential responses can be detected. In this way at the end of the session each can provide feedback on the results - positive or negative, direction of the pack(s), number of individuals, distance, etc. An azimuth calculation or triangulation should be performed on the ground if the response is positive. If the team is not sure about the result it is better to say at the end that no wolf howl response was heard. Experienced staff can much easily distinguish between for instance a wolf and a dog howling. For transparency, it is recommended to record the response and to store it as evidence and further analysis (e.g. sonogram analysis).

Fig. 3. Playing wolf howls in the survey area.

The howls should be played for 25-30 seconds at a time. The process should be repeated after 2-3 minutes, not more than 3-5 times. After a positive response, there is no need to reply the howl again. However, if the response was not clear enough, the stimulation can be repeated.

The observations, including the environmental features - biotic and abiotic factors, should be recorded with a voice tracker or written in a field book. One basic field form for data collection is found in Annex 1. Other materials needed for the survey are: 4x4 car(s) if possible equipped with cable puller system, GPS devices with detailed local maps, spare batteries for the megaphone, head/ flashlights, compasses and other field equipments (e.g. boots, warm and rain clothes, first AID toolkits).

The best period to perform bio-acoustic monitoring corresponds to the mating period (Papp *et al.* 2013). We recommend performing the monitoring twice a year: in wintertime (ideally in January-February) when wolves are mating and the success of the method can be maximised (considering that wolves are organised in larger packs and are highly territorial) and in late-summer (August-September) when the pups are raised and begin to travel with other pack members.

The acoustic stimulation should not be performed in unfavourable weather conditions - e.g. winds greater than 12 km/h or precipitation (Harrington & Mech, 1982). The calling should not be performed at least 10 minutes after stopping the car's engine. Lights should be turned off and team members should stay quiet. Artificial smells (e.g. perfumes) and smocking should not be permitted at the calling stations. No animals (dogs or other pets) should be taken to the survey area.

The whole process of data collection and then analysis, interpretation, use of results should follow the process below:

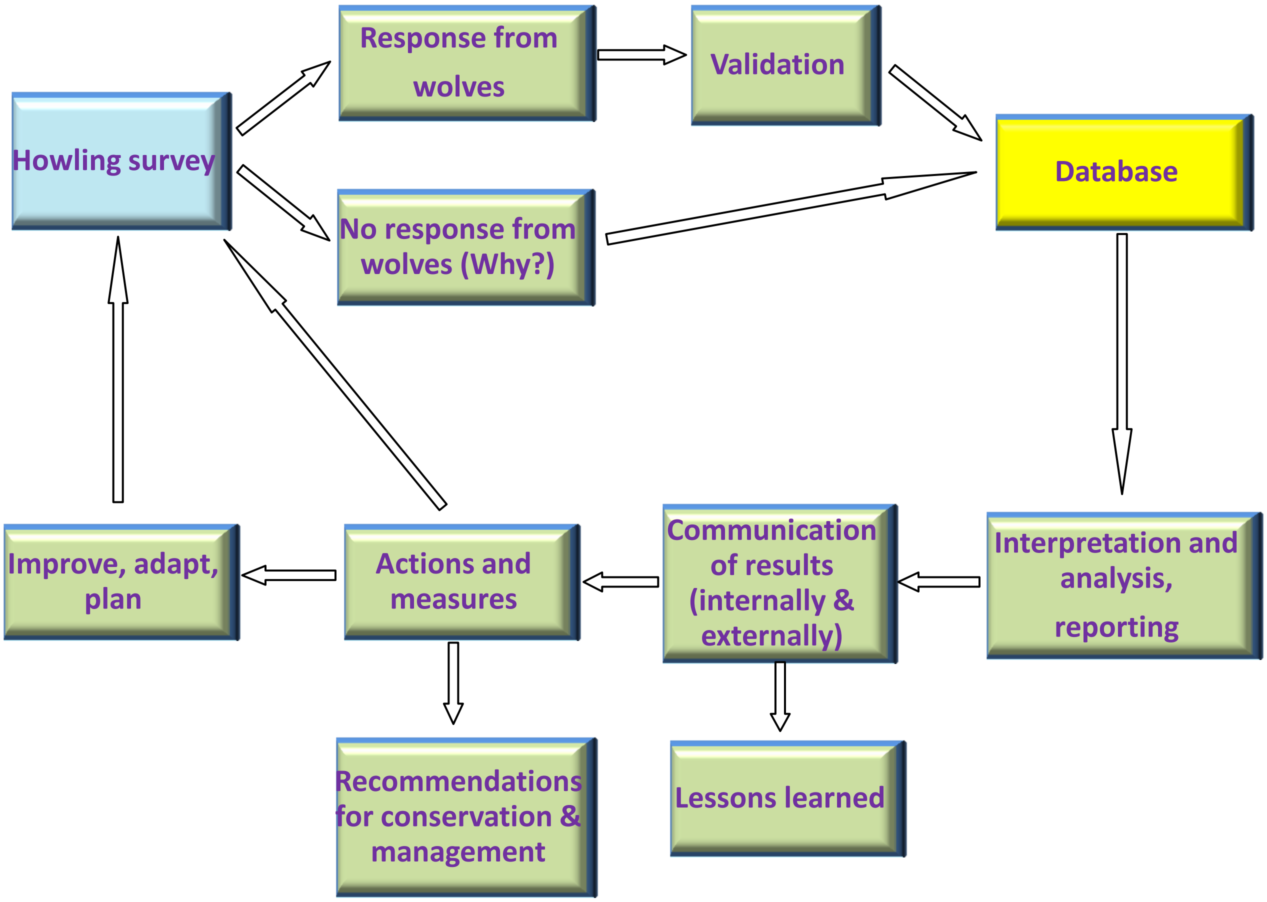

Fig. 4. Using the data gathered from the wolf howling survey

The howling survey can be completed with other methods, depending on the objectives of the study.

3 Results

The survey was performed during 4 nights in 2 sessions, namely 11-12, respectively 24-25 February 2016. The first night (11.02) was dedicated mainly to the training of the field conservation staff of the Life Connect Carpathians project. The following nights 2-3 mixed teams performed the survey.

A total of 42 calling stations were installed in the 4 protected areas and in between 3 of them. 16 positive replies have been recorded (fig. 5), with over 38% success reply rate. This is spectacular considering that Crete and Messier (1987) when tested the method had a reply rate of only 3%. They considered that this low rate poses statistical problems of precision and demands high levels of fieldwork and concluded: “We are inclined not to recommend this technique. At best it can provide an index of wolf abundance, but requiring a considerable amount of work and expense”.

Fuller and Sampson (1988) made an excellent evaluation of the method in the field. They used 6 contiguous packs with radio-collared wolves in a 1400 km^2 area. The surveys were carried out by the second author, who did not know the wolves' locations. They concluded that the logistical and statistical constraints probably prevent the use of this technique for surveys over large areas, where the aim is to monitor population changes. However, they located 5 of the 6 packs living in the study area, confirming that wolf howling is a good technique to locate wolf packs on a relatively small study area.

The technique has evolved and nowadays with the use of the megaphone the results that can be obtained are at least satisfactory. In the end, not the technique should dictate the research but the other way round. In addition, the observer/ practitioner experience is important and can influence the results greatly. Thinking like the animal being studied can lead to the selection of the most appropriate spots for monitoring.

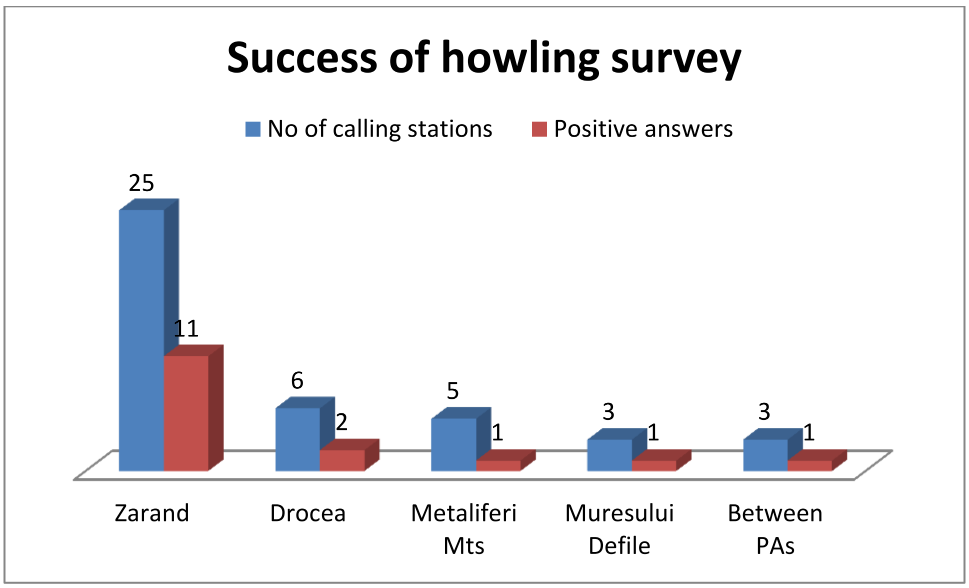

Fig. 5. No of calling stations and responses/ PA

The calling stations and the responses obtained are as follows (fig. 6):

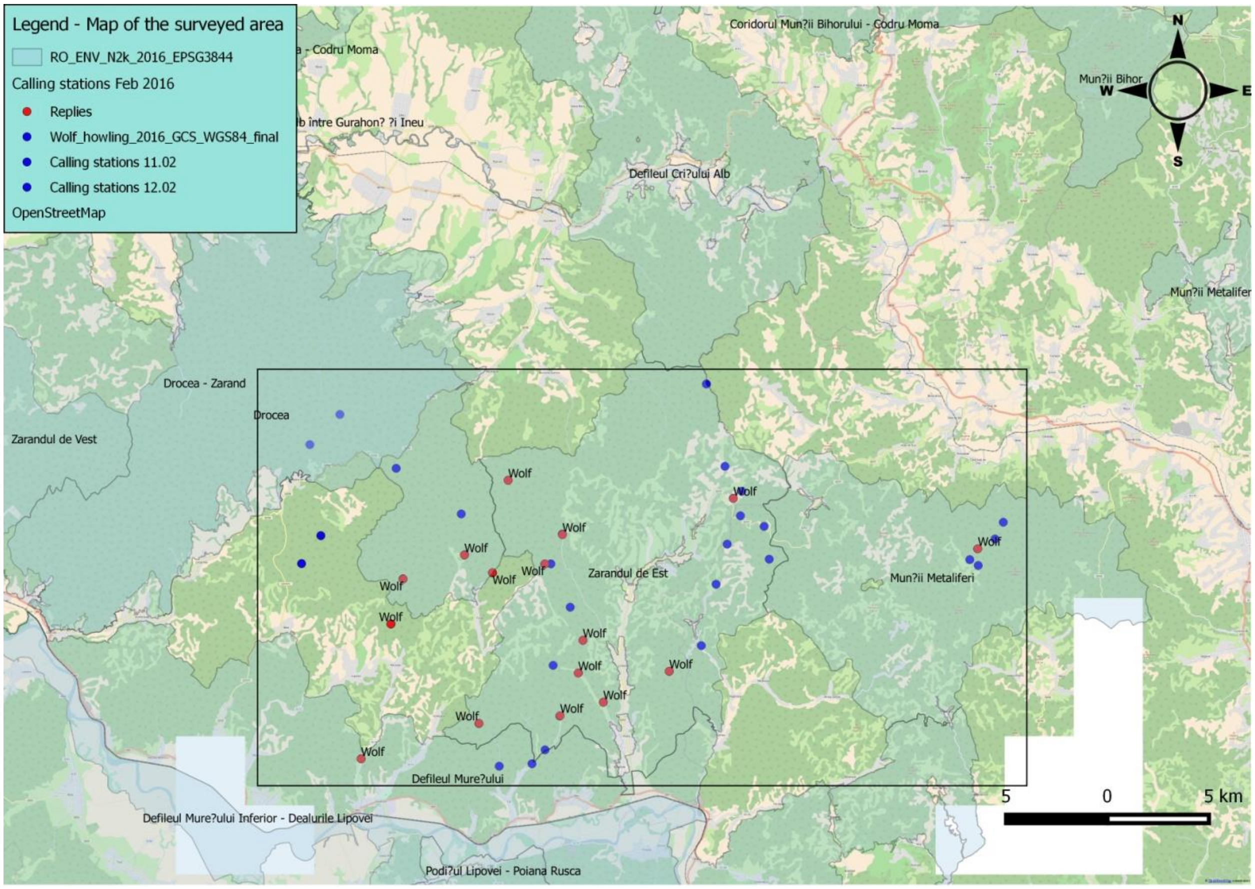

Fig. 6. The situation of responses/ presence of wolves during the survey

The directions from where the responses came are presented in figure 7. In two cases one group from an area responded to another group from the vicinity after being stimulated. This fact indicate again the territoriality of the species and the fact that intruders are not welcome if 2 separate packs responded, or, that 2 groups from the same pack communicated between each other indicating probably that they are close and can push away together the potential enemies. This was the case in day 1 and 3 (see the responses from these groups below).

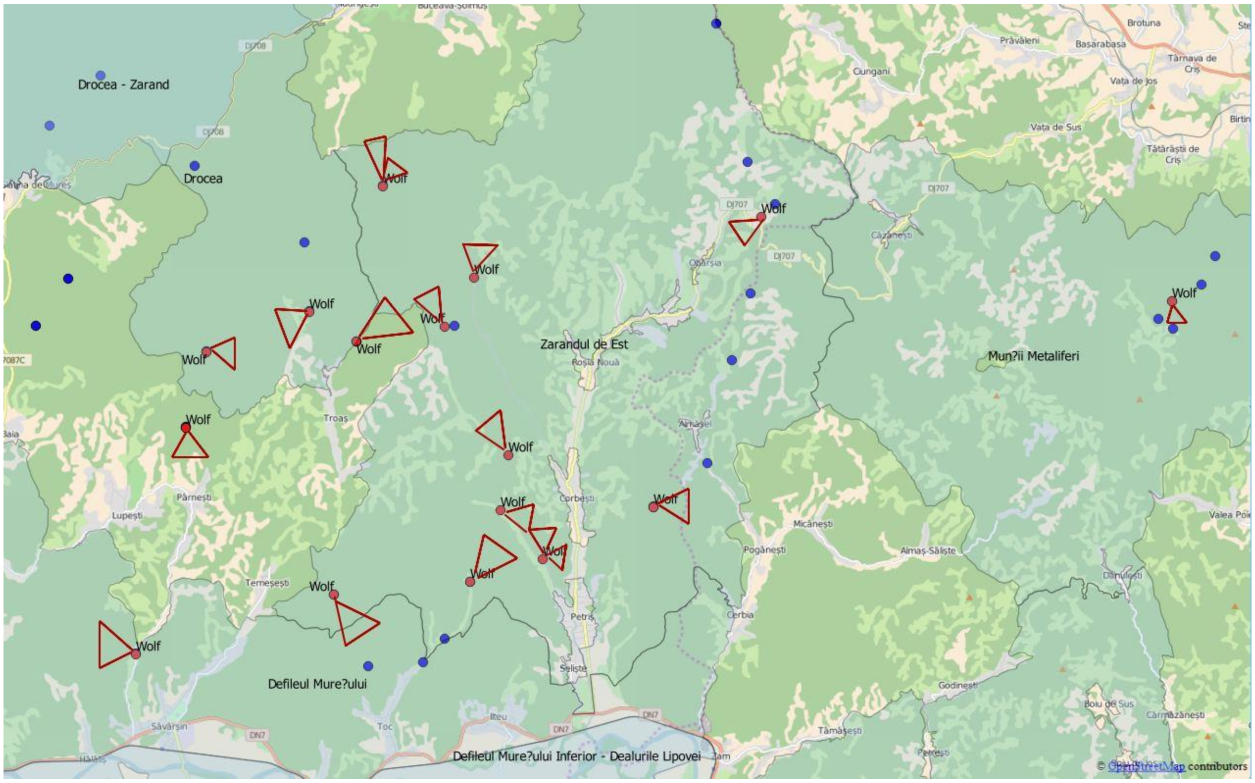

Fig. 7. The responses of wolves and their direction.

The results by day are as follows:

Day 1, 11.02.2016

Out of the 7 howling playbacks (fig. 8) there were 5 positive answers from at least 4 groups consisting of at least 2 individuals each, considering the direction and distance of the wolves that replied. In the case of 2 calling stations we can assume that the responses came most probably from 2 groups that responded earlier.

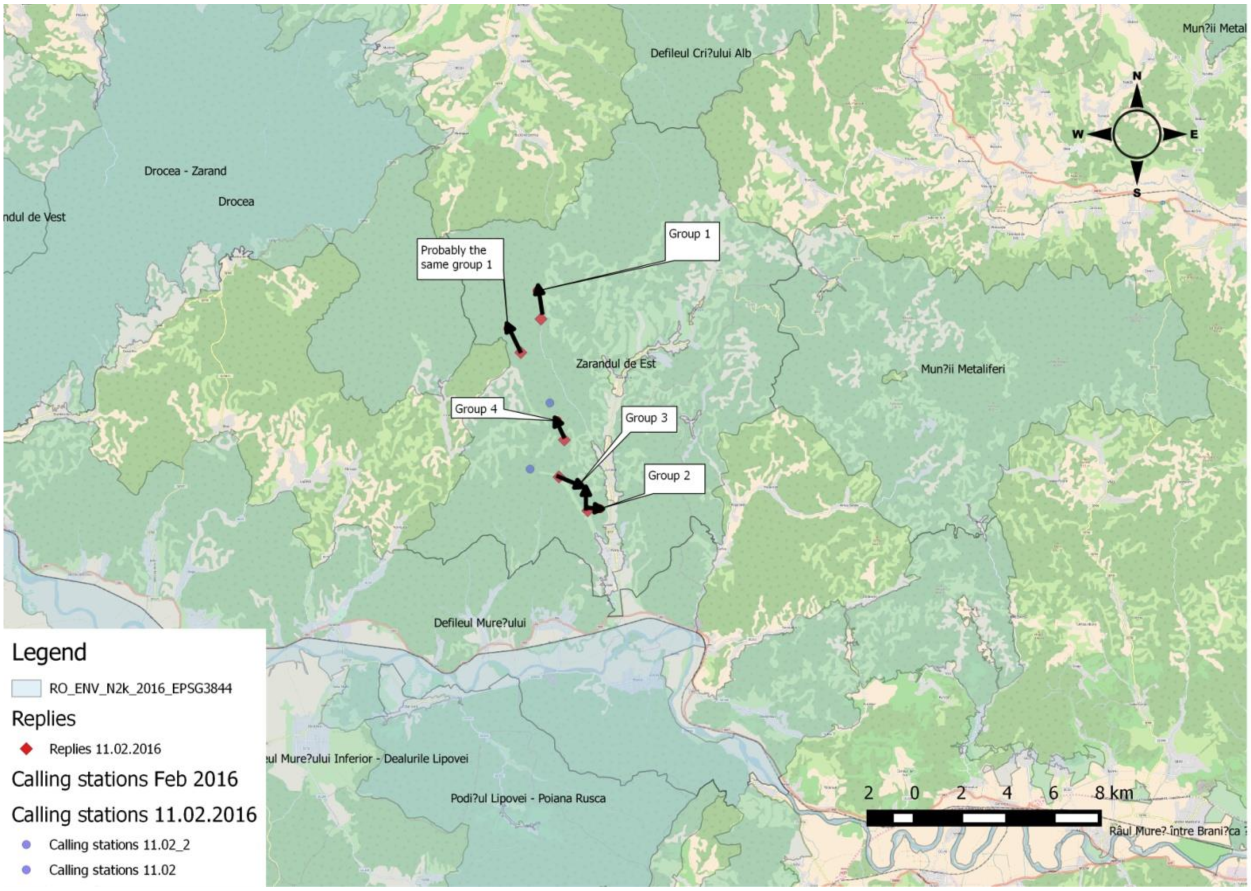

Fig. 8. Results of wolf howling on day 1

The groups may form a single pack or they are part of 2 packs.

Many authors assume that all pack members travel and hunt together in winter, even with no snow at all (e.g. Blanco and Cortes, 2012). This would mean that each reply come from individual packs. However, it seems that the members of the packs in the survey area split in groups to travel and hunt together even in winter. The same was observed for instance in Spain (Llaneza *et al*. 2009) where the average size of the wolf groups which were travelling together was 3.7, while the average winter pack size (the mean of December and March) was 8.6 wolves. In the Polish Carpathian Mountains an average pack in winter consisted of 4.0 wolves (Nowak *et al.* 2008). The single individuals or pairs can be dispersers or peripheral wolves. These loners can be considered a buffer for the population, making it less vulnerable to exploitation as they are adult individuals that can quickly replace breeders when they die (Fuller et al., 2003). Fuller et al. (2003), in an extensive review, concluded that the average percentage of loners in North American studies was 12% (range: 7–20%).

In our case the replies came from at least 2 individuals at each calling station. Adult solitary individuals usually do not respond. Single pairs do respond but it is hard to differentiate between the pairs/ groups of a pack or a whole individual pack, unless combined with other sources of data (e.g. camera trapping or DNA analysis).

The chances to double count one group, after the azimuth calculations are performed, are very low considering that the time interval between 2 howling stimulations was short, between 20-30 minutes. If we add another factor, namely the speed of travelling, our supposition is still valid. Data on the speed of travelling wolves are still scarce (Jedrzejewski *et al.* 2001). However, the mean rates of wolf movement (i.e., mean distance walked per hour, including all bouts of resting, stopping, and pausing) calculated from Burkholder (1959), Bibikov *et al.* (1985), Ciucci *et al*. (1997), and Jedrzejewski *et al.* (2001) ranged from 0.8 to 1.1 km/h. If only bouts of movements (directional and nondirectional) are considered, but with short stops and pauses included, the mean speeds of wolves would range from 2 to 4 km/h (Musiani et al. 1998; Jedrzejewski *et al.* 2001). Finally, when rigorously measured during directional travelling with all stops excluded, the speed of travelling wolves can reach 8-9 km/h (e.g. Shelton, 1966), which is in the interval of 6–13 km/h provided by Mech (1994). Considering also the difficult terrain in Zarand area, the average speed of wolves in case of for instance crossing one ridge is probably below the averages presented above.

If we use the same average size of the wolf groups as in Spain, during the first night the presence of 14.8 wolves was detected. If we multiply the number of groups with the minim of 2 individuals per group, we end up having at least 8 wolves identified during the first night.

Day 2, 12.02.2016

9 calling stations were installed (fig. 9). 3 of them generated answers from individual groups. Most probably they come from 2 different packs. The ones in the SW of Zarandul de Est site belong to the same pack while the group from NE of the site is part of another pack.

Wolves cover larger distances from their home range during winter. They have a strong tendency to utilize their territory in a rotational way, fact highlighted by Jedrzejewski *et al.* (2001). During their studies, areas utilized on 2 consecutive days usually overlapped very little. In autumn–winter, wolves most often used new areas each day, so the overlap with the range on day 1 declined on days 2–5 (to 10–12%) but then markedly increased on day 6, to decline again on days 7 and 8.

Group number 2 (fig. 9) was detected at less than 2 km distance from groups number 2 and 3 from the first day (fig. 8). This group from day 2 is probably the same as one of these previously detected groups. This might indicate that the home range of this pack from this SW area is smaller, perhaps because of the prey availability and good habitat conditions (to be further investigated).

As for group number 1, this is probably part of a separate pack.

The number of wolves detected in the 2nd day of the survey is at least 6 and at least 2 of them being different from the ones from the 1st day (from group 1).

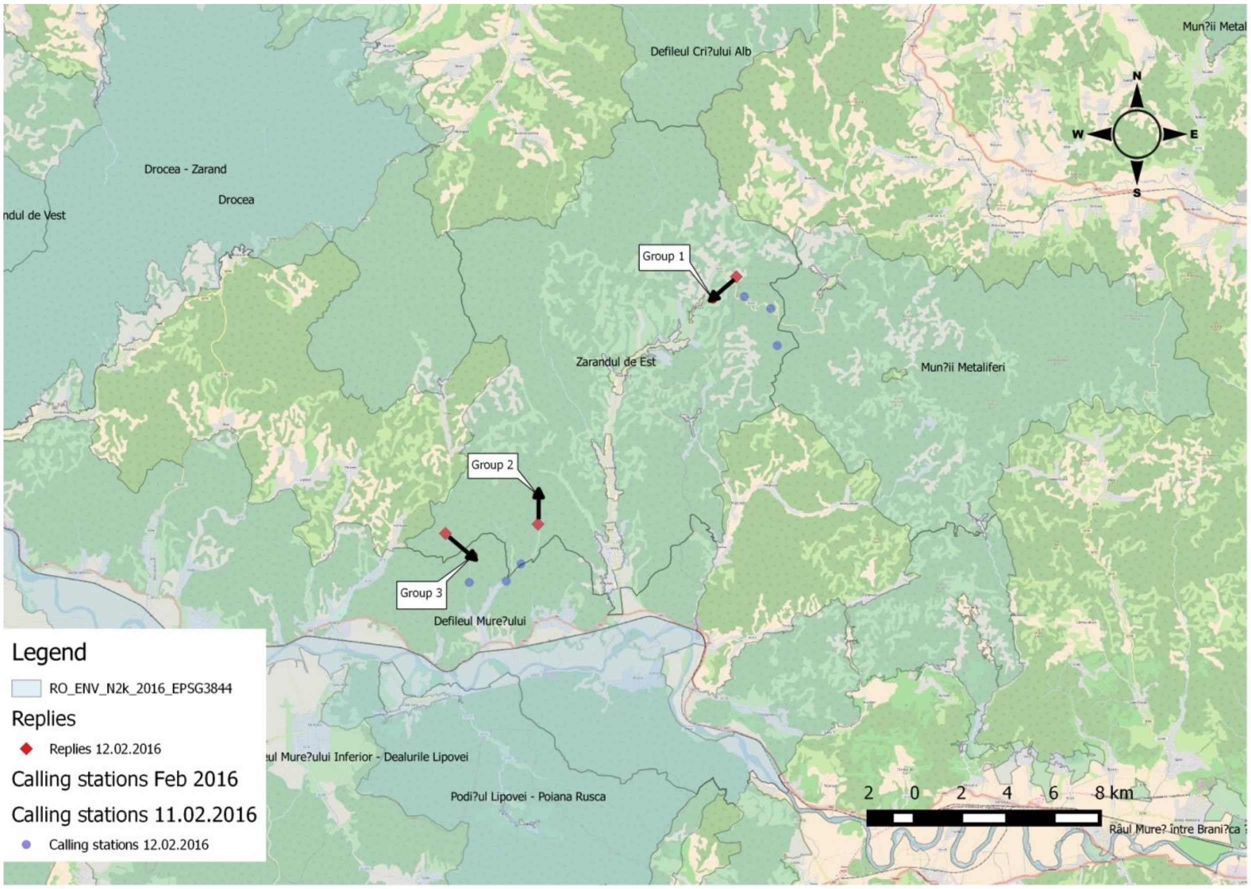

Fig. 9. Results of wolf howling on day 2

This means that in the first 2 days of the survey, at least 10 individual wolves have been identified and 2-3 packs.

Day 3, 24.02.2016

From a total of 10 callings performed 3 replies were obtained from 4 groups. Group 1 and 2 are most probably part of the same pack. The wolves from group 3 might be also be part of this pack, or of the one that was detected as being quite active in the SW part of Zarandul de Est site.

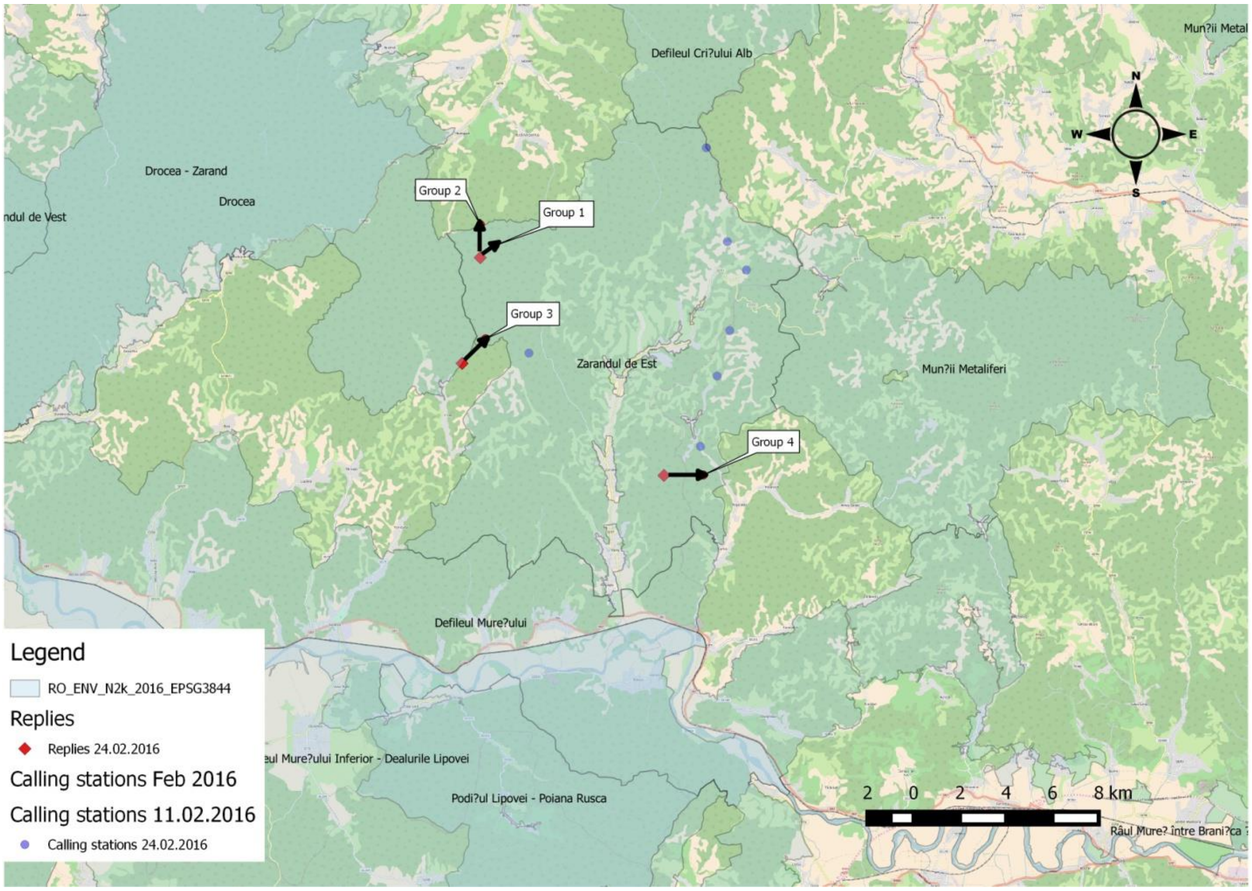

Fig. 10. Results of wolf howling on day 3

Group 4 is either belonging to the pack most active in the SW part of the site, or, is part of another pack that might have its territory overlapped at least partly with the Muntii Metaliferi site.

According to the howling operator (Radu Popa) group 1 was consisting of 8-10 wolves. The size of the group/pack might be large indeed, or, some sort of exaggeration might have been produced by the answering wolves. The observation that chorus howling by adult pairs is often perceived as that of larger groups with pups/sub adults suggests that chorus structure has evolved to exaggerate the apparent size of the pack especially those newly-established or otherwise reduced in number. If so, wolf howling choruses may represent a mammalian example of the Beau Geste effect, made particularly viable because of the relative immunity of the signal to probing (Harrington, 1989).

When animals compete, they often engage in behaviours designed to exaggerate their size. Wolves stand tall, raise their hackles, ears and tails, and produce low, menacing howls, all to convince their opponent that a retreat from this "big, bad wolf" is the best option. Thus most confrontations involve a lot of bluff and very little bloodshed. Similarly, packs that are able to exaggerate their numbers are more likely to keep their neighbours at bay. The structure of a pack or chorus howl is well suited to this kind of deception (Harrington, 2000).

The rapid changes in pitch make it difficult to follow one individual's howls if several others are howling simultaneously. In addition, as the sound travels through the environment, trees, ridges, rock cliffs and valleys reflect and scatter it. As a result, competing packs hear a very complex mix of both direct sound and echoes. If the howls are modulated rapidly enough, two wolves may sound like four or more. During the great American Civil War, General Ulysses S. Grant reported hearing what he took to be a pack of "not more than 20 wolves" while travelling. A short time later he reached the pair of wolves that had been making all the noise (Harrington, 2000)!

On the other hand, the duration of elicited howling increases significantly with group size. Nowak *et al.* (2007) found during their study that howls by single wolves or pairs lasted, on average, 34–40 s, whereas those of five to seven wolves (including pups) had an average duration of 67–95 s, with a maximum length of nearly 4 min. This is why we recommend recording the answer if possible. In addition, visual inspection of the chorus by spectrogram and spectrum proved to be useful in determining the number of concurrent voices in a wolf chorus (Passilongo *et al.* 2015). Several studies have already found both individual (Tooze *et al.* 1990; Palacios *et al.* 2007; Passilongo *et al.* 2012) and group vocal signature (Zaccaroni *et al.* 2012) by using spectrographic analysis, thus emphasising the high potential of bioacoustic tools to improve the knowledge on this species.

Based on the previous observations (including data from snow-tracking) this pack from the NW part of Zarandul de Est site is consisting of around 8 individuals.

These wolves may likely be in strong competition with the pack from the SW part of Zarandul de Est site where several droppings and scent marks have been detected. The wolves that Peters and Mech (1975) followed responded to the scent marks of neighbouring wolf packs by marking at high rates. The alpha male of a pack (the dominant male and father of subordinate pack members) even intruded a couple hundred meters into the territory of a neighboring pack to scent mark. Consequently, a territory boundary became a fuzzy space a few hundred meters wide with an amalgam of scent marks, and not a distinct boundary. Distinct boundaries of territories may at times be no easier to identify than are boundaries of undefended home-ranges. Apparent overlap of territories seen in telemetry data for instance may be due to telemetry error but, more likely, are real (Powell, 2012).

We can assume that during this day 8-12 individuals have been detected, belonging to 2-3 packs.

Day 4, 24.02.2016

During this day at least 4 groups have been identified from the 15 calling stations (fig. 11), even if some light showers interfered with the survey. The weather condition was rather poor overall and thus we recommend to further investigate the Drocea-Zarand area in future where the acoustic stimulation was negative this time.

In one case we believe that 2 replies came from the same group (1), although the distance between the calling stations was more than 4 km. To avoid potential double counting we concluded that the answers came from the same group.

Group 2 might be part of the pack that was initially detected in the SW part of Zarandul de Est, or could belong to a separate pack. Group 3 probably belongs to the pack which includes the wolves from group 1, or, it might be part of another pack together with group 2. Group 4 seems to belong to a totally different pack from what we identified so far.

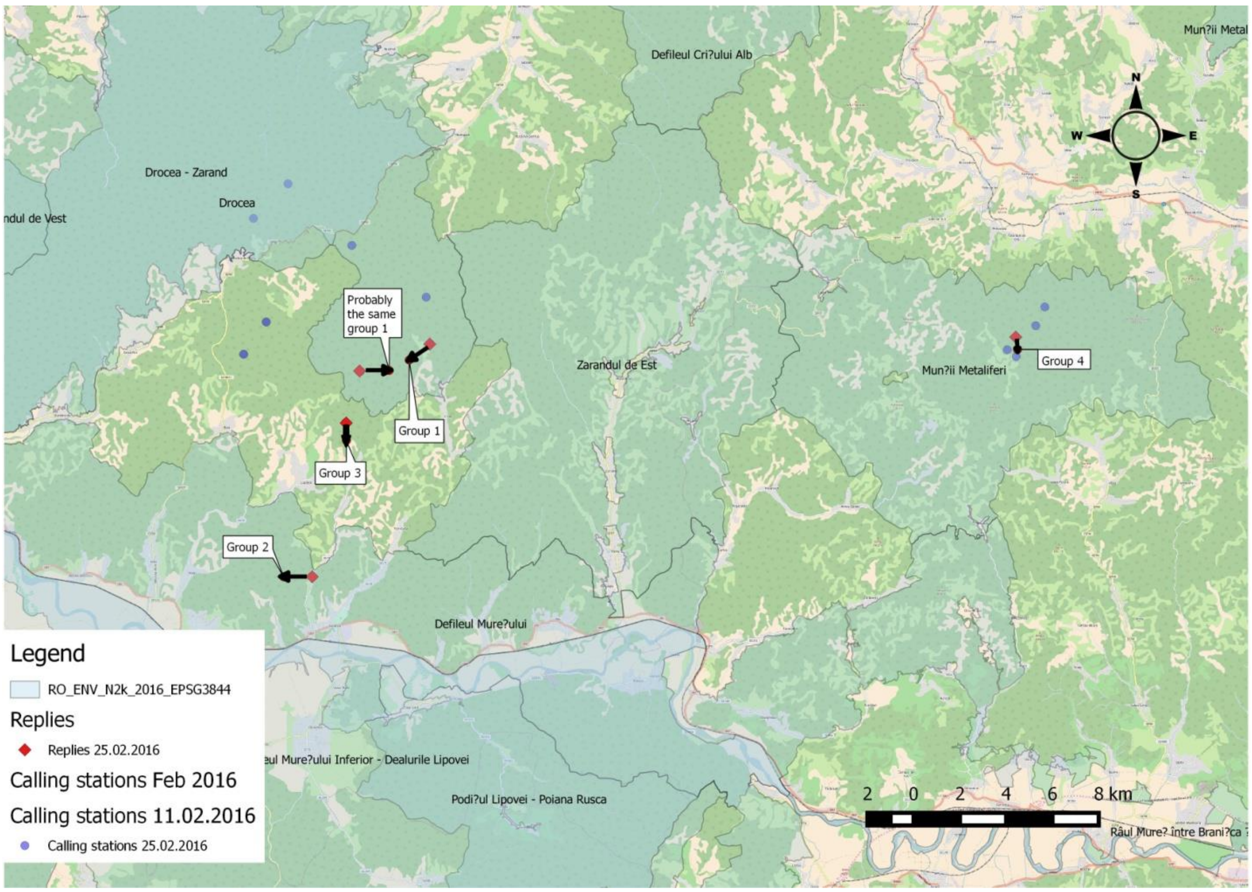

Fig. 11. Results of wolf howling on day 4

The presence of at least 8 wolves has been identified in the last day of the survey, as part of at least 3 packs.

4-6 additional wolf individuals might be added to the previous day (24.02), which means that on day 3 and 4 of the February monitoring the number of identified wolves is 12-18, belonging to 3-4 packs.

After the 2 monitoring sessions (after the 4 days) we can estimate that in the surveyed area there are between 16-22 wolves. If we would add the loners (12%, as in the case of Fuller *et al*. (2003)) the total numbers would be 17.9-24.6 wolves.

As for the total number of packs identified in February this ranges between 3 and 5.

The strictest scenario would indicate that there were identified only 3 packs (fig. 12).

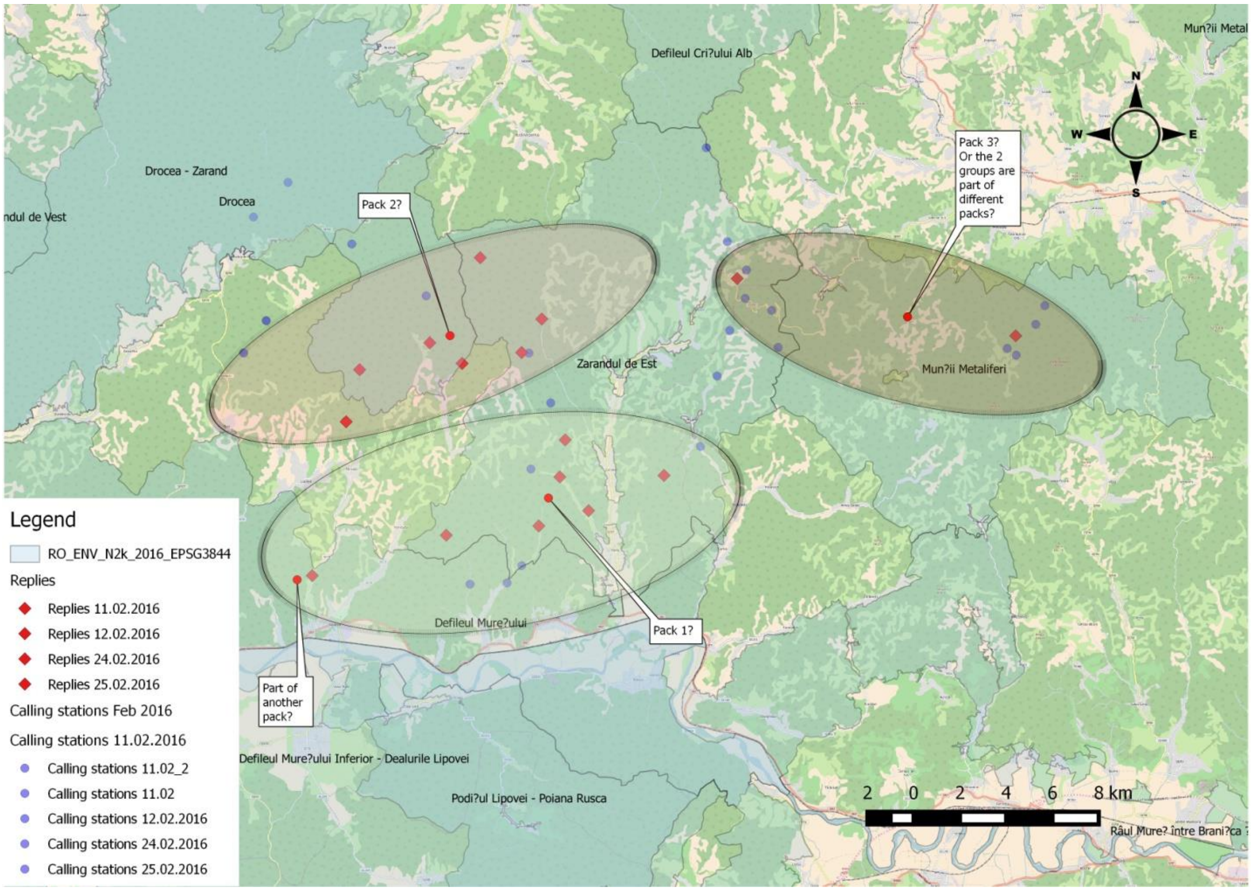

Fig. 12. First scenario with 3 packs identified

Pack number 1 would have a home range of about 380 km^2 and pack number 2 about 200 km^2 from the first rough estimations. For pack 3 if presumably was correctly identified and represented on the map, the home range would have around 170 km^2. However, considering the movement of the individuals from pack 1 and the use of the territory in 2 consecutive days (11 and 12.02), its home range is probably much smaller (100 - 150 km^2).

Another more realistic scenario is that 4-5 packs have been detected (fig. 13).

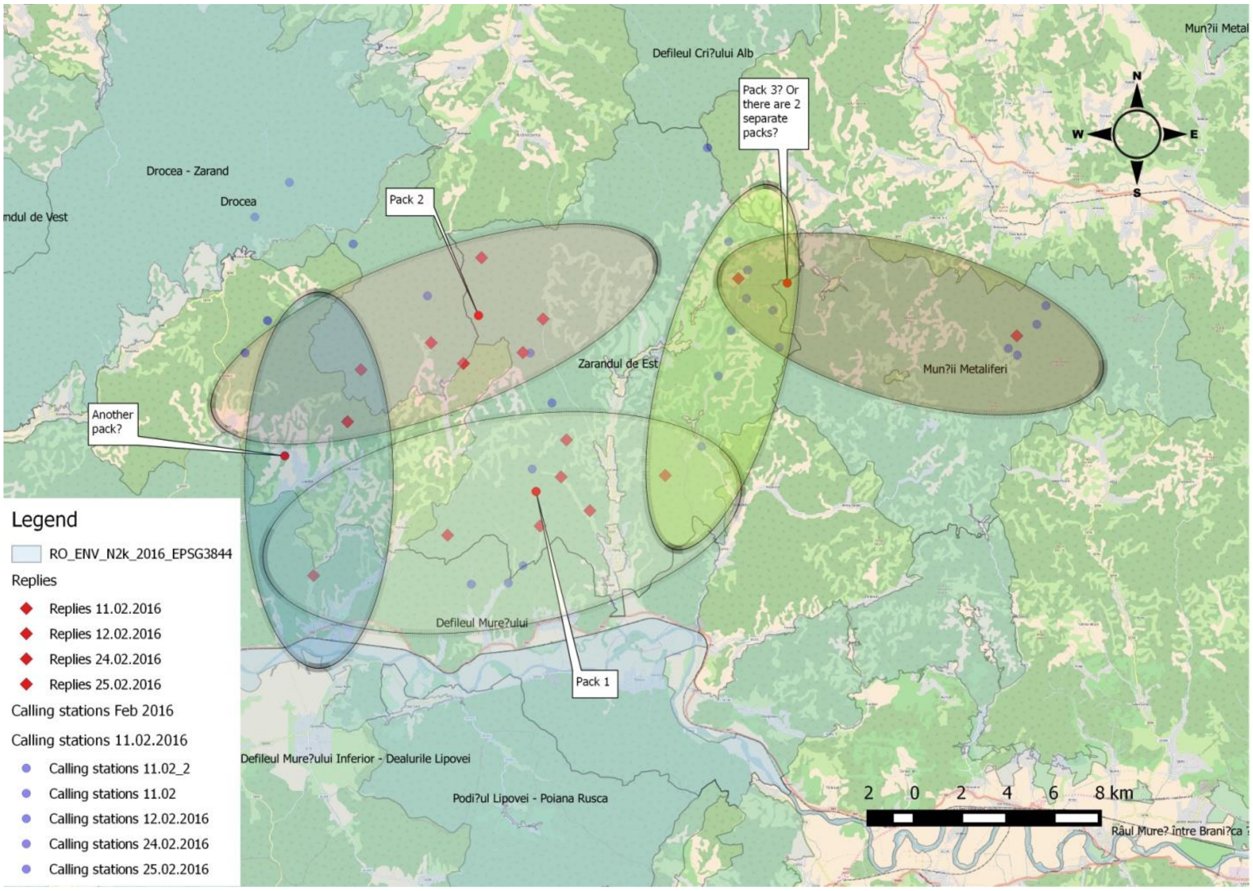

Fig. 13. Second scenario concerning the number of packs identified

In this case the home ranges would be closer to the reality than the first scenario, considering that the limiting factors are represented by the availability of food, quality of habitats and disturbance caused by humans.

The wolf packs can have a very large range, from 15 to 1500 km^2 (http://www.wolfcountry.net/, 2016). The smallest well-documented territory reported seems to be that of the Farm Lake pack of 6 in north-eastern Minnesota, which occupied an estimated 33 km^2 (L.D. Mech and S. Tracy, unpublished data). Wolves travel for long distances but not the whole territory can be considered as part of their home range if they do not defend it. Due to some disturbances for instance wolves can exit their home range during their patrol or hunting activity, in which case they do not show a defence behaviour.

Theoretically, if territory holders are competing maximally with neighbours, territorial mosaics should resemble the hexagonal cells of honeybee hives (Grant, 1968; Wilson, 1975). This spacing allows the maximum number of territories with the least space among them (Wilson, 1975). The shape of the home ranges is irregular and it is generally admitted that landscape features also influence this basic mosaic structure and thus overlapping of home ranges often happen (e.g. Powell, 2012).

Differences in core area and home range sizes are definitely influenced by human activity (e.g. hunting, logging, sheep grazing, etc.). Kusak et al. (2005) found that in their case in Dalmatia wolf locations were closer to the nearest water source (mean=937 m) and farther from houses (mean=653 m), compared with random locations. In National Parks in Alaska and Alberta for example, gray wolves do not avoid human activity inside protected areas, but show typical avoidance of human activity outside (Thurber *et al.* 1994; Hebblewhite and Merrill 2008). During our survey generally the responses came from less disturbed areas. Where heavy forestry works were undertaken or there was other human presence (e.g. settlements or houses with dogs) there were almost no answers.

The wolf pack surveys are probably far more accurate in areas with expanding (low density) wolf populations in the borders of the wolf range, where packs are apparently well separated. In saturated populations, like probably in the case of the ones from Zarand area, where the packs are contiguous and share a portion of their home ranges, identifying every pack is a hard task, especially considering that packs are very dynamic and unstable (Blanco and Cortes, 2012).

Estimating the number of wolves from the area by the number of packs, and considering the figures provided by Nowak *et al.* (2008) in the Polish Carpathian Mountains with an average pack in winter consisting of 4.0 wolves, the number of wolves in the study area would be 16-20, considering our 2nd scenario. We do not know the average number of wolves consisting a pack in the Romanian Carpathians and thus we are not fully confident in such estimation. Further investigations have to be done in the future. However, we should consider that one of the problems in obtaining pack size estimates over the years is that wolf packs are changing over time, both in pack and territory sizes. Even in protected wolf populations, pack size can change every year. For instance, the same pack in the High Arctic studied during 8 years by Mech (1995, 1997) had 7, 7, 4, 8, 3, 3, 2 and 5 adult/subadult wolves from 1986 to 1993. Another pack monitored for 8 years in Minnesota had 2, 6, 2, 7, 6, 6, 11 and 6 wolves in winter from 1973 to 1981 (Mech and Hertel, 1983).

In terms of densities in wolves they vary greatly depending on the habitat types, availability of food, threats, etc. In Spain for instance the density is estimated at 1.5-2 individuals/ 100 km^2, while in Minnesota is 4.5 wolves/ 100 km^2 (Blanco and Cortes, 2012).

Considering the extended surface of 1.000 km^2 that was investigated during the February survey, the first estimated densities are 1.6-2.2 wolves/ 100 km^2 (or 1.79-2.46 together with the loners).

These are only the first estimates and we are aware that further information is needed to complete the picture of wolves' distribution, abundance, densities and packs in the corridor area.

4 Conclusions and Recommendations

Conclusions:

• The wolf howling survey can provide additional and relevant data about the distribution and relative abundance of wolves in the area.

• Out of the 42 calling stations, in 16 cases the responses from wolves were positive (38%).

• At least 3-5 packs and 16-22 wolves were identified in the area, with a potential density of 1.6-2.2 wolves/ 100 km^2.

• The Western part of Zarandul de Est and Drocea-Zarand areas seem to be the most important from wolves conservation point of view.

Recommendations:

• The database should be at a centralised level and filled in with all required information and observations should be categorised according to the protocol.

• Preferably some form of recording that can be reanalysed and verified should be used in the future. Analysing the sound can later offer information about the number of wolves that answered (the duration of the response can also better indicate the number of wolves).

• Extend the study to other areas relevant from conservational point of view at the regional level, e.g. the Apuseni Mountains.

• Repeat the howling survey in late summer and continue the monitoring twice a year following the same protocol (which can be improved in time).

• Each team member should follow the same method and field protocol for relevant, harmonised and comparable results.

• The survey should be done with more teams in parallel, to determine the direction and distance of the wolf pack(s) more precisely and eliminate the suspicions of double counts.

• Complete the information with other data sources - observations, tracks in snow or mud, DNA, collaring, camera traps, etc.

5 References

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6 Annexes:

- Field monitoring sheet (.doc)

- Database (.xlsx)

- Wolf howls (.avi)