HABITAT BREADTH AND POPULATION STABILITY AND STRUCTURE OF THE ROCK VOLE, *Microtus chrotorrhinus*, IN NORTHEASTERN MINNESOTA

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Department of Natural Resources
State of Minnesota
Box 7, 500 Lafayette Road
St. Paul, Minnesota 55146

By: Frederick J. Jannett, Jr., Ph.D.
Curator of Biology
Department of Biology
The Science Museum of Minnesota
30 East 10th Street
St. Paul, Minnesota 55101

(612) 221-9429

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OBJECTIVES

The objectives of the study were: 1) to determine the presence of rock voles on sites where they were and were not trapped in 1982-1989; 2) to determine the numbers of rock voles which could be secured in four-day samples as opposed to the two-day samples undertaken in previous years; 3) to monitor sites where reproductively active female rock voles were trapped as well as some where they were not trapped in previous years; 4) to determine basic aspects of rock vole social structure; and 5) to attempt censuses on some sites.

METHODOLOGY AND RESULTS

1.1. Presence of Rock Voles in 1990 on Boulder Sites and Eskers.

Boulder fields of various sizes in Cook County, Minnesota, on which rock voles were trapped in 1982 (Christian, 1982a) and annually from 1983 through 1989 (Jannett, 1983, 1985a, 1985b, 1986, 1987, 1988, 1989) (= "boulder sites"), and eskers on which rock voles were trapped 1984-1989, were resampled in 1990 to ascertain if rock voles were still present. These survey transects were run in September using Museum Special traps; the presence of rock voles is easier to detect in September than in August, and easier to do with Museum Special traps than with live-traps (Jannett, 1983). The standard transect line consisted of 50 traps, one trap per station, and most had 20 paces

between stations. Wherever possible, transects were straight line(s). However, since some of the sites originally located by Christian (1982a) were small, the traps had to be deployed on these in an essentially gridded pattern. At sites where Christian (1982a) did not secure rock voles, the distance between stations was shortened to 10 paces because these sites tend to be small and narrow. All trap stations had been marked with flagging in 1985 and reflagged as necessary in subsequent years, and most of this material was still present in 1990. In the text below, sites trapped in 1982 were reported by Christian (1982a) and those in 1983, 1984, 1985, 1986, 1987, 1988, and 1989 were reported by Jannett (1983, 1985a, 1985b, 1986, 1987, 1988, and 1989, respectively); these citations, however, will not be repeated.

Transects on boulder fields and eskers were run for four nights. If more than 50% of the traps were set-off and empty on one night, the line was left out for an additional 24-hour period. Heavy rain resulted in leaving some lines out five, six, or seven nights to get four nights which met the 50% criterion. At site C32, a hare conspired with the rain and, even after six nights, there were only two which met the criterion.

In 1990, seven sites were sampled to ascertain if rock voles were present where they were not trapped in 1982 but were in 1983-1989, nine boulder sites were sampled to ascertain if rock voles were present where they were trapped

in 1982 and subsequent years, and two eskers were sampled. Eskers were identified by Sharp (1953). (The third esker monitored 1984-1989 was not trapped in 1990 because it has been heavily damaged by bear in previous years and there was already by September abundant bear damage to live-traps in 1990. Ironically, there was virtually no disturbance by bears on transects in 1990.) All sites where rock voles were secured in 1990 for any purpose are listed in Tables 1 and 2. Table 1 lists transect sites by dates trapped and locations. Table 2 lists sites by presence or "absence" of rock voles and of adult females.

One or more rock voles were taken in 1990 at 13 of these 18 sites. None was taken at the other 5, despite the increased trapping effort in 1990. This was the first year since 1982 trapping by Christian (1982a) in which rock voles were not secured at some sites. Disregarding eskers, there was a trend of more sites without a rock vole secured in 1990 to be among the subset of seven where Christian got none in 1982 (3 of 7 sites), but a comparison of these with two boulder fields (out of the remaining 9) with no rock voles was not quite significantly different (Fisher Exact Test, α =.05).

1.2. Presence of Rock Voles on an Older Clearcut.

The increased trap effort to four days at each boulder field and esker precluded trapping on older clearcuts, where numbers have been constant, or younger clearcuts where

numbers have clearly dropped off. (The actual number of trap-nights on transects, even when days with excessive set-offs are excluded, increased in 1990 by 12% over recent years.) However, one older clearcut, site C5, was proximate to two boulder fields and was therefore more easily gotten to than others. It was sampled as in previous years but for four days. In 1990, no rock voles were secured in the first two days; only three were gotten in the latter two days. In the two-day trap period each year 1985-1989, there had been an average of 18.4 rock voles; this site had been among the very few where rock voles had been relatively common.

2.0. Reproduction.

Among the 19 transect sites, there were only three parous (adult) females, each at different sites. None were still lactating or pregnant. At telemetry/census site C24 in September, there were two parous females, one still lactating, neither pregnant. At telemetry/census site C30S in September, there was one lactating non-pregnant female.

3.0. Telemetry.

3.1. Methods.

Live-trapping and telemetry work was undertaken July 25 - August 9. Sites used were C30S, C24, and J29. There were only two adult voles. Each of them received an SM1-Mouse Type radio transmitter (AvM Instrument Company Ltd., Dublin, California). The apparent nest locations were

determined on the basis of multiple readings from the same point, after which each point site was set with 12 live-traps to determine what other rock voles were perhaps using the presumed nest. These traps were left out for up to four days.

There were no adult meadow voles (M. pennsylvanicus) or bog lemmings (Synaptomys cooperi) at the telemetry sites.

3.2. Results.

Site C30S. Instead of trapping heavily at the three small C30 boulder fields and using a mere 25 or 50 traps placed along the contiguous alder swamp, I concentrated all effort at C30 in 1990 on the swamp. It was completely surrounded, except for a small spur, with 150 live-traps. The swamp is about 120' x 300'.

One adult parous female and one small subadult were the only rock voles secured. The adult was neither lactating nor pregnant in July - August. She ranged extensively over about one-half of the swamp and nested at the base of a large cedar in the swamp. She never ranged onto one of the contiguous boulder fields. No other rock voles were trapped at her nest. Additional heavy trapping in the swamp not traversed by the female also failed to yield more rock voles.

Site C24. This is a discrete boulder field about 33,500 sq. ft.. In most previous years, this site had more rock voles than any other telemetry site. There were no rock voles secured in three days of live-trapping in 1990,

after which traps were removed because of bear damage.

Extensive live-trapping was subsequently done upslope from the C24 boulder field and one adult lactating female was secured and radio-telemetered. She ranged in closed canopy woods and her range included a boulder-strewn dry streambed and patches of rocks. However, she was never located on or peripheral to the main boulder field. No other voles were secured at her nest until September when young subadults first entered these traps.

J29. This site is closed canopy mixed woods. There are scattered rocks but few small patches of rock. There is no boulder field in the area trapped. A lactating female was radio-telemetered at the site in 1987.

In 1990, the enumeration attempt differed from all previous attempts in that live-traps were deployed in a grid of 13 x 13 = 169 stations at an interval of 20'. Stakes marked the stations. On the fourth day of trapping, bear or bears crushed about 125 of the traps. No rock voles had been secured.

4.0. Enumeration and numbers caught per day.

4.1. Enumeration.

The two sites (C30S and C24) where telemetry had been undertaken in July and August were trapped heavily to attempt enumerations of the respective populations.

One-hundred live-traps were deployed along the eastern edge of the alder swamp, C30S. When Museum Special traps

were added after two days of live-trapping, each was set in the general vicinity of a live-trap.

At C24, the long side of the boulder field on the east is bordered by dense willow in a narrow zone between the boulders and a road. The west long side is slightly elevated and has a dense forb cover. Because of the road, the site is partially isolated, and since the telemetry has shown that the maximum width of the boulder field is not a large distance for rock vole movements, it is reasonable to assume that any vole actually using the boulder field would reach the west border. Therefore, most of the live-traps were set along the west border, a few were set at the north edge, and a few were set at the south edge. Museum Specials were not deployed because there was early bear damage at this site.

Since no voles had been secured at J29 in July - August, and since bear activity there was relatively high, no attempt was made to census voles at this site.

The eyes of all voles obtained in these census attempts were fixed for later determination of relative age upon dry lens weights (cf. Gourley and Jannett, 1975).

Dates and numbers of voles trapped are listed in Table 3. Figure 1 shows the removal of voles by day and by trap type. The entire effort at C30S was aborted on September 21 because a bear or bears destroyed or upset nearly every live-trap and Museum Special trap. Similarly, work ended at C24 on September 23 because of bear damage.

The catch clearly drops off from day 1, as is typical of late fall populations of other species of voles, e.g., M. montanus (Jannett, unpubl. data). At C24, all of the rock voles had presumably dispersed onto the area since July - August.

The number of voles trapped out would hopefully be comparable to an estimate of numbers present. Hayne's (1949) regression technique was used to obtain an estimate of the "population" sizes at C30S and C24. The regression was based on the first two days of live-trapping. Bear damage and the resulting early cessation of censusing precluded a comparison of the estimate with a six-day census attempt as carried out in previous years.

A comparison of the number of voles censused and estimated at C30S cannot be made with numbers from previous years because the trapping effort in 1990 was greater at the swamp than in previous years, and because the contiguous boulder fields were not trapped in 1990 as in previous years. Overall number of voles trapped at C24 cannot be compared with numbers from previous years because of the attenuated trap session. However, the estimate (n =17) can be compared at C24, and it was greater than in two previous years (1985 and 1988) and lower than in three (1984, 1986, 1989). It was also lower than the average, 24.5 estimated, 1984-1989.

4.2. Transects.

The same profile shown in transects in previous years wherein the catch fell off after the first day of trapping was also seen in most 1990 transects. There were 14 transects, including the clearcut, in which one or more rock voles were trapped. From day one to day two of trapping the number of rock voles increased on one transect, remained the same on three transects, and decreased on nine transects. For this comparison, all rock voles taken on days with >50% set-off traps were counted as being taken on the next day with ≤50% set-off traps. There were only two individuals trapped in these "intervening" days.

When rock vole numbers on the first two days (and accompanying intervening days with >50% set-off traps) were compared to rock vole numbers on the third and fourth days, they increased on one transect, remained the same on two transects, and decreased on 10 transects. Site C32 was not included in this comparison because it was not represented by sufficient trap days. No rock voles were secured on "intervening" days after day two.

4.3. Numbers of Rock Voles in 1990 versus previous years.

In a comparison of non-clearcut transects in 1990 versus each of the seven preceding years, data for the two eskers were included with the 16 boulder field sites because it now appears that they are not fundamentally different from the latter with respect to forbs, rocks, and nearby water. To test if the numbers of rock voles in 1990 were different than in previous years, an ANOVA was undertaken on square-root transformed data. To count the rock voles on days with >50% set-off traps, I added them to the next day with ≤50% set-off traps, as in the consideration of voles trapped on days 1 versus 2. Only data from days 1 and 2 were used because, except in 1983, previous transects were for two, rarely three, days. Data were set aside from site C11 in 1988-1990 because an immediately adjacent area, including some of the marginal trap stations, was clearcut in early 1988. There were only four other missing cells due to rain and bear damage 1983-1989.

To more accurately reflect the traps available for rock voles, numbers were expressed per 100 trap-nights, and the following were subtracted from the maximum 100 to 350 trap-nights: one-half trap-night for each trap upon being checked which was set-off or broken, had another species, or was nonfunctional as when an object had been blown under the treadle; one trap-night for each trap not found. There were two ANOVA's performed: one on the data from the "1983

subset" trapped 1983-1990, one on the data from all sites trapped 1984-1990. Duncan multiple range tests were done.

Figure 2 depicts the average number of rock voles per sample and per 100 trap night sample. The longitudinal data for 1984-1990 include only those sites for which there were complete data sets.

In the 1983 subset of eight sites, there was a significant difference in numbers of voles between years ($F = 11.00$, d.f. = 7 , $P < 0.0001$). The Duncan test grouped 1983 with only 1990, and all other years as equal ($\alpha = 0.05$).

In the overall suite of sites over 1984-1990, there was also a significant difference between years ($F = 13.58$, d.f. = 6, $P < 0.0001$). The Duncan test grouped all years together except 1990 ($\alpha = 0.05$).

Site C11 had seven rock voles in 1990, all of which were taken on day one. In the four years proceeding the 1988 clearcutting up to its margin, an average of 7.8 voles had been secured. Ironically, even after as many as seven days of trapping per site in 1990, only one site yielded more than 7 individuals.

DISCUSSION AND COMMENTS

1. The conclusion that rock vole numbers were very low in 1990 is supported by several lines of work : the 18 September transects on boulder fields and eskers, the September transect on an older clearcut where rock voles had

been relatively common, the summer enumeration by live-trapping, and the attempted censuses in September.

2. Rock vole population numbers in 1990 were similar to those in 1983. In the intervening years, the numbers were more constant than those of any other microtine rodent ever studied, and even more constant than those in most populations of Peromyscus and Apodemus (Jannett, in press). Clearly, the species does not have 3-4 year cycles which characterize the group (Krebs and Myers, 1974). It remains to be seen if numbers were "temporarily" low in 1990 and will soon recover, or if they have dropped to a low level which will persist. The proximate mechanism for this year's pattern is unknown, but, upon first analysis, the pattern does not appear to be widespread in the small-mammal community. Numbers of red-back voles (Clethrionomys gapperi) appear to have "peaked" in 1990. Overall numbers of other species were also relatively "high".

3. Only five (24%) of the 21 sites trapped in September, 1990 had one or two adult females each. This was the smallest number of adults obtained in any September, 1984-1990. These few females were at sites which have regularly had adult females.

4. I had planned to examine the results of increasing the length of the transect from two to four days. Inasmuch as the numbers of rock voles were so abnormally small in 1990, this increased trap effort did not yield much information. On the other hand, the concentrated effort on boulder fields

and eskers instead of clearcuts was fortuitous. Numbers remained small despite the increased effort. By coincidence, the only previous year in which transects were out for four days was 1983, the other year of very low rock vole numbers. Within one year, numbers had risen to their 1984-1989 plateau level.

5. It has been shown by telemetry that the habitat of the species is not restricted to boulder fields as previously thought (Kirkland and Jannett, 1982; Christian, 1982b). In 1990, the only voles found for telemetry were not even associated with boulder fields. There was no apparent social grouping except that of dam-offspring.

6. Mammals collected under this contract were deposited in The Science Museum of Minnesota and were given the accession number Z90:4.

7. I thank R.J. Oehlenschlager for help in the field and S. Nowland for typing the report.

8. I thank the Tofte District, Superior National Forest, National Forest Service (USDA) for use of a cabin that made the field work much more reasonable logistically. Most importantly, it enabled us to make better time in early September, and to fix more females in the field for histological examination. A copy of this report will be forwarded to the Tofte District office.

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Table 1. Locations of sites and transect trapping dates in Cook County, Minnesota, for *Microtus chrotorrhinus* during 1990.

Site Code	Transect Trapping Dates	Total Number of Nights	Number of Nights with ⩽50% Sprung Traps	Location
C 1	Sept. 5-9	4	4	Co. Rd. 3, 1.3 mi W Sawbill Trail, S side
C 3	Sept. 5-9	4	4	F. R. 165, SE intersection F. R. 339
C 5	Sept. 5-9	4	4	Co. Rd. 3, 4.5 mi W Sawbill Trail, N side
C10	Sept. 19-24	5	4	F. R. 165, 0.3 mi W Baker L. access road, N side
C11	Sept. 6-10	4	4	F. R. 165, 0.4 mi E Baker L. access road, N side
C18	Sept. 19-24	5	4	F. R. 326, 0.95 mi N junc. F. R. 153/165, W side
C21	Sept. 19-24	5	4	F. R. 326, 1.0 mi N junc. F. R. 153/165, E side
C23	Sept. 19-24	5	5	F. R. 326, 1.5 mi N junc. F. R. 153/165, E side
C24	---	-	-	F. R. 326, 2.5 mi N junc. F. R. 153/165, W side
C30S	---	-	-	F. R. 153, 5.8 mi E junc. Caribou Trail, N side
C31	Sept. 11-17	6	4	F. R. 153, 2.1 mi W junc. F. R. 323, N side
C32	Sept. 11-17	6	2	F. R. 153, 1.2 mi W junc. F. R. 323, S side
C54	Sept. 4-8	4	4	Sawbill Trail, 4.5 mi N southerly junc. Co. Rd. 3, E side
C56	Sept. 19-24	5	4	F. R. 165, 0.9 mi E Baker L. access road, N side
C57	Sept. 19-24	5	4	F. R. 165, 2.1 mi E Baker L. access road, S side
C59	Sept. 10-17	7	4	F. R. 153, 2.3 mi E Caribou Trail, S side
C60	Sept. 10-16	6	4	F. R. 153, 2.7 mi E Caribou Trail, S side
C61	Sept. 10-17	7	4	F. R. 153, 6.2 mi E Caribou Trail, S side
C62	Sept. 11-16	6	4	F. R. 323, 1.8 mi N F. R. 153, N/E side
J 4	Sept. 5-9	4	4	Parents Lake Road Esker, Co. Rd. 3, 5.3 mi W Sawbill Trai N side road, E side creek
J14	Sept. 7-11	4	4	Four Mile Esker, F. R. 170, 9.1 mi SW Sawbill Trail, E si
J29	---	-	-	F. R. 326, 5.4 mi N junc. F. R. 153/165, E side

Table 2. Summary of presence of rock voles in 1982 - 1990.

Site Code	Year									Type of trapping Effort in 1990[b]
	1982	1983	1984	1985	1986	1987	1988	1989	1990[a]	
C 1	+	+	AF	AF	AF	AF	AF	+	+/+	Transect
C 3	+	+	+	AF	+	+	+	+	0/0	Transect
C 5	+	+	+	AF	AF	AF	AF	+	0/+	Transect (clearcut)
C10	+	+	AF	+	+	+	AF	+	+/+	Transect
C11	+	+	+	AF	AF	AF	AF	AF	AF/0	Transect
C18	+	+	AF	+	+	AF	+	+	+/0	Transect
C21	+	+	AF	AF	AF	+	AF	+	0/0	Transect
C23	+	AF	AF	AF	AF	AF	AF	AF	+/+	Transect
C24	+	+	AF	AF	AF	AF	AF	+	AF	Telemetry + Enumeration
C30S	NT	NT	NT	AF	AF	AF	AF	AF	AF	Telemetry + Enumeration
C31	+	AF	+	+	AF	+	+	+	+/0	Transect
C32	+	AF	AF	AF	AF	AF	AF	AF	+/-	Transect
C54	0	AF	AF	+	AF	AF	AF	+	AF/+	Transect
C56	0	+	+	+	+	+	AF	+	0/0	Transect
C57	0	AF	+	+	+	AF	+	AF	+/+	Transect
C59	0	+	+	+	AF	AF	+	+	0/0	Transect
C60	0	+	+	AF	+	+	AF	AF	0/0	Transect
C61	0	+	+	+	AF	AF	AF	AF	AF/0	Transect
C62	0	+	+	+	+	+	AF	+	+/0	Transect
J 4	NT	0	+	AF	AF	AF	+	AF	+/+	Transect (esker)
J14	NT	NT	+	+	AF	+	AF	AF	+/+	Transect (esker)
J29	NT	NT	NT	NT	NT	AF	NT	NT	0	Telemetry

\+ = Rock vole(s) taken but no adult females.
AF = Rock vole(s) taken included one or more adult females.
0 = No rock vole taken.
NT = Site not trapped this year.
a = Trap day one and two/day three and four.
b = The type of trapping effort in previous year(s) was not necessarily the same as it was in 1990.

Table 3. Attempted enumeration and estimation of Rock Vole numbers at sites C30S and C24. See text for explanation and discussion.

Site	C30S	C24
Dates of removal by live-trapping	Sept. 16-21*	Sept. 20-23*
Number of live-traps deployed	100	100
Dates of removal with Museum Specials	Sept. 18-21*	-
Number of Museum Specials deployed	100	0
Total number of Rock Voles removed by live trapping	8	14
Total number of Rock Voles removed with Museum Specials	0	0
Total number of Rock Voles removed	8	14
Estimate of number of Rock Voles present by regression method	8	17

*There were no rock voles in the fifth trap-night at C30S or third trap-night at C24, both of which had virtually all traps disabled by bear.

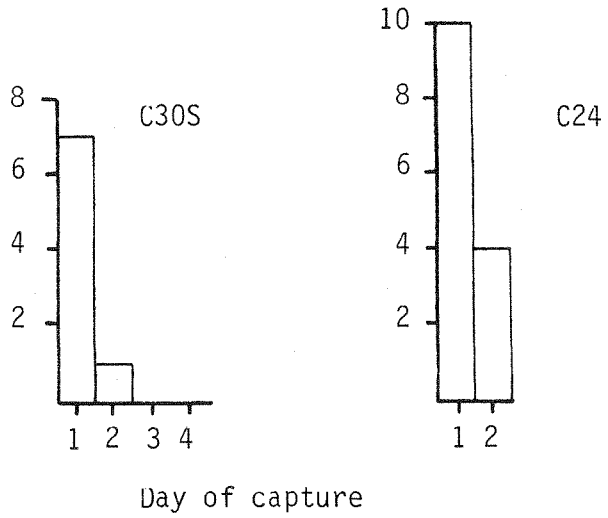
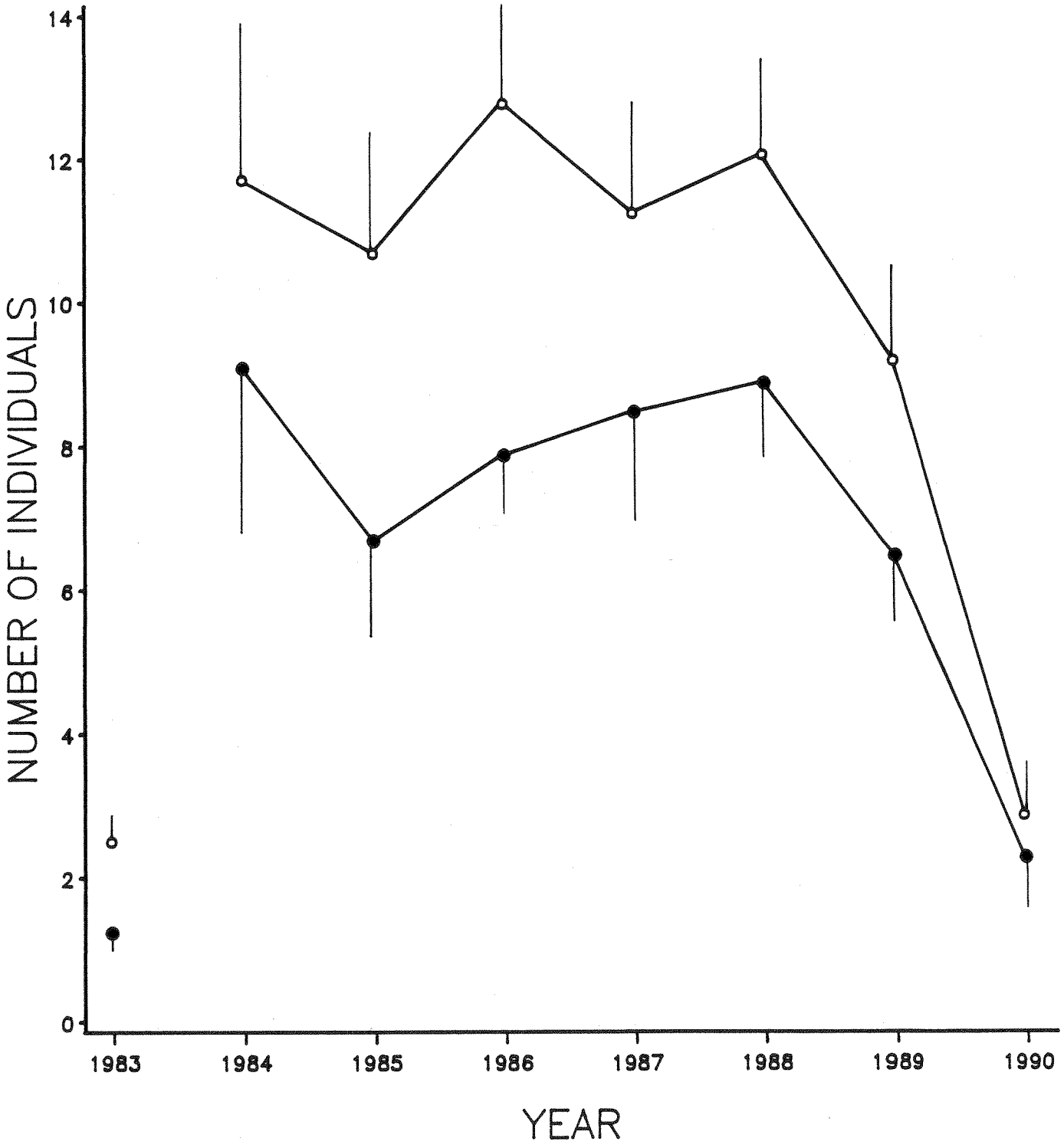


Figure 1. Removal trapping distribution by day and trap type. There were four or two full days of live-trapping depending on bear damage, Museum Special traps being added after day two at C30S. □ = rock vole in live-trap; no rock vole was taken in a Museum Special trap

Figure 2. Average number of rock voles per sample (-SEM) (points) (upon four samples in 1983, 10 in 1984-1990), and average number of rock voles per 100 trap night sample (+SEM) (circles) (upon seven samples in 1983, 15 in 1984-1990).


NUMBER OF INDIVIDUALS
0
2
4
6
8
10
12
14
1983
1984
1985
1986
1987
1988
1989
1990
YEAR