# LEMMING SIGN SURVEYS

Charles J. Krebs, Department of Zoology, University of British Columbia

There are three simple methods of obtaining an index of lemming abundance in a local area without capturing or killing animals. I will describe each of these methods briefly and try to give an estimate of the time needed to do such work.

### (1). Winter Nest Surveys

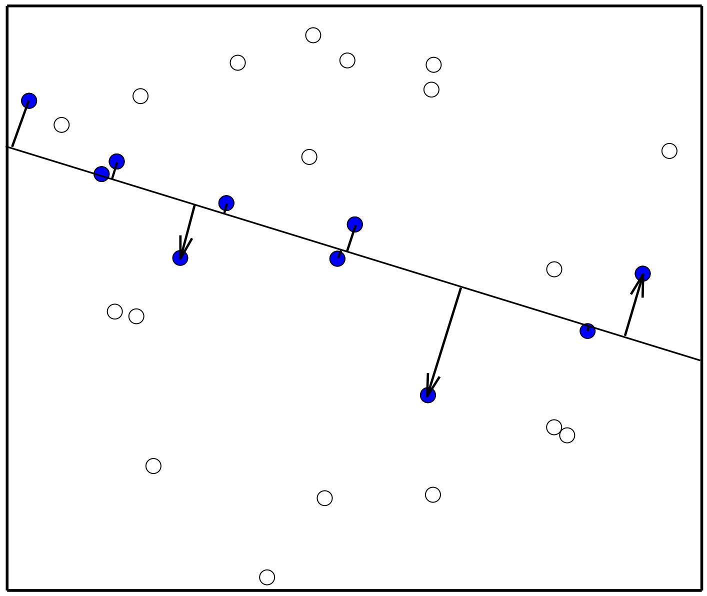
Lemming abundance over the previous winter is relatively easy to measure indirectly by a survey for winter nests. Lemmings build winter nests of grasses and sedges under the snow and use them to keep warm. They appear to us like a ball of cut grass, about 12 cm (5 inches) in diameter. Since they are abandoned in spring and not reused, they can be counted and picked up without harming the animals.

Both the brown lemming and the collared lemming build winter nests, as do voles like *Microtus* (tundra vole) and *Clethrionomys* (red-backed vole) in tundra habitats. It may be possible to tell what species constructed the nest from small amounts of hair left in with the grass, but this is relatively difficult and time consuming. In most cases we would simply record the nest and not know what species constructed it. In all parts of the tundra you may find gigantic winter nests 30 cm or more in diameter and lined with much fur. These are weasel (ermine) nests. Weasels hunt lemmings and voles under the snow and convert lemming nests to their own use. Often you will find lemming stomachs left behind in weasel nests. We record weasel nests separate from lemming nests, since it gives a rough indication of the amount of weasel predation over the past winter.

Nest surveys are best done early in the summer, since high winds can blow the nests around after the snow melts. They cannot be done very easily in dense willow habitats or in tussock tundra where the nests are often invisible under the tussocks. Count only fresh nests. Nests that are one year old are usually completely flattened and the grass has a grey colour rather than a tan colour. The procedure used is the line transect method, which is described briefly in Krebs (1999, page 158) and more extensively at http://www.ruwpa.st-and.ac.uk/distance/ (which has a book on-line to explain the details of the line transect method).

The line transect method operates as follows:

a). The observer walks a straight line searching visually for lemming nests. Upon sighting a nest, he or she records the perpendicular distance of the nest from the line of travel. The data set consists of these perpendicular distances and the total length of survey line the observer walks. The procedure can be illustrated schematically as follows: circles represent winter nests, and the line marks the survey line walked by the observer. Solid circles represent winter nests seen by the observer, and the lines mark the perpendicular distances measured to the center of the winter nest. Only one survey line is shown for clarity.



Two key aspects of line transect sampling are shown in the diagram. First, not all winter nests are seen along the travel path. Second, all winter nests exactly on the line of travel are seen. But in general, the farther the nest is from the line of travel, the less likely it is to be seen, so that detection falls off with distance. All nests that are seen are measured, no matter how far they are from the line of travel.

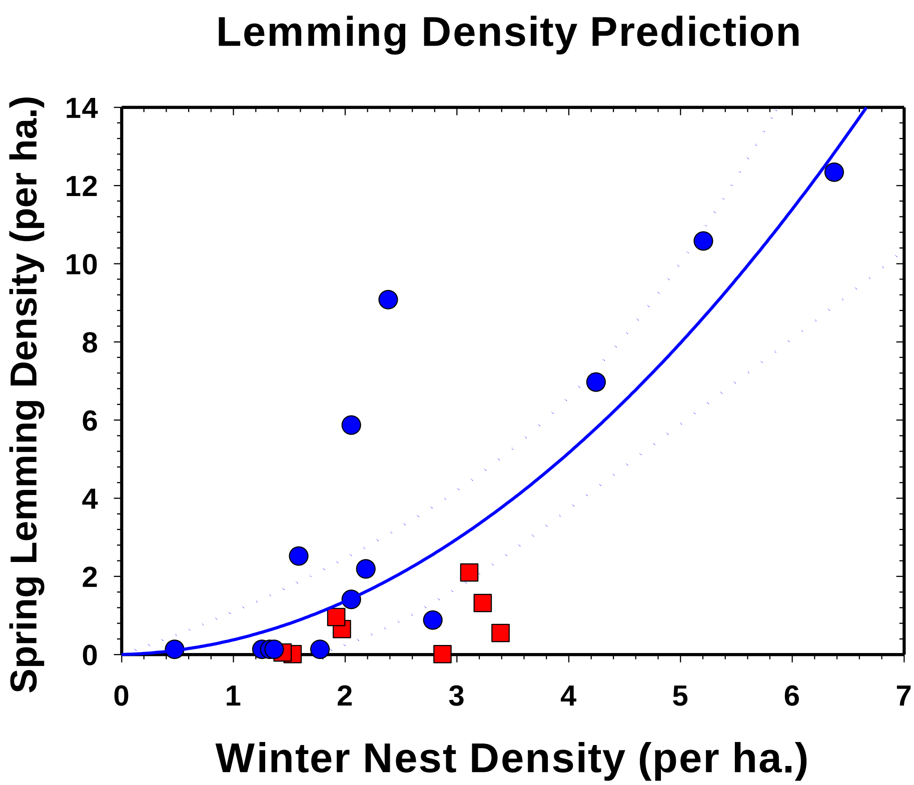
Line transect sampling should be done until at least 40 nests are seen and their perpendicular distances measured. 60-80 nests would be better, but clearly these sample sizes cannot be obtained in low-density years. In general I would recommend about one day of walking effort per site should be sufficient to generate an estimate of the number of winter nests per hectare. The larger the sample size the more precise the estimate will be.

The distance traveled can be determined from a GPS if this is available, or alternatively by estimation of the number of kilometers walked. On the tundra it is clearly impossible to walk a straight line, but this should not matter as long as one does not double back to cover the same ground.

These data can be analyzed with program DISTANCE, which is available from the web site given above. Alternatively we could arrange a central data analysis system to which the raw data could be submitted each year. Program DISTANCE will calculate the number of lemming nests per hectare, and the next problem is to convert these into absolute numbers. We do not have enough data to be very precise about this conversion yet. A preliminary regression that we have developed so far is shown in the next figure. The regression is:

Lemming spring density per ha = 0.0711 (WN) + 0.3046 ($WN^2$)

where WN is winter nest density per ha.




It is clear that more data are needed to test this regression and to make it more precise.

<u>Data required</u>: perpendicular distances to each nest
total distance of lines surveyed
number of lemming nests taken over by weasels

### (2). Runway Transects

Brown lemmings and voles tend to live in wetter habitats and build runways that are clearly seen as mini-superhighways through the grasses and sedges. One indirect way to estimate their abundance is to count runways intersected by a line of given length. The principle is similar to that of the line transect just described but simpler because the information recorded is the number of active runways crossed by a straight line crossing the habitat.

The key decision is whether or not a runway is active or inactive. Lemming runways can last several months after lemmings have declined so one must check to see if a runway is being used or not. This is done by looking down the runway for fresh fecal pellets (green) or fresh clippings of sedges or grassed, and if one can find this sign within 1 meter on either side of the transect line, the runway can be called active. Do not count inactive runways.

Transects can be done in exactly the same place year after year if permanent stakes are put out in wet habitats. Searching for runways is somewhat tedious since you must crawl along the transect searching carefully for covered runways. The method proceeds as follows:

1. Lay out a tape or rope in a straight line across an area of wet habitat. If possible use permanent stakes to locate these lines.
2. Moving along the line, record for each 15 m segment the number of active runways cut by the line. Some runways will snake back and forth across the transect line and they may be counted several times.
3. Count enough 15 m segments to obtain a total of 25 or more runway intercepts, if possible. When lemming or vole numbers are low, you may find no active runways in many areas.

I would estimate that it would take about 1 person-day to survey a wet site for runways.

It is possible to distinguish *Microtus* runways from brown lemming runways by their width and by the size of their fecal pellets in areas where these two species both occur.

<u>Data required</u>: number of active runways bisected in each 15 m segment of line searched.

### (3). Burrow Counts

Collared lemmings live in dry habitats typically and do not build runways that are obvious. They dig burrows, and can be censused indirectly by counting active burrows in a specified area of dry habitat.

Active burrows can be recognized by fresh digging and soil thrown out of the burrow or by the presence of fresh (green) feces partly down the entrance of the burrow. Old burrows may also have spider webs inside them.

To use this method proceed as follows:

1. Stake out an area of at least 1 ha (100 m by 100 m) and preferably about 2 ha with permanent stakes. The same area should be counted each year.
2. Walk parallel lines within this area at approximately 5-7 m intervals looking for all burrows.
3. Examine each burrow and classify as active or inactive. Count all burrows whether active or inactive.

If these burrow counts are done in relatively dry habitats, they will almost entirely be for collared lemmings, since brown lemmings rarely venture out of wet, sedge areas.

The time required for one person to search 1 ha thoroughly is approximately 3-4 hours.

Data required: number of active and number of inactive burrows
area of habitat searched.

## Conclusions

Lemming abundance changes from year to year can be monitored by a relatively simple set of methods that require virtually no equipment except a tape measure and if possible a GPS. We have concentrated most intensively on winter nest surveys, but depending on the area the other two methods could also be used. We do not at present have the data to convert runway counts or burrow counts into absolute lemming densities, but they would show very clearly the changes from year to year that are characteristic of the lemming cycle.

Since winter nest surveys provide an average estimate of overwinter abundance, and the runway transects and burrow counts provide immediate indices of summer presence, there is no reason to assume they will give exactly the same index in years in which lemming numbers are falling rapidly or rising rapidly. For this reason it is best if the same method, whatever is chosen, is used year after year to monitor changes in numbers. In a few sites it may be possible to calibrate these indices by live trapping, mark-and-release methods that estimate absolute abundance, but this will normally be a specialized research activity.

The picture of where strong lemming cycles occur in the Canadian arctic and whether or not they are in phase in local and regional areas within the arctic make it most useful to extend these surveys as much as possible in the north.

## References

Buckland, S. T., D. R. Anderson, K. P. Burnham, and J. L. Laake. 1993. *Distance Sampling. Estimating Abundance of Biological Populations*. Chapman & Hall, London. (available at http://www.ruwpa.st-and.ac.uk/distance/)

Krebs, C. J. 1999. *Ecological Methodology*. Addison Wesley Longman Inc., Menlo Park, California.