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MONITORING WOLF (*CANIS LUPUS* L.) IN THE «KINBURNSKA KOSA» REGIONAL LANDSCAPE PARK

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In Ukraine, wolf numbers have been controlled periodically in an effort to reduce predation on game and domestic livestock. The Kinburn protected area, where several hunting districts and farms are located, in this respect, has been no exception. The reduction of wolf numbers was primarily the responsibility of these districts, however, most of them, as state enterprises, have come to an economic standstill and/or are in the state of being reorganised in one way or another. Due to the economic slowdown they are nowadays hard pushed to cope with only a fraction of their previous responsibilities, including the control of wolf numbers. This has become a cause of concern for the Kinburnska Kosa authority, because locals are perceiving wolves as an increasing threat to domestic livestock and are demanding eradication measures.

The Kinburnska Kosa authority, however, is not considering the situation to be so alarming, but realises that a sound decision in this case can be made only if numbers or data reflecting the relative abundance of wolves in the area are available. The purpose of this survey was to gather such data and set a quantitative baseline for monitoring wolf abundance in the area in the coming years.

Numerous studies have been conducted on the ecology and population dynamics of wolves. However, because of their highly mobile nature and generally large home ranges, obtaining accurate and precise population estimates can be difficult. Nevertheless, because wolves leave behind conspicuous signs such as tracks, scats and kills, wolf inventories can be relatively successful. Various techniques for surveying wolves and estimating abundance have been developed, but most are non-statistical since they do not employ sampling. This disallows any probabilistic modeling, standardized replication, or establishment of confidence levels about a mean.

The best estimates of population sizes are considered to come from the total count methods using, for instance, aerial snow-tracking surveys, or radio-telemetry for determining absolute abundance. These methods, however, are not available to the staff of the Kinburnska Kosa Landscape Park for a variety of reasons, ranging from purely natural (for instance, in dense pine-forested areas where visibility is poor an aerial survey technique may not be practical) to technical (lack of suitable equipment and training).

Under these circumstances, the prudent option is to focus, for the current study at least, on relative abundance methods that produce indices reflecting the density of the wolf population. For example, given a standard technique, such as counting tracks along transects, it is possible to say that if area A has a higher frequency of tracks than area B, there must be more animals in area A, even if we do not know the exact numbers in either area. Similar logic is used to compare relative abundance in the same area over time.

However, although a linear relationship is assumed between the index and actual density, indices have rarely been validated for most groups of animals. Despite this, indices are increasingly being employed in many management contexts, largely because of the problems associated with obtaining precise counts of estimates of population size. In this respect, track surveys are relatively quick, easy, and inexpensive methods for determining relative abundance of wolves.

Wolf track surveys are usually limited to the winter months and snowy conditions. However, the sandy terrain of the Kinburn peninsula offers an opportunity to spot wolf tracks at any time of the year, although the track imprints might not be so clear in sand as they would be in snow, especially if for a week or two there has been no rain.

Table 1.

Variety and percentage of habitats crossed (and/or bordered) by the transect WCTR1

<table>
<tr><td colspan="3">Forested area — 65.6%</td><td colspan="2">Open area — 34.4%</td></tr>
<tr><td colspan="2">Dense — 56.3%</td><td rowspan="2">Patchy
9.3%</td><td rowspan="2">Open area with some pine — 7.1%</td><td rowspan="2">Open grassland
27.3%</td></tr>
<tr><td>Mature — 18.2%</td><td>Medium to small — 38.1%</td></tr>
</table>

One uninterrupted ploughed transect line (encoded WCTR1), about 2 m wide and 7.33 km long cross-cutting the peninsula in a near-to-longitudinal direction was established for track count surveys. The transect, in fact, follows a lane between forest quarters 14/15, 34/35, 62/63, 87/88, 123/124, 157/158, 157/176. Natural borders for this transect are set by the fresh to subsaline waters of the Dnieper Estuary in the North and by sea waters of the Yagorlytsky Bay in the South. Hence any movements across the transect, particularly in a latitudinal direction (i.e., E-W, and vice-versa), are most likely to be detected. The transect crosses (and/or borders) a variety of habitats, consisting of both forested and open areas (Table 1). This transect was surveyed in the beginning from Wolf Camp 1, located nearby the transect in forest quarter 86 (46°31.008' N, 31°44.005'E); later, after moving the campsite to another place, the transect was reached by car.

Because of the heat, but primarily because of the heavy devastation of the pine forest by a sawfly pest (*Neodiprion sertifer* Geoffr.), the campsite was moved to the seaside and located in forest quarter 139 (46°29.712' N, 31°37.607'E). A second ploughed transect (WCTR2), similar to the first one, was established following a lane between forest quarters 25/26, 44/45, 69/70, 104/105, ending up in quarter 139. In general, WCTR2 runs parallel to WCTR1, the distance between them being about 9 km. The terrain here is much more open (Table 2), and most of the mature forest plantations have perished from fires, having occurred in 2001 and 2002. In the destroyed pine forest stands most of the charred trees, although dead and deprived of needles, remain rooted for some time. In a short time the forest floor is taken over by an abundance of tall weeds and grasses. Later, in a year or two, trees are toppled by winds and create in many places impassable heaps blocking lanes running between the forest quarters. Foresters are removing the deadwood, but in the meantime most of it yet untouched.

Surveys of the transects were done on foot. The expedition's survey team consisted of several paying, untrained expedition team members who gave up their holiday time to assist in this research project. Their work and the expedition contribution they paid made this research possible. Expedition team members were taught how to recognise and record wolf tracks by the local scientists and the expedition leader. Field guides were also provided.

Table 2.

Variety and percentage of habitats crossed (and/or bordered) by the transect WCTR2

Forested area — 42.9%		Open area consisting mainly of grassland 57.1%
Burnt forest (mature to small) — 21.3%	Sparse pine forest (medium to small) — 21.6%	

WCTR1 was surveyed 6 times. Crossings were recorded between 4 and 23 September 2003. The average time between two checks was about 6.8 days. WCTR2 was surveyed 9 times. Crossings were recorded between 8 and 19 September 2003. The average time between two checks was about 3.1 days. All wolf tracks were registered on the survey routes and as well anywhere where found off the routes. According to the tracks, the direction and number of animals were estimated. If the number of animals was unclear, it was clarified by following the tracks. A number of tracks were measured according to [2] and digital photos taken of them, however many had to be rejected, because of their vague outlines in the sand. Measurements of footprints from digital images were carried out using UTHSCSA Image Tool software.

Wolf scat location and condition was recorded, the condition being scored as (1) *very fresh* (recently deposited; usually less than a day), (2) *fresh* (moist; one or several days), (3) *medium* (dried; 1 to several weeks old), (4) *leached* (mostly hair remaining; probably more than 1 month old), (5) *amorphous and crumbly* (probably several months to a year old).

Results were registered in a log, indicating the survey route (transect), footprint direction and the number of animals, and occasionally footprint measurements. Abundance was calculated as the number of wolves (i.e. individual tracks) per kilometre of route. An array of conventional statistical methods were used to process the transect data. In order to attract the wolves bait (a cow head) was set nearby Wolf Camp 2 on 18 September. The bait, however, remained intact.

As in the previous reports, we start by exploring the relationship between track numbers and the number of wolves (or, possibly, their activity as far as wolves could have been moving faster around) in the area of the transect to check how constant this relationship is throughout the time of the survey. This can be assessed by plotting cumulated numbers of tracks against the dates from the beginning of the survey up to its end, and estimating corresponding regression values. For this purpose dates have been transformed, following [4], into a continuous sequence of numbers, so, for instance 20 August (the start date of the survey) has the number 173, and 26 September (the final day of the survey) has the number 207. To avoid any bias we use tracks/km/day instead of just simply the number of tracks recorded on a day.

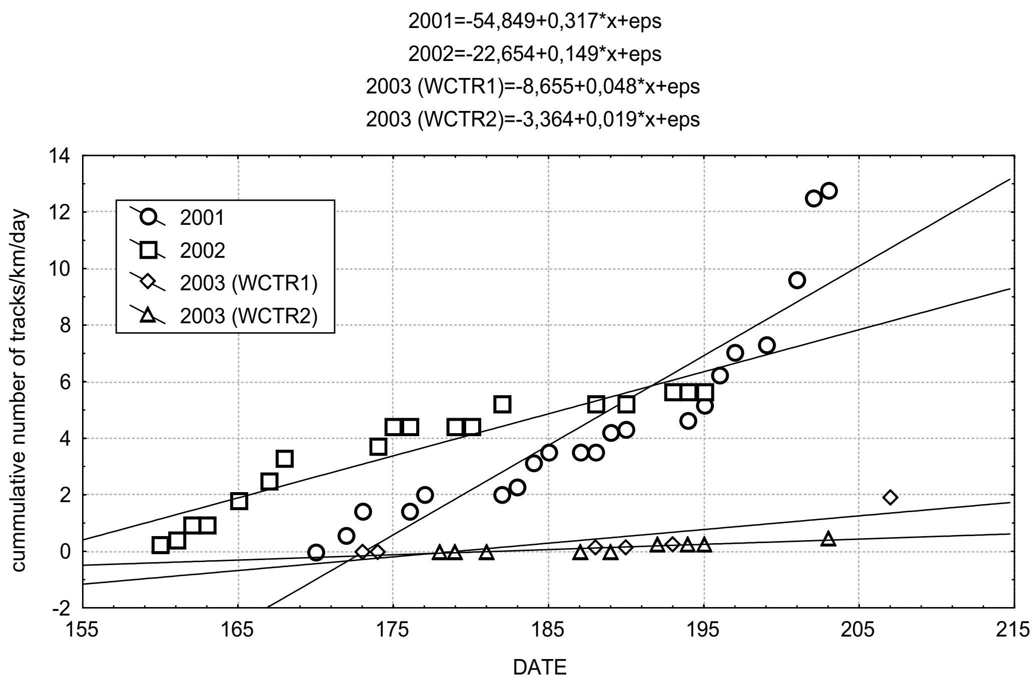

Fig. 1. Growth of cumulative numbers of wolf tracks/km/day during the surveys of 2001–2003.

Cumulated numbers of tracks/km/day versus dates for both WCTR1 and WCTR2 fit well into the linear model (see fig. 1), R^2 being 0.687 and 0.815, the slope (*B*) equalling 0.048±0.016 (n=6) and 0.019±0.003 (n=9), respectively. The fact that the data is well approximated by the linear model means that wolf tracks are appearing on the transects during the survey at a more or less steady rate, just as it was the case in the previous surveys of 2001 and 2002. However, comparing both surveys, it can be stated that in the third year the rate of the appearance of wolf tracks crossing the transect is greatly reduced, meaning considerably less wolf activity and/or fewer animals populating the area.

Less wolf activity last year (2002) could be due to the earlier start of the survey, however the survey of the same duration this year had started 2 weeks later, so more wolves could be expected to be recorded, once they in due course begin to congregate. Although the survey lasted till late September, no signs of such gathering of wolves into groups were detected. Wolves for most of the time of the survey continued to remain solitary. Indeed this year, usually 1 to 4 individuals would form a set of tracks (average for WCTR1, from which there is sufficient data, totalling 1.550±0.113, n=40), however in most cases (22) it was one animal recorded. If we consider animals to be spread out predominantly one by one, then the presence of 2 or more animals together could be a matter of chance. This easily is checked by viewing the record of one animal as no departure from the «norm» and assigning it the value of zero, the record of 2 animals as one departure (+1), and 3 as 2 (+2), and comparing the mean (M) and variance (s^2) of this series. Both are fairly similar (0.550 and 0.511, respectively) and their relationship is identical to 1 ($\chi^2 = 36.2$, $df = 39$, $p > 0.05$), so we are dealing with a Poisson series, giving a theoretical number of solitary wolves expected to be met as 23.1.

Slope values of the linear model (B), given the appropriate time frame, seem to be good estimators of wolf number (and/or activity) dynamics and may be used for monitoring purposes. For this reason we consider a full account should be presented of the regression summaries (Table 3).

Table 3.

Regression summaries for cumulative numbers of wolf tracks/km/day

WCTR1: 17.08.–19.09.2001		
Model: Y=A+B*x		
R=0.913 Variance explained: 83.474%		
n=21	A	**B**
Estimate	–54.849	0.317
Std. Err.	6.08	0.032
t(19)	–9.022	9.797
p-level	0	0
WCTR1: 7.08.–11.09.2002		
Model: Y=A+B*x		
R=0.939 Variance explained: 88.191%		
n=18	A	**B**
Estimate	–22.654	0.149
Std. Err.	2.403	0.014
t(16)	–9.426	10.931
p-level	0	0
WCTR1: 4–23.09.2003		
Model: Y=A+B*x		
R=0.829 Variance explained: 68.720%		
n=6	A	**B**
Estimate	–8.655	0.048
Std. Err.	3.063	0.016
t(4)	–2.825	2.964
p-level	0.048	0.041
WCTR2: 8–19.09.2003		
Model: Y=A+B*x		
R=0.903 Variance explained: 81.517%		
n=9	A	**B**
Estimate	–3.364	0.019
Std. Err.	0.629	0.003
t(7)	–5.344	5.556
p-level	0.001	0.001

Indeed, together with the intuitive vision of decreasing wolf numbers in the study area, the slope value B (highlighted in bold in Table 2.3b) for WCTR1 steadily decreases from 0.317 in 2001 to 0.149 in 2002, and 0.048 in 2003, meaning an overall 6.6 decline. In conventional statistical terms, these figures are highly significant ($p<0.05$). From the point of view of methodology it is as well interesting to note the absence of difference between the regression slopes obtained in one year for the data from WCTR1 and WCTR2 (t=1.83, df=11, $p>0.05$), meaning our data derived from transect surveys are indeed producing replicable and well justified results, despite the distance between the both transects.

Somewhat contradictory may seem to be the results of calculations of abundances. As earlier stressed, one should be aware that we are dealing with relative abundances (i.e. indices), the significance of which appear when the transect is surveyed for wolf tracks in the same way a number of times. Table 4 presents the relative abundance of wolves, estimated as the number of tracks per one kilometre of transect recorded during the surveys of 2001–2003.

As far as the raw data is not distributed normally (in terms of statistics), transformations have been applied to make the comparison between the figures in a correct manner according to rules of statistical procedures (see [1]). Most suitable is the conversion of raw data by adding to each value 3/8 and then extracting the square root.

Table 4.

Relative abundance of wolves, estimated as number of tracks per 1 km of transect

	Valid N	Mean	Minimum	Maximum	Std. dev.	Standard Error
2001						
NUM/KM	21	0.607	0	2.887	0.738	0.161
SQ(NUM/KM)	21	0.941	0.612	1.806	0.320	0.070
2002						
NUM/KM	18	0.313	0	0.852	0.340	0.080
SQ(NUM/KM)	18	0.805	0.612	1.108	0.203	0.048
2003 (WCTR1)						
NUM/KM	6	0.318	0.000	1.637	0.650	0.265
SQ(NUM/KM)	6	0.781	0.612	1.418	0.316	0.129
2003 (WCTR2)						
NUM/KM	9	0.052	0.000	0.235	0.104	0.035
SQ(NUM/KM)	9	0.650	0.612	0.781	0.074	0.025

Although there is an obvious drop in the relative abundance of wolves in the area, nevertheless the general decline is not statistically significant. Whatever method is used for comparisons, p exceeds 0.05, the commonly accepted significance threshold. In other words, this means that the probability of making a wrong conclusion about the equality of the relative abundances under comparison exceeds 5%. It may be, however, that we are treating the results gained by a fairly «rough» method, as transect counts may be, especially if wolf numbers are very low, by a superfluous statistical standard. Indeed, most statistical surveys, particularly in the field of precise experimental research, require gaining estimates (of any kinds of parameters), standard errors of which will not exceed 5% of the estimate value itself. Biological field studies, where a countless number of factors are involved and the «experiment» is beyond control of the researcher, accept standard errors to comprise up to 20% and even more of the estimated parameter.

In our case these percentages for the derived means (Table 4) have ranged from 26.5 (in 2001, when there seemed to be more wolves) to 83.3 (in 2003, when their numbers have seemed to decline). So it is reasonable to reconsider the significance threshold of p, which may stand, for instance, 0.20 (which, in fact, is an arbitrary decision). Indeed, p from the comparison of the means for 2001 and 2002 (WCTR1 data), using the non-parametric Mann-Whitney test (U), equals 0.195, so the probability of making a wrong conclusion about the equality of the means is around 19.5%. Comparison of means for 2001 and 2003 gives a p of 0.137, so the chances for wrong conclusions become lower (13.7%), strengthening in such a way our confidence of the presence of a trend for wolf number decline. In this respect slope values B discussed above have turned out to produce more reliable proof (values of p for between-year comparisons less than 0.05), possibly because of their relatively small standard errors (ranging from 9.4 to 33.3% of B).

Considering the question of whether there is any preferred direction in which wolves are moving we have taken into account only generalised latitudinal movements (from E to W, and vice-versa) as these are most clearly defined by the nature of the transect and comprise the majority of the collected data (sufficient only for WCTR1).

Generally speaking, in 2001 there had been no preferred direction in which wolves have been moving. In 2002 wolf movements across WCTR1 were primarily in a western direction, possibly because bait was twice set west of the transect line. This has been checked by sorting out how many series there have been of alternative movements across the transect from the beginning up to the end of the survey, excluding those records when on the same day the transect was crossed in both directions by an equal number of wolves. This time series for 2003 can be shown in the following way: W EE WW EEEEE WWW E. That is, we have 6 series of alterations. This sequence may be of non-random character if there are only a few series or, on the contrary, too many of them. A quantification of what is few or much is given by the serial criteria R [3], and in our case these values are 3 = <*R*> = 12, so 6 is in between, meaning that wolves have been crossing the transect in both directions randomly. Note: no bait has been set here this time. The data of this year is too scarce to confirm the random selection by wolves of habitat types along the transect. Records of wolf tracks have been made both in forested and open areas, and most of them, as usually, are confined to roads and lanes. A directional analysis of all recorded during the expedition wolf tracks (33) has shown no preferred bearing (χ^2=0.33, df = 3, p = 0.95). The sequence of bearings as well seems to be of random character: 19 series of alterations (11 = <*R*> = 23).

In 2001 and 2002 the animals have been crossing WCTR1 predominantly in its middle part around the location of forest quarters 87/88. The pattern of this year is very different (see fig. 2), having wolves clearly avoiding the middle part of the transect. One substantial reason for such behaviour, in addition to the droughty weather, may be the devastated condition of the forest there, where much of the pine canopy has been destroyed or damaged by sawfly larvae, so shelter and shade is scarce.

The analysis of track (footprint) measurements provides a pattern similar, in general, to the previous ones. As mentioned above, imprints of wolf tracks in sand may be fairly obscure, so they are not easy to measure and raise certain doubts that this can be done accurately enough to carry out a meaningful analysis. In total, 26 complete footprints of the wolf foreleg were measured. As in previous surveys, the measurements do not vary much as shown by their coefficients of variation: 9.90% (n = 29) for the length (L) of the footprint, 12.05% (n = 27) for the width (B), and 5.47% (n = 26) for the shape (S), computed as (B/L) x 100.

It is quite evident that tracks have been produced by a variety of animals differing by age and sex. One way to expose this fact is to plot foot length (L) against foot width (B) (Fig 3). The scatter-plot reveals two patches of plots: one of smaller animals and one of larger. For the sake of objectivity the method of *k*-means clustering was applied, using L and B as variables. This obtained pattern and figures may be reflecting the ratio of young and adult wolves roaming in the area during the time of the survey. If so, young in 2001 made up at least 29% of the wolf population in the area, whereas in 2002 around 25%, and 38.5% in 2003. The differences are statistically insignificant (p > 0.05). Perhaps these figures could have changed, had the survey been extended for a month or two after the wolves had congregated.

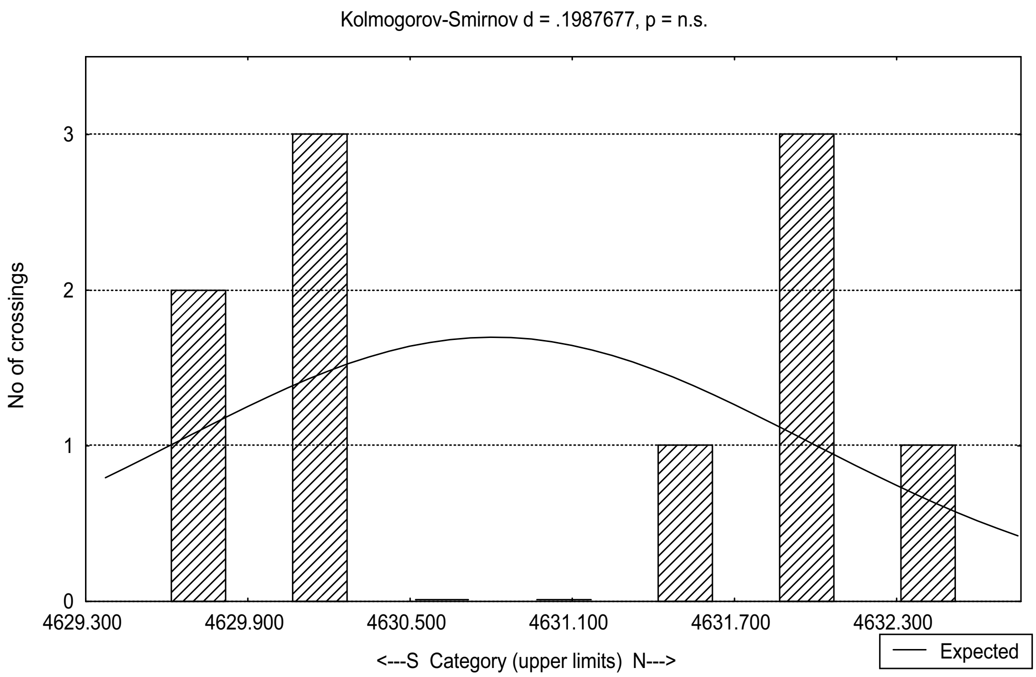

Fig. 2. Distribution of wolf track numbers along WCTR1 in the survey of 2003.

As in the analysis of footprint measurements recorded in the previous survey a fairly distinct classification was made of male and female footprints. Indeed, according to Rukovski [2], male tracks should be wider (S being around 77%), whereas female tracks should be somewhat elongated (S around 67%). These proportions have been derived primarily from measurements of footprints made in the snow, so we can expect that our data may differ from these particular proportions. However, in any case the difference between male and female footprints should stay clear. The relatively small number of measured footprints in our samples may also be a source of variation. To separate the footprints by sex objectively, the method of *k*-means clustering was applied, this time using S as the only variable, and assuming that animals in different clusters are either females or males. Numbers of footprints belonging to a particular age group and sex, according to the results of the *k*-clustering analyses, as well as means of S for the distinguished clusters, are summarised in Table 5. The between-year differences for generalised figures of L, B and S, as indicated by the ANOVA test, are insignificant.

Once again, we may assume the ratio of footprints left behind by animals of different sex to be reflecting the proportion between males and females. If so, the ratio between adult male and female wolves inhabiting in the study area is identical to 1:1 (as indicated by the chi-square test: p in all cases is considerably above the value of 0.05).

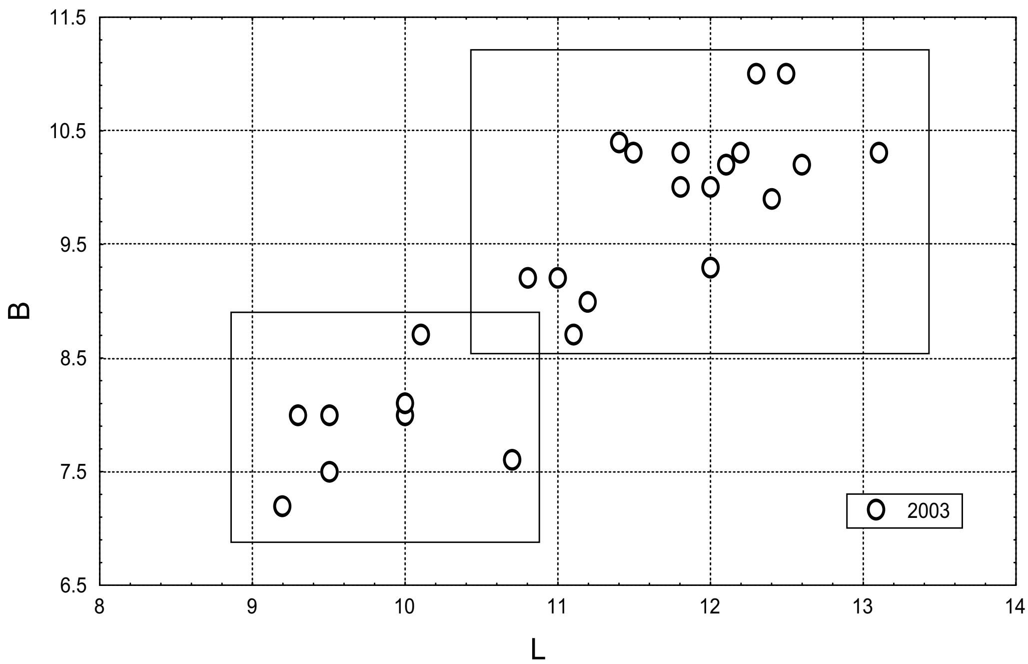

Fig. 3. Scatter-plot of wolf foot length (L) by foot width (B) measured in centimetres (cm)

Table 5.

Results of *k*-means cluster analysis of footprint measurements

Group	Sex	n (number of footprints)	S = (B/L) x 100
2001			
Adults	Female	9	79.70±1.71
	Male	8	91.32±1.44
Young	Female	1	89.41
	Male	6	91.44±1.34
2002			
Adults	Female	7	79.10±1.20
	Male	11	89.38±1.26
Young	Female	2	82.18±0.18
	Male	4	89.04±1.71
2003			
Adults	Female	5	79.45±0.62
	Male	11	86.30±0.87
Young	Female	6	79.94±1.45
	Male	4	85.39±0.45

An interesting fact resulting from the cluster analysis may be that most of the recorded in 2001–2002 footprints have turned out to be ones belonging to male individuals, 6 out of 7, and 4 out of 6, respectively. That could mean that young male wolves start at an earlier time exploring their surroundings and/or moving a longer distance than their sisters. It may be too that we have to double the estimate of young, that may indeed total about half of the wolf population in the area. In the 2003 survey, however, the sex ratio of juveniles (according to footprint numbers) is fairly close to 1:1.

Finally, a few words on scat records. A total of 16 such records was made. The average score stands for 2.97±0.37, half of the records being considered of very fresh or fresh condition. Twice the diet of the animal was recorded vegetarian and consisted once of water melon (17.09) and on the other occasion (24.09) of grapes. The spatial pattern of scat distribution is, in general, random. Unfortunately, there is not enough data to check the character of the sequence of scat records, although it too seems be random.

Conclusions. During the 2003 survey, as in previous years, wolves have been crossing the transect WCTR1 at a more or less permanent rate, which this year has considerably slowed down. Wolves continue to prefer roads and lanes, however recorded bearings are distributed randomly. In 2001–02 the animals have been crossing WCTR1 predominantly in its middle part around the location of forest quarters 87/88. The pattern of this year is very different, having wolves clearly avoiding the middle part of the transect. One substantial reason for such behaviour, in addition to the dry weather, may be the devastated condition of the forest there, where much of the pine canopy has been destroyed or damaged by a sawfly pest, so shelter and shade is scarce. The quantitative baseline set in 2001 for monitoring the relative abundance of wolves in the area and checked in 2002, has been checked repeatedly against the data for 2003. There seems to be a sharp decline in wolf numbers, best indicated by regression analysis of cumulative numbers of recorded on the transects wolf tracks /km/day. The decline may be due to the extremely cold and harsh winter of 2002–2003. Although wolf numbers seem to be very low, there has been no distortion of such pivotal population parameters as the sex ratio (remaining 1:1) and percentage of young individuals (up 50% of footprints belong to young wolves), giving hope that under favourable conditions (mild winter, sufficient food etc.) the wolf population in the area may restore itself.

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