

FINAL REPORT

DISTRIBUTION AND ABUNDANCE OF THE FIVE-LINED SKINK
(Eumeces fasciatus) IN MINNESOTA

by

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submitted to

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in fulfillment of Contract A40-05825 & 05832

"dem damn dings---dem lizards have been here a hundred
years and will be here another hundred years.....
What d'ya want dem damn dings for, anyway?"

Emmit Sander
Swedes Forest
May 1982

Unfortunately, the results of this study suggest otherwise.
We will need to answer Mr. Sander's question soon.

Acknowledgements

I thank all of those who have assisted me in various ways
with this study.

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The five-lined skink (Eumeces fasciatus), a small smooth-scaled lizard, occurs in southwestern Minnesota as a disjunct population(s) on rock outcrops in a restricted region of the upper Minnesota River valley. Determination of the species' status in the state requires detailed and accurate data on its current distribution and abundance ---the objectives of the present study.

Fieldwork was carried out in May-July 1982; suitable habitat was located and surveyed for skinks. A total of 119 captures/sightings were recorded. The species was found on 26 specific sites at three localities between Granite Falls and Redwood Falls. Each locality (Swedes Forest, Delhi, and South Granite Falls) is described with respect to location, distribution, suitable habitat, skink populations, and land ownership and use. Skinks occur in high densities in favorable habitat, but skink distribution is patchy. Estimated population sizes range at maximum levels from 45,900-3600 to 4590-360 at minimum levels and vary considerably among localities. Suitable habitat is characterized by 1) proximity to bedrock exposures, 2) open sunny areas, 3) abundant cover, and 4) access to water. Bare rock openings with large and small loose rock for cover are the preferred habitat, but disturbed areas that are open and near rock outcrops are also favored. Activity and hence habitat requirements change seasonally; skinks are very active in the early spring and summer but not later in the season.

Dense stands of eastern redcedar now cover many rock outcrops which were formerly (prior to 1930s & 1940s) devoid of vegetation. Open areas on rock outcrops in 1938 occupied three times the area occupied in 1968. If cedars continue to encroach into openings at the present rate, openings will virtually disappear by 1990. Skink populations have probably declined with the reduction in the "openness" of rock outcrop habitat, and will likely continue to decline in the future as openings on the rock exposures are vegetated.

In many important life history attributes, e.g., growth rate, age at maturation, annual reproduction, the Minnesota population(s) of five-lined skinks are similar to populations in Kansas. Prairie skinks (Eumeces septentrionalis) were found at the same sites and in the same habitats with five-lined skinks. Prairie skinks appear to be inhabiting rock outcrops as these become vegetated; if so, then interactions between these two skink species may ultimately affect the distribution and abundance of five-lined skinks in Minnesota.

Protection and management of suitable skink habitat is recommended as well as prohibition on collecting/taking. Specific recommendations have been formulated for the three localities. The major threat to the species' continued existence in Minnesota appears to be the loss of suitable habitat due to the spread of eastern redcedar on previously exposed bedrock; management by controlled burning, selective cutting, etc. is considered essential. Furthermore, additional fieldwork is needed at the South Granite Falls locality and in areas south of Delhi. An appropriate public relations program is desirable in order to acquaint local residents and visitors with the various species, including skinks, which live on the rock outcrops. Specific recommendations are advanced for the overall protection, preservation, and management of the rock outcrops together with the plants and animals which inhabit this unique natural feature of the Minnesota landscape.

1.1

Project Rationale

The five-lined skink (Eumeces fasciatus) is a small, smooth-scaled lizard. The species is both terrestrial and arboreal and frequents wooded, damp habitats (Conant, 1975). Selected references are cited in the species account of the Minnesota Natural Heritage Program (1980); a summary from a monograph by Fitch (1954) on the life history and ecology of the species in Kansas is included as Appendix O. The five-lined skink inhabits the eastern woodlands and certain prairie and savannah habitats in the mid-central U.S. (Fitch, 1954; Conant, 1975). The species reaches the northern limit of its range in central Wisconsin (Vogt, 1981); but it is also recorded from the western edge of the state from the St. Croix Falls area (Breckenridge, 1944). Disjunct populations occur in northeastern Iowa and in northwestern Iowa-extreme southeastern South Dakota (Conant, 1975; see map in Appendix A). The latter population may be extirpated from South Dakota (Ashton, 1976) and Iowa (Christiansen, 1981). Another disjunct population is located in Minnesota (Breckenridge, 1944), separated from the species' main range in northern Missouri by 525 miles and in central Wisconsin by 400 miles.

The local distribution of the Minnesota population of Eumeces fasciatus has been poorly documented; specimens and/or sightings were described for only two specific localities. One of these was immediately south of the city of Granite Falls, Yellow Medicine County (NW 1/4, Sec. 4, T115N, R39W); the other was in Redwood County just east of the Yellow Medicine-Redwood County line and south of the Minnesota River (SW 1/4, Sec. 7, T114, R37W). These localities were about 10 miles apart. An earlier record in Yellow Medicine County and also one in Renville County were incorrectly figured in a recent distribution map (prepared by the Minnesota Natural Heritage Program). These specimens were in fact from the recently reported locality in Redwood County (locality cited above; Breckenridge, 1944). Brecke (1979) searched for skinks on two field trips to the known localities, but these efforts were brief (2-3 days), were hampered by rainy weather, and were carried out (as Brecke correctly noted) at the "wrong" time of year, i.e., during the summer months when skinks are typically secretive (Fitch, 1954; Fitch and Von Achen, 1977; Vogt, 1981; Lang, unpublished observations).

With the exception of Brecke's limited efforts, the occurrence of the five-lined skink in Minnesota has not been documented in recent years. Furthermore, the distribution and abundance of the species in the state, to my knowledge, has never been studied systematically and/or in detail.

As a consequence, the current status of Eumeces fasciatus has been difficult to determine. Previous status determinations listed the five-lined skink as 1) a "peripheral" species (Breckenridge in Ashton, 1976), 2) a "priority" species (Uncommon Ones, DNR, 1980), 3) a "special" animal (Minnesota Natural Heritage Program, 1980), and 4) a "threatened" species (Endangered Species Technical Advisory Committee, 1982; see Appendix A). In these reports, the recommendations were unanimous that research be initiated in order to learn more about the present distribution and abundance of the species in Minnesota. The recommended research activities include studies of distribution, determinations of population size, and estimates of population trends (Minnesota Natural Heritage Program, 1980). Maintenance of habitat and protection from human disturbance have been listed as possible management schemes; but both strategies require recent, detailed, and accurate data on the distribution and abundance of the species.

1.2 Study Objectives

The objective of this study was to determine the distribution and abundance of the five-lined skink in the Minnesota River Valley. The specific objectives were:

- 1) to delineate the present distribution of the species initially within a four county region (Yellow Medicine, Chippewa, Redwood, and Renville) and additionally in other areas as indicated by recent evidence (records, sightings, etc.),
- 2) to identify within the Minnesota range of the species localities where it appears to be relatively common and/or abundant,
- 3) to determine and define the specific habitat and/or life history requirements that control or limit the species' distribution and/or abundance,
- 4) to estimate abundance, movement and activity patterns, and survivorship trends in selected populations (where feasible) by utilizing live capture techniques within the limited period of study.

2.1 Study Schedule and Methodology

The field research was conducted during the month of May in order to achieve the objectives listed above. The study was carried out in three phases: 1) preparation (February-April), 2) field work (May-June), 3) analysis and report (July-September).

Prior to commencing fieldwork, I reviewed and evaluated existing information on the five-lined skink in Minnesota (summarized above) and examined the records and specimens available at the Bell Museum of Natural History, University of Minnesota. I spoke by phone with Bruce Brecke, Ron Huber, and Welby Smith to clarify previous locality records for the species in Minnesota reported recently by them. I also attempted to contact interested persons in the study area without success. Institutions/museums which may have held specimens of Eumeces fasciatus from Minnesota localities were contacted by letter; the results of this survey are summarized in Appendix B which includes copies of my letter and responses. The results of these additional investigations (prior to conducting fieldwork) confirmed my initial supposition that the species was known only from the two localities outlined in section 1.1.

Evaluation and assessment of previous records was facilitated by assembling relevant topographic and geologic maps and 1:20,000 aerial photos of the study region; in addition, plat maps of the land ownership of selected townships were obtained. These materials were readily available in the Map Library, Wilson Library, University of Minnesota. Local phone directories were obtained to facilitate contacts with property owners, but no contacts were made prior to fieldwork. Field supplies and equipment were organized.

I initiated fieldwork on 11 May and was in the field daily through 27 May. During this period, Michael Tenneson worked as a very effective and competent research assistant. In addition, I made two subsequent visits to

the study area in June (4-6) and July (5-11). Thus, person-days in the field on the project totaled 41 days; and on most days, an average of 8-10 hours were spent on reconnaissance and collection (=350+ hours in the field). Friends/colleagues assisted in the field on a number of occasions. In addition, I spent one day in the field visiting sites with Ms. Emily Nietering who was surveying the rock outcrops in the region for plant species of interest in conjunction with the Nature Conservancy. Furthermore, captive skinks were maintained and observed in indoor enclosures in the lab at UND during June-August.

A base of operations was established with the kind permission of Richard Tjossas, Park Supervisor, and Sandra Berg, Minnesota Historical Society Site Manager, at the Upper Sioux Agency State Park. Posters illustrating the skink and soliciting information were distributed locally at cafes, meeting places, park shelters, etc. in the Granite Falls-Redwood Falls area (Appendix C), and local contacts were made with DNR personnel and other interested persons. A set of photos were used to compare the two species of skinks when interviewing local residents about the presence of skinks (Appendix D). Initially, the two known localities (outlined in section 1.1) were surveyed for skinks. Subsequent fieldwork involved: 1) intensive sampling at and in the vicinity of known localities, and 2) extensive searching in adjacent areas judged to be suitable for skinks.

Fieldwork consisted primarily of surveying potential habitats as determined from maps and air photos, informants, and/or inspection from the road; these areas were searched on foot for the presence of skinks. Permission was obtained to look for skinks on private land. Skinks were seldom seen on the surface; so most cover items, including large rocks, were turned in efforts to locate skinks. Later, at some localities, cover items were positioned deliberately to attract skinks, a technique which was often effective within 1-2 days.

When a skink was found, it was captured if possible and notes were taken on features of its habitat. All the captures and/or sightings were recorded on data sheets that were coded for computer compilation; an example of the data sheet illustrates the format and lists the variables recorded at each encounter (Appendix E). Most of the captured skinks were marked and subsequently released at the site of capture. At one locality, skinks were captured and held for several weeks before release in an effort to assess local abundance. Other captives were maintained in large enclosures in the lab for behavioral observations; and a small number of skinks from new localities were preserved as museum specimens (to be deposited in the herpetology collection, Bell Museum of Natural History, University of Minnesota; field numbers listed in Appendix B).

3.0 RESULTS

3.1 Introduction

A total of 73 five-lined skinks (Eumeces fasciatus) were captured during the present study. Of these, 22 were retained in captivity for further investigation; the rest were released at sites of capture. In addition, 32 sightings were combined with 14 sightings by reliable informants to provide a total of 119 records (Appendix F). The distributions of skink age and sex relative to the total released, held captive, and sighted are summarized in Table 1. Five-lined skinks were collected at three localities (described in detail in section 3.3); the distributions of skink age and sex with respect to locality are summarized in Table 2.

Table 1. Distribution of 119 records of five-lined skinks (Eumeces fasciatus) from Minnesota which were examined and released (=O), held captive(=C), or sighted(=S) with respect to age and sex.

	<u>young</u>	<u>males</u>	<u>females</u>	<u>unident.</u> <u>adults</u>	<u>totals</u>
.O	26	9	16		51
.C	3	10	9		22
.S	11	12	5	18	46
	<u>40</u>	<u>31</u>	<u>30</u>	<u>18</u>	<u>119</u>

Table 2. Distribution of 119 records of five-lined skinks (Eumeces fasciatus) from Minnesota localities (Swedes Forest, Delhi, and South Granite Falls) with respect to age and sex.

	<u>young</u>	<u>males</u>	<u>females</u>	<u>unident.</u> <u>adults</u>	<u>totals</u>
Swedes Forest	23	11	14	9	57
Delhi	4	10	4	1	19
South Granite	14	10	12	7	43
	<u>41</u>	<u>31</u>	<u>30</u>	<u>17</u>	<u>119</u>

3.2 Identity of Skinks in the Minnesota River Valley

The identity of the skinks found in the Minnesota River Valley as Eumeces fasciatus (Breckenridge, 1944; Conant, 1975) was verified in this study. Five-lined skinks (Eumeces fasciatus) are readily distinguished from prairie skinks (Eumeces septentrionalis), a sympatric species in Minnesota, by 1) presence of a postnasal scale, 2) extension of median light line onto the top of the head, and 3) presence of five rather than seven light stripes on body (Breckenridge, 1943). Skinks found at the three Minnesota localities (see section 3.3 and Appendix F) were identified using the criteria of Taylor (1936; summarized by Fitch, 1954). These include: 1) a five-lined juvenal pattern, 2) postnasal present, 3) maximum snout-vent length of 80 mm., 4) postmental=2, 5) 28-30 scale rows at midbody, 6) postanal scales undifferentiated, 7) large scales on the back of the thigh absent, and 8) median subcaudals widened. This suite of characters is sufficient to separate the fasciatus group from other groups in the genus and the species fasciatus from the closely-allied laticeps and inexpectatus. Representative photos of Minnesota specimens of Eumeces fasciatus are included in Appendix G (photos 53-59,63).

A detailed study of the scutellation of the Minnesota populations has not been possible previously because so few specimens were available, particularly with specific locality data (see Appendix B). A comparison of this sort is now feasible, but has not been attempted as part of this study. Morphological differentiation of the Minnesota populations from populations to the south and east at the subspecific level seems unlikely. Taylor (1936) comments on the lack of geographic variation in the morphology of the species despite its extensive range, and Fitch (1954) notes that species differences between fasciatus and inexpectatus are at the level usually found between subspecies of the same species in both morphology and ecology. Apparently, the species fasciatus has differentiated little and is generally recognized as conservative in its morphology. My limited observations of Missouri vs. Minnesota populations of the five-lined skink bear out this supposition. The appearance and habits of the species from these dissimilar habitats were remarkably similar.

3.3 Distribution

3.3.1 Introduction

The area surveyed in this study extended from Montevideo southeast along the Minnesota River Valley to Franklin, a distance of 55 miles. Potential habitats in eleven townships of four counties were examined systematically for skinks (Figure 1). In addition, brief visits were made to selected localities in the Ortonville-Odessa area (Figure 1) as well as to Blue Mounds State Park in Rock County. A total of 90 locality records (designated to the nearest 1/64th of a section=10 acres; section grid included as Appendix H) are listed in order from the northwest to southeast in Table 3. This listing is a compilation of 1) specific sites examined for skinks during this study (55 sites + 6 return visits=61 records), 2) 1962 sightings by others (interviewed by me=9 records; details in Appendix F), and 3) previous records based on reports and specimens (=20 records including some sites reexamined in

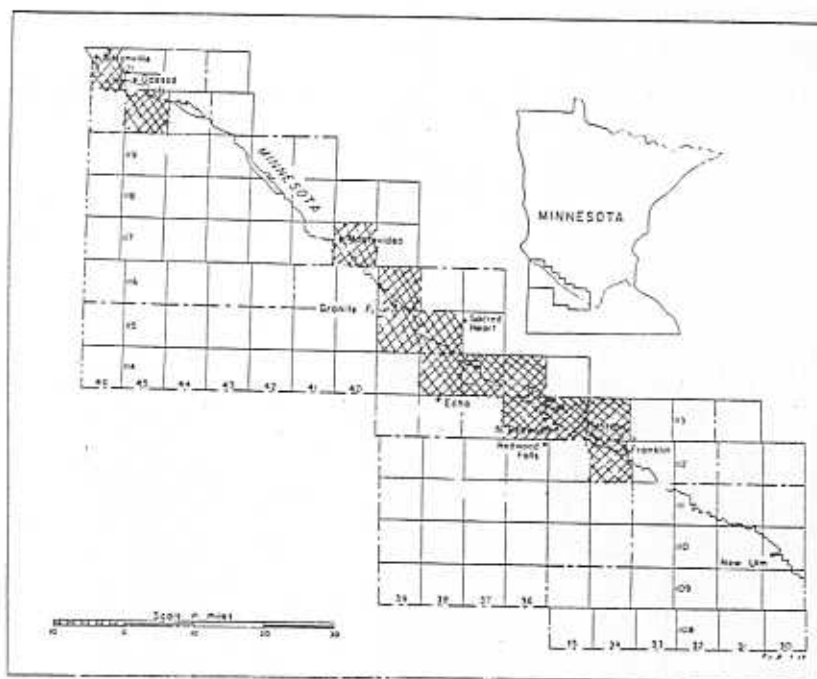


Figure 1. Location of the study sites in the upper Minnesota River valley. Townships surveyed in this study are shown with cross-hatching.

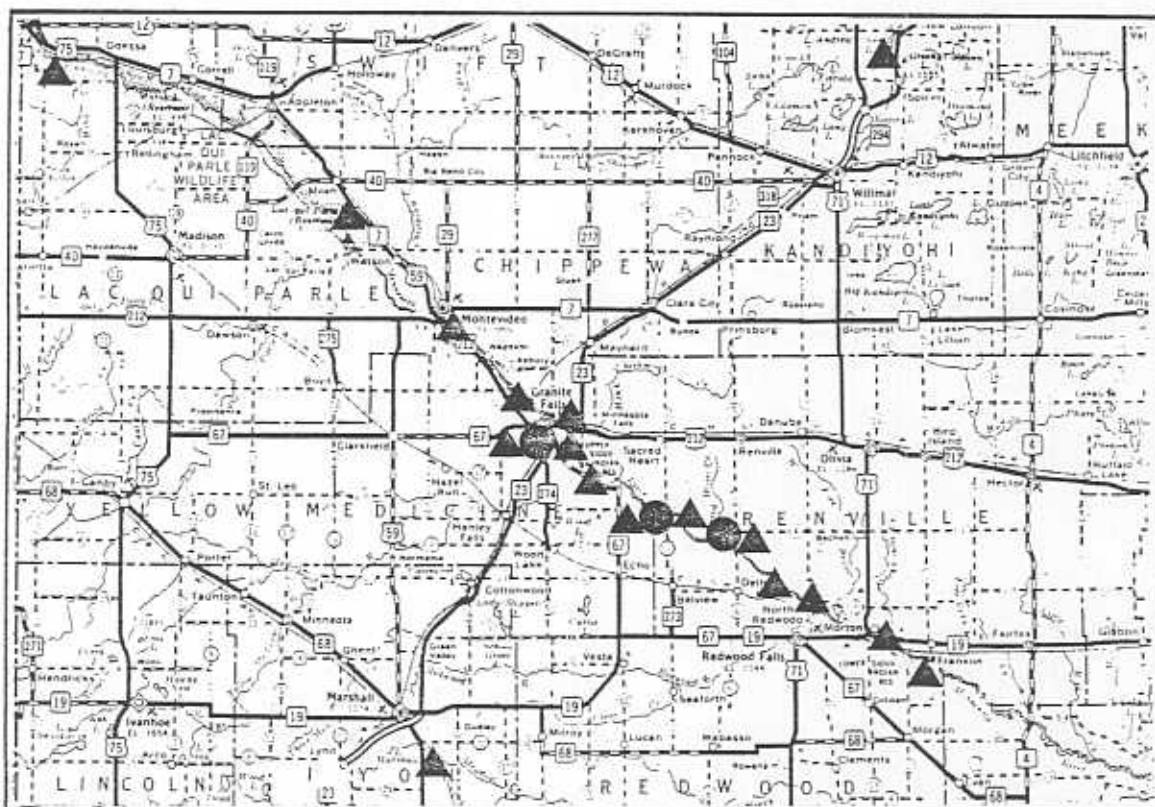


Figure 2. Regional distribution of prairie skinks (circles) and five-lined skinks (triangles) in southwestern Minnesota [base map=state highway map 1982].

Table 3. Specific sites from which skinks have been recorded in the upper Minnesota River valley. Localities are designated to the nearest 1/64 of a section=10 acres; in some instances, the time when the site was examined is also indicated. The observations, specimens, and records of W. Breckenridge, B. Brecke, and W. Smith have been included here and cross-referenced with the sites examined in this study. The specific sites at each of the three localities where five-lined skinks were recorded are listed under the locality heading.

DATE ****	LOCALITY *****	TWN RM SEC 1/4 16 64 *****	TIME ****	SKINKS *****
05-22-82	BIG STONE NWR	121-46-27 NE	11-12	S
05-22-82	BIG STONE NWR	121-45-27 SE	12-13	S
05-22-82	ODESSA QUARRIES	120-45-15 NW	13-14	NONE
05-22-82	ODESSA QUARRIES	120-45-15 SW	13-14	NONE
05-22-82	BLUE MOUND S.P.	103-45-24 SE	14-18	S
07-12-79	MONTEVIDEO QUARRY*	117-40-29 NW NW		S
07-12-79	MONTEVIDEO OUTCROP*	117-40-20 SW SE		NONE
07-06-82	MONTEVIDEO OUTCROP	117-40-20 SE SE NW	09-11	NONE
05-14-82	FARM N. GREEN CO.	114-39-29 NE SE SW	15-16	S
05-14-82	GREEN CO. QUARRY	114-39-37 NE NE NE	14-15	S
S. GRANITE FALLS				
05-14-82	N. OF BAKER PASTURE	115-39-04 NW NW SE	09-10	NONE
05-14-82	N. OF BAKER PASTURE	115-39-04 NW NE SW	10-11	S
05-14-82	HINZ PROPERTY	115-39-04 NE SW NW	11-12	F, S
07-12-79	BAKKE PROPERTY*	115-39-04 NE NW SW		F
05-19-82	BAKKE ROAD SITE	115-39-04 NE NE NW	08-10	F, S
05-19-82	BAKKE SALT BARN	115-39-04 NE NE SW	08-10	F, S
07-09-82	YFI MD CO HIST MUSE	115-39-04 NE NE NE	S	F
07-07-82	HINZ PROPERTY	115-39-04 NE SW SE	10-12	NONE
07-09-82	HINZ PROPERTY	115-39-04 NE SW SW	S	F
07-07-82	SEARING PROPERTY	115-39-04 NE SE W	18-20	NONE
07-12-79	HINZ-SEARING PTY*	115-39-04 SW		NONE
07-08-82	SEARING PROPERTY	115-39-03 NW SW NW	10-12	NONE
05-18-82	NELSON RESIDENCE	115-39-03 NW SE NW	S	F
07-08-82	MEMORIAL PARK	115-39-03 NW NW SE	S	F
07-08-82	MEMORIAL PARK	115-39-03 NW SW NE	09-11	NONE
07-08-82	MEMORIAL PARK	115-39-03 NE NW S	18-20	NONE
07-13-79	MEMORIAL PARK*	115-39-03 NE		NONE
07-09-82	EAST G.E. OFF PARK	115-39-03 NW NW NW	10-12	NONE
06-22-82	RYRSIDE SANITORM*	115-39-02 NE		S
05-17-82	DE F HOMME FARM	115-39-11 SW NE NW	14-16	S
07-08-82	DE F HOMME FARM	115-39-11 SW NE NW	12-14	S
05-13-82	IL. ST. LOUIS AGNCY S.P.	115-38-29 SE NW SW	08-09	S
05-24-82	IL. ST. LOUIS AGNCY S.P.	115-38-30 SE SE NE	16-17	S
06-06-82	IL. ST. LOUIS AGNCY S.P.	115-38-30 SE SE NE	19-20	S
07-06-82	IL. ST. LOUIS AGNCY S.P.	115-38-30 SE SE NE	18-19	S
* SWEDEN FOREST				
05-20-82	HOMME (KOIJN) FARM	114-38-12 NE SW NW	S	F
05-14-82	WIRSCHER FARM	114-37-07 SW NW NW	S	F
05-15-82	SOUTH QUARRY (ARN)	114-38-13 NE NE SW	14-16	F, S
07-07-82	SOUTH QUARRY (ARN)	114-38-13 NE NE SE	08-10	F
07-28-79	SMITH QUARRY (ARN)*	114-37-07 SW SW		F
05-20-82	SMITH QUARRY (ARN)	114-37-07 SW SW NE	10-12	F, S
07-10-82	ROADSIDE F. SMITH QY	114-37-07 SW SE SE	08-09	F
07-12-79	VIEW QUARRY N. RD*	114-37-07 SW SE NE		F
05-13-82	ACTIVE QUARRY	114-37-18 NE NW SW	16-18	F, S
05-15-82	ACTIVE QUARRY	114-37-18 NW NE SE	10-12	F, S

07-11-79	SANDERS' CORNER*	114-37-08	SW		F, S
08-00-80	SANDERS' CORNER***	114-37-08	SW SW SW		F
05-15-82	SANDERS' CORNER	114-37-08	SW SW SW	09-11	F, S
07-09-82	SANDERS' CORNER	114-37-08	SW SW SW	16-18	F, S
05-24-82	KNITSON PROPERTY	114-37-07	NE NW SE	10-12	F, S
07-07-82	KNITSON PROPERTY	114-37-07	NE NW SE	12-13	F
05-12-82	LECY RESIDENCE	114-37-18	NW SW SW	S	F, S
07-08-82	LECY RESIDENCE	114-37-18	SW NW NW	18-19	S
07-09-82	SANDER E. OUTCROP	114-37-08	SW NW SE	10-12	F, S
05-25-82	HWY 7, SE OUTCROP	114-37-08	NW NW SW	09-10	S
05-20-82	SANDERS' SE OUTCROP	114-37-08	SE SW SE	S	F
06-23-89	BROWN MANSTON**	114-37-08	NE SE NE		S
05-15-82	BROWN WAYSTONE	114-37-08	NE SE NE	11-12	NONE
05-24-82	ENSTVEDT SEED CO.	114-37-16	NE SW SW	09-11	S

DELIST

05-23-82	HILL TOUTST FARM	114-37-24	SE NE SW	09-12	NONE
05-30-82	RENUVE CTY PK 2	114-36-19	SW NE SW	S	S
05-20-82	RENUVE CTY PK 2	114-36-19	SW NE SE	13-15	F
05-20-82	RENUVE CTY PK 2	114-36-19	SW SE NE	13-15	F
05-19-82	STONE'S RESIDENCE	114-36-19	SE SW NW	11-12	F
05-19-82	WILTER PASTURE	114-36-30	SE SW NE	10-12	S

07-28-79	KERKHOF PASTURE*	114-36-30	SW		NONE
07-28-79	KERKHOF PASTURE*	114-36-30	NW		NONE
05-19-82	KERKHOF PASTURE	114-36-30	SE NE SW	13-14	S
05-19-82	PRAHL PASTURE	114-36-29	NW SW NE	12-13	NONE
05-20-82	WILTER FARM (RN)	114-36-29	NW NE NW	15-16	NONE
05-21-82	MERTENS FARM	113-36-03	SW SE SE	10-12	S
05-21-82	MERTENS FARM	113-36-10	NW NE NE	10-12	S
05-12-82	CEDAR ROCK WMA	113-36-03	SE SE SE	16-18	S
05-19-82	CEDAR ROCK WMA	113-36-03	NW NW SE	14-16	S
05-23-82	MUETZEL+SCHMIDT	113-36-11	NE NW NE	13-15	NONE
05-23-82	MUETZEL+SCHMIDT	113-36-12	SE SW SW	13-15	NONE
07-29-79	BEAVER FALLS*	113-35-20	SW		NONE
06-05-82	KEMNITZ PROPERTY	113-35-20	SE NW NE	10-11	S
07-13-79	TIGER LAKE*	113-35-34	NE		NONE
05-18-82	TIGER LAKE	113-35-34	NE	16-18	NONE
07-27-79	MORTON OUTCROP*	113-34-31	NW		NONE
06-04-82	MORTON OUTCROP	113-34-31	NW SW NE	15-16	NONE
07-10-82	MORTON OUTCROP	113-34-31	NW SW NE	10-11	NONE
07-27-79	MORTON QUARRY (ARN)*	113-34-31	SE NW SE		S
06-05-82	MORTON QUARRY (ACT)	113-34-31	SE NE NE	10-12	S
06-05-82	MORTON QUARRY (ACT)	113-34-31	SE NW NE	10-12	S
07-29-79	CEDAR MOUNTAIN*	112-34-15	E		NONE
07-29-79	CEDAR MOUNTAIN*	112-34-14	W		NONE
06-05-82	CEDAR MOUNTAIN	112-34-15	SE NE NE	14-16	S
07-28-79	LAKE MARSHALL*	110-41-25	SW		S

KEY:

**=R. RECKE
 ***=RECKENRIDGE
 ****=WEIRY SMITH

S=STIGHT-
 ING

S=SEPTENTRIONAL IS
 (PRAIRIE)
 F=FASCITUS
 (S-I INF)

1982. Photographs of a number of the sites listed in Table 3 are included in Appendix G. The records listed in Table 3 and several additional records from the region (Bell Museum #795; DNR Uncommon Wildlife Report Summary-D. Larson, B. Meyer, and C. Henderson) have been incorporated into a map summarizing the distribution of the two species of skinks in the Upper Minnesota River Valley and environs (Figure 2).

In Minnesota, the distribution of the prairie skink (Eumeces septentrionalis) is widespread (Breckenridge, 1944; Figure 2). The species occurs at localities outside the Minnesota River Valley as well as in the valley and is found in a variety of habitats, including woodland and grassland on soil, sand, gravel, and rock substrates. In contrast, on the basis of available data, the distribution of five-lined skinks is limited to a 20 mile stretch of the upper Minnesota River Valley between Granite Falls and Redwood Falls (Figure 2). The species is restricted to the river valley floor where it is associated with exposed bedrock. Within this section of the valley, five-lined skinks have been found at three separate localities in 1982, including the two localities previously reported and a new locality discovered during this survey.

These three localities are designated as: Swedes Forest (=1), Delhi (=2), and South Granite Falls (=3) and are shown on Figure 3. The distances between the localities are: Swedes Forest-Delhi=6 miles, Swedes Forest-South Granite Falls=14 miles, Delhi-South Granite Falls=20 miles. Substantial numbers of breeding adults and young were found at all three of these localities in 1982, indicating the existence of breeding units at each locality. The absence of skinks and/or suitable habitat in the intervening areas suggests that these are three apparently separate populations.

The granite rocks in the region are among the oldest in the world, dating 2,600-3,000 million years ago; detailed maps of the granite and gneiss formations were presented by Lund (1950, 1956). Other selected references on the precambrian rocks of the valley include: Goldich, et al., 1961; Himmelberg, 1968; Grant, 1972; and Goldich, 1972. The quaternary geology and vegetation of the region is summarized by Matsch (1972) and Wright (1972) respectively. The soils in the area are described in Hokanson (1981). On the valley floor in the outcrop areas, the dominant type is Copaston-Rock outcrop (=well drained, undulating to steep soils formed in alluvium and colluvium over bedrock; areas of rock outcrop). The valley itself extends through a till plain and contains a river which is grossly underfit; the physiography of the region is described by Wright (1972)(see Appendix P). A description of the climate included in the account by Hokanson (1981) is included as Appendix N. The original vegetation on the till plains surrounding the Minnesota River was upland tallgrass prairie; river bottom forest and oak openings and barrens occupied the valley (Marschner, 1930). The tree species characteristic of river bottom forest include elm, ash, cottonwood, boxelder, oaks, basswood, maple, willow and aspen. The oak openings are dominated primarily by bur oak.

3.3.2 Swedes Forest (=Locality 1)

3.3.2.1 Location

Swedes Forest is located in the extreme northwest corner of Redwood County in Swedes Forest Township (T114N,R37W) and adjacent parts of Yellow Medicine County to the west and Renville County to the north (Figure 3). This area, known locally as "Rock Valley," is distinguished by prominent exposures of Sacred Heart granite and Morton gneiss. Abandoned quarries and grout piles are numerous in the area, but active quarrying has been restricted principally to one site on the south side of Iverson Lake in recent years (Figure 4). Eastern redcedar (Juniperus virginiana) is the dominant tree species on the bedrock exposures many of which are covered with dense stands of this species. The combination of elevated topography and evergreen vegetation delineates the region from the surrounding terrain in the valley. The prominent landscape features and vegetation of the locality are shown in Figure 6 and illustrated by photos 27,28,30,&34 (Appendix G).

3.3.2.2 Distribution

The local distribution of both species of skinks in the Swedes Forest area is presented in Figure 5. Within this area, skinks were captured and/or sighted at 17 specific sites (Table 3; Figure 5). Five-lined skinks (Eumeces fasciatus) were found at 13 sites located on the four large rock units and on three small adjoining outcrops (drawn in outline on Figure 5). Prior to this study, the species was recorded at three specific sites in the area (Brecke and Smith, unpublished observations). Skinks were collected and/or observed repeatedly at 7 sites (south quarry, smith quarry, active quarry, Sanders corner, Lacy residence, Sanders east field, Knutson property); at all of these sites, both species were found in identical situations (in some cases, under the same rock) with no apparent habitat separation. At two sites located on the east (=Enestvedt Seed Co.) and northeast (=Brown mansion) of the river and on the periphery of the granite/gneiss exposures, only prairie skinks (Eumeces septentrionalis) have been found (Figure 5).

The presence of five-lined skinks on the Knutson property (Figure 5, area "b") across the river to the north suggests that the Minnesota River in this region is probably not an effective barrier to skink movements. According to local residents, the river channel is narrow and very shallow in places during most years late in the summer; and, in dry years, it consists of a series of isolated pools. In addition, in recent times, bridges span the river at numerous locations, providing easy access across the channel. Furthermore, both species of skinks regularly retreat to water when threatened and readily dive and submerge underwater. An alternate explanation for the presence of skinks on the Knutson property is that the river changed course during Holocene time, and in the process isolated a population of skinks at this locality. This explanation seems less likely in light of the skinks' aquatic tendencies. It should also be noted that the rock type on the Knutson property (=Morton gneiss) differs from the type at other sites at the Swedes Forest locality (=Sacred Heart granite) (Figure 4). Consequently, it seems unlikely that rock composition per se constitutes a specific habitat requirement for either species of skink.

Figure 6. Aerial photo (composite; scale=1:20,000) of Swedes Forest locality showing vegetation and landforms.

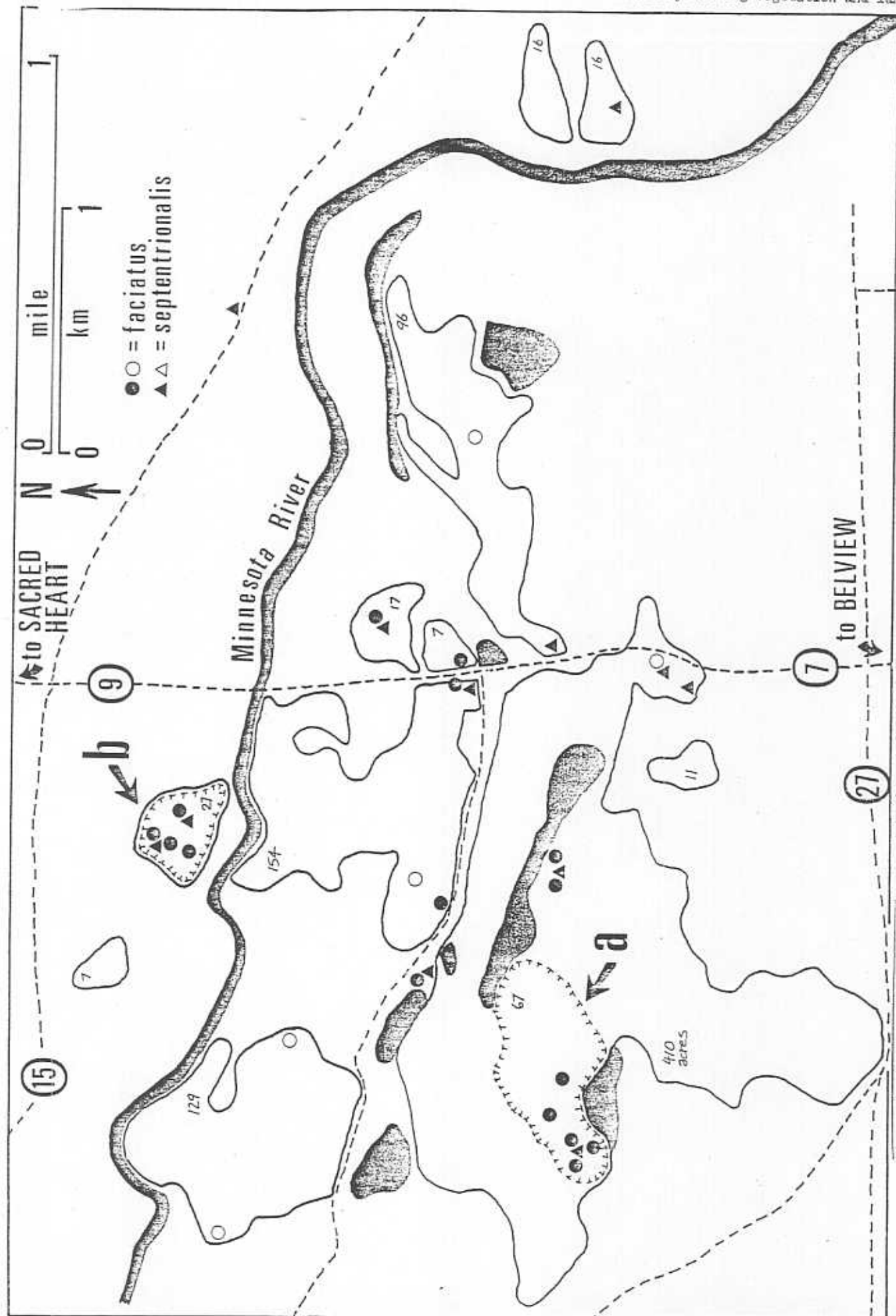


Figure 5. Distribution of five-lined skinks (circles; solid=capture; open=sighting) and prairie skinks (triangles; solid=capture; open=sighting) at Swedes Forest (=locality 1). Solid black lines enclose rock exposures and associated woodland; areal extent indicated in acres within each unit. Areas denoted with dashed lines ("a"=south quarry; "b"=limestone quarry) were analyzed for vegetation change (see section 3.5.3). Total area of suitable habitat at this locality=260 hectares or 648 acres.



3.3.2.3 Habitat

The habitats at the Swedes Forest locality judged to be suitable for five-lined skinks (=rock outcrops and associated woodland) comprises 369 hectares or 918 acres in total area (Figure 5; excluding Enestvedt Seed property=32 acres and 7 acres NW of Knutson property). Specific sites where five-lined skinks were commonly found were open (=sunny exposures) with adjacent woodland (\leq trees 100m from the capture site). Typical natural sites were open, south-facing rock exposures with little or no vegetation and with loose rock on the bedrock surfaces. Examples in this area were: south quarry (Figure 5, area "a"; photo 34, Appendix G) and Knutson property (Figure 5, area "b"; photo 37, Appendix G). Skinks were also found at sites disturbed by human activities, including the active quarry (s. of Iverson Lake), abandoned quarries (south quarry), roadside rock outcrops (roadside E. of Smith's quarry, photo 28, Appendix G; Sanders corner, photo 27, Appendix G), old fields near quarries (Smith's quarry, photo 32, Appendix G), and rock exposures in grazed fields (Sanders east outcrop, photo 30, Appendix G).

3.3.2.4 Skink Population(s)

A total of 57 five-lined skinks were observed/captured at the Swedes Forest locality; of these, 23 (40%) were young (Table 2). During the study, skinks of all age classes were found at most sites, both natural and disturbed. Gravid females and breeding males (with bright orange-red head coloration) were seen in May. Females brooding eggs were discovered under large rocks in natural and disturbed locations in July (nest along roadside E. of Smith's quarry, photos 28-29, Appendix G; nest on Knutson property, photos 37-38, Appendix G).

3.3.2.5 Land Ownership and Use

All of the habitat suitable for skinks at the Swedes Forest locality is currently in private ownership. A map of land ownership at the locality has been assembled from county plat maps with updates in the field (Figure 7). Most of the landowners reside locally; a directory of residents is provided in Appendix I. The principle commercial landowner is View Quarry Co, a subsidiary of Rex Granite Co. in St. Cloud, Minnesota. Virtually all of this tract (99 hectares=248 acres) contains habitat suitable for skinks. The company operates the only active quarry in the area; Marv Skogen, a local resident, is foreman at the quarry.

At present, quarrying is limited to an area of less than 10 acres at a site occupied for a considerable length of time; numerous other quarries, most operated for only a short time and now abandoned, dot the area (Figure 4). Agricultural use of suitable habitat is limited to grazing, particularly on the properties owned by Sanders, Wurscher, and Homme. The rough rocky terrain precludes cultivation of crops; limited quantities of timber, mostly redcedar, are currently being harvested from some rock exposures (Wurscher property). An extensive gravel deposit on an adjacent property (Melvin Grannes) is mined periodically. A number of local residences are located on or next to rock outcrops.

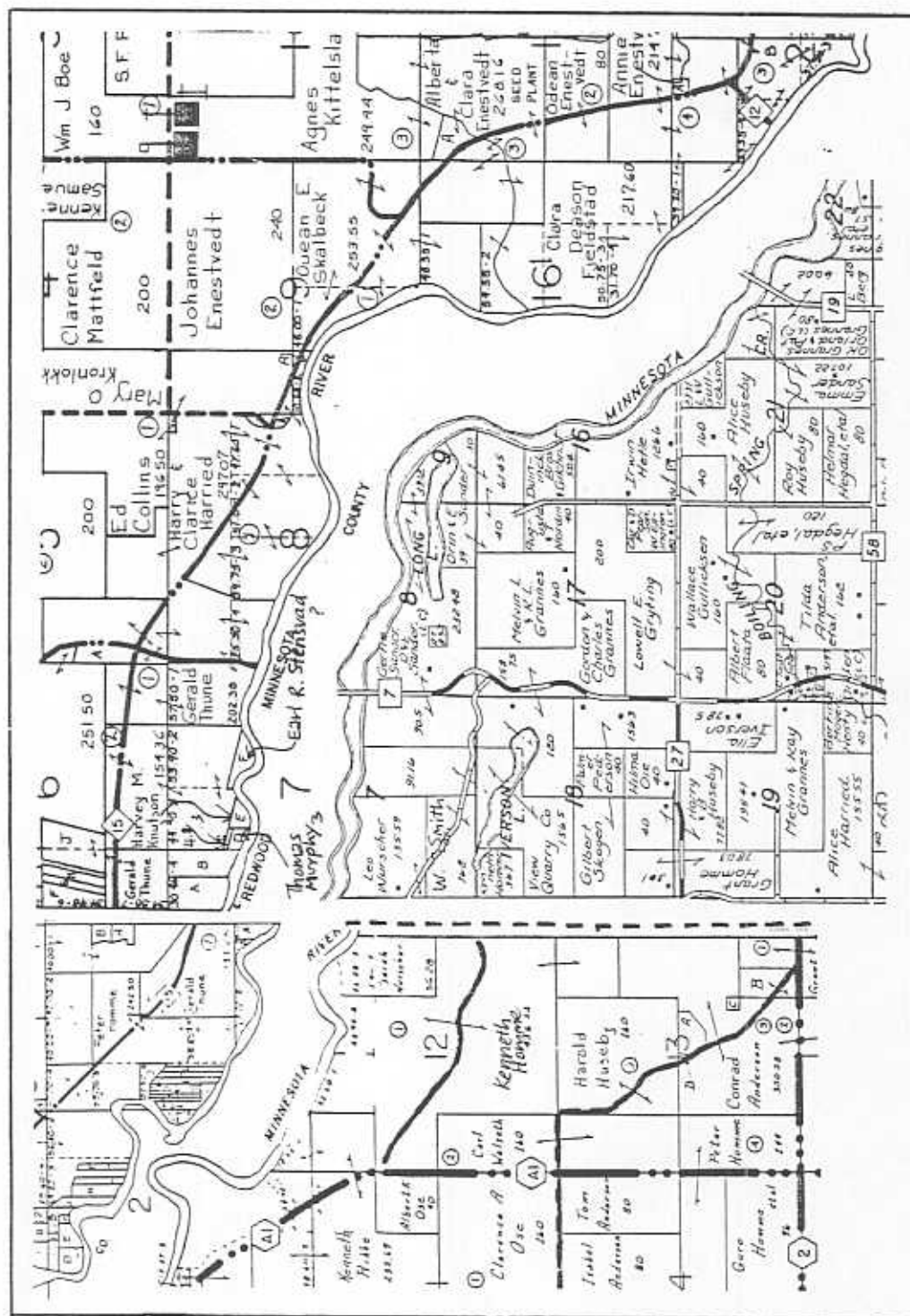


Figure 7. Land ownership at Sweden Forest locality (=1). Dotted line on south side of river separates Yellow Medicine (left) and Redwood (right) counties; Renville county lies north of the river. A directory of landowners is included in Appendix 1.

3.3.3 Delhi (=Locality 2)

3.3.3.1 Location

The Delhi locality is situated 6 miles southeast (downriver) of Swedes Forest on the north bank of the Minnesota River and south of the town of Renville; it is located in Renville County (Figure 3). This locality was first discovered during fieldwork for this study and represents an extension of the range of *Eumeces fasciatus* in Minnesota. The rock exposures in this area are Morton gneiss; redcedar is the dominant tree species, growing in dense monotypic stands on the exposed bedrock. The prominent landscape features and vegetation of the locality are shown in Figure 10.

3.3.3.2 Distribution

The distribution of skinks at the Delhi locality is mapped in Figure 8. Five-lined skinks were collected/observed at three specific sites on and near one rock formation, but the species was not found on adjacent rock exposures to the west across the river (=Hultquist property) and to the south (=Wolter and Kerkhoff properties) and east (=Prahl property) despite searches in these areas (Figure 8). Prairie skinks were collected and/or observed at several of the adjacent sites; but, in contrast to the Swedes Forest and South Granite Falls localities, the two species were not found together at the same sites here.

Two of the Delhi sites where five-lined skinks occurred were south-facing, open bedrock exposures rising steeply above the valley floor. Rocks, both large and small, were scattered on the bedrock in these openings, surrounded by dense stands of cedar (Renville County Park No.2; photos 43,44, Appendix G). Lifting rocks on such exposures was the most reliable method of collecting skinks (photos 45,46 Appendix G). Natural habitat such as these two sites contrasted with the third site; it was nearby, in the yard and outbuildings of a private residence located at the base of the same rock formation (=Stone's residence; photo 47, Appendix G). Five-lined skinks were observed readily moving on storage buildings, wood piles, and other cover at this site on warm, sunny days in May. They were also collected easily under cover (i.e. metal roofing, boards, tarpaper, etc.) in the early morning and on cool days in May.

3.3.3.3 Habitat

The habitat at the Delhi locality judged to be suitable for five-lined skinks (=rock outcrops and associated woodland) comprised 29 hectares or 74 acres in total area (Figure 8). Two rock outcrops lying to the south (17 hectares or 43 acres) and east (15 hectares or 38 acres) lack open rock exposures; no skinks were found on or near these outcrops. Across the river, there is a large tract of woodland (=Hultquist property; 94 hectares or 235 acres); prominent rock outcrops are located on its eastern perimeter directly above the river. These rock exposures (photo 42, Appendix G) face east-northeast and are similar in type and surface relief to the south-facing outcrops on the opposite bank where the skinks were found (photo 43, Appendix G). Neither species of skink was found at this site (Table 3). Prairie skinks were found on rock outcrops to the southeast of the Hultquist property on the south side of the river (=Wolter and Kerkhoff properties; Figure 8; Table 3).

Figure 10. Aerial photo (scale=1:20,000) of Delhi locality showing vegetation and landforms in 1967

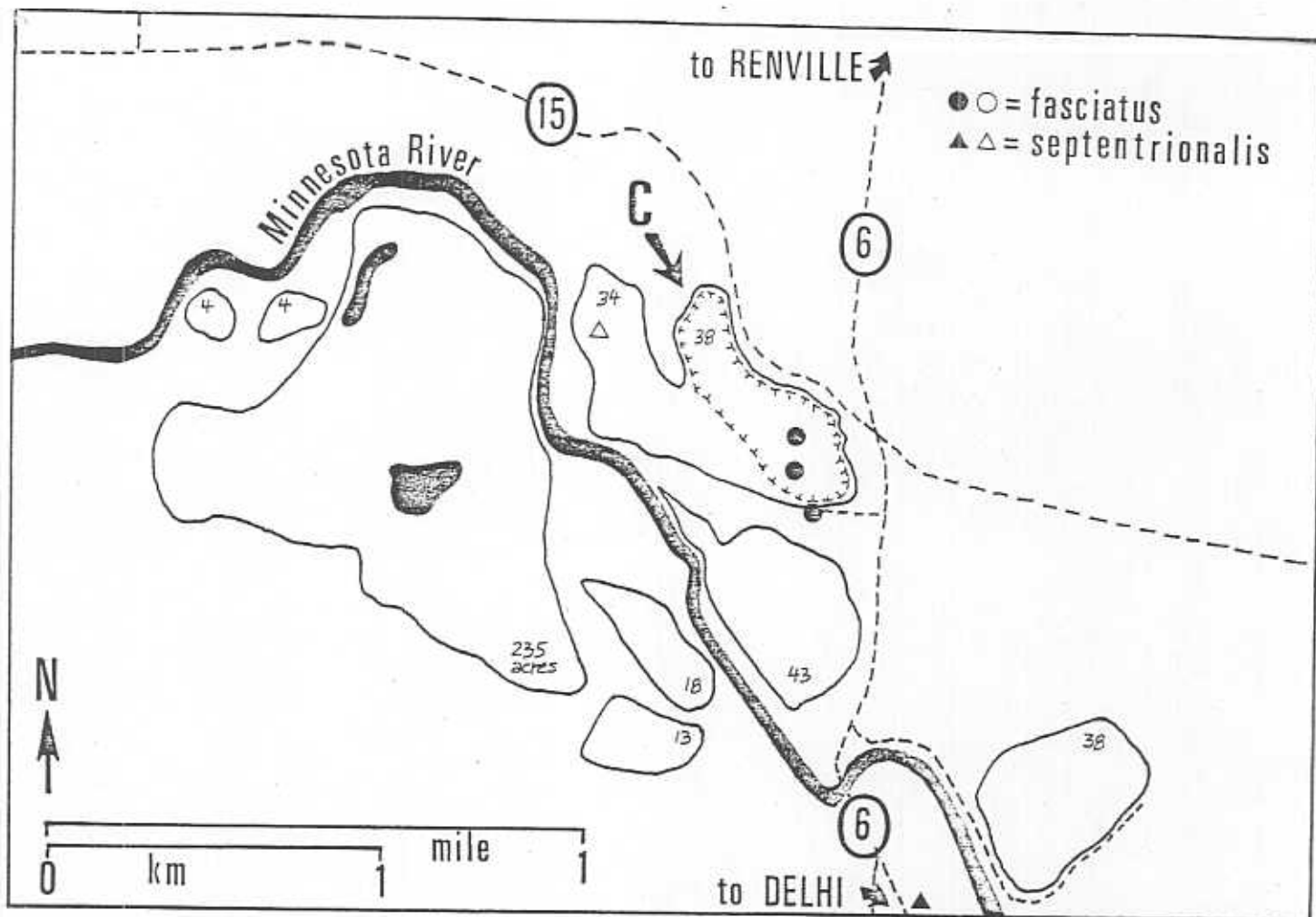


Figure 8. Distribution of five-lined skinks (circles) and prairie skinks (triangles) Delhi locality (=2). Symbols as in Figure 5; area "c" (=Renville County Park No. 2) was analyzed for vegetation change (see section 3.5.3). Total areal extent of suitable habitat at this locality=29 hectares or 74 acres.

Figure 11. Aerial photo (scale=1:20,000) of South Granite Falls locality showing vegetation and landforms in 1967. Hwy 23 (on overlay) was constructed after this photo was taken.

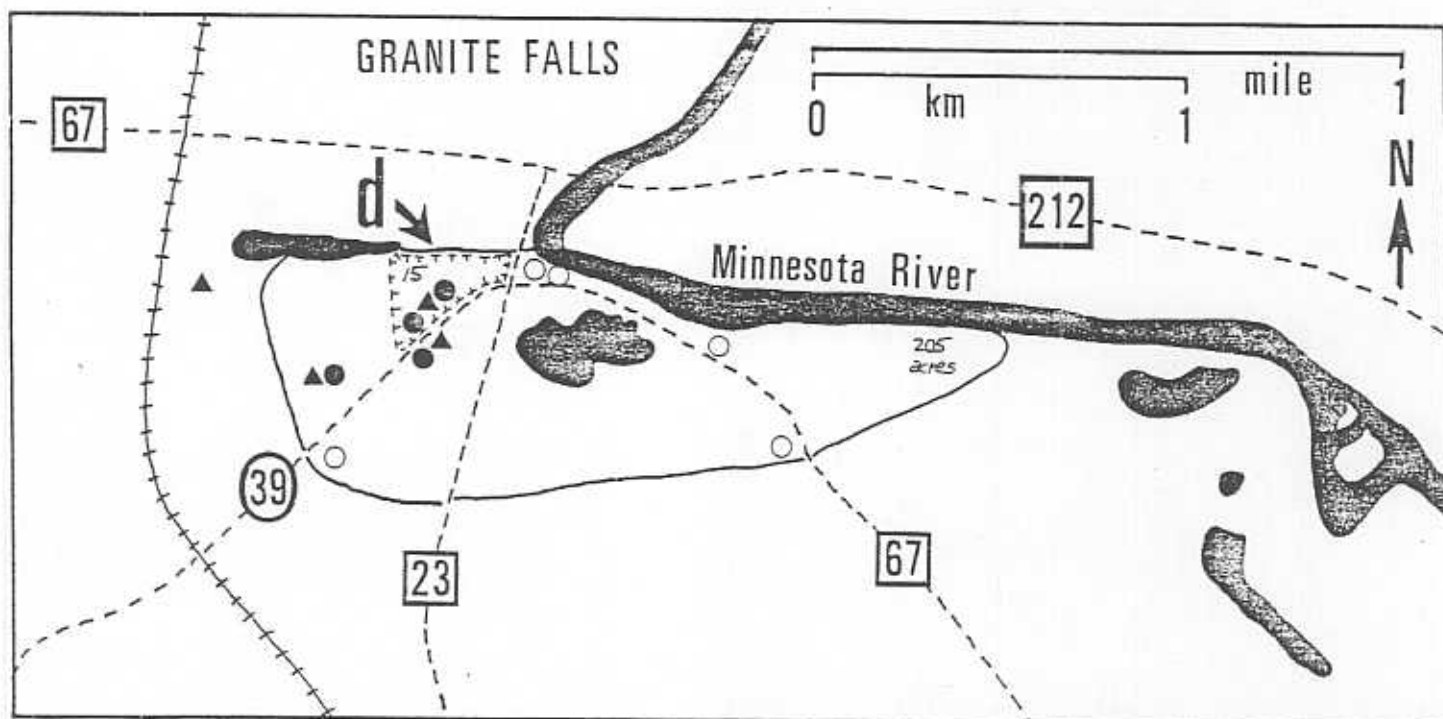
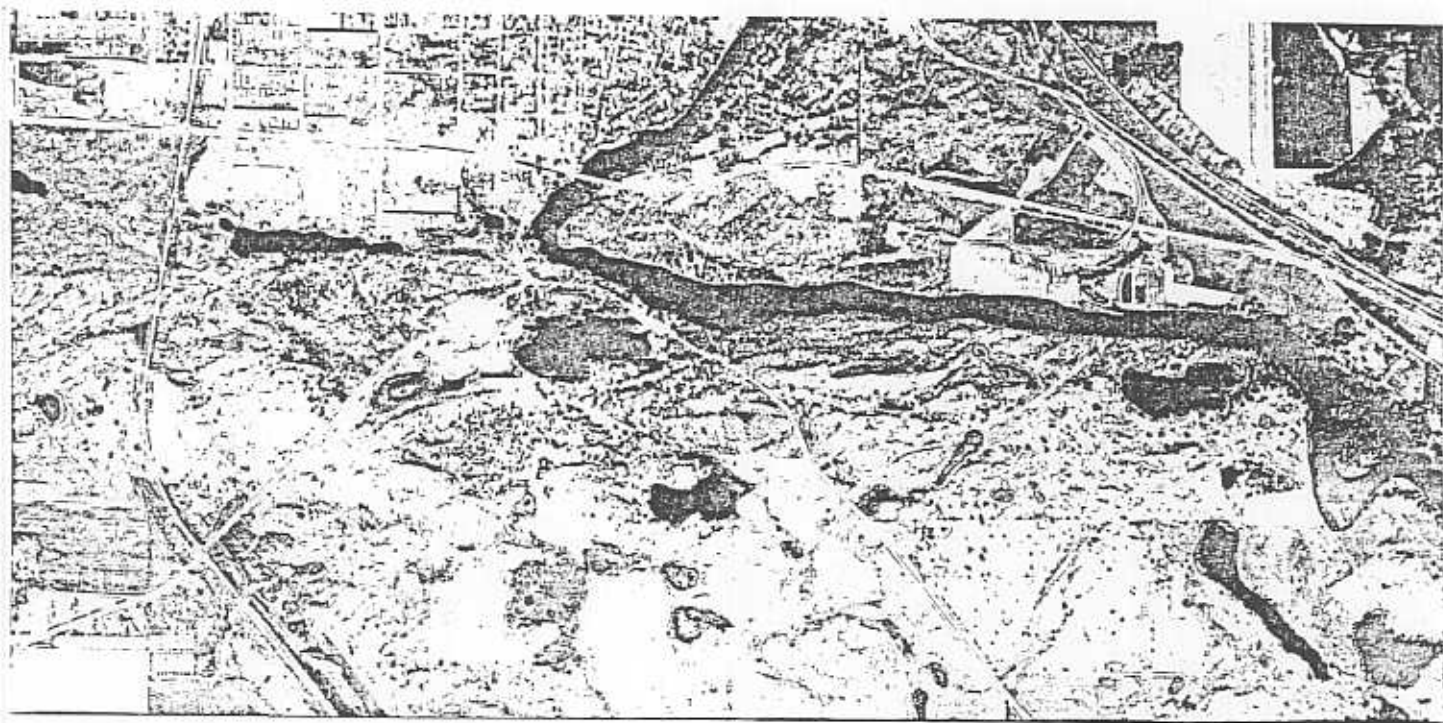
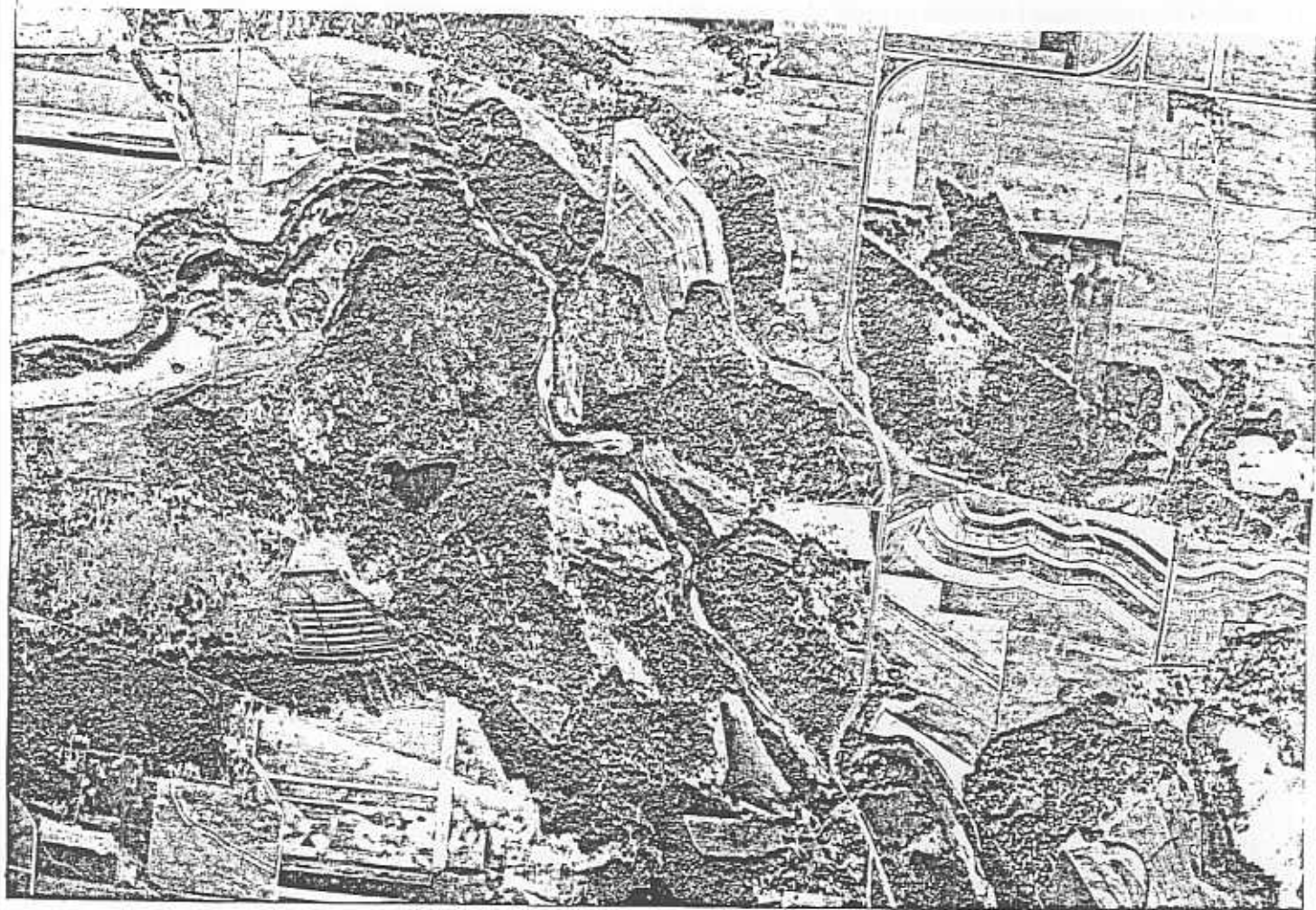


Figure 9. Distribution of five-lined skinks (circles) and prairie skinks (triangles) at South Granite Falls locality (=3). Symbols as in Figure 5; area "d" (=Bakke-Hinz properties) was analyzed for vegetation change (see section 3.5.3). Total areal extent of suitable habitat=82 hectares or 205 acres.



3.3.3.4 Skink Population

A total of 19 five-lined skinks were observed and/or captured at the Delhi locality (Table 2). Of these, 4 (21%) were young. Gravid females and breeding males (=orange-red head coloration) were seen in May; mating was observed at the Stone residence on 20 May. Eggs were not found at this locality, but young from the previous year were collected on the rock exposures and in the yard of the residence nearby. This is the only locality where prairie skinks were not collected at any of the sites where five-lined skinks were found.

3.3.3.5 Land Ownership and Use

A map of land holdings in the vicinity of the Delhi locality is presented in Figure 12. The two sites on natural rock exposures are located within the boundaries of the Renville County Park No. 2. The park encompasses all of the skink habitat at this locality (29 hectares=72 acres) as well as another outcrop to the south (17 hectares=43 acres). Some bottomland lying within the park (about 20 acres) and adjacent to these outcrops has been cultivated recently but woodland extends from the river to the rock exposures in other areas. The third site is the private residence of Ed Stone (0.8 hectares=2 acres), a local naturalist who has made valuable observations on the natural history of the skinks in his yard and in the park. The adjoining land is currently in private ownership. The woodland opposite Renville County Park No. 2 referred to in section 3.3.3.2 as the Hultquist property is actually owned by three parties: Hultquist, Tufto, and Dirlan. The east-facing rock exposures appear to be on the Dirlan property (Figure 12).

The park is open to the public all year; hunting is prohibited within the park. However, the surrounding bottomland is considered to be prime deer habitat; and apparently, there is a lot of hunting in the area during the fall. Picnic areas within the park are used often during the summer months and maintained by mowing; some of the bottomland forest has been logged recently. Apparently, timber cutting has not occurred on the rock outcrops. Agricultural utilization of land adjoining the park consists of crop cultivation on even ground and grazing by cattle and sheep in the rocky areas.

3.3.4 South Granite Falls (=Locality 3)

3.3.4.1 Location

The South Granite Falls locality is northwest (upriver) of the other localities on the south side of the Minnesota River; it is situated in Yellow Medicine County directly south of the city of Granite Falls (Figure 3). The rock exposures in this region are Granite Falls gneiss and Montevideo granite gneiss with associated inclusions (Lund, 1956; Figure 14). The dominant trees growing on the outcrops are bur oak (*Quercus macrocarpa*) and eastern redcedar (*Juniperus virginiana*). The prominent landscape features and vegetation of the locality are shown in Figure 11.

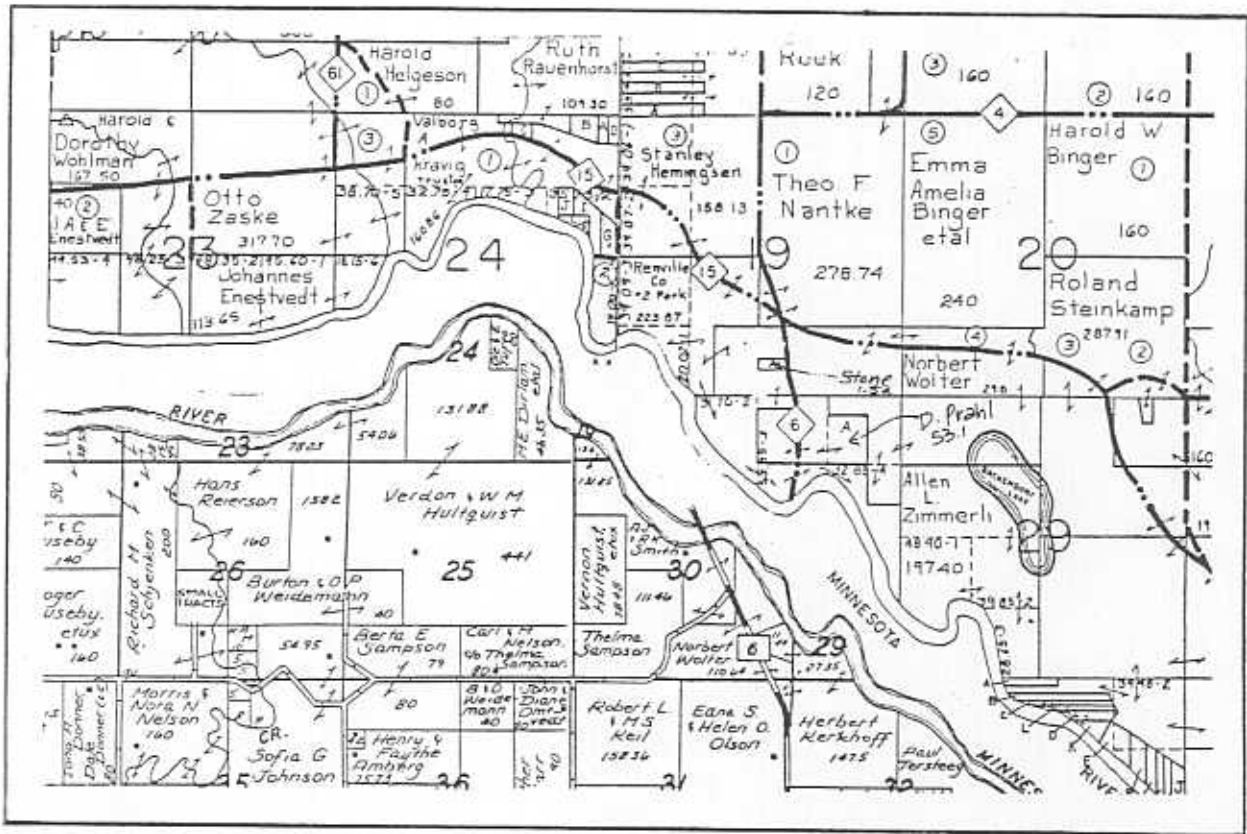


Figure 12. Land ownership at Delhi locality (=2); the river separates Renville (top) and Redwood (bottom) counties. A directory of land owners is included in Appendix I.

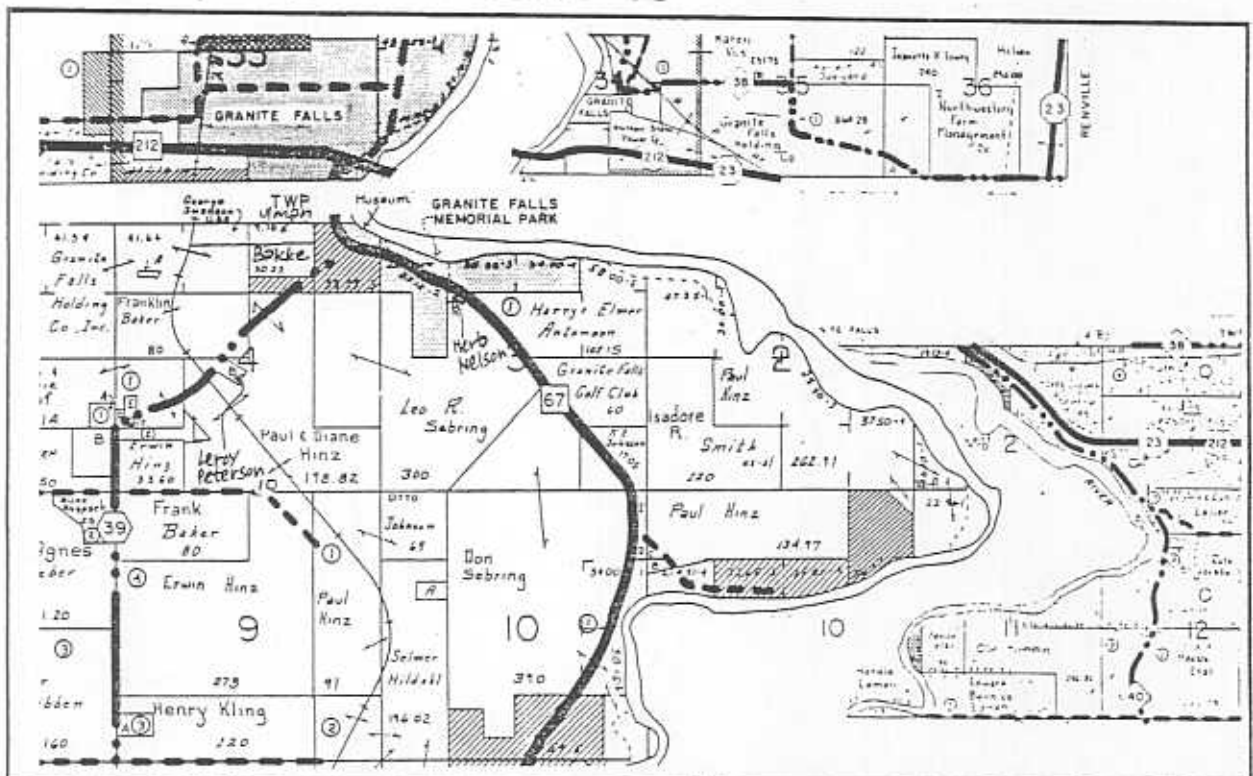
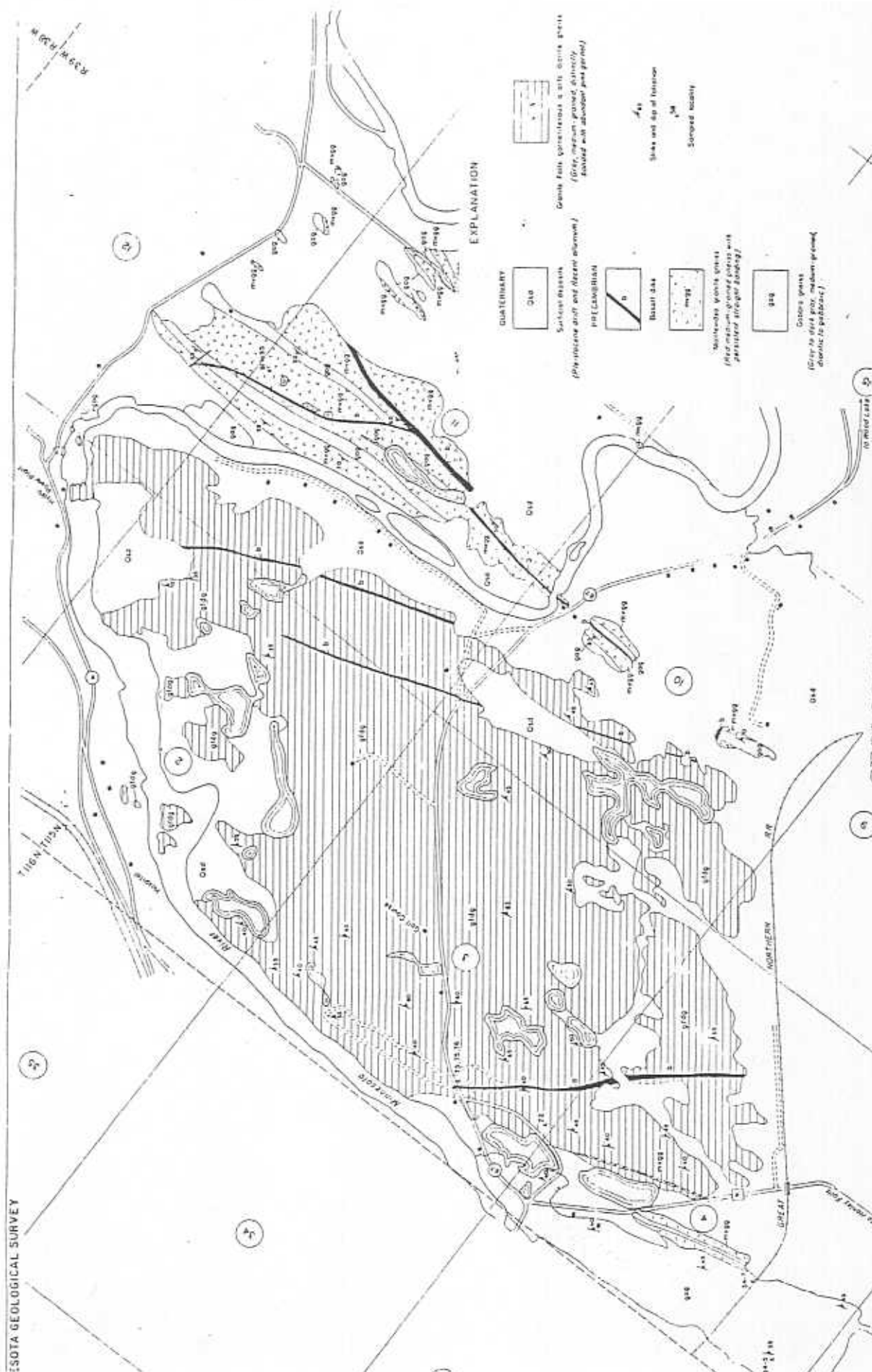


Figure 13. Land ownership at South Granite Falls locality (=3); the river separates Yellow Medicine (left) and Chippewa (right) counties. A directory of landowners is included in Appendix I.



GEOLOGIC MAP OF AREA SOUTHEAST OF GRANITE FALLS

Chippewa and Yellow Medicine counties, Minnesota

use map from aerial photographs

Geology by E. H. Lund, 1949



Figure 14. Geologic map of the area southeast of Granite Falls
(from Lund, 1950)

3.3.4.2 Distribution

The local distribution of both species of skinks at this locality is shown in Figure 9. Within this area, skinks were collected and/or sighted at 10 specific sites (Table 3). Five-lined skinks were collected at 3 sites and were sighted at 5 additional locations. Prairie skinks occurred at 4 sites, 3 where five-lined skinks were repeatedly found and one other (Figure 9). In some instances, both species were found under the same cover at two of the three common sites.

3.3.4.3 Habitat

The habitat judged to be suitable for five-lined skinks at this locality (=rock outcrops and associated woodland) comprises 82 hectares or 205 acres; this area is delineated by a solid line enclosing known capture/observation sites (Figure 9). Although the rock exposures in the region are extensive (see Figure 14), five-lined skinks were only found on or near wooded outcrops. On open, grassy rock exposures, often part of the same outcrop, no five-lined skinks were encountered despite extensive searching. Thus, suitable habitat at this locality appears to be restricted to wooded rock outcrops. Wooded rocky habitats were examined at two neighboring sites in Chippewa County, one directly across from Memorial Park and the other 2 miles downriver (=Ole Homme farm; Table 3; Figure 15). Five-lined skinks were not found at either locality.

Specific sites where the species was collected included the south-facing slope of a rock exposure on the edge between grassy and wooded terrain. This site was located in a fenced pasture and was grazed during the study (=Hinz property; photos 12-15, Appendix G). The other two sites were: 1) a grassy roadside embankment at the base of an extensive outcrop (=Bakke road site; photos 7-11, Appendix G), and 2) a grassy area with abundant cover between an outcrop and a building and located opposite the Bakke road site (=Aakre sale barn; photo 8-10, Appendix G). Human activities at the latter two sites had been extensive in recent years, including the re-routing of county road 39 and the construction of a four-lane highway (23) in 1979. At both sites, skinks were typically collected under sheet metal and boards in May and early June, but not in July. "New" cover items were utilized within a day or so of placement in exposed locations.

The other sites at this locality were disturbed habitats frequented by humans: Nelson residence, Memorial Park (trail and pavillion; photo 21, Appendix G), Yellow Medicine County Historical Museum, Hinz property near the Peterson residence (photos 16-20, Appendix G). Each location was characterized by some open (usually grassy) areas and rock exposures nearby ($\leq 50\text{m}$).

3.3.4.4 Skink Population(s)

A total of 43 five-lined skinks (36% of those recorded) were observed and/or captured at the South Granite Falls locality. Of these, 14 (33%) were young. Breeding males and gravid females were seen in May and early June; young of the previous year were found at several specific sites (Table 2).

3.3.4.5 Land Ownership and Use

A map of the property owners at the South Granite Falls locality is shown in Figure 13. The area designated as suitable habitat is a mosaic of land owned by a number of private parties and governmental agencies. The public agencies include the City of Granite Falls (Memorial Park), Yellow Medicine County (part of NE 1/4 of NE 1/4 of section 4), State of Minnesota (part of NE 1/4 of NE 1/4 of section 4). The principle private landowners are: Jacques Bakke (~29 acres), Paul Hinz (40 acres), B.S. Aakre et al. (~10 acres), and Leo Sebring (~60 acres). These holdings were verified by me at the County Clerk's office in July 1982; approximate property boundaries are shown in Figure 15. These individuals are included in the directory in Appendix I. Further clarification of the boundaries and ownership of tracts in the NE 1/4 of NE 1/4 of Section 4 is required; in addition, local residents indicated that some of the land owned by Paul Hinz was reverting to bank ownership, but Hinz is currently listed on the tax rolls for these properties (as of July 1982).

At present, there are multiple uses for the land designated as suitable habitat. The Bakke, Hinz, and Sebring properties have been grazed in recent years; the large yellow-flowered cactus Opuntia "humifusa"=compressa, a species indicative of recent grazing, was common on the outcrops of the Hinz and Sebring properties (photos 16-19, Appendix G). The Bakke land was pastured with cattle during May-July 1982 (see photo 14, Appendix G).

The Aakre sale barn site was in use as a storage area for building supplies (e.g., piles of stone, brick, boards, etc.). The abandoned house and farm buildings and associated debris at the Bakke road site were not disturbed during the study. The Yellow Medicine County Historical Museum trails and the Memorial Park picnic area were visited daily by people; and the grounds where the skinks were observed were maintained periodically (grass cutting, raking, etc.). A similar pattern of activity, but less intensive, occurred at the other residential sites. Thus, all of the sites at the South Granite Falls locality were disturbed in varying degrees by human activities.

3.4 Abundance

Five-lined skinks were relatively abundant during May at the following sites: Bakke road site, Smith quarry, active quarry, south quarry, Sanders corner, Knutson property, Renville County Park No. 2, and Stone residence. Manipulation of the habitat by distributing cover (e.g. boards, sheet metal) resulted in more skinks encountered and/or captured at the Bakke road site, Smith quarry, and the Stone residence. Relatively few skinks were found on subsequent visits to these and other sites during early July. Thus, there was a decline in the apparent abundance of skinks at a particular site. This effect, in my opinion, reflected a seasonal shift in the cover preferred by the skinks (and consequently my ability to find them) rather than an actual decline in skink densities at these sites.

The number of skinks located each day was strongly influenced by daily weather conditions and by the daily activity patterns of the skinks.

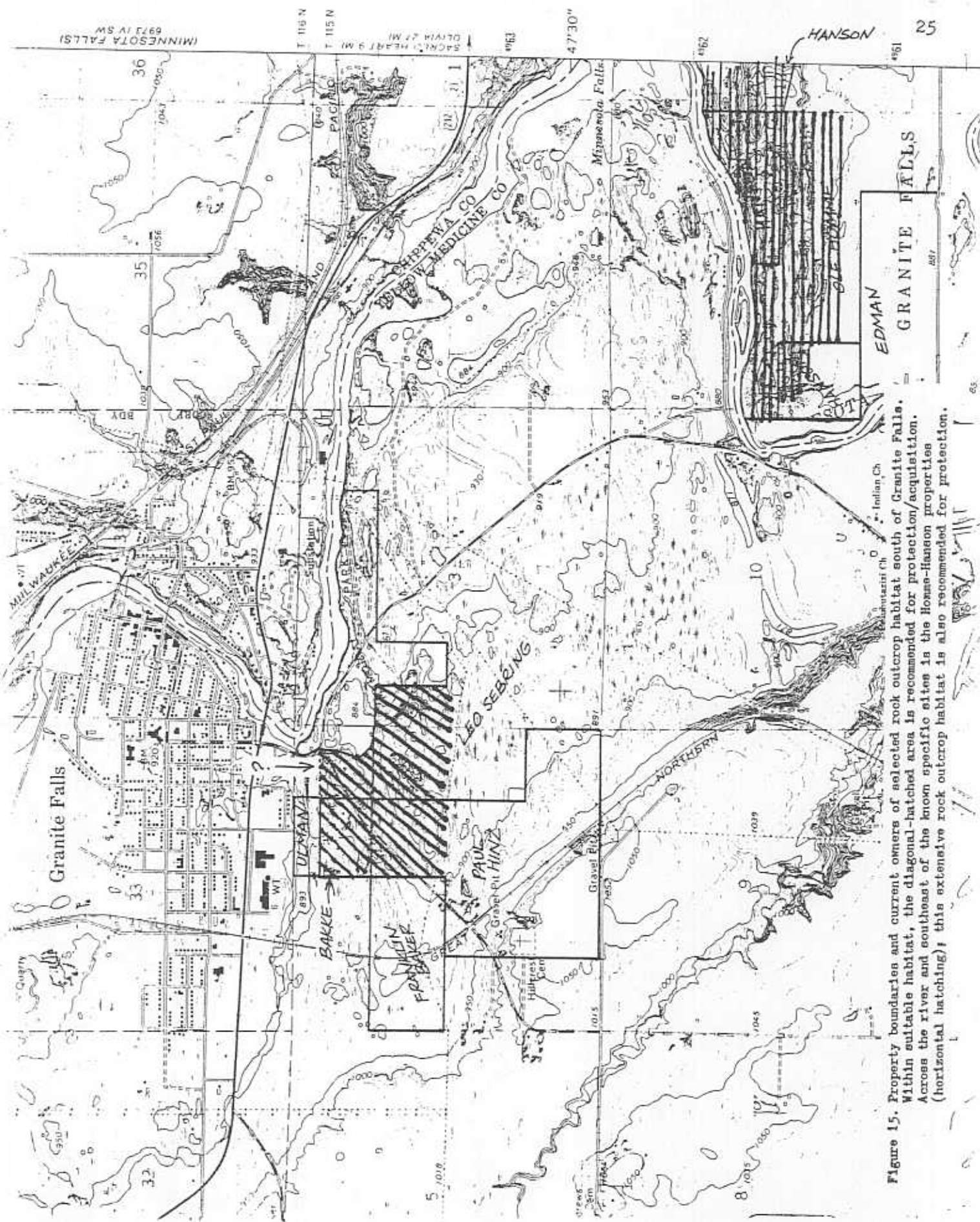


Figure 15. Property boundaries and current owners of selected rock outcrop habitat south of Granite Falls. Within suitable habitat, the diagonal-hatched area is recommended for protection/acquisition. Across the river and southeast of the known specific sites in the Hanson-Hanson properties (horizontal hatching); this extensive rock outcrop habitat is also recommended for protection.

Skinks were found readily under cover following warm, sunny days. Finding skinks during periods of cool, rainy weather was difficult because few skinks remained at the surface; presumably, most retreated under ground until favorable weather prevailed. Searching under cover items was most effective in the early morning when skinks were relatively cool and inactive; later in the day, skinks were active and exceedingly difficult to capture. Furthermore, cover items were avoided during midday.

These seasonal and daily changes in the use of cover introduced large sampling errors into any density estimates based on mark and recapture/resight data (Fitch, 1954; Heckel and Roughgarden, 1979; Lang, unpublished observations). An alternate technique, in which individuals were removed (temporarily) over a period of days, was employed to provide a quantitative measure of skink density at the Bakke road site, South Granite Falls locality (photo 11, Appendix G). The same cover items (boards and sheet metal; $N=23$) were examined daily prior to 0900 for ten days (17-27 May); and all the skinks which were encountered were collected and removed. Within the initial 5 days, 19 individuals were captured; during the subsequent 5 days, 5 additional skinks were found. Thus, in 10 days, 24 skinks (17 adults and 7 young) were taken from an area of $< 150\text{m}^2$ or 0.015 hectare. On this basis, the population density at the site was 1600 skinks/hectare or almost 650 skinks/acre.

Fitch (1954) estimated densities of 746-1960 skinks/acre at one disturbed site in northeastern Kansas where skinks were found "in remarkably high concentrations." In natural habitats on his study area, Fitch estimated densities of 50-100 skinks/acre. In a subsequent study in which he and a coworker monitored individual skinks, Fitch and Von Achen (1977) reported: 1) the area occupied by a skink changes seasonally, 2) a skink's range is neither uniform nor regular, 3) the area occupied is a succession of hiding places, 4) such places are clumped in distribution, 5) intervening areas are used only infrequently. These findings reinforce our convictions as collectors that these skinks tended to be "patchy" or clumped in their distribution and did not occur throughout the habitat at equivalent densities.

The average size of circular home ranges measured by Fitch in his two studies was about 800 m^2 based on average movement radii of 16 m. If the density of skinks at the Bakke site is calculated using Fitch's estimate of average home range (=activity center + movement area), a density of 300/hectare or 120/acre is estimated. This figure is only slightly higher than Fitch's estimates of 49-92 skinks/acre in favorable habitat. Using an estimate of 50 skinks/acre based on Fitch's study and my estimates of suitable habitat at each Minnesota locality, I calculated the maximum population sizes to be: $918 \times 50 = 45,900$ at Swedes Forest; $72 \times 50 = 3600$ at Delhi; $205 \times 50 = 10,250$ at South Granite Falls. Because "open" areas comprise only about 10% of selected suitable habitats (see section 3.5.3 following), the maximum estimates have been reduced by a factor of 10. The estimated minimum population sizes remain substantial with the possible exception of the Delhi locality: Swedes Forest = 4590; Delhi = 360; South Granite Falls = 1025 (total = 5975). However, such "guesstimates" must be interpreted in light of the marked patchiness in skink distribution; these populations appear to be dependent upon a small number of favorable sites (with high densities) within suitable habitat.

3.5 Habitat Requirements

3.5.1 Introduction

The specific sites inhabited by five-lined skinks during May-July have been described and illustrated previously (section 3.3.2-3.3.4). These sites were characterized by 1) proximity to bedrock outcrops, 2) open, sunny rock or grassy areas, usually with southern exposures, 3) abundant cover, either natural or man-made, and 4) access to water, either temporary or permanent. Selected features of these sites were recorded for each capture/sighting (N=119; Appendix F).

Most skinks were found under cover (84%; N=100) rather than on the surface (16%; N=19). Of those found under cover, about half were beneath rocks (40% of total found); the remainder were under metal (26%), wood (16%), or tarpaper (2%). Those on the surface were seen on rocks (8%), wood (6%), or vegetation (2%). The substrate type was rock in half of the instances (60/119=50%) vs. dirt (59/119=50%). Most sites were edge situations (90%; 107/119) vs. open (9%; 11/119) or wooded (1%; 1/119). A large proportion of the sites were disturbed (=altered to an appreciable extent by human activities; 78%, 93/119) or grazed (6%; 7/119). In relatively few instances, the sites were undisturbed (=natural; 19/119, 16%). Most sites were moist (94%; 91/96) vs. wet (4%; 4/96) or dry (2%; 2/96) in part because during May rainfall was frequent and plentiful. A third of the captures/sightings occurred on days with rain (31%; 34/104) or within one(23%; 24/104), two(22%; 23/104), or three(22%; 23/104) days following rain.

It is important again to note 1) that skinks concentrated activity on the surface during May, and 2) that there was a marked decline in skink abundance at all sites in July and presumably later in the summer and fall. Fitch (1954) and Fitch and Von Achen (1977) reported similar seasonal shifts in capture records and activity for the species in Kansas. Skinks appear to utilize different features or microenvironments within habitats at different phases of the annual cycle. Therefore, habitat preferences and/or requirements likely change on a seasonal basis; features important in May may not necessarily be relevant at other times of year.

In Kansas, skink activity in late summer and fall was greatly reduced, in sharp contrast to spring and early summer; and captive individuals showed little inclination to feed in late summer and fall. Presumably skinks retreated underground prior to hibernation. In northeastern Kansas, skinks hibernated in rock ledges and rock walls where they were able to escape prolonged exposure to freezing temperatures (Fitch, 1954; Fitch and Von Achen, 1977).

3.5.2 Rock Outcrops

In Minnesota, five-lined skinks probably retreat to depths below the frostline (1.5-2+m) by moving into fissures and cracks in bedrock exposures. Support for this suggestion was provided by Marv Skogen, foreman at the View Quarry Company, Swedes Forest Locality. He reported that skinks (identified as Eumeces fasciatus) were discovered during February-March in fissures 2-3m below the surface of the active quarry. Hand removal of large blocks of granite exposed the skinks which were

torpid but alive. In captivity, five-lined skinks from Minnesota and Missouri were much less inclined to burrow beneath the surface and excavate tunnels than were prairie skinks. Prairie skinks are known to hibernate in sandy and/or gravelly substrates at depths which they presumably reach at least in part by burrowing (Breckenridge, 1943, 1944; Nelson, 1963).

Skinks were not found at any of the sites in this study at distances exceeding 100 m from bedrock exposures despite extensive searches in surrounding woodland and along wooded stream and river valleys. In Kansas, five-lined skinks were relatively sedentary. The longest recorded movement was 119m by an adult male; most movements were ≤ 15 m (Fitch and Von Achen, 1977). If Minnesota populations behave similarly and if these populations are restricted to hibernacula in bedrock (in part because they are "poor" burrowers), then these behavioral differences provide at least a partial explanation for the species' distribution which is restricted to bedrock exposures in the Minnesota River valley.

3.5.3

Open Areas

The open and exposed rock or grassy areas which were typical of all sites may provide skinks with a variety of microhabitats, including some which are thermally advantageous relative to those in surrounding areas. At several localities (e.g. Delhi and Swedes Forest), skinks were notably absent from north-facing sites similar in other aspects to south-facing slopes where skinks were present. At selected sites at each locality, the "openness" of the habitat was assessed by measuring the open vs. wooded areas. At Swedes Forest, two areas were examined. Open areas comprised 11% of the total area at the Knutson property (Figure 5, area "b"; Appendix J); at south quarry, open areas equaled 10% of the total (Figure 5, area "a"; Appendix J). At Delhi, open habitat amounted to 7% of the total area (Figure 8, area "c"; Appendix J). The habitat at South Granite Falls was relatively more open, comprising 63% of the total (Figure 9, area "d"; Appendix J). These values are based on analyses of 1967-68 aerial photographs; ground survey in these areas in 1982 indicated a definite reduction in open areas relative to openings shown in the air photos.

During the study, senior local residents indicated to me that the rocky exposures were not covered with vegetation half a century ago. According to these informants (E. Sander and O. Homme), eastern redcedars (*Juniperus virginiana*) invaded the outcrops in the years following the dry years of the early 1930s. What was formerly open bare rock was transformed into a mosaic of dense cedar stands and bare rock openings; in recent years, openings have diminished as cedars encroached onto open areas. Now, on most outcrops, openings comprise only a small fraction of the previously open area. These observations were consistent with my observations that openings had been reduced between 1967-68 and 1982.

I attempted to quantify changes in vegetation at selected sites (areas "a-d") which presently provide suitable habitat for five-lined skinks. An analysis of aerial photos of these areas taken at intervals between 1938 and 1968 provided evidence that there has been a definite decrease in the "openness" of the rock outcrop habitat at these sites as well as others at these localities. The proportions of openings at areas a-c in 1968 were only about one-third of the 1938 values.

The reductions in openings from 1938-1968 were: area "a" 29%→10% (photo 33), area "b" 31%→11% (photos 35-36), area "c" 24%→7% (photos 40-41), area "d" 89%→63% (photo 6). Portions of the air photos which were analyzed are reproduced in the photo appendix (Appendix G) and an analysis of selected sites on these photos is included in Appendix J. If the documented decrease in "openness" is projected as a linear rate of change (10% decrease every 17 years), then the amount of open area reaches zero in 1988-89. Using this projection, the 5% level was reached in 1980. Although the cedars may not be able to completely cover some rock exposures as rapidly as predicted by these figures, it appears that the areal extent of open areas on the rock outcrops will continue to decline through the 1980s.

The ecological factors promoting such a dramatic increase in the vegetation on rock exposures are not obvious, but two probable causal agents are periods of drought and/or the absence of fire. Eastern redcedar increases in importance in proportion to the dryness of the site in the savanna communities of Wisconsin (Curtis, 1959). On dry sites, it is the dominant tree species. According to Moran et al. (1976), late Holocene time was generally much like the past 35 years with intervening dry periods like the 1930s. If so, then it seems unlikely that drought per se has been responsible for the recent growth of cedar stands on the rock exposures; the absence of fire or some other factor related to agricultural practices in historic times may be a more likely causal agent. If the postglacial vegetation of the area were known, then the age of the cedar stands that now dominate the rock exposures could be assessed. The air photos indicate the present stands are recent.

Eastern redcedar is the dominant tree species in the cedar glade community described by Curtis (1959) for Wisconsin. In some instances, cedars develop into dense pure stands which take on the internal aspect of a northern hemlock forest (Curtis, 1959; Appendix Q); on some rock outcrops at the study localities and elsewhere in the region, cedar stands conform to this description. Elsewhere, cedars form savannas characteristic of the cedar glade community described by Curtis (1959). The groundlayer is similar to a dry prairie in composition, and shrubs are of less importance than in other savanna communities. The difference in light intensity beneath the cedars and in the openings is great. Curtis (1959) emphasizes the extreme fire-sensitivity of eastern redcedar; its domination of previously unforested sites is apparently due to the absence of fire in such areas in recent time. In areas where there is fire, cedars only grow on protected sites. On the basis of this preliminary analysis, it appears that cedars have only recently vegetated the rock outcrops in the upper Minnesota River valley, and that the success of this species is due in large part to the absence of fire in the region in recent time.

It is difficult to judge with confidence how the documented change in vegetation on rock outcrops has affected skink populations, particularly without prior baseline data. The overall and immediate effect is a gradual loss of the natural openings and/or clearings on rock exposures--the primary habitat of five-lined skinks in undisturbed situations. This observation, in turn, suggests that five-lined skink populations have declined with the historic loss of rock outcrop habitat and will continue to decline as the cedars encroach into existing situations. The incidence of captures/sightings at disturbed sites (84% of total) all of which were open may reflect the gradual loss of natural openings on rock exposures.

3.5.4 Cover

As has been noted, many types of cover were utilized by five-lined skinks at the various sites. While large rocks (>.5m in diameter) appeared to be favored on rocky exposures, skinks were often found beneath debris, including pan lids, cardboard, and cloth. Sheet metal and tarpaper in exposed situations were particularly attractive; on a number of occasions, skinks readily sought cover under such objects (within 1-2 days) following the addition of these items to existing favorable sites. Although cover was an essential ingredient in finding and capturing skinks and probably provided some advantages (e.g. warmer microhabitats) for skinks, the absence of certain kinds of cover may not necessarily preclude skinks from otherwise suitable habitats. In particular, skinks may inhabit rocky exposures devoid of movable cover but remain undetected to collectors/observers because cover suitable to turn and examine is absent.

3.5.5 Water Availability

Similarly, permanent and/or temporary sources of water were available at all localities. In most cases, permanent water (ponds, sloughs, marshes, rivers, streams) was within 100m of specific sites. In addition, solution and erosion cavities in the bedrock exposures trapped rain water in temporary pools that remained for weeks on outcrops. Fitch (1954) notes that an abundant supply of moisture is a necessity for these skinks and that the species is limited to a climate of high humidity. Dew is a common feature of these habitats during the spring and summer months and not only provides necessary surface moisture but also serves as an accessible water source. Fitch (1954) comments further that dew normally supplies the drinking water without which the skinks rapidly become emaciated and die.

3.6 Life History Attributes

3.6.1 Reproduction and Population Dynamics

On the basis of long-term studies in Kansas, Fitch and Von Achen (1977) summarized some significant biological traits of Eumeces fasciatus as follows: strong sexual dimorphism with males assuming bright coloration in the brief breeding season, sexual maturity attained late in 2nd year, a single annual egg clutch per female (averaging 9-10), female guarding eggs during incubation, habits partly arboreal.

In Minnesota, five-lined skinks emerged from hibernation sites in early May and were found on the surface by the second week in May. Breeding commenced at about this time and peaked during the third and fourth week of May. Gravid females were taken in late May and early June. In late June, captive females began laying egg clutches. In July, females in the field were found in excavated chambers guarding clutches of eggs. In the lab, hatching occurred during the last half of July. Hatchlings and females gained weight rapidly during August in the lab.

Skinks captured in May were easily divisible into two size classes: one group ranged from 35-46mm. in snout-vent length, the other from 62-81 mm. snout-vent length (Figure 16). These represented yearlings (hatchlings from the previous August) and adults (including a few sub-adults) respectively. A few records from subsequent collecting in June-July and the growth rates of yearlings in captivity (depicted by the dotted lines in Figure 16)

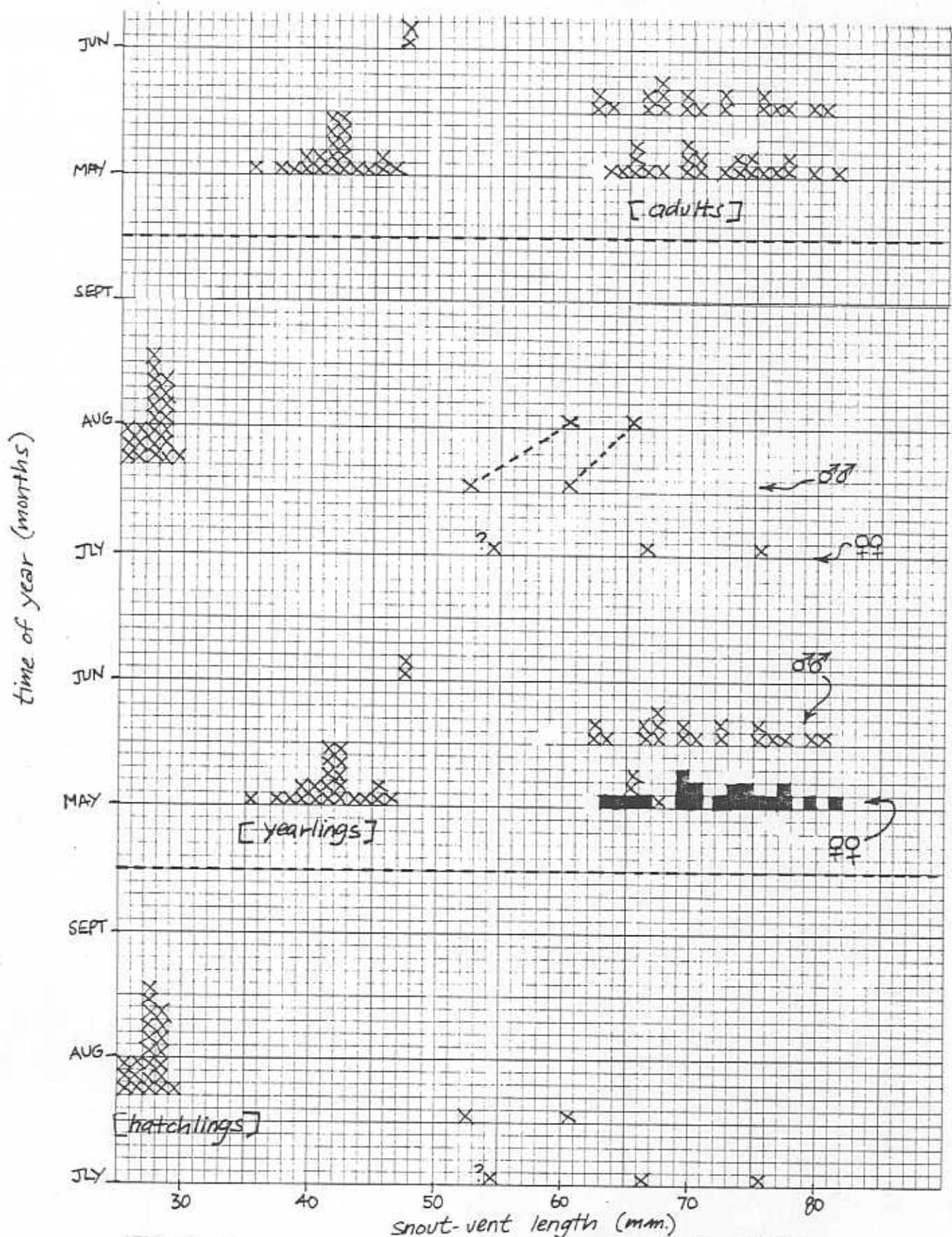


Figure 16. Size-age distribution of five-lined skinks from Minnesota populations in 1982. Measurements of hatchlings from clutches incubated in captivity (June-July 1982) are included. The records for 1982 are duplicated at the top and bottom of graph to simulate previous and subsequent years. Thus, hatchlings in August emerge the following May as yearlings, and reach adult size by their second spring (at an age of 21 months). Most adult females in May 1982 were gravid (solid boxes). Two yearlings held in captivity during late summer grew to nearly adult size by the end of August (dotted lines connecting two records in July-August).

provide additional evidence that the yearling class attains adult size after one growing season at an age of about 21 months. In the May sample of adults examined, males typically had the red-orange head coloration (including 3 small males, ≤ 66 mm. snout-vent length) characteristic of sexually-mature individuals; and nearly all the females were gravid (including the two smallest individuals; Figure 16). Minimum adult size appears to be 62-63mm snout-vent length, slightly smaller than the 65mm. minimum adult size indicated by Fitch for the species in Kansas. Otherwise, the size/age classes and projected growth rates of the Minnesota population are nearly equivalent to data on the species in northeastern Kansas (Fitch, 1954). If there are significant differences between these populations with respect to these parameters, these may be quantitative rather than qualitative and hence difficult to detect without larger samples. For example, three small females (63-67mm. snout-vent length) were apparently not gravid although adult in size (Figure 16). The frequency of non-reproductive females was lower in Kansas (1 in 77; Fitch, 1954). Fitch (1954) has suggested that reductions in reproductive potential of this sort may be typical of northern localities where cool climates result in shorter growing seasons. However, on the basis of the data shown in Figure 16, Minnesota females appear to reproduce every season, i.e., annually.

Fitch (1954) has suggested further that attainment of breeding maturity may normally require more than the requisite two years typical of the species in Kansas on the northern edge of the range. If it were valid, the reproductive potential of a population maturing in three years would be lower by more than a factor of 10 (over a 10 year period) relative to maturation in two years. This contention is contradicted by the data in Figure 16; in Minnesota, five-lined skinks typically begin breeding at an age of 22 months at a minimum adult size of ≈ 62 mm snout-vent length. In all of these respects, the Minnesota populations of five-lined skinks conform to the pattern of maturation and reproduction characteristic of prairie skinks in Minnesota (Breckenridge, 1943; Nelson, 1963).

Clutch size for 7 five-lined skinks from the Minnesota population ranged from 5-13; large clutches were produced by large females. Females remained with eggs in the field and brooded eggs until they hatched in captivity. The two natural nests which were discovered were located beneath large rocks on outcrops (photos 29,38; Appendix G).

3.6.2 Food Habits

Food habits were not analyzed in detail but scats collected in the field or produced by field-collected skinks contained, on cursory examination, large quantities of orthopteran (mainly roaches) and spider remains. Fitch (1954) notes that spiders, orthopterans, and beetles make up the bulk of the diet in Kansas. During my study, captives fed readily and gained weight on a diet of mealworms.

3.6.3 Predation

Fitch (1954) indicated that short-tailed shrews (Blarina brevicauda) were the most important predator on skinks in Kansas, but other predators included hawks, predatory small mammals, and snakes. The only recorded instance of predation in my study was the report of a landowner that a farmyard cat was consuming one and had done so in the past on other occasions.

3.6.4 Parasites

During May, ectoparasites were not found on the skinks; but skinks collected in early June and particularly in July were infested with orange chiggers, probably of the genus Trombicula. Fitch(1954) reported that chiggers of this genus commonly infest skinks in Kansas.

3.6.5 Associates

A number of species were commonly found associated with skinks under cover items. These included: red-bellied snake (Storeria occipitomaculata), common garter snake (Thamnophis sirtalis), plains garter snake (Thamnophis radix), fox snake (Elaphe vulpina). A complete list of the amphibians and reptiles from the region is included as Appendix K. Fifteen new county records for various species were recorded during this study; most of these are represented by specimens to be deposited in the Bell Museum of Natural History, University of Minnesota.

3.6.6 Interactions with Prairie Skinks (Eumeces septentrionalis)

During the study, information was obtained on the distribution, abundance, and natural history of the northern prairie skink (Eumeces septentrionalis). The distribution of the species has been mapped and compiled for the region (Figure 3; Table 3) and for each of the three localities (Figures 5,8,9; Table 3). Prairie skinks were found with five-lined skinks at specific sites at South Granite Falls and Swedes Forest, but not at Delhi. At common sites, the two species were sometimes found together under the same cover and often seen in the same microhabitats on different days.

Differences in habitat utilization between the two species were not apparent, but the abundance of five-lined skinks on rock exposures appeared to be greater relative to prairie skinks in this habitat. At other sites, such as Smith's quarry which was a grassy meadow near an abandoned quarry, the abundances of the two species appeared to be nearly equivalent. Five-lined skinks were not found in open(=not wooded), drier habitats whereas prairie skinks were typically found at many such sites throughout the region.

The two species have very similar life histories, particularly with respect to growth, minimum adult size, and reproduction (Fitch, 1954; Breckenridge, 1943; Nelson, 1963). Breeding occurs in both species at about the same time in Minnesota (Lang, unpublished observations). Eggs of both species are laid at about the same time in similar situations (under rocks) and brooded during incubation by females, based on field and lab observations of both species. Furthermore, the activity patterns, home ranges, and movements of the two species are very similar on the basis of studies by Fitch (1954) and Fitch and Von Achen (1977) in Kansas and of Breckenridge (1943) and Nelson (1963) in Minnesota. One behavioral difference which is documented is the arboreal habit of Eumeces fasciatus vs. the fossorial habit of Eumeces septentrionalis. However, in the Minnesota rock habitat of the five-lined skinks, most individuals were found on or near the ground.

On the basis^{of} scat collections from both species, qualitative differences in food habits were not evident. On rock exposures, roaches appeared to be the dominant prey during the spring and early summer. Roaches were very abundant under rocks and other cover on rock outcrops. Direct aggressive or competitive interactions between the species were not apparent. In captive enclosures, prairie skinks tolerated both young and adult five-lined skinks, and vice-versa.

One possible, as yet unsubstantiated, scenario is the following: as the rock exposures have become progressively more vegetated during the past 30 years, soil and dry prairie vegetation have accumulated on many of the previously bare rock surfaces (see section 3.5.3 on recent vegetation changes). Prairie skinks, a species which has a well-established fossorial habit, appears to be colonizing rock outcrops as they become covered with^{soil} vegetation; eventually, prairie skinks will out-compete five-lined skinks in rock outcrop habitat and eliminate the species by competitive exclusion.

Both species of skinks now coexist at two (and probably three) of the localities in Minnesota. Whether this situation is stable or transitional is difficult to determine. Fitch (1954) studied one population of five-lined skinks in Kansas at a locality where prairie skinks were scarce; the latter species preferred open, grazed habitats. Clearly, more information is needed on the ecologies of both species, especially where they occur together, and on possible interactions which may occur between these two species.

4.0 RECOMMENDATIONS

4.1 General

These recommendations have been formulated as a working plan designed to enhance the survival of populations of five-lined skinks in Minnesota. This plan is of necessity provisional and subject to revision in the light of new information. The recommendations of the Amphibian and Reptile Group of the Endangered Species Technical Advisory Committee for the five-lined skink (Appendix A) are:

- 1) Protection/acquisition of specific sites where skinks are known to occur, particularly localities vulnerable to major alteration/disturbance,
- 2) Further information on local distribution and abundance to assess status and implement 1 above,
- 3) Prohibition on collection or taking of this species.

The recommended Minnesota status of the species is "threatened," a category which does not afford legal protection from collecting/taking or habitat destruction/alteration.

4.2 Collecting

At present, on the basis of available evidence, collecting/taking of the species is not considered to be a major threat. However, it would be prudent to provide legal protection for the species, perhaps as part of an overall protection for all amphibians and reptiles in Minnesota. In all instances, commercial collecting of this species should be prohibited legally. The very limited distribution and

habitat specificity of the species together with its secretive nature and season-specific activity makes collecting five-lined skinks in Minnesota quite a challenge for the professional herpetologist. Consequently, casual collecting will probably not have significant impacts on these populations.

4.3

Protection/Management of Habitat

However, protection and management of known and potential habitats are considered critical for the continued survival of the species in Minnesota. Protection is necessary because 1) the rock outcrop habitat is very limited in distribution; relatively few areas are protected at present, and 2) within this restricted habitat, the distribution of skinks is patchy and site-specific. Once an area is protected, management is necessary because 1) the rock outcrop habitat is gradually being vegetated by cedars in the absence of fire, and 2) this vegetation change may favor the invasion of altered rock outcrops by prairie skinks and competition between species of skink. Controlled burning to maintain bare rock exposures in this habitat is apparently the preferred management strategy.

4.3.1

Swedes Forest: Specific Recommendations

Of the three known localities, Swedes Forest (Figure 5) has: 1) the greatest number of specific sites (=13), 2) the largest estimated minimum population size (=4590), and 3) the largest area of suitable habitat (=369 hectares or 918 acres). All of this area is currently in private ownership; land use varies from quarrying (intensive) to grazing (moderate) to recreational (light use).

Specific recommendations for the Swedes Forest locality are:

- 1) notification of all owners of private land on which specific sites are located and registration of suitable habitat in the Private Lands Registry (TNC),
- 2) easements, leases, and/or purchases should be considered for the habitat owned by View Quarry Company, O.&E. Sander, W. Smith, H. Knutson, and L. Wurscher. The Knutson property is of particular interest because it is across the Minnesota River and not contiguous with other habitat. This population is vulnerable to local extirpation if the Knutson habitat is altered or destroyed,
- 3) management of selected areas of habitat on an experimental basis by controlled burning, selective cutting, or other means to restore the open rock exposures which are the primary habitat of the five-lined skink
- 4) periodic monitoring (at intervals of ≤ 5 years) of specific sites and other additional sites in suitable habitat to assess the status of the skink population at this locality

4.3.2 Delhi : Specific Recommendations

The Delhi locality (Figure 8) has: 1) the fewest specific sites (=3), 2) the smallest estimated minimum population size (=360), and 3) the smallest area of suitable habitat (29 hectares=74 acres). Virtually all of this habitat is owned by the County of Renville and lies within the boundaries of Renville County Park No. 2. At present, land use is recreational; park regulations prohibit hunting. The degree of protection provided by the County for non-game species within the park is not known.

Specific recommendations for the Delhi locality are:

- 1) notification of owner (currently Ed Stone) of private land on which a specific site is located and registration of suitable habitat in the Private Lands Registry (TNC),
- 2) an easement, lease, or purchase should be considered at some future date, but does not seem necessary at present because Mr. Stone is enthusiastic about maintaining the species on his property,
- 3) registration of the suitable habitat within the Renville County Park No. 2 in the Minnesota Natural Heritage Register,
- 4) a management plan should be developed for the park that would seek to maintain openings on the rock outcrops; this objective may be accomplished by controlled burning, selective cutting, or some other suitable means. Initially, this would be an experimental manipulation designed to increase skink abundance; consequently, careful monitoring would be essential in evaluating the effectiveness of any such plan,
- 5) periodic monitoring (at ≤ 5 year intervals) of these specific sites and other additional sites in suitable habitat in order to assess the status of the skink population at this locality,
- 6) designation of the Cedar Rock Wildlife Management Area (section 10 + 11, T113N, R36W) as a scientific and natural area on the basis of a) unique habitat associated with rock outcrop landform, and b) proximity of suitable habitat at the WMA to known occurrence of the five-lined skink at Delhi locality, 3 miles upriver.

4.3.3 South Granite Falls : Specific Recommendations

Relative to the other localities, the South Granite Falls locality (Figure 9) has an intermediate: 1) number of specific sites (=10), 2) estimated minimum population size (=1025), and 3) area of suitable habitat (=82 hectares or 205 acres). This area is in public and private ownership and differs from the other two localities primarily by its proximity to development in and around the city of Granite Falls. Current land use in the vicinity includes road construction (destruction of habitat on Hwy 23 right-of-way), quarrying (Green Co. Quarry), residential and industrial sites (city of Granite Falls), grazing, and recreational (park, museum, and golf course). Because there is a recent history of various habitat alterations in the immediate vicinity and because the locality is proximate to the city of Granite Falls, a city

which is likely to continue to grow and develop, I consider the South Granite Falls skink population(s) to be particularly vulnerable to extirpation and recommend that habitat protection/acquisition at this locality be given highest priority.

Specific recommendations are:

- 1) notification of owners of private lands on which specific sites are located and registration of suitable habitat in the Private Lands Registry (TNC),
- 2) easements, leases, and/or purchases should be sought for these land holdings as soon as possible. In particular, I consider the following properties critical to the continued survival of five-lined skinks at this locality in order of priority:

J. Bakke	~29 acres	NW 1/4 of NE 1/4, Sec. 4
?	~20 acres	W1/2 of NE 1/4 of NE 1/4, Sec. 4
P. Hinz	~40 acres	SW 1/4 of NE 1/4, Sec. 4
L. Sebring	~60 acres	SE 1/4 of NE 1/4, Sec. 4

[approximate boundaries indicated in Figure 15]
- 3) registration of the suitable habitat in a) the Memorial Park, b) Yellow Medicine County Historical Museum, and c) other public lands within the area of suitable habitat at this locality. The maintenance of these area should include some provisions for protecting and maintaining skink habitats, i.e., selective cutting or controlled burning may be desirable on some outcrops on park and museum grounds.
- 4) clarification of land owners, both public and private, in the NE 1/4 of NE 1/4 Section 4. The county recorder, Mr. Norman Opdahl, has indicated at least a portion of this tract is owned by the State of Minnesota (Appendix L),
- 5) more information on the specific sites occupied by skinks at this locality is needed; all of the known sites are disturbed to some extent. Grazed vs. not grazed areas might be compared with respect to skink occurrence and abundance; other strategies might involve providing cover or creating openings as dictated by specific portions of habitat. A detailed management plan for this locality is not feasible without additional data on skink distribution and abundance,
- 6) periodic monitoring of these specific sites (at intervals of ≤ 5 years) and additional sites in suitable habitats in order to assess the status of skink population(s) at this locality. The frequency of monitoring should be dependent on the extent of habitat alteration and/or acquisition.

4.4

Future Fieldwork: priorities

Additional fieldwork is required to delineate skink distribution and abundance. Detailed information on the distribution of five-lined skinks at South Granite Falls locality is essential. The habitat at this locality is fragmented and disturbed; and consequently, it is more difficult to designate areas as suitable habitat or likely specific sites of skink abundance without the "ground truth" provided by fieldwork.

Additional land owners should be contacted; and properties to the south, southeast, and east (across the river) of the known locality should be examined for skinks. There are a number of sightings (see Figure 9) that were made by reliable observers, but verification and documentation of these records is desirable. Finally, additional fieldwork at this locality is a prerequisite for a detailed management plan. Additional fieldwork is also recommended in the vicinity of the Delhi locality to delineate skink distribution and abundance, particularly in the areas across the river (Hultquist property) and between Delhi and the Cedar Rock Wildlife Management Area (3 miles SE of Delhi).

4.5

Relocation and Restocking

Although it is premature at this stage in the development of a management plan for Eumeces fasciatus in Minnesota, it should be pointed out that relocation of skinks to areas of suitable habitat is a possible management strategy. On the basis of observations in Kansas, Fitch (1954) reported that skinks transferred from an original location settled in a new range if the habitat was favorable, sometimes after an initial wandering period. In my judgement, the availability of a suitable hibernaculum nearby may be of critical importance in the success of such a procedure in Minnesota. Nevertheless, there may be occasions in the future management of the species which might include relocation or (re)introduction of skinks to areas of suitable habitat. On the basis of available evidence, this would appear to be a viable alternative.

4.6

Public Relations

Implementation of the above recommendations will require skillful public relations because 1) the five-lined skink is generally not recognized by local residents as a unique, useful, or desirable member of the regional fauna, and because 2) most residents, though extremely helpful and courteous to me personally, are generally not in sympathy with the objectives of the Non-game Program in particular or the DNR in general. There is, however, some recognition of the unique features of the region (e.g., the extraordinary age of the precambrian rocks). An effective management plan for the continued survival of the five-lined skink in the upper Minnesota River valley should include a public relations program which would emphasize the skink as an indicator of the unique plant and animal community endemic to the rock outcrop habitat and the necessity of protecting and preserving the diversity of the region.

4.7

Protecting and Preserving Rock Outcrop Habitats

There is a critical need to preserve the rock outcrops and associated flora and fauna in the upper Minnesota River valley in a natural or near-natural condition. At present, I estimate that less than 10% of the outcrops and exposures which I visited during this study were in public ownership; and none to my knowledge were under management as scientific and natural areas. Furthermore, private conservation agencies such as The Nature Conservancy have few, if any, nature preserves that encompass these rock outcrops.

These areas should be preserved, protected, and managed because they contain unique assemblages of plants and animals. This view contrasts markedly with the prevailing utilization of these rock areas as extensively-grazed pasture, as storage areas for discarded agricultural implements, and/or as trash dumps. Management of the rock outcrop habitat is critical in light of the documented changes in the vegetation; in particular, the spread of eastern redcedar in this habitat appears to be a major threat to the continued survival of the five-lined skink in Minnesota. Vegetation change likely threatens the continued existence of other species reliant on the rock outcrops and exposures unique to the area.

4.7.1 Specific Recommendations

In my opinion, it is essential that public and private agencies draw attention to this unique habitat by example and that these agencies actively protect and preserve the rock outcrops in the upper Minnesota River valley. My specific recommendations in this regard are:

- 1) commendation of the Renville County Park Board or responsible officials on the establishment and maintenance of a system of county parks along the Minnesota River, a system which now includes rock outcrop habitat. Similar efforts in Yellow Medicine, Redwood, and Chippewa counties should be initiated and encouraged,
- 2) evaluation and designation of Cedar Rock Wildlife Management Area as a scientific and natural area; inventory of other state-owned properties containing rock outcrop habitat for inclusion in the SNA or similar program,
- 3) easement, lease, or acquisition of desirable private properties; on the basis of my fieldwork, I recommend the following two outcrop habitats because both a) are near known localities of five-lined skinks and contain suitable habitat, and b) are large rock outcrops which are relatively undisturbed; these are the O.Homme/Hanson properties (Figure 15) and the Hultquist/Tufto/Dirilan properties (Figure 12).
- 4) a management plan be devised to control eastern redcedars; such a plan should include a variety of control measures (burning, cutting, etc.), should be cognizant of the local industry utilizing redcedar (for cedar chests, lining, curios, etc.), and should include some incentives for implementation; introduction on an experimental basis and scientific evaluation of the effects of various treatments are essential,
- 5) development of an active interpretive program focused on the unique flora and fauna of the region and aimed at both visitors and local residents; an ideal facility for such a program already exists at the Interpretive Center, Upper Sioux Agency State Park.

5.0

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