Final Report

Field Study on *Microtus chrotorrhinus*

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The study of *Microtus chrotorrhinus*, the rock vole or yellow-nosed vole, was designed to meet two objectives. The first objective was to test the hypothesis that water, in the form of humidity and available free water, is a limiting factor in habitat selection by *M. chrotorrhinus*. The second objective of the study was to locate additional populations of the species in Northeastern Minnesota and supply this informatin to the Minnesota Natural Heritage Program. Protection of these colonies may be necessary due to the rarity of the species in Minnesota and the limited and unique habitat in which it exists.

Prior to this study, three populations of rock voles had been identified in Minnesota. The first site, located in 1921 by Vernon Bailey near Burntside Lake in St. Louis County (Swanson, 1945) was inadequately described and despite efforts by numerous investigators, has not been relocated. The other two populations were located in Cook County. One was identified by Bob Timm in August, 1973 (Timm, 1974, 1975, Timm *et al*., 1977) off the Gunflint Trail, 27 km. north and 1.6 km. west of Grand Marais (NW ¼, S. 29, T. 64 N, R. 1 E) and the other in September, 1976, during a United States Forest Service (U.S.F.S.) study near Red Rock Bay on Saganaga Lake (SW ¼, NE ¼, and SE ¼, NW ¼, S. 17, T. 66 N., R. 5 W) (Buech *et al*., 1977; Timm *et al*., 1977). The Gunflint Trail and the Saganaga Lake sites were selected for the study of water balance and microclimate in *M. chrotorrhinus*. Locations for additional investigation within Cook County were chosen with the help of the U.S.F.S. and the Minnesota Department of Natural Resources (M.D.N.R.) in Grand Marais.

Water Balance Study

To test the hypothesis that water is a limiting factor in habitat selection by M. chrotorrhinus, I proposed to compare the water requirements of M. chrotorrhinus with two closely related species: Clethrionomys gapperi and Microtus pennsylvanicus. Field work was to include trapping to determine species distribution and various population parmeters and measurement of several microclimate parameters at the two sites throughout the summer.

STUDY SITES

Saganaga Site

The vegetation at this site is extremely variable, ranging from dense lowland spruce to mixed upland forest. The climax community of the area is black spruce (Picea mariana). Much of the dense spruce canopy has opened due to windfalls which has resulted in the development of numerous seral areas characterized by shrubs (round-leaved dogwood, Cornus rugosa; beaked hazel, Corylus cornuta; red maple, Acer rubrum), and light tolerant tree species (paper birch, Betula paperifera; balsam poplar, Populus balsamifera). The physical characteristics which identify this area include extensive igneous rock outcrops (primarily rhyolite and basalt) and relatively high moisture levels (despite below normal precipitation in the area early in 1980). The slope is steep and rocky cliffs are common.

Gunflint Trail Site

This site is characterized by an extensive boulder field, a deposit of presumably glacial origin. The vegetation in the boulder field varies from sparse vegetation on the exposed rocks, consisting of several species of lichens and moss, to a seral successional stage on the periphery of the boulder field, to finally, a developing climax forest of northern white cedar (Thuja occidentalis), black spruce, and balsam fir (Abies balsamea). Further diversity in adjacent areas has been created by commercial logging in the recent past. Boulders in this field consist of granophyre, gabbro, and other kinds of rock (Grout et al., 1959). The boulder field is relatively low and flat compared to the surrounding area.

MATERIALS AND METHODS

Trapping

Initially, modified Fitch live traps (Fitch, 1950) were used in the study. It was found that although the traps proved to be extremely sensitive, their size and unforseen problems with the mechanics of the trap on a slope led to the use of a less sensitive, but smaller and more flexible, Sherman live trap. Grids were set up at both sites with an interval between stations of 8 m., 1 trap/station. At the Gunflint site, grids were set up along the periphery of the exposed rock of the boulder field and extended into the forest to the point where ground vegetation was determined to be too sparse to support small mammal populations and/or where the forest floor was very dry--usually due to considerable direct exposure to the sun. A rectangualar grid was set up at the Saganaga site, in a direction parallel to that used in the U.S.F.S. study of 1976 (Siderits, 1977). The number of traps at each site varied to include the appropriate habitat for the three mammal species. Three, three day trap periods, at approximately three-week intervals, were designed for both sites, beginning in early June. Exact dates of trapping are listed on Table 1. Traps were baited with a peanut butter and rolled oats mixture in the evening between 4 - 6 p.m. and checked and closed the following morning between 7 - 9 a.m. Information on species identification, trap location, sex, weight, repro-

Table 1

Dates and Localities Trapped

Saganaga Lake Site	June 9 - 12
Gunflint Trail Site	June 17 - 21
	July 8 - 11
	Aug. 11 - 14
	Aug. 15 - 18
	Aug. 20 - 23
	Aug. 25 - 28
New Sites	
F.S. Rd. 304	June 30 - July 3
	Aug. 21 - 27
F.S. Rd. 316	Aug. 11 - 13
F.S. Rd. 152	Aug. 15 - 17
F.S. Rd. 153	Aug. 21 - 23

ductive status, and size (tail, ear, foot and total body lengths) was recorded for each animal collected. Animals were marked for identification by toe clipping and then released.

Following the trapping period in August, live trapping continued at the Gunflint Trail site in order to collect animals for use in water balance studies in the laboratory. In September, an additional grid was set up near Duluth, in St. Louis County, to collect specimens of M. pennsylvanicus, which were not found on the Gunflint Trail site. These animals were also used in the laboratory study.

Microclimate

The microclimate parameters studied included relative humidity, ambient temperature, diurnal temperature variation, and soil temperature. These parameters were measured in June at both sites following the checking of traps. Measurements were taken on second consecutive days of sunshine.

Dry bulb and wet bulb temperature readings were taken using a Bailey thermometer, model BAT - 9, adapted for field use. Measurements were taken at 1 m. and 1 cm. above the surface and at approximately 5 cm. into the nearest runway. Soil temperature was measured at 1 cm. and at 7 cm. below the soil surface (where possible). These readings were taken from ten stations at each site. Minimum-maximum thermometers were placed at two of the stations, 2 cm. above the soil surface and read the following day. This procedure took approximately 4 hours to complete. Additionally, information describing each trap station was recorded. This included vegetation, relative exposure to the sun, presence of standing water, obvious runways, position of trap and physical characteristics such as rocks, logs, stumps, etc.

New Sites

Populations of rock voles are localized and uncommon throughout their range. Prior to this study only three reports had been made of *M. chrotorrhinus* in Minnesota. The purpose of this portion of the study was to identify additional populations of rock voles in order to determine how widespread these colonies are in northern Minnesota. This determination would be useful for future management decisions.

STUDY SITES

Selection of Sites

Selection of areas for investigation of the presence of *M. chrotorrhinus* populations was based on habitat descriptions described by Timm (1974, 1975; Timm *et al.*, 1977) and Buech *et al.* (1977) in their work on the rock vole in Minnesota. Rock outcrops and vegetation similar to that found at the Red Rock Bay site were encountered throughout the Saganaga Lake area. However, inaccessibility due to steep slopes at these sites prevented further investigation. Habitats similar to that represented by the Gunflint Trail site were generally more accessible and more easily identified by area foresters and biologists. Characteristics which identified these areas were: significant boulder deposits, relatively high moisture levels (as evidenced by standing water and/or moss-covered boulders), and by vegetation adequate to sustain a significant small mammal population.

An attempt was made to identify boulder fields through the use of aerial photographs but according to Mark Hurd, aerial photographer, no photogtaphs of the area have been taken at a range which would make identification of these areas possible. Photographs at a lower elevation are currently being made of the state. Hurd, however, anticipates that photos of Cook County will not be taken for some years.

An additional effort was made to identify these areas based on the geology of the area. Boulder fields, however appear to be simply glacial deposits which are scattered throughout the area. Their only relationship to other geologic formations in the area appears to be that they are often found in conjunction with running water. The most recent information available on the geology of Cook County appears to be that by Grout, Sharp and Schwartz in 1959, in which only brief mention is made of the boulder deposits.

NEW SITE DESCRIPTIONS

(Legal descriptions of new sites are included on Table 2.)

F.S. Rd. 152

Two sites were established on this road approximately ¼ mile apart. The first was located about one mile from the junction with the Gunflint Trail, adjacent to the road. This site was a fairly mature spruce forest which led into an alder (Alnus sp.) swamp. Boulders were mostly moss and soil covered with only those nearest the alders protruding and partially barren. Although predominently black spruce, this site contained a mixture of fir, spruce and cedar with few shrubs (mostly alder). Only scattered forbs were present, primarily bunchberry (Cornus canadensis), twinflower (Linnaea borealis), dewberry (Rubus pubescens), and a few strawberries (Fragaria sp.). The second site began at the road and continued inward through the forest approximately 40 m. where it opened onto an exposed boulder field adjacent to the north branch of the Brule River. The canopy consisted primarily of cedar with occasional stands of fir and birch. The

Table 2

TRAP LOCATIONS

Microtus chrotorrhinus sites

F.S. Rd 316 Site
E ½, SW ¼, NW ¼, S. 29, T. 64 N, R. 1 E
(Forest Service property)

Gunflint Trail Site
N ½, NE ¼, NE ¼, S. 30, T. 64 N, R. 1 E
(Forest Service property)

F.S. Rd. 153 Site
S ½, SE ¼, NW ¼, S. 4, T. 62 N, R. 1 W
(State property)

Saganaga Lake Site
SW ¼, NE ¼, and the
SE ¼, NW ¼, S. 27, T. 66 N, R. 5 W
(B.W.C.A.)

F.S. Rd. 152 Site
S. 31, T. 64 N, R. 1E
(Forest Service property)

Synaptomys site

F.S. Rd. 304 Site
NE ¼, NE ¼, S. 25, T. 62 N, R. 1 E
(Ownership uncertain)

Other possible *M. chrotorrhinus* sites

NE ¼, S. 34, T. 64 N, R. 1 E
(Forest Service property: Off F.S. Rd. 144)

T. 62 N, R. 1 W and R. 2 W, and possibly R. 3 W
(Some portions - state property: Off F.S. Rd. 153)

herbaceous layer was similar to the first site with the addition of clintonia (Clintonia borealis), labrador tea (Ledum groenlandicum), and wintergreen (Pyrola sp.). As on the above site, boulders were mostly buried under moss and soil with extrusive boulders emerging only along the waters edge. The overstory at both sites permitted little light penetration and therefore, relatively little herbaceous cover existed. Grids at both sites covered 1600 sq. m.

F.S. Rd. 153

The boulder field at this site runs for many miles along F.S. Rd. 153 commencing at the junction with Cook County Road 27 and continuing to at least Cook County Road 4. Vegetation along this strip varies in successional stages from exposed fields of several acres to areas of late successional stages. The site selected was located across from Two Islands Lake on state property. Much of this site had an open, or partially open, canopy. The water table was high and standing water was observed at several stations. The forest floor varied from immense exposed boulders to well-developed soil in upland areas. Adjacent to the road, some areas appeared to have been burned in the recent past. The predominant tree species was black spruce but many species of light tolerant types such as birch, balsam poplar, and aspen (Populus tremuloides) were also present. Herbaceous cover varied greatly and included: honeysuckle (Lonicera sp.), thimbleberry (Rubus parviflorus), bracken fern (Pteridium aquilinum), and other more shade tolerant species such as bunchberry, twinflower, labrador tea, and Lycopodium spp. Boulders were often covered by a dense layer of moss and lichen and contained many holes and crevasses leading to underground runways. The grid at this site covered 2496 sq. m. and encompassed numerous different microhabitats.

F.S. Rd. 304

This site was characterized by extruding boulders and numerous deadfalls in the midst of a dense mixed hardwood-conifer forest. The exposed portion of the boulder field was not extensive but evidence of boulders underlying much of the nearby forest floor was noted. Many of the deadfalls were fir but it was unclear whether age, wind or infestation had recently opened up the area. Moisture levels were high but there was no evidence of standing water. Soil development on the area adjacent to the boulder field was considerable; little was present on the boulder field itself however. The predominant tree species was fir, accompained by an occasional birch, spruce and cedar. Mountain maple (Acer spicatum) was also common and contributed considerably to the shading of the forest floor. Forbs at this site varied considerably in diversity. They included Clematis (Clemaits verticillaris), Oxalis sp., Peltigera sp., twinflower, bunchberry, dewberry, Lycopodium spp., and others. Sedges were abundant in several wet areas around the periphery of the exposed boulder field and as in all locations, rocks were often covered by moss and lichens. This site was trapped twice. (See Table 1 for dates of trapping periods at each site.) During the first trapping period the grid covered approximately 1730 sq. m.; during the second period, the grid covered approximately 2370 sq. m.

F.S. Rd. 316

An extensive boulder field was located at the junction of F.S. Rd. 316 and the Gunflint Trail. This site is located in close proximity to Swamper Creek but is separated by dense forest. Upon entrance from the road, the area is heavily moss-covered and moist, with little light penetration. The exposed boulder field begins approximately 45 m. from the road and extends approximately 100 m. into dense hazel and spruce. The area trapped included boulders which were moss and lichen covered. The overstory varied from dense to partially opened. Mature trees included spruce, birch, tamarack (Larix laricina), pine (Pinus spp,), fir and balsam poplar. Shrubs included juneberry (Amelanchier sp.), alder, and dogwood. Herbaceous cover was mixed with a predominance of labrador tea, bunchberry, twinflower, dewberry, blueberry (Vaccinium spp.), wintergreen and large leaf aster (Aster macrophyllous). Some standing water was observed beneath boulders. The grid at this site covered 3200 sq. m.

F.S. Rd. 144

This potential site was described to us by a M.D.N.R. wildlife official from Grand Marais. The site apparently contains a series of boulder fields in a wet, swampy area south of Woodpile Creek. It is relatively inaccessible as the bridge on this road, which crosses the North Brule River, has been closed. Further, this site is approximately 1¼ miles north of F.S. Rd. 144 on an unmaintained trail.

MATERIALS AND METHODS

Trapping

Grids at each new site were established at the periphery of the exposed boulder field and extended into the forest to where ground vegetation was determined to be too sparse to support small mammal populations and/or where the forest floor was very dry. Size and shape of each grid therefore, varied at each site. Stations were spaced at an interval of 8 m.

with one commercial snap trap placed at each station. Traps were baited with peanut butter between 4 - 6 p.m. each evening and checked and closed the following morning between 7 - 9 a.m. Trapping continued for three nights or until the first rock vole was taken. Information on species identification and trap location was recorded. Animals were then frozen for later examination. Study skins of as many specimens as possible were prepared and stored with the University of Minnesota, Duluth, mammals collection. (Some specimens will be transferred to the Bell Museum in Minneapolis at a later date.) Following the trapping session, the vegetation, relative degree of light penetration, available free water, and rock formations at each station were characterized.

Note: As the purpose of this portion of the study was to locate new populations of rock voles and not to investigate characteristics of these populations, it was felt that the populations could best be preserved by discontinuing the snap trap effort upon capture of a single rock vole. Further study of the population dynamics at these sites might best be accomplished by live trapping.

RESULTS AND DISCUSSION

In June, M. chrotorrhinus was not trapped at any of the sites examined (Table 3). C. grapperi on the other hand was abundant and was observed in traps as both juveniles and overwintered adults. M. chrotorrhinus was trapped in July when both juveniles and adults were taken and in August when juveniles and sub-adults were trapped. These results suggest that M. chrotorrhinus, which reportedly breeds from early spring through fall (Doutt, 1973; Linzey and Linzey, 1971; Hamilton, 1943), failed to reproduce before July. As mentioned previously, precipitation was extremely low until August of 1980. One might speculate that if moisture levels are a limiting factor in the habitat selection of M. chrotorrhinus, this factor might also be reflected in the rate of successful reproduction of this species. In August, no overwintered adults were trapped. It is therefore assumed that following breeding, all overwintered animals died and only juveniles and sub-adults remained in the population.

There was a concern that M. chrotorrhinus was not trapped in June because of trap shyness. Therefore, trapping during July at the Gunflint Trail site was modified by the use of a snap trap in addition to the Fitch live trap at each station. Results (Table 4) of trapping during this period show a markedly greater trap success with snap traps than with live traps and particularly noteworthy is that M. chrotorrhinus occurred in both types of traps. In August, Sherman live traps were substituted for the Fitch type traps. During the trapping period early in August a total of 4 M. chrotorrhinus and 18 C. gapperi (180 total trap-nights) were trapped as compared to 1 M. chrotorrhinus and 5 C. gapperi trapped in July with Fitch traps (109 total trap-nights). Though trap success apparently increased

Table 3

June Trap Success

Saganaga - June 9 - 12 (150 total trap-nights)

Species	Number Trapped*
Clethrionomys grappi	10
Peromyscus maniculatus gracilis	2
Eutamias minimus	1

Gunflint Trail - June 16 - 20 (335 total trap-nights)

Species	Number Trapped*
Clethrionomys grapperi	15
Peromyscus maniculatus gracilis	5
Sorex cinereus	3

F.S. Rd. 304 - June 30 - July 3 (81 total trap-nights)

Species	Number Trapped*
Clethrionomys grapperi	1
Peromyscus maniculatus gracilis	3
Eutamias minimus	2
Sorex cinereus	2
Blarina brevicauda	1

* The number of animals trapped indicates new invidivuals only and does not include animals which were subsequently recaptured.

Table 4

Trap Success in Live and Snap Traps on
the Gunflint Trail Site During July (200 total trap-nights)

Species	Animals Trapped	
	Live Traps	Snap Traps
Clethrionomys gapperi	5	13
Eutamias minimus	1	3
Microtus chrotorrhinus	1	7
Peromyscus maniculatus gracilis	4	11
Sorex cinereus	2	9
TOTAL ANIMALS CAPTURED	13	43

during August, evidence is not complete enough to interpret this as the effect of the change in traps and may instead be due to an increase in population size.

In collecting animals for laboratory studies during August, traps were occasionally set and checked twice a day, once in the morning and again in the late afternoon. *M. chrotorrhinus* was caught during both periods confirming the results of Timm *et al*. (1977), that these animals are active during both the day and at night. In contrast to the extremely active and aggressive behavior of trapped *C. gapperi* and *M. pennsylvanicus*, *M. chrotorrhinus* was only moderately active and often docile during handling.

Relative numbers of *M. chrotorrhinus* to *C. gapperi* are considerably lower than those recorded by other investigators (Kirkland and Knipe, 1979; Kirkland, 1977; Martin, 1971) which indicate a 1:2 to 1:3 ratio respectively. Results from these studies show that this ratio more closely approximates 1:4.6 (from data on the Gunflint Trail site). Association of *M. chrotorrhinus* with other microtines (*M. pennsylvanicus* and *S. cooperi*) has been reported by Kirkland (1977), Martell and Radvanyi (1977), Kirkland and Knipe (1979), and Timm *et al*. (1977). During the initial study at the Gunflint Trail site in 1973 (Timm, 1974) the only other microtine trapped was *C. gapperi*. In the 1975 study by Timm *et al*. (1977), *S. cooperi*, *M. pennsylvanicus* and *M. chrotorrhinus* were all trapped at the site. During the current study, *S. cooperi* and *M. pennsylvanicus* were again absent (Table 5). These findings suggest interesting relationships between these species, particularily in terms of competitive exclusion and microtine cycling.

Table 5

ASSOCIATED SPECIES

	Number Trapped	% of Population Represented
Gunflint Trail Site		
Peromyscus maniculatus gracilis	32	13.5
Clethrionomys gapperi	98	41.4
Sorex cinereus	16	6.8
Eutamius minimus	51	21.5
Microtus chrotorrhinus	29	12.2
Mustela spp.	4	1.7
Blarina brevicauda	7	3.0
F.S. Rd. 152 Site		
Peromyscus maniculatus gracilis	3	33.0
Microtus chrotorrhinus	3	33.0
Clethrionomys gapperi	2	22.0
Sorex cinereus	1	11.0
F.S. Rd. 153 Site		
Peromyscus maniculatus gracilis	9	32.1
Sorex cinereus	7	25.0
Clethrionomys gapperi	9	32.1
Blarina brevicauda	2	7.1
Microtus chrotorrhinus	1	3.6
F.S. Rd. 304 Site		
Peromyscus maniculatus gracilis	8	23.5
Eutamius minimus	2	5.9
Sorex cinereus	12	35.3
Clethrionomys gapperi	9	26.5
Blarina brevicauda	2	5.9
Synaptomys cooperi	1	2.9
F.S. Rd. 316 Site		
Clethrionomys gapperi	3	30.0
Peromyscus maniculatus gracilis	1	10.0
Blarina brevicauda	1	10.0
Sorex cinereus	3	30.0
Microtus chrotorrhinus	2	20.0

The occurrence of S. cooperi and the absence of M. chrotorrhinus at the F.S. Rd. 304 was unexpected. Habitats at all sites investigated were similar and no single factor could be identified to distinguish this site from others. It is interesting to note that the association of S. cooperi with the other species at this site (Table 5) does not appear to differ from the relationship of M. chrotorrhinus and its associated species at the other sites.

Following the discovery of three new colonies of M. chrotorrhinus, it may be suggested that this species is more widespread in northern Minnesota than originally believed. The populations of these colonies, however, do not appear very large and it may be further suggested that although this species is widespread, it is not abundant in the state.

Habitat preference of M. chrotorrhinus in Minnesota appears to follow the general pattern reported throughout its range. In the sites investigated, relatively high moisture levels, cool temperatures and adequate herbaceous cover appear to be most important. Though a wide diversity of forbs were common to the Minnesota sites, evidence of nibbling was found principally on blueberry and bunchberry plants. Boulders were abundant at all new sites but their significance is unclear.

Management recommendations by Loman (1975) suggest that this species would benefit from maintenance of forests in an undisturbed state: to restrict clear cutting and permit forests to attain the later stages of natural, ecological succession. The study by Martell and Radvanyi (1977) however, shows that though clear cutting of land altered the environment and produced habitats unsuitable for M. chrotorrhinus, selective cutting of an area produced a 400 percent increase in population size over the mature forest. This study, and that by Kirkland (1977), demonstrate that some disturbance of an area probably benefits this species.

Microclimate data are listed on Table 6. These records indicate averages for the trapping period during June at each site. The differences between each of the various levels measured appear to vary enough to suggest that physiological differences could result, depending on the habitat occupied.

Further work will be undertaken during the next two years to complete the water balance study. Measurements on evaporative water loss are currently being made in the laboratory. This work will continue next fall (1981) following trapping of additional specimens this summer. Microclimate and population information will be collected the subsquent summer. Methods of measuring microclimate parameters have been modified in order to gather data more efficiently. In addition to parameters previously studied, measurement of light penetration with the use of Ozalid paper and collection of soil samples to determine substrate moisture will be added to the procedure. This study will culminate with the correlation of the results from the population distribution, microclimate and water balance studies.

Table 6

Microclimate Data

	Average T °C	Average Relative Humidity	Average Absolute Humidity	Average Saturation Deficit
Saganaga Site (June 9 - 12)				
Air T °C, 1 m. above surface	20.7	63.2	11.36	6.97
Standard Deviation	1.4	3.9	.61	1.23
Air T °C, 1 cm. above surface	20.0	67.3	11.66	5.94
Standard Deviation	1.2	3.0	.57	.94
Air T °C, runway	15.5	82.2	10.85	2.46
Standard Deviation	2.4	7.7	1.13	1.48
Minimum air T °C (2 stations)	18.1			
Maximum air T °C (2 stations)	27.2			
Gunflint Trail Site (June 17 - 21)				
Air T °C, 1 m. above surface	19.4	74.0	12.48	4.65
Standard Deviation	2.8	4.8	2.12	1.38
Air T °C, 1 cm. above surface	18.8	76.5	12.39	4.08
Standard Deviation	3.1	8.2	2.25	1.47
Air T °C, runway (8 stations)	11.9	91.3	9.69	.79
Standard Deviation	1.5	3.6	.91	.45
Soil T °C, 1 cm. below surface	18.6			
Standard Deviation	2.4			
Soil T °C, 7 cm. below surface	12.2			
Standard Deviation	2.4			
Minimum air T °C (4 stations)	4.9			
Standard Deviation	1.3			
Maximum air T °C (4 stations)	25.6			
Standard Deviation	3.3			

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