Evaluation of Pit-trap Transects With Varied Trap Spacing in a Northern Michigan Forest

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EVALUATION OF PIT-TRAP TRANSECTS WITH VARIED TRAP SPACING IN A NORTHERN MICHIGAN FOREST[1]

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ABSTRACT

The study compared effects of four distances between traps (range 0.5–4.0 m) on arthropod captures. Twelve traps were aligned in each of four transects, and 20 samples/trap were obtained during summer and fall in a northern Michigan deciduous forest. Catches proved to be unaffected by trap spacing. Rather, they reflected local within-site differences in abundance of dominant species.

In August 1982, we began preparing for a long-term investigation of forest-floor arthropods in Michigan's Upper Peninsula. Knowing that pit-trapping would be one of our research tools, we used the first half-season for a preliminary trapping experiment in hardwood forest. We intended to obtain taxonomic information on arthropods of the area, which is faunistically poorly described, as well as to quantify potential effects of different distances between traps on catch sizes.

SITE AND CLIMATE

The site was located in an extensive deciduous forest in Dickinson County (T44N, R29W, S19), in the south-central portion of Michigan's Upper Peninsula. It was dominated by *Populus grandidentata* Michx. (55%), with *Acer saccharum* Marsh subdominant (34%). *Amelanchier canadensis* (L.) Medic. dominated the understory. Saplings and seedlings of *Picea mariana* (Mill.) and *Abies balsamea* (L.) Mill. were rare. Herbaceous vegetation was dense and even, with *Pteridium aquilinum* (L.) Kuhn, *Lycopodium obscurum* L. and *Aster macrophyllus* L. its most conspicuous components in mid- and late summer. Typical of this once-glaciated region, the site consisted of an elongate ridge flanked by shallow depressions.

The area has a temperate continental climate of the cool-summer type (30-year average temperatures for July: 26°C maximum, 3–4°C minimum). Annual normal precipitation is 76 cm, evenly distributed, with snowfall occurring from September to May.

MATERIALS AND METHODS

Four transects were laid out, each containing 12 traps, and each facing no more than one neighboring transect at a distance of $\geq$ 10 m (Fig. 1). Distances between traps in transects 1–4 were 4, 2, 1 and 0.5 m respectively.

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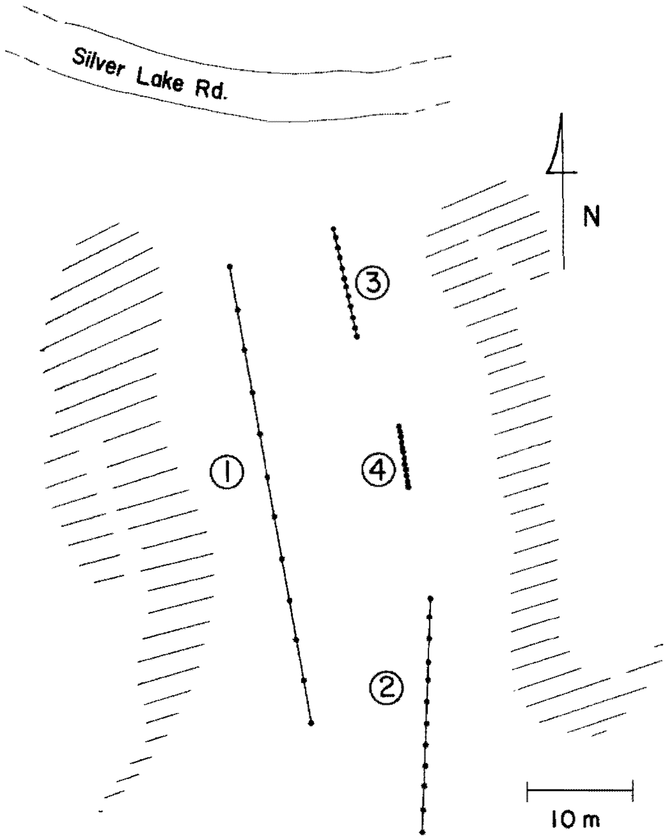

Fig. 1. Disposition of trapping transects in the Silver Lake site.

Ethylene glycol was used as the collecting medium, in uncovered clear plastic cups (8.5-cm dia.) installed one week prior to the first trapping date to avoid a digging-in effect (Joosse and Kapteyn 1968). Traps were approached along the same pathway at all times and were handled from a distance of ≥ 0.5 m.

At intervals of approximately three weeks, traps were activated and emptied on five consecutive days: 3–7 and 26–30 August, 13–17 September and 4–8 October. Twenty samples were thus obtained from each trap.

RESULTS

Winged Diptera, Hymenoptera, and Lepidoptera were excluded from totals discussed below. Hypopi (phoretic deutonymphs of mites, mainly Acaridae) tended to outnumber all other mites combined, especially in traps with larger arthropods. They were also excluded because they did not actively enter traps.

The first sampling period yielded the largest catches, probably due to seasonally high active densities (Table 1). If trap distance had affected capture rates, ranking of transects should have been possible (i.e., 1 through 4 based on increasing or decreasing numbers

Table 1. Mean ± SE arthropods caught per trap, using total five-day catch per trap (n = 12 traps per transect). Winged Diptera, Hymenoptera, and Lepidoptera, and hypopal mites, excluded.

	TRANSECT			
	1	2	3	4
(Trap spacing)	(4.0 m)	(2.0 m)	(1.0 m)	(0.5 m)
3–8 August	89.0 ± 13.3	64.1 ± 5.3	80.6 ± 5.3	69.1 ± 6.0
26–30 August	35.1 ± 3.4	23.6 ± 2.8	35.5 ± 5.5	22.7 ± 2.3
13–17 September	36.2 ± 4.3	32.7 ± 3.3	36.2 ± 3.1	32.0 ± 3.8
4–8 October	30.8 ± 3.8	28.2 ± 2.4	32.4 ± 1.9	27.6 ± 2.0

caught). However, mean catches were essentially equal in 1 and 3 and in 2 and 4, and seasonal changes in numbers, minor after the first period (Table 1), were parallel in all transects.

Among the six most frequently captured orders, Collembola, Acarina, and Coleoptera were prevalent (Fig. 2). Mites and Collembola, both more abundant in transects 1 and 3, were responsible for the larger catches in those transects (Table 1). Diplopoda (Fig. 2) consisted mainly of *Uroblaniulus canadensis* (Newport), with distinctly stage-specific activity (86% adult and subadult). Spiders (Fig. 2) were predominantly unidentifiable immatures. Of 16 families total, four contributed almost equally to total catches: Lycosidae (21%), Micryphantidae (22%), Linyphiidae (21%), and Agelenidae (20%). Activity of adults was distinctly seasonal in some species. *Bathyphantes pallida* (Banks) and *Centromerus persoluta* (O.-P.-Cambridge) disappeared entirely after 30 August. *Centromerus sylvaticus* (Blackwell) and *Wadotes calcaratus* (Keyserling) were trapped exclusively in October. On the other hand, the common lycosids *Pirata marxi* Stone and *P. maculatus* Emerton were active throughout the study period.

If distance between traps had taxon-specific effects, then only Opiliones seemed to be affected and were captured more efficiently by traps spaced 4 m apart (Fig. 2). Catches of other taxa were transect-related in a non-linear way. Collembola totals, for instance, maintained a constant proportionality between the four transects, i.e., $3 > 1 > 4 > 2$, through all periods (Fig. 2). This suggested that catches were proportional to different arthropod densities in different parts of the site.

In order to assess distributional (transect location) factors, three groups were further analyzed at the species level: Collembola (high species diversity, apparently transect-dependent numbers), Carabidae (few species, no apparent transect-catch relations), and Opiliones (least diverse, catches potentially affected by trap spacing).

COLLEMBOLA

Hypogastruridae

Odontella substriata Wray***
Xenylla acauda Gisin***
Neanura muscorum (Templeton)*
Pseudachorutes spp. complex

Isotomidae

Isotoma (*Desoria*) *nigrifrons* Folsom**
I. (*Isotoma*) *viridis* Bourlet*

Entomobryidae

Tomocerus (*Pogonognathellus*) *flavescens* Tullberg*
T. (*Tomocerina*) *lamelliferus* Mills**
Orchesella hexfasciata Harvey*

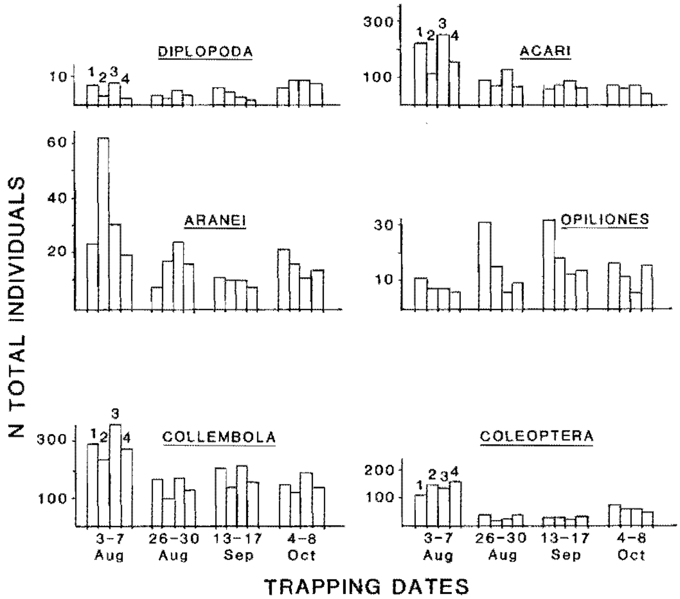

Fig. 2. Total catches per transect and period (summed over five days) of the most frequently trapped orders.

Table 2. Total number of each family of Collembola trapped over the study period, and percent dominance of the prevalent species within each family (N_i / NT × 100).

	TRANSECT							
	1		2		3		4	
	n	%	n	%	n	%	n	%
Sminthuridae	500		391		415		356	
S. henshawi		63.4		71.3		77.3		67.7
S. lepus		24.6		16.4		9.4		11.5
Entomobryidae	268		167		369		288	
T. flavescens		67.1		66.4		66.9		71.9
O. hexfasciata		16.4		13.2		17.6		14.2
Isotomidae	50		36		84		67	
I. nigrifrons		50.0		55.6		57.1		76.1
I. viridis		50.0		44.4		42.9		23.9
Hypogastruridae	37		15		70		11	
Total species	17		17		20		21	

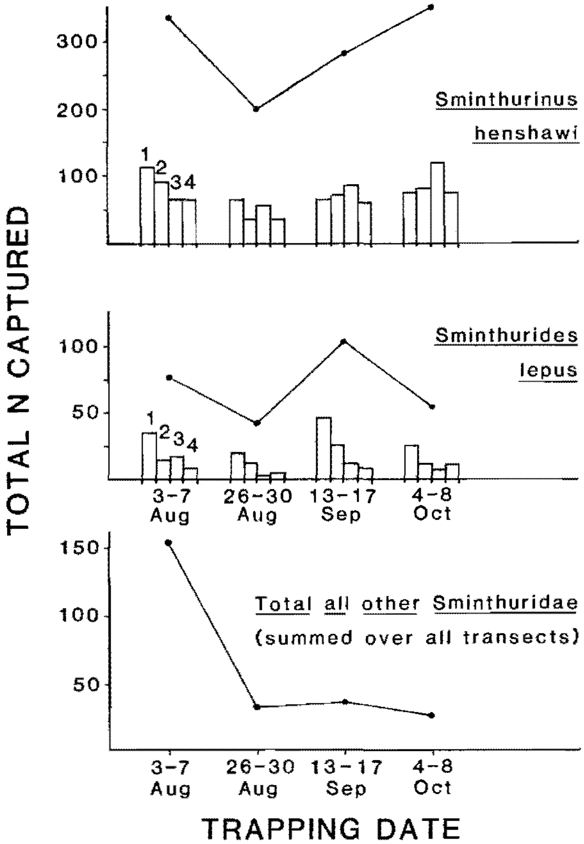

Fig. 3. Total number of selected sminthurids captured per transect and period (bars), and overall totals per trapping period (solid line, sum of all transects).

Lepidocyrtus helenae Snider**
L. hirtus Christiansen and Bellinger***
L. lignorum (Fabricius)*
L. paradoxus Uzel**
L. violaceous Fourcroy*
Entomobrya (*Entomobryoides*) *purpurascens* (Packard)*
E. assuta Folsom**
E. clitellaria Guthrie*

Sminthuridae

Arrhopalites amarus Christiansen***
A. benitus (Folsom)*
Sminthurides lepus Mills*
Sminthurinus henshawi (Folsom)*
S. conchyliatus Snider***
S. intermedius Snider***
S. quadrimaculatus (Ryder)*
Bourletiella (*Bourletiella*) *hortensis* (Fitch)*

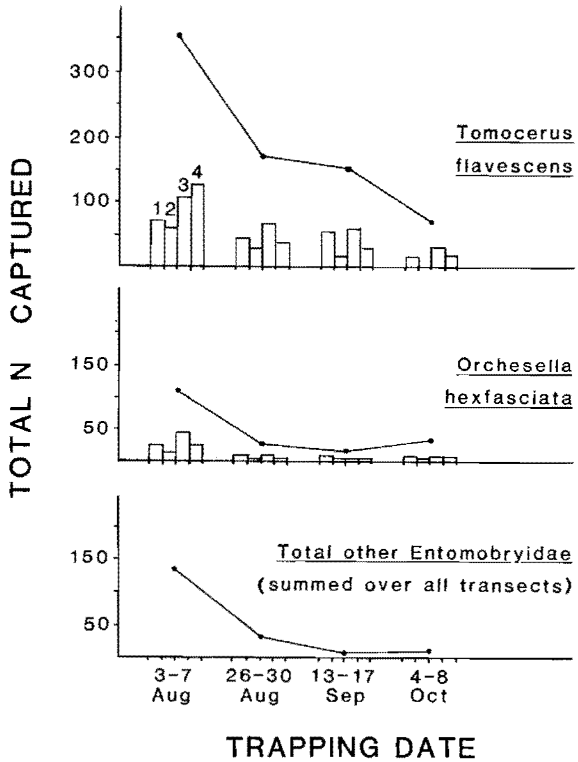

Fig. 4. Catches of selected entomobryids per transect and period (bars) and overall totals per period (solid line, sum of all transects).

Table 3. Total carabids caught over the study period, and percent occurrence, within each transect, of the four most common species.

	TRANSECT							
	1		2		3		4	
	n	%	n	%	n	%	n	%
Carabidae	167		164		150		165	
P. melanarius		25.1		40.2		22.0		42.4
P. pensylvanicus		30.5		26.8		34.0		16.4
S. impunctatus		22.2		15.9		20.7		17.6
P. coracinus		10.8		8.5		9.3		11.5
Totals (%)		88.6		91.4		86.0		87.9
Total species	9		9		11		9	

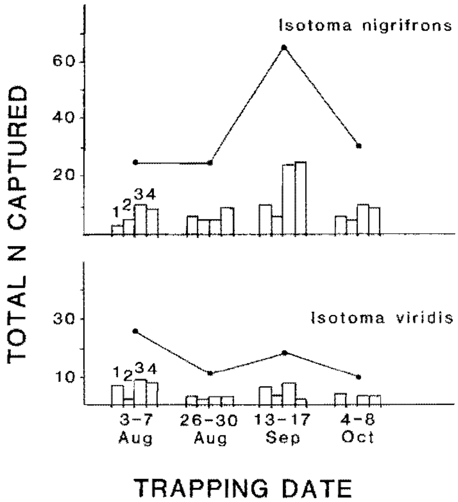

Fig. 5. Catches of isotomids per transect and period (bars) and totals per period (solid line, sum of all transects).

Sminthurus butcheri Snider**
Dicyrtoma (Ptenothrix) marmorata (Packard)*

* New record for Dickinson County
** New record for the Upper Peninsula
*** New record for Michigan

Most individuals belonged to the families Sminthuridae and Entomobryidae, each dominated by one species (*S. henshawi* and *T. flavescens* respectively) (Table 2). In all transects, the same two species furnished approximately 80% of each family total, the remainder occurring in very low numbers or singly.

Transect 4 yielded the highest number of species (Table 2), but unidentifiable immatures make diversity comparisons inconclusive. All transects had a number of *Entomobrya* and *Lepidocyrtus* spp. unique to them. Again, immatures of both genera also were captured in all transects. The six species listed in Table 2 together furnished 80% of the grand totals captured in each transect.

Overall, sminthurid active density increased as the season progressed. *S. henshawi* determined this trend, counteracting that of all other species (Fig. 3). Entomobryid activity decreased (Fig. 4). *Isotoma nigrifons* was particularly active in September (Fig. 5), coincident with its marked vertical migration from litter into the soil.

The proportionality discussed earlier (numbers in transect 3 > 1 > 4 > 2) was repeated only by *T. flavescens*, and only on three of four dates (Fig. 4). Whether a transect (location) effect existed was assessed by testing effects of season (four trapping periods) and effects of transects for their independence (χ^2 approximation). Lack of independence was significant for catches of *S. henshawi* ($P < 0.001$) and *T. flavescens* ($P < 0.005$), and for total catches of Sminthuridae ($P < 0.025$) and Entomobryidae ($P < 0.005$).

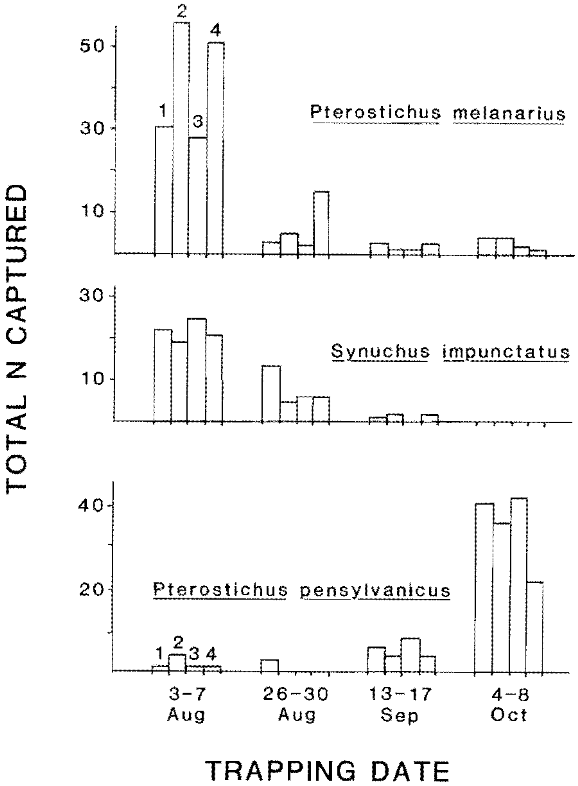

Fig. 6. Transect-specific catches of three common species of carabids in each trapping period.

Table 4. Number of individuals and species of opilionids caught in each transect over the study period, and percent occurrence of the four most common species.

	TRANSECT							
	1		2		3		4	
	n	%	n	%	n	%	n	%
Opiliones	82		43		30		40	
C. boopis		17.1		11.6		20.0		12.5
O. pictus		6.1		7.0		16.7		12.5
L. nigripes		68.3		62.8		40.0		30.0
S. crassipalpi		6.1		14.0		23.3		25.0
Totals (%)		97.6		95.4		100.0		80.0
Total species	6		5		4		7	

COLEOPTERA
Carabidae

Pterostichus melanarius Illiger
P. pensylvanicus LeConte
P. coracinus Newman*
P. novus Straneo
P. adoxus Say
P. adstrictus Eschscholtz*
Synuchus impunctatus Say*
Calathus ingratus Dejean*
C. gregarius Say
Cymindis cribricollis Dejean*
Carabus sylvosus Say
Notiophilus aeneus Herbst*

* New record for Dickinson County

Carabidae constituted 62–87% of all Coleoptera captured per period. Total numbers per transect, summed over all dates, were clearly equal, four species together furnishing approximately 90% of the site's carabid fauna in summer and fall (Table 3). High numbers of *P. melanarius* and *S. impunctatus* in early August (Fig. 6) reflected the end of their summer activity period (Barlow 1970, Lindroth 1979). The October activity peak of *P. pensylvanicus* (Fig 6) represented the second of the season, mainly due to appearance of teneral adults (Barlow 1970, Nesmith 1985).

Traps in the eastern part of the site (transects 2 and 4) caught relatively more *P. melanarius* and fewer *P. pensylvanicus* than 1 and 3 (Table 3). Tests of independence (season and transect effects), however, gave results which were not significant for three of the common species, and only marginally so for *P. melanarius* ($P < 0.1$).

OPILIONES
Phalangiidae

Caddo boopis Crosby**
Odiellus pictus (Wood)*
Leiobunum nigripes Weed**
L. politum Weed
L. longipes Weed**

Ischyropsalidae

Sabacon crassipalpi (L. Koch)**

Nemastomatidae

Crosbycus dasycnemus (Crosby)**

* New record for Dickinson County
** New record for the Upper Peninsula

Transect 3 traps caught the lowest number of individuals and species (Table 4). Transect 4 yielded the most diverse catch, consisting of all seven species, while transects 1 and 2 were clearly dominated by one, *L. nigripes* (Table 4).

Both *C. boopis* and *O. pictus* showed declining activity in the fall, while *S. crassipalpi* became increasingly active in September and October, and *L. nigripes* activity peaked in mid-September (Fig. 7). High active density of *L. nigripes* was probably associated with

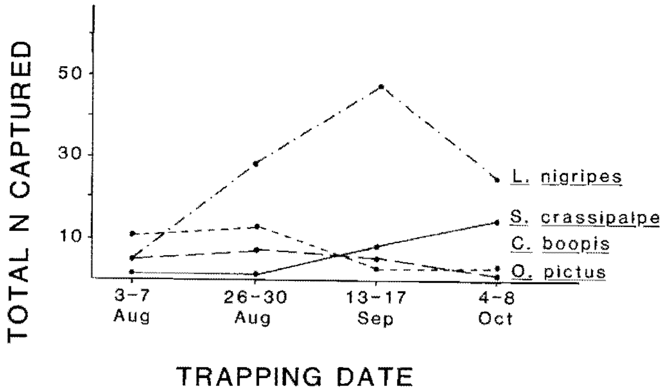

Fig. 7. Total catches (summed over transects) of four species of Opiliones during each trapping period.

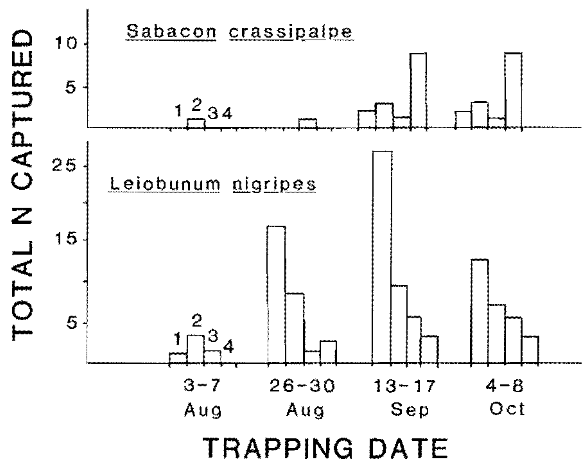

Fig. 8. Transect-specific catches of *S. crassipalpi* and *L. nigripes* during each trapping period.

maturation to adulthood. Frequency of immatures, in percent of total catch, progressively declined from 60% in early August to 48% in late August, 8% in September, and 4% in October.

Catches were transect (location) specific. Transect 4 traps captured more *S. crassipalpi* than any other traps, and transect 1 yielded most individuals of *L. nigripes* (Fig. 8). Since the latter was numerically dominant (55% of all specimens), transect 1 seemed superior to all others for catching opilionids as a group (Fig. 2). Lack of independence (season and transect effects) could be shown only marginally for *S. crassipalpi* as well as *L. nigripes* ($P < 0.1$), probably due to frequent low catches.

DISCUSSION

In other studies, disposition of traps relative to each other varies from random (e.g., Benest and Cancela da Fonseca 1980) to a number of different patterns such as concentric circles (Carter 1980) or grids (Dennison and Hodkinson 1984). In non-random designs, distance between traps is generally held constant within any one habitat. In the present study, transect distribution over the site essentially resulted in one line of 12 traps versus three lines of 36 traps total (Fig. 1). Removal of arthropods was thus three times more pronounced along the eastern side of the site. Conceivably, depletion of populations could have been further compounded by closely spaced traps, at least for smaller, less mobile species. No such effect materialized, possibly because all transects were equally open to immigration on one side, and the study period was relatively short.

The data showed, however, a transect (location) effect. Assuming that activity patterns of the species inhabiting the site did not differ over a distance of 30 or 40 m, then catches reflected transect-specific density variations of several populations. Indeed, had a trap-distance effect existed, these variations over different parts of the site would not have become apparent.

Unexpectedly, the results thus indicated that trapping can be a valid means of comparing faunal densities in relative terms. By extrapolation (from two parts of a site to two different sites), trapping could be used to compare the faunas of two sites, as long as their habitat and climate characteristics are closely similar. Ericson (1979), working with a more extensive set of data on field carabids, came to similar conclusions.

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