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The cone trap – a useful tool for index trapping of small mammals

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The properties of coniform pitfall traps (35 cm deep, 11.5 cm Ø; smaller than the types previously used) in trapping small mammals were studied in field experiments in southern Finland. The traps are sheet-iron cones standing on their peaks in the ground and partly filled with water to kill the animals caught. They are fitted with an inner cone of aluminium for easy removal of the catch, including invertebrates.

The maximum small mammal catch was 6 ind./night/cone. Cone traps are more effective than live or snap traps for catching small mammals, particularly shrews.

Trapping with cone traps has several advantages when permanent trap points are used and the traps are uncovered only during trapping periods. For monitoring changes in the relative population densities of small mammals the "small quadrat method" (SQM) is recommended, supplemented by one cone trap per trap station.

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1. Introduction

For capturing small mammals pitfall traps of various kinds are used: cylindrical cans or jars made of metal, plastic, ceramic or glass (e.g. Snigirevskaja 1939, Novikov 1953, Howard & Brock 1961, Andrzejewski & Wroclavek 1963, Skarén & Kaikusalo 1966, Boonstra & Krebs 1978) or coniform pitfall traps (Pucek 1964, 1969, Aulak 1967, Pelikan et al. 1977). This latter type — the cone trap — has many advantages over the cylindrical pitfalls. Here I report the construction and properties of the cone traps I have used in a 4-year study on small mammals in southern Finland (Pankakoski 1978).

Index trapping of small mammals on trap lines (e.g. Hansson 1967, Spitz et al. 1974) or on "small quadrats" (Myllymäki et al. 1971) is useful when estimates of absolute density are not needed. The small quadrat method (SQM; Myllymäki et al. 1971: each quadrat consisting of a 15 × 15 m square with 3 snap traps in each corner) is one of the index trapping methods most often employed in Fennoscandia. The SQM is well suited for trapping rodents for forecasting purposes (Myllymäki et al. 1977) but does not correctly reflect the actual species composition of the small mammal community in the study area. At least the shrews (Soricidae) seem to be underestimated in the SQM (see also Hansson 1975). Cone traps may offer a valuable alternative or supplement for snap traps in index trappings.

2. Construction and properties of the cone trap

The cone traps I have used differ from the original type (45—50 cm deep, 13—15 cm Ø; Pucek 1964, 1969, Aulak 1967) in being smaller: 35 cm deep, 11.5 cm Ø (Fig. 1). They are made of 0.5 mm galvanized sheet iron. The seam is soldered watertight with tin. The trap is strengthened by bending outwards a horizontal flange about 5 mm wide at the upper edge of the cone. The cone traps are treated with special matt black paint, which reduces reflections and prevents rusting.

The cone is partly (15—20 cm from the bottom) filled with water, so that the animals falling into the trap are drowned (Fig. 1; cf. also Prince 1941, Aulak 1967). Addition of a detergent to the water ensures that the mammals are thoroughly wetted immediately. The catch is best removed from the cone with long pincers.

Between trappings the cone traps can be left *in situ*,

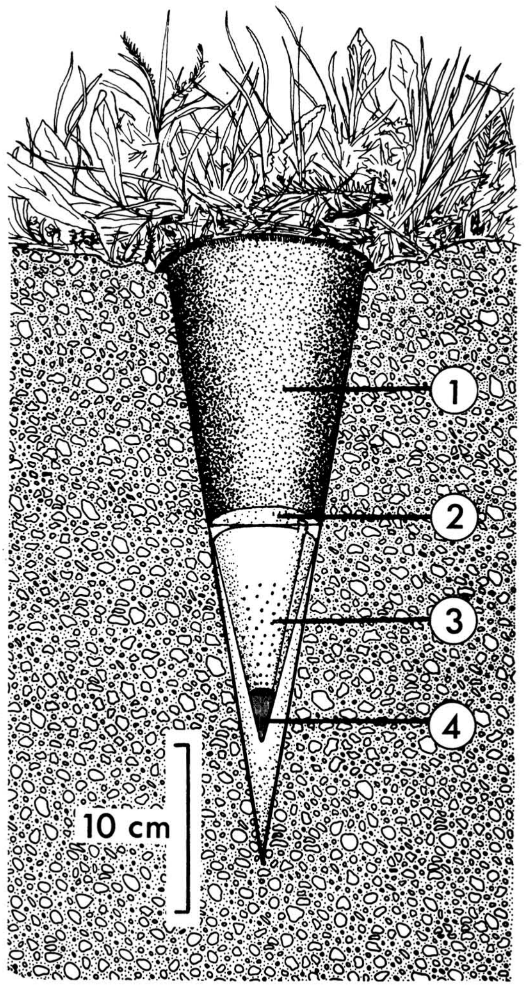

Fig. 1. Longitudinal section of a cone trap sunk in the ground. Small mammals fall into the trap (1), which is partly filled with water (water surface = 2), and drown. The catch, which also includes invertebrates (and occasionally amphibians and lizards, see also Bulavinčev 1978), is easily removed with the aid of a perforated aluminium inner cone (3). A lead weight (4) holds the inner cone in place.

covered with a square of sheet iron (15 × 15 cm), the corners of which are bent down. This lid can be weighted with a fist-sized stone.

The cone trap is difficult to make, and its production is handwork, which raises the costs. But cone traps are durable and almost unbreakable, and their simplicity increases their functional life. After 4 years, during which most of the traps have remained continuously in the ground, they show no noticeable rusting. The coat of paint has now and then to be renewed.

Cone traps are easier to sink into the ground than cylindrical pitfalls, particularly in stony soil and in woodlands. A suitable hole can be made with a crowbar. However, it is clearly more laborious to set up a new line or grid with cone traps than with snap traps or with box-shaped live traps. One man can install a trap line of 30 cones in about 1 h. Therefore trapping with cone traps is most economical when permanent trap points are used and the traps are kept uncovered only during the trapping periods. The traps can be stacked one inside the other, which makes them easy to transport.

Cone traps can be left in the ground even during the winter. The water in the cones can distend upwards when freezing, and the traps are not damaged. Thus the traps are ready for trapping immediately after the snowmelt, when it would be difficult to make new holes in the frozen ground. But actual trapping is not successful in winter, because the traps rapidly fill with snow. In late autumn or in spring freezing of the water in the cones can be prevented by adding alcohol.

Snap traps tend to damage the skulls or skeletons of small mammals. The dead animals in these traps are also frequently attacked by insects or predators. Cone traps — and water traps in general (see Prince 1941) — do not suffer from these drawbacks. The cold water in the cone traps tends to prevent decomposition of the catch. The water also prevents the shrews from cannibalizing each other in the trap (Moore 1949), as is commonly the case in multi-catch live traps. On the other hand, small mammals trapped in cone traps are thoroughly wet, which makes species identification in the field difficult for a beginner. When wrapped in absorbent paper and placed in plastic bags, however, the animals dry rapidly.

Cone traps as a means of collecting terrestrial invertebrates

When cone traps are used for trapping small mammals, considerable numbers of terrestrial invertebrates (mainly Coleoptera, Arachnida and Annelida) can also be collected with little extra effort (see e.g. Balogh 1958). For this purpose, I have taken to using special inner cones made of perforated sheet aluminium (0.15 mm thick; Fig 1). A small lead weight helps to anchor this inner cone in the cone trap. The inner cone is removed from the cone trap with long pincers. The inner cones are also useful for removing litter from the traps.

3. Types of experiments conducted

In the study area on Jalassaari (60° 13′ N, 23° 54′ E), an island (3.7 km²) in the lake Lohjanjärvi, southern Finland, cone traps have been used in seven trapping areas in trap lines or in small quadrats. In trap lines (15—50 stations, usually one trap/station) the distance between the stations has been about 20 m. Trapping was performed at intervals of about 1 month during the snowfree season (April — November) in 1975—1978. The habitats were old fields reforested with young trees, wet meadows, and forests of different kinds, all rather luxuriant for Finnish conditions.

The relative efficiency of three different trap types (live traps, cone traps and snap traps) was tested with three parallel trap lines 30 m apart, each line containing only one type of trap, or on a single trap line with one trap of each type at every trap station. The latter method was also used in comparing cone traps of different sizes. The snap traps were metal traps of commercial type, mounted on aluminium bases and baited with dried apple and cheese. The live traps were multiple-catch "Ugglan special" traps (Hansson 1967), baited with oats or barley.

The effects of bait and of the inner cone on the numbers of small mammals trapped were investigated with a circular trap line of 50 one-trap stations. The accessories investigated were placed in alternate cone traps, and after trapping for 1—2 days they were transferred to the other cones for a further 1—2 days.

The snap trappings performed with SQM in the same study area in 1968—1971 (Myllymäki et al. 1971, Myllymäki & Pankakoski unpubl.) afford the best available data for comparison with the cone trapping results of this study. The cycle phases of the voles and at least the common shrew (*Sorex araneus*) were comparable during the two series of trappings and the traps were placed mainly in the same trapping areas on Jalassaari. For these reasons the comparisons can be considered fairly reliable.

4. Results

Changes in the relative population densities of four species as revealed by cone trapping are presented in Fig. 2 as an example of a small mammal survey. The annual catch indices (individuals / 100 trap-nights) in cone trappings of all species combined have ranged from 13.0 to 30.8, which can be regarded as high (Fig. 2). The highest catch index for any one night was 132 (41 small mammals trapped in 31 cone traps). For the material as a whole the average catch for the cones containing small mammals was 1.39 ind./night. The frequency distribution of catch size in the pooled results is as follows:

animals / trap	number of traps	% frequency
1	615	72.6
2	164	19.4
3	44	5.2
4	16	1.9
5	6	0.7
6	2	0.2

In the experiments in which the different trap types (live, cone and snap traps) were compared, the numbers caught were largest in cones and smallest in snap traps (Fig. 3). The order was the same for insectivores or rodents alone. Both live traps and cone traps are multi-catch traps, unlike snap traps, which are thus not fully comparable in regard to trapping results.

In some stony areas it is difficult to sink even 35-cm-deep cone traps into the ground. However, a smaller type of cone trap (25 cm deep, 11.5 cm Ø, as in the bigger one) proved unsatisfactory (Table 1 A). No bait is used in the

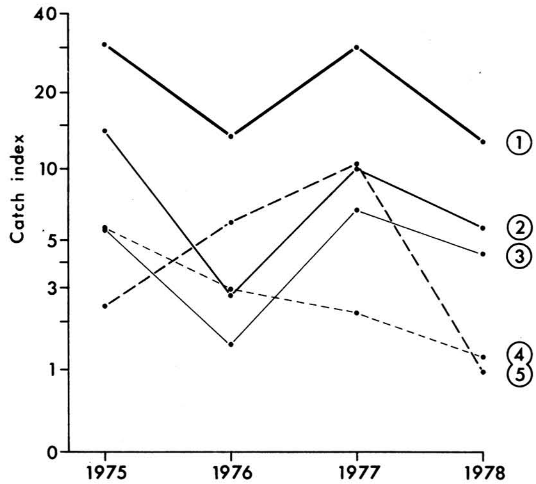

Fig. 2. The relative numbers of the four most abundant small mammal species obtained by cone trapping during 4 years on Jalassaari. Vertical axis (ind./100 trap-nights) on a log (x + 1) scale. 1 = all species, 2 = *Sorex araneus*, 3 = *Clethrionomys glareolus*, 4 = *S. minutus*, 5 = *Microtus agrestis*.

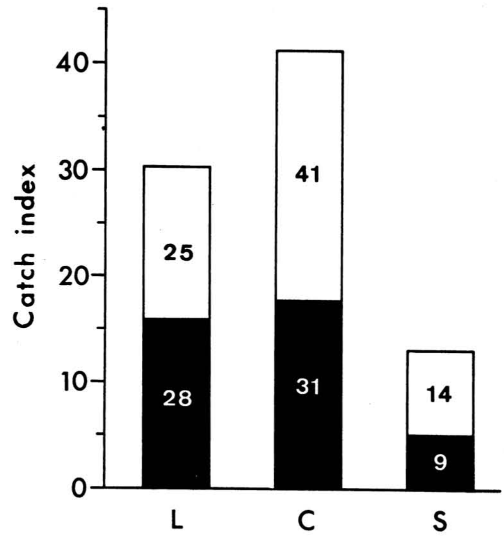

Fig. 3. The efficiency of three different types of trap used for catching small mammals. Black parts = insectivores, white parts = rodents; L = live traps, C = cone traps, S = snap traps; catch index = ind./ 100 trap-nights. The figures in the columns indicate the number of animals in each category. Jalassaari, June — Aug. 1977, 525 trap-nights. Difference between trap types: $\chi^2 = 24.74$, $P < 0.001$.

cone traps. Whether the use of bait would improve the trappability of small mammals was tested with meat or dried apple + cheese as bait. The bait was attached to a support of bent iron wire and placed above the cone at soil level. Neither type of bait increased the catch numbers (pooled results in Table 1 B). Nor did the presence of the aluminium inner cone affect the trapping results (Table 1 C).

Table 1. The influence of the depth of the cone trap and of some accessories on the numbers of small mammals caught. Experiment A performed on Jalassaari in 1976–77, experiment B in 1977 and experiment C in 1978.

	Insectivores	Rodents	Total	Trap-nights
A. Depth of cone				
35 cm	12	12	24	218
25 cm	2	0	2	218
Total	14	12	26	436
P = (Binomial test)	0.013	<0.001	<0.001	
B. Influence of bait				
with bait	17	36	53	250
without bait	20	29	49	250
Total	37	65	102	500
χ^2	0.24	0.75	0.16	
	n s	n s	n s	
C. Influence of inner cone				
with inner cone	44	39	83	597
without inner cone	39	52	91	599
Total	83	91	174	1196
χ^2	0.32	1.81	0.34	
	n s	n s	n s	

In snap trappings on small quadrats performed in the same study area in 1968—1971 the catch deviated in species composition from that trapped with cone traps (Table 2). The difference was greatest for insectivores, for which cone traps are much more effective than snap traps. The catch indices for the smallest mammalian species — *Sorex minutus* and *Micromys minutus* — were much greater in cone trappings than in snap trappings in the same area. These small species trigger snap traps only accidentally. In contrast, the catches of *Microtus agrestis* and *Apodemus flavicollis*, especially the latter, were greater in snap trappings, and *Arvicola terrestris* was not trapped in the cone traps at all (Table 2).

Most of the few *Apodemus* caught in cone traps were young animals. Also, the catch of *Microtus* consists of smaller (=younger) individuals than those in the snap trap material (Pankakoski & Myllymäki, unpubl.), at least in the autumn (Table 3). The difference in the mean weight of the animals caught is not so great in *Clethrionomys*, and in *S. araneus* there is no difference between the trapping methods in this respect.

The rate of removal of small mammals during the trapping period is reflected in the catch curves (Fig. 4). There is no statistical difference between the curves for cone traps and snap traps (the latter from Myllymäki et al. 1971: Tables 4—6, results from the same area in 1969). The decline in the catch numbers seems steeper with cones than with snap traps in *Microtus* and *S.*

Table 2. Comparison between cone trap and snap trap catch indices (ind./100 trap-nights). Trappings were performed on Jalassaari: the cone trappings in 1975–78, the snap trappings in 1968–71.

Species	Cone traps (C)		Snap traps (S)		Ratio of indices
	catch index	n	catch index	n	C/S
Sorex araneus (L.)	7.68	445	1.36	243	5.6
S. minutus (L.)	2.52	146	0.07	12	37.4
Neomys fodiens (Penn.)	0.22	13	0.06	11	3.6
Talpa europaea (L.)	0.24	14	—	—	—
Clethrionomys glareolus (Schreb.)	4.68	271	3.36	598	1.4
Arvicola terrestris (L.)	—	—	0.56	100	—
Microtus agrestis (L.)	4.52	262	7.33	1305	0.6
Micromys minutus (Pall.)	0.40	23	0.01	1	70.7
Apodemus flavicollis (Melch.)	0.12	7	0.63	112	0.2
Rattus norvegicus (Berk.)	—	—	0.02	3	—
Mus musculus (L.)	—	—	0.06	10	—
Mustela rixosa (Bangs)	—	—	0.02	4	—
Total	20.38	1181	13.47	2399	1.5
Trap-nights	5796		17808		

Table 3. Comparison of the weights (g; mean, standard error and n) of three small mammal species caught in snap and cone trappings. Jalassaari: snap trap catches from June — Oct. 1969, cone trap catches from June — Oct. 1977 at comparable stages of population cycles.

		Snap trappings	Cone trappings	Difference	t	P
Microtus agrestis	June — July:	34.7 ±0.67 (427)	32.7 ±2.04 (55)	2.0	1.02	n s
	Aug. — Oct.:	27.9 ±0.50 (335)	22.1 ±0.59 (48)	5.8	4.32	<0.001
Clethrionomys glareolus	July:	18.9 ±0.59 (100)	19.1 ±1.75 (10)	−0.2	0.13	n s
	Aug. — Oct.:	17.4 ±0.22 (282)	16.0 ±0.30 (46)	1.4	2.49	<0.05
Sorex araneus	June — July:	8.8 ±0.29 (67)	8.7 ±0.20 (78)	0.1	0.42	n s
	Aug. — Oct.:	7.6 ±0.16 (50)	7.6 ±0.17 (45)	0.0	0.13	n s

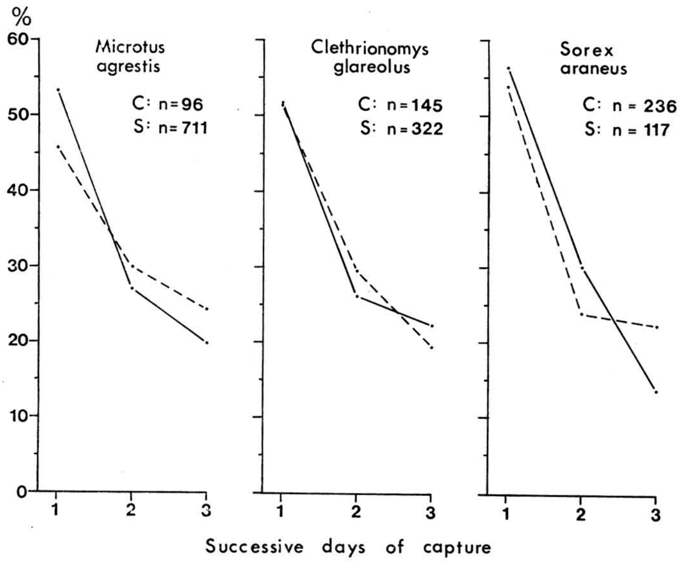

Fig. 4. The comparison of catch curves for cone and snap trappings of three small mammal species. Jalassaari: snap trap material (S, broken lines) June — Oct. 1969 (from Myllymäki *et al.* 1971), cone trap material (C, solid lines) pooled from 17 trapping periods in 1975—1978.

araneus. Comparing different species, the catch curves for cones are steeper in *S. araneus* than in the voles; the difference is not statistically significant, however (the two vole species combined versus *S. araneus* : $\chi^2 = 4.85$, P = 0.088).

5. Discussion

Pitfall traps are generally considered to be the best type of trap for insectivores and at least as effective as live or snap traps for most species of rodents (Moore 1949, Sealander & James 1958, Aulak 1967, Pucek 1969, Pelikan et al. 1977 etc.). In several studies reliable estimates of the density of shrew populations have only been made possible by the use of pitfall traps (Brown 1967, Pucek 1969). It is sometimes almost impossible to catch the smallest species of shrews at all in box-shaped live traps or snap traps, although pitfall traps show them to be present, and even numerous (Brown 1967, Kaikusalo 1967). This seemed to be the case with *S. minutus* in the present study, as well as with the smallest mouse species (*Micromys*). In contrast, the abundance of *Apodemus* species is easily underestimated in pitfall trappings, because these mice are able to jump out of the traps (Adamczewska 1959, Chelkowska 1967, Pelikan *et al.* 1977).

If the weight of the small mammal is taken as a rough criterion of its age, then the voles trapped in cones seem to be younger than those trapped in snap traps in the autumn in the present study. According to several authors (e.g. Chelkowska 1967, Pelikan et al. 1977, Boonstra & Krebs 1978), pitfall traps tend to catch a younger and often more transient portion of the rodent population than other types of trap. This phenomenon has not been observed in trapping shrews (Pelikan et al. 1977).

The removal rate of insectivores is in general more rapid with pitfall traps than with snap traps (Pucek 1969, Pelikan et al. 1977) as seems also to be the case in this study. However, the present rather heterogeneous material does not confirm the observation of Pucek (1969) that the removal rate is more rapid in rodents than in insectivores.

According to Pucek (1969), during the period of late autumn to spring pitfall traps are not as effective in trapping small mammals as other types of trap. The reason for this might be that the animals prefer traps with bait in winter (Pucek 1969). In Finland it is not possible to test this explanation by using baits in the cone traps because of the snowy winters (see above). At least during the period of abundant food, however, bait in the cone traps has no effect on the trappability of small mammals.

In my opinion the cone trapping method, in which samples are taken at regular intervals from permanent trap lines or quadrats, is suitable for monitoring changes in the relative population densities of small mammals. The method serves best in studies on shrews, but is suitable for most rodents as well. Regarding voles the cone trapping method seems to be more suitable for trapping *C. glareolus* than *M. agrestis*.

When the study is mainly concerned with the fluctuation in the numbers of a rodent species (e.g. Myllymäki et al. 1977), index values obtained by means of snap trapping, for example with the SQM (Myllymäki et al. 1971) or BIG (Hörnfeldt 1975), may give sufficiently reliable results. But when specific studies are focused on insectivores, or on the complete spectrum of the potential prey of predators (see Järvinen 1977), etc., cone trapping is a superior tool for improving the accuracy of the data. A combination of SQM and cone traps may be suggested for use in the form of 1 cone + 3 snap traps at each corner of the small quadrat.

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