SOME COMMENTS ON DIFFERENT METHODS OF COUNTING BROWN BEAR, *URSUS ARCTOS* L., 1758, POPULATIONS USED IN THE FORMER USSR

IGOR E. CHESTIN, Department Vertebrate Zoology & General Ecology, Moscow State University, Leninskive Gori, Moscow, 117513, Russia

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Since the establishment and development of the game and trapping industry in the 1920-30s, censusing of game animals has become a problem. The Winter Route Census (WRC) was suggested as a uniform technique for determining densities and population sites of all game animals, from sables (*Martes zibellina*) to moose (*Alces alces*) (Formosov 1932). This is a relative method involving the use of fixed routes, or transects, along which note is made of all animal tracks crossing the trail. Subsequently, density of each species was calculated by number of tracks per km of trail divided by the length of average day route of particular species. This procedure was best performed soon after snowfall to eliminate the old tracks of the same individual. Different coefficients were suggested for inclusion in the formula, but their review is beyond the scope of the current paper.

The Winter Route Census became the primary technique used for game censusing throughout Russia. However, it has never been widely used for counting brown bears *(Ursus arctos* L.), because in February, when WRC usually takes place (after the game hunting season) the bears are in their winter dens. Thus, other methods were developed for this species.

Brown bear census methods can be divided into 2 groups, according to the geographic scale of their application. One group combines various methods seeking to determine the number of bears in single areas, such as natural reserves or game industry sites. These areas are usually quite uniform as bear habitats. The second group is aimed at estimating bear numbers in large regions, limited usually by administrative (e.g., between oblasts, autonomic republics etc.) rather than natural borders. The ultimate goal of the latter group is to determine bear numbers in the entire republic.

Because the methods from the first group (which can be called local) have been designed for different natural zones, there is still no unique standard technique for bear censusing. However, as far as all of them are very time-consuming and labor-intensive, censusing usually takes place on a small area, with subsequent extrapolation to the whole area of habitat. Thus, all the techniques face the problem of distinguishing the uniform zones. In other words, the zones and habitats must be more or less equal in order for extrapolation to yield valid results (Caughley 1979, Pikunov 1987). In almost all cases, such zones are determined arbitrarily and so this is probably the weak point in the population estimation process.

The local methods can be divided into 2 categories. The first category includes all the techniques that are based on the seasonal bear concentrations. There are numerous examples of such methods. Censusing bears during the concentration periods was first suggested by Nasimovich (1952), who recommended this technique for regions where individual home ranges are not distinct or clear. Aerial censusing in the Kamchatka Peninsula, where the bears concentrate along rivers during salmon runs, was performed by Ostroumov (1968). He also proposed the coefficients for determination of population density using the data from aerial survey. However, it was pointed out that the best results can be obtained when aerial and ground censusing are conducted simultaneously.

Shilov (1976) proposed the combined technique for censusing brown bears in the Altay Mountains (South Central Siberia). Using the well-known bear habit of concentrating on south-facing slopes in early spring, Shilov (1976) found that visual censusing was the best for that region. This absolute censusing, according to Shilov (1976), should be accompanied by indices censusing of bear tracks on the trails during the first half of May (about 1 month after the peak of den exit). The data of the latter method were processed as usual for WRC and the results were extrapolated to all forest zones up to the snow line. Thereafter, Shilov (1976) suggested the "comparison and generalization" of the data, collected by 2 methods, although not mentioning in what way.

Varnakov (1979, 1986) reported on absolute censusing of brown bears feeding on the oat fields in Central and Northern European Russia.

Bobyr (1981), seeking to elaborate brown bear censusing techniques for the mountain regions, rejected all the methods based on track counting. He chose visual counting in May-June, when the bears concentrate near the upper limit of the forest zone and in the alpine zone. Obviously, this is very similar to the technique suggested by Shilov (1976).

Pikunov (1937) pointed out the following difficulties

with censusing bears in the forests of the Russian Far East: (1) difficulties caused by the necessity of distinguishing between brown and Asian black (*U. thibetanus*) bears; (2) variations in the dates of den entrance and exit among individuals; (3) seasonal food movements and migrations toward the den sites; (4) temporal autumn concentrations; (5) occurrence of the den concentration sites. Because of the autumn food-related migrations, Pikunov (1987) rejected the methodology of bear censusing by individual home ranges. He suggested counting the bears on sample territories in autumn, where food-related concentrations of bears occur. He further suggested that another appropriate method, following Pikunov (1987), is counting the bears' tracks during their migration to the den sites. Regarding the latter, he suggested choosing the whole river valley 30-40 km long as sample unit and putting the trails for track counting on the ridges that border the valley. This should be accompanied by transects across the valley. Censusing brown bears in the Far East while they migrate to the winter dens was also proposed by Abramov et al. (1979) and Kostoglod (1979).

Zavatzkiy (1990), rejecting aerial censusing and track counting, suggested 2 methods for the mountain forests in South Siberia (Sayan Mountains). One of them is visual censusing of the bears in the alpine zone (July was determined as the best time). His expert estimation of the bears, which cannot be otherwise censused because they stay in the forest zone, equalled 30%. The second technique can be applied when there is a good crop of Siberian pine nuts. When this occurs, bears keep feeding on the nuts for 1-2 months after snow cover settles. Thus, it is possible to count bear tracks of different size in the concentration sites (Zavatzkiy 1990).

In Georgia, Arabuli (1990) counted the tracks crossing the ridges during periods of den entrance and exit. The tracks were counted through binoculars up to 3-4 km.

Local methods from the second category are based on the absolute censusing out of concentration periods. In Central Russia, about 200 km to the northeast of Moscow, mapping of individual home ranges was used for brown bear censusing (Kuzyakin 1972). The author compared the results of the above method with those of visual censusing on the routes and through use of polls among the hunters. Mapping of the home ranges and polls were found more reliable, while the visual counting led to underestimation.

Pazhetnov and Korablev (1979) reported on another technique for the same area. They suggested counting bear tracks, distinguishing individuals by the footprint size. They said that this procedure should be performed simultaneously on the whole study area. Assuming that the bears' average travel distance a day is 6 km, the tracks of the same size within this range could be regarded as belonging to 1 animal. After exclusion of tracks of the same individuals, the resulting figure of the tracks of different size can be assumed to be the total number of bears in the area.

DISCUSSION

The first category of local methods seems inappropriate for bear censusing, nor do those methods have any value as the standard technique for the country. At least 2 factors influence the number of bears counted at concentration sites. First, the technique does give you a real number of bears, but second, the number depends entirely upon the relative attractiveness of each particular site in a particular year. The latter factor can hardly be evaluated because it includes not only the crop of some food source (e.g., pine nuts, beech nuts, salmon) that attracts bears to the site, but also the crop of other food sources that are or are not available to bears outside the concentration sites. For example, the number of bears grazing on the south-facing slopes can be influenced by the phase of population dynamics of rodents, which bears can dig out, or by the number of animals that died that spring in avalanches and are thus available as carrion. Thus, for example, the number of bears feeding on salmon can be influenced by the crop of berries, dwarf Siberian pine nuts etc.

Our experience (Lobachev et al. 1988, Chestin 1991) provided evidence that in Caucasus, where bear concentrations do occur in beech and chestnut forests, an essential part of the population keeps feeding on grass, carrion, or berries at higher elevations, and that this part, or percentage, varies from year to year. Zavatzkiy (1990), cited above, assumed 30% of bears being out of the survey, but this figure cannot be constant for all the years.

Therefore, even though censusing at concentration sites gives some information, it is fairly difficult assessing what kind of information it provides: is it providing an accurate trend in bear numbers or just monitoring relative attractiveness of the site as bear habitat?

Counting brown bears on their routes to the winter dens does not seem reliable either. One confusion can be due to the earlier (before the snow period) hibernation of some the bears (Chestin 1991, Pikunov,

pers. commun.). Those individuals that den prior to the first snowfall are excluded from censusing. Another confusion can arise because bears migrate to the den sites in a very short time (Pikunov 1987, Lobachev et al. 1988). Therefore the possibility of missing 2-3 critical days always exists. Moreover, extrapolation of data collected on migration routes can cause more faults, because it is unclear from what area (that is, how large an area) the bears come to a particular site.

Kudaktin (1986) came to similar conclusions, rejecting censusing brown bears on migration routes and during the concentration periods.

Assessment of various censusing techniques allows us to determine certain criteria that should be met if the method is to be considered valid and reliable in all parts of bear range. First, it should be based on some common features rather than on local peculiarities of bear biology. This is crucial for comparison of the data coming from different regions. Second, considering the best period for censusing, it is better to choose one when the bears are equally spread on the territory rather than concentrated in particular habitats, because this even distribution will better justify extrapolation to a larger area. Third, as was also mentioned by several authors cited above, distinction of the zones with different bear densities is highly desirable if not obligatory.

The following technique, developed during the 8-year bear research in Western Caucasus, seems to meet all the above criteria.

We found out that the bears are most equally spread on the territory during the breeding season (Lobachev et al. 1988, Chestin, 1991). This was confirmed by the studies done in other regions (Zavatzkiy 1977, Pikunov 1987). At this time the individual home ranges of most adult males can be distinguished in the regions where they can hardly be identified on the other phases of bear circannian rhythm (Pikunov 1987). Thus the breeding season seems to be the best time for censusing.

Our experience in Central Russia (about 500 km to the northeast of Moscow, 1978) and in the Caucasus (1983-1990), and the experience of 2 graduate students, who have been doing bear research in the Sayan mountains (southeastern Siberia) and in the Chukotka Peninsula under our supervision, showed that it is possible to monitor bear movements by their tracks in spring and summer. Identification of bear individuals by size of their footprints was extensively used in Central European Russia (Pazhetnov 1979) and in the Caucasus (Kudaktin and Chestin 1987, Chestin, 1991). The main problem with this method is that the study area should be small enough to minimize the possibility of several bears with the same track size living on it at the same time. On the other hand, if the territory is not too large, one can easily distinguish all the bears visually by some peculiarities in their fur color, body shape, etc.

After choosing the area where the censusing is going to be undertaken, it is necessary to develop the routes, preferably using the animals' trails, because probability of track registration there is higher. If the alpine zone is included, it is better to set routes by the ridges because this will provide better potential for visual observations. Once the censurers are sure that the route system will allow monitoring all the bears on the sample area, the procedure can start. The forest routes should be passed regularly in 1-2 days during the whole censusing period, which in our study averaged 10 days. The alpine zone should be investigated every day. When a bear is seen, it is highly desirable to find and measure its footprint, thus making sure that this particular bear can be distinguished both by its appearance and footprint size. After the end of censusing the number of days on which each bear was registered on the territory should be calculated. The latter forms the coefficients that precede summarizing of all registered bears. For example, if the bear stayed on the territory for the whole 10 days, the coefficient for this individual should be 1.0. If it entered the area just for 2 or 4 days, the coefficients would be 0.2 or 0.4 correspondingly.

The above technique is quite close to the mapping of individual home ranges (Kuzyakin 1972) and counting the tracks of different size (Pazhetnov and Korablev 1979), but it allows counting non-territorial individuals, such as subadults. It also allows registration of different sex and age groups separately. At least 5 categories can be distinguished according to their behavior: breeding males, breeding females, females with cubs, females with yearlings, and the rest (probably subadults). The area we used in the Caucasus was near 50 km^2. Two people were required for censusing. The zones with equal densities were determined by comparing the number of tracks per 1 km of route on the sample territory and on the potential area for extrapolation. Regarding censusing techniques for the Caucasian Mountains, Kudaktin (1986) also suggested visual and track counting during the breeding season, although only in subalpine and alpine zones.

Our results for Western Caucasus (the density was determined as 1.2 individuals per 10 km^2) coincided with those for Central Caucasus obtained by Bobyr (1981), who used visual counting on the south-facing

slopes in early spring, but this can be regarded as happenstance rather than as predictable.

CONCLUSIONS

The necessity of monitoring all the bears on the censusing area can seem the weak point of the above technique; therefore, choosing location, square area, and routes are crucial points in the survey. One of the limitations of this method is that it can be successfully used only by personnel experienced in track searching and distinguishing and moreover knowing the whole territory fairly well. Thus, the method can be recommended for the reserves and other places where game management is permanent and well-developed.

Regarding the methods of the second group, large-scale methods have been used for determination of bear numbers in administrative divisions. Strictly speaking, these are methods of estimation rather than censusing. However, they are very useful since this is probably the only way of estimating bear numbers on large territories and thus the only basis for setting up the quota of licenses for game hunting in different administrative units.

The first attempt of estimating the number of brown bears in the entire country was undertaken by Vereshchagin (1972), who used the records of the fur offices, which buy bear skins from the hunters. He augmented that material with the data from several correspondents and regional game managers. Priklonskiy (1969) and Polyakova (1975) used questionnaires mailed to the foresters in the European part of the USSR. A similar technique was used by Brilliantov (1990) who interviewed professional trappers in the Krasnoyark region (Central Siberia). However, the last author used his own data, collected at several sites for comparison. In 1979, Gosokhotuchet was established in Russia—the department responsible for censusing game animals. This body started collecting data on the number of all game species, including brown bears, from local game departments of all Russian republics. Because the origin of those data differs among administrative units (it can be either the expert evaluation of game managers, or an extrapolation from actual censusing) those materials were augmented by the comparison with data coming from the nearest reserves, where censusing is more accurate, or from aerial counts performed by the staff of Gosokhotuchet. The detailed analysis of these data and their comparison with the materials obtained by questionnaires has been done by Chestin et al. (in press).

Because the current paper was devoted to the techniques that were used in the former USSR, no comparison with the methods used in other parts of brown bear range was provided. However, it is worth mentioning that not many papers dealing with this problem have been published.

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