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

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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; 2) to compare the responses of rock voles to different types of traps; 3) to determine basic aspects of rock vole social structure; and 4) to make recommendations about the monitoring of rock vole populations.

METHODOLOGY AND RESULTS

1.0. Presence of Rock Voles in 1983.

1.1. Presence of Rock Voles where they were trapped in 1982.

During August, traps were set at 23 sites where Christian (1982) secured rock voles in 1982. Additionally, one site was trapped which was thought to have been trapped by Christian but which, in retrospect, had probably not been trapped by him. Table 1 shows dates of trapping and site locations. Each of the sites trapped previously by Christian (1982) are referred to in this report with the prefix "C", and the numbers correspond to those in Table 1 of Christian (1982). Sites not trapped previously by Christian (1982) are herein designated J1, J2, and J3.

Sites were chosen to represent different sizes of suitable habitat over a relatively wide geographic range, but many sites in the center of the range were, on the other hand, chosen because they were close to each other in order to identify more local variation in rock vole presence.

Each site was trapped with 25 live traps and 25 snap traps, except one site which had 22 of each type trap because there was less suitable habitat. Pit traps were also set at three of these sites. Placement of traps and relative trap success are discussed below in section 2.0. Most trap lines were set between 1300 and 1800 hours; two were completed slightly after 1800 hours. Lines were checked daily, usually between 0900 and 1200 hours, and were left out for four days.

Species of mammals secured are given in Table 2. One or more

Table 1. Locations of sites and trapping dates in Cook County, Minnesota for *Microtus chrotorrhinus* during 1983.

Site Code	Trapping Dates	Location
C 1	Aug. 4- 8.	Co. Rd. 3, 1.3 mi W Sawbill Trail, S side
C 3	Aug. 9-13.	F. R. 165, SE intersection F. R. 339
C 5	Aug. 5- 9; Sept. 11-15.	Co. Rd. 3, 4.5 mi W Sawbill Trail, N side
C10	Aug. 8-12; Sept. 10-14.	F. R. 165, 0.3 mi W Baker L. access road, N side
C11	Aug. 5- 9.	F. R. 165, 0.4 mi E Baker L. access road, N side
C12	Aug. 7-11.	F. R. 165, 0.6 mi E Baker L. access road, N side
C13	Aug. 6-10; Sept. 11-15.	F. R. 165, 1.9 mi E Baker L. access road, N side
C15	Sept. 11-15.	F. R. 165, 4.75 mi E Baker L. access road, S side
C18	Aug. 11-15.	F. R. 326, 0.95 mi N junc. F. R. 153/165, W side
C21	Aug. 12-16.	F. R. 326, 1.0 mi N junc. F. R. 153/165, E side
C22	Aug. 12-16.	F. R. 326, 1.3 mi N junc. F. R. 153/165, W side
C23	Aug. 14-18.	F. R. 326, 1.5 mi N junc. F. R. 153/165, E side
C24	Aug. 14-18.	F. R. 326, 2.5 mi N junc. F. R. 153/165, W side
C25	Aug. 14-18.	F. R. 153, 1.1 mi E junc. F. R. 326, S side
C26	Aug. 15-19; Sept. 11-15.	Cascade L. access road, N of F. R. 153
C27	Aug. 16-20.	F. R. 153, junc. Caribou Trail, N side
C29	Aug. 16-20.	F. R. 153, 3.4 mi E junc. Caribou Trail, S side
C30	Aug. 17-21.	F. R. 153, 5.8 mi E junc. Caribou Trail, N side
C31	Aug. 19-23.	F. R. 153, 2.1 mi W junc. F. R. 323, N side
C32	Aug. 21-25.	F. R. 153, 1.2 mi W junc. F. R. 323, S side
C33	Aug. 20-24.	F. R. 153, 0.65 mi W junc. F. R. 323, N side
C34	Aug. 19-23.	F. R. 153, 0.4 mi W junc. F. R. 323, S side
C35	Aug. 20-24.	F. R. 323, 0.3 mi N junc. F. R. 153, E+W sides
C42	Aug. 21-25.	F. R. 323, 0.9 mi N junc. F. R. 153, E side
C54	Sept. 21-25.	Sawbill Trail, 4.5 mi N southerly junc. Co. Rd. 3, E side
C56	Sept. 12-16.	F. R. 165, 0.9 mi E Baker L.access road, N side
C57	Sept. 16-20.	F. R. 165, 2.1 mi E Baker L. access road, S side
C58	Sept. 16-20.	F. R. 165, 4.1 mi E Baker L. access road, S side
C59	Sept. 16-20.	F. R. 153, 2.3 mi E Caribou Trail, S side
C60	Sept. 17-21.	F. R. 153, 2.7 mi E Caribou Trail, S side
C61	Sept. 17-21.	F. R. 153, 6.2 mi E Caribou Trail, S side
C62	Sept. 18-22.	F. R. 323, 1.8 mi N F. R. 153, N/E side
J 1	Aug. 11-15.	F. R. 165, 4.85 mi E Baker L. access road, S side
J 2	Sept. 20-24.	Carlton Mountain, just south of summit
J 3	Sept. 20-24.	Carlton Mountain, just east of summit

Table 2. Mammalian species captured at localities in Cook County in 1983.

Site	*Microtus chrotorrhinus*	*Microtus pennsylvanicus*	*Clethrionomys gapperi*	*Synaptomys cooperi*	*Peromyscus maniculatus*	*Zapus hudsonius*	*Napaeozapus insignis*	*Eutamias minimus*	*Myotis* sp.	*Condylura cristata*	*Blarina brevicauda*	*Sorex cinereus*	*Sorex palustris*	*Sorex arcticus*	*Microsorex hoyi*
C 1	X		X		X	X		X			X	X			
C 3	X		X		X						X	X			
C 5	X	X	X	X	X	X		X				X	X		X
C10	X		X		X						X	X			
C11	X		X		X						X	X			
C12	X		X		X							X			
C13			X		X	X				X	X	X	X		
C15	X		X	X							X	X		X	X
C18	X		X			X	X			X		X	X	X	
C21	X		X		X	X	X				X	X			
C22	X		X									X		X	
C23	X		X		X							X			X
C24	X		X									X		X	
C25	X		X		X			X			X	X		X	
C26	X		X		X			X		X	X	X			X
C27	X		X		X						X	X			
C29	X		X		X		X		X			X			
C30	X		X		X						X	X			
C31	X		X								X	X			
C32	X		X		X			X			X	X	X		X
C33	X		X					X			X	X			
C34	X		X									X		X	
C35	X		X		X						X	X		X	X
C42	X		X		X						X	X			X
C54	X		X		X						X	X	X		X
C56	X		X		X						X	X			
C57	X		X		X						X	X			
C58			X		X						X	X			
C59	X		X		X			X			X	X		X	
C60	X		X		X						X	X		X	
C61	X		X		X						X	X			
C62	X		X	X							X	X			
J 1											X	X		X	
J 2			X		X						X	X			
J 3			X		X							X			

rock voles were taken at 19 of the 23 sites where they had been secured in 1982. None was taken at J1, which was probably not suitable habitat.

1.2. Retrapping of August, 1983, sites in September, 1983.

Christian (1982) reported that all three sites where he trapped no rock voles on August 6-8 of 1982 yielded rock voles when retrapped on September 4-6 of the same year. Since the present work was designed to make recommendations for monitoring rock vole populations, I extended the research protocol and retrapped in September the four Christian sites (C5, C10, C13, C26) which did not yield rock voles in August, 1983, but had in 1982.

Each site was trapped with 50 snap traps, 25 of which were set over the same path where traps had been set in August. In some lines the trap station location markers had been left out and the traps were set in the exact locations where traps had been in August. The second 25 traps at each site were set in a different line to sample a different part of the suitable habitat. Trapping dates are presented in Table 1. Traps were deployed during the afternoons, and checked on the next four mornings.

Species of mammals secured are given in Table 2. One or more rock voles were taken at three of the four sites where they had not been secured in August, some voles even at stations which had been set in August.

(In addition, C15 was similarly trapped in September. It had yielded rock voles in 1982 and they were secured again in September, 1983.)

1.3. Presence of Rock Voles where they were not trapped in 1982.

Fifty snap traps were set at each of eight sites trapped by Christian (1982) where he took no rock voles. The only site listed by Christian (1982) where he did not trap rock voles that I chose not to retrap was C55; I did not trap it because it so very much resembled J1 (dense spruce, "boggy" cover) where I secured no rock voles in August, and which I thought was poor rock vole habitat. Additionally, 50 were set at each of two sites (J2 and J3) on Carlton Mountain in Cook County where Jannett trapped for them in 1982. Site locations and trapping dates are given in Table 1. Traps were deployed during the afternoons, and checked for four days.

Only live traps were used at J2 and J3 in 1982 and no rock voles were captured. Both J2 and J3 have overstories of birch (*Betula* spp.), and forbs such as *Cornus canadensis* known to be in the diet of rock voles (Kirkland and Jannett, 1982). J2 has large boulders and J3 has smaller rock outcrops among more soil. Neither appears to be as moist as the more inland sites.

At all sites, traps were set at intervals of about 10 paces, but when a series of boulders was encountered at J3, the traps were placed closer together.

Species of mammals secured are given in Table 2. One or more rock voles were taken at seven of the eight sites where they were not trapped by Christian in 1982. No rock voles were taken at either J2 or J3.

2.0. The catch of Rock Voles in different types of traps.

To determine which type of trap might take more rock voles, two or three different types of traps were set at each station in the August trapping. The three types of traps were small nonfolding aluminum live-traps manufactured by H.B. Sherman Traps of Tallahassee, Florida, Museum Special snap traps manufactured by the Woodstream Corporation of Lititz, Pennsylvania, and pit traps, each being a 46-ounce can with the top, i.e., one end, removed. The habitat at most sites consisted of such densely packed boulders that pit traps were only set at sites C1 and C5 where there was sufficient soil to make flush with the tops of the cans and/or where boulders had large enough spaces for fitting the cans. Cans were also set at all stations at site J1. No rock voles were taken in pit traps at these sites or at other sites similarly trapped for shrews with smaller cans.

The two or three types of traps set at each station were set close to each other, often within inches of each other. When there was insufficient space to set them all in or at the same crevice, they were rarely more than about three feet apart. Because of spatial configurations, some sets could only be made with snap-traps, others only with live-traps. Otherwise, trap locations within the triad or dyad were chosen at random. Stations were about 10 paces apart.

Museum Special traps were baited with peanut butter and dry rolled oats. Live-traps were baited with peanut butter, oats, and apple inside and on the door. A small amount of oat flakes and a very small bit of apple were scattered in front of each snap- and

live-trap. Pit traps were unbaited and to each was added about two inches of water.

All live-traps were cleaned before being initially deployed at a site, but not thereafter. Most of the SMM Museum Special traps had not previously been used.

To increase the numbers available for analysis, the number of sites trapped in this manner in August was increased to 24 from the initially proposed 12.

Table 3 lists the catches of rock voles by sex, reproductive status, and trap type. An adult male is defined as one with scrotal testes; a few males which probably had regressing testes were categorized as non-adult. An adult female is defined as one which was parous (on the condition of the teats and/or placental scars present) or nulliparous pregnant.

Only the first rock vole catch at a given station is considered inasmuch as any subsequent catches would not be independent events.

Within a trap line, all live traps were initially clean. However, an animal caught in a live trap, even if not a rock vole, may have influenced the probability of that trap catching a rock vole subsequently. Therefore, the data in Table 3 include only rock voles caught at stations where the live trap was still clean.

Lastly, rock voles were excluded from Table 3 if the opposite trap at the station was set off or contained another mammal of any species on the day the rock vole was trapped.

When the sums of voles trapped in live-traps and snap-traps are

Table 3. Rock Voles caught in different types of traps in August.

	Trap Type	
	Museum Special	Sherman
Adult Males	9	1
Non-adult Males	11	5
Adult Females	5	0
Non-adult Females	10	2

compared using a χ^2 test corrected for continuity (Simpson, et al. 1960), the catch is found to be unequal with more voles having been taken in Museum Specials than in Sherman live-traps (χ^2_c=8.06 $P < .005$). The same trend is indicated by each sex/reproductive class but with insufficient numbers for assigning probabilities.

3.0. Telemetry.

3.1. Sites trapped.

Ten boulder patches at or near localities where Christian secured rock voles in 1982 were live-trapped for radiotelemetry in 1983. Each was trapped for at least three days before abandoning it if no adult female rock vole was trapped. Each site was trapped heavily, the number of traps initially dependent on the size of the habitat patch and ranging from 25 to 125. When a female was secured, additional live traps were set (12 to 25) where she was caught, and, after radio-tagging, where she frequented.

Trap sites where adult females were not trapped included one patch at C28 trapped in August and again in September, one additional patch at C28 in September, and five patches at C7 in September.

Those patches where adult females were trapped were two at C30 (neither of which was trapped in August) and one at C45. These three sites were live-trapped in September. Only one adult female was trapped on each patch. The two patches at C45 were about 51' apart, and there were additional patches in the area at greater distances.

3.2. Movements of adult females.

The adult female trapped at one patch at C30 seemed in poor condition (thin) when trapped, so a radio transmitter was not implanted. The female trapped at the second C30 boulder patch ("C30 female") and the female trapped at C45 ("C45 female") each received an SMI-Mouse Type transmitter (AvM Instrument Company Ltd., Dublin, California) implanted abdominally while she was anesthetized with Metofane (methoxyflurane; Pitman-Moore, Inc., Washington Crossing, New Jersey). There were at least 30 minutes between two consecutive

point locations of a female.

Over a period of four days, (September 22-25) C30 female was located 18 times. Her movements covered essentially the entire boulder patch, about 4100 sq. ft.. She was recorded off the patch on one occasion at a small jumble of logs and rocks about 51' from her nest (a slightly lesser distance to the nearest edge of the patch), and twice at lesser distances from the patch. Her nest, as determined by frequency of use, night-time use, and subsequently my digging it out, was at the very edge of the boulder patch in a slightly raised mound of soil beneath a cedar tree.

Over a period of four days (September 26-29) C45 female was located 22 times. Her movements covered about two-thirds of the "arm" (about 1800 sq. ft.) of a very large boulder "field." She nested on the patch near one edge but in a slightly higher area than was most of the boulder field. On five occasions she was found off the boulder field on a small patch of boulders about 12' away. This ancillary patch was separated by a line of trees and shrubs but was apparently connected to the main boulder field by subsurface boulder crevices.

By standing very still after locating a radio-tagged vole, I was able to observe each one on several occasions while she collected and ate leaves of grass, forbs, and shrubs. Where cover was sparse, the vole took its food material to the space under a boulder where it was then seen eating.

3.3. Assemblages of Rock Voles.

The three boulder patches where the adult females were caught for telemetry were trapped very heavily with live-traps where the

females were trapped, where they frequented, and where they nested. Snap-traps were also used after telemetry.

No subadults or adults were caught in the immediate vicinity of the nests. Although one lactating and one pregnant rock vole had been trapped as late as September 12 at site C15, none of the voles secured for telemetry was still lactating. Each of the three sites where adult females were live-trapped for telemetry did have, however, an assemblage of two, three, and six subadults, respectively. Each of two of the three also had one large adult male with regressing testes.

(The possibility of rock voles being monogamous was also suggested by some of the transect trapping.)

The most interesting capture was that made at the point where C30 female had made the longest sally off the boulder patch. After four days of snap-traps at this site, a new adult female was secured. It is possible that rock voles maintain points of contact outside their usual ranges as was found for otherwise territorial female montane voles, *Microtus montanus* (Jannett, 1978). The significance of their activity off the boulder patches remains unknown.

Fixed and dried eye lenses from the voles in these assemblages have not yet been weighed.

4.0. Electrophoretic patterns.

Tissues were removed from 51 rock voles and frozen on dry ice for future analysis of genic structure as may be indicated by electrophoretic patterns. The data may yield information on microgeographic patterns inasmuch as the represented sites are spread from C1 in the western region of study to C45 in the east, i.e., over a distance of about 29 miles. The sample includes three adult females and three respective assemblages of subadults.

5.0. Summary of day of first capture and reproductive condition.

5.1. Day of first capture.

Table 4 summarizes the day-of-first-capture from all August and September samples and the four sites where voles were captured for recapture study. If rock voles were captured at a site, then the first vole captured was taken on the first or second day.

5.2. Reproduction.

Of the total 121 rock voles taken in samples and recapture areas, 73 (60%) were males, and 48 (40%) were females. 16 (22%) of the males had scrotal testes. At least 15 (31%) of the females were parous or nulliparous pregnant.

Table 4. Numbers of sites by day of first rock vole capture.

	Day 1	Day 2	Day 3	Day 4
Number of August Sites	15	4	0	0
Number of September Sites	11	0	0	0

DISCUSSION AND COMMENTS

1. It is not possible to compare the numbers of rock voles taken in 1983 by Jannett et al. with those taken in 1982 by Christian et al. because, in order to identify as many sites with rock voles as possible, Christian et al. set variable numbers of traps for various lengths of time.

2. It should be borne in mind that, because traps were set in pairs during August, the effectiveness of the trapping regime was diminished in terms of area covered and number of voles taken. More rock voles could probably have been secured had stations been composed of single traps in lines twice as long.

3. Previous trapping by others which has not identified rock vole populations may not have been in appropriate habitat. For example, Timm (1975) stated that he had trapped for rock voles in frost-fracture rock outcrops, but most of the sites located by Christian (1982) seem to be glacial till.

4. It is not yet possible to even tentatively conclude if rock vole populations are stable and show an annual cycle of abundance, or exhibit a short term microtine "cycle," or undergo a long-term fluctuation in numbers.

5. At least 31 of the 121 rock voles captured in 1983 were reproductively active. This proportion is very much higher than that of three out of 87 rock voles trapped in 1982 by Christian.

6. Mammals collected under this contract and deposited in The Science Museum of Minnesota were given the accession numbers Z83:27 and Z83:41 for August and September collections, respectively.

All standard measurements were made by Jannett. After heads were removed, carcasses were fluid preserved. A collection of plants was made by M. Candee at rock vole trap sites in order to identify stomach contents at a later time on the basis of epidermal structure. This is a relatively large series of rock voles, particularly valuable for the number of adults, and will be used for studies of food habits, reproduction, survivorship, social structure, habitat of breeding females, and morphometric characterization of the Minnesota population(s).

7. I thank Mary Candee and Jack Davies of The SMM and Dr. Robert Stehn of the U.S. Fish and Wildlife Service for help in the field. Richard Joarnt of the Sherburne Wildlife Refuge loaned traps for use in September.

8. Copies of this report have been forwarded to the Headley Library (SMM), Dr. D. Christian, and Dr. R. Stehn, respectively.

RECOMMENDATIONS

1. Rock vole populations should be monitored to ascertain if they are relatively stable and the monitoring should be standardized.

2. Vole populations can more easily be found in September than in August. If gestation for this species is 21 days as it is in many other species in the genus, the difference between early August and late September could be as much as two litter-cohorts in the trappable population.

3. Trapping in September should be done before leaf fall which tends to obscure the subtle indications of vole activity in crevices.

4. Snap-traps will more efficiently sample rock voles than live-traps and are probably easier to set.

5. Traps should be set singly at stations and should be in lines of 50 stations in order to traverse as much habitat as possible.

6. To ascertain the presence of rock voles, two days is a reasonable trap period. Nothing is gained by leaving the traps out for four days.

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