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WINTER TERRITORIES AND NIGHT ROOSTS OF NORTHERN SHRIKES IN IDAHO[1]

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Abstract. To study the winter ecology of Northern Shrikes in southwest Idaho, I observed the activities of six color-banded and six radio-tagged shrikes over the winters of 1988-1989 and 1989-1990. These shrikes occupied winter territories that averaged 216 ha in size (minimum convex polygon method). Over one-half of the activity of each shrike was confined to a core area of approximately 50 ha. Five of nine individual Northern Shrikes perched in or hunted within mesic areas significantly more than expected and four of the nine utilized grasslands significantly less than expected. Linear habitats such as riparian corridors and rimrock outcroppings appeared to be important to wintering shrikes since the former provided night roost habitat whereas the latter provided warm and productive areas for prey populations.

I located 10 night roosts of Northern Shrikes. All were in deciduous shrubs with many small stems. Shrikes may depend upon these roosts for thermal protection and escape from predators.

Key words: Lanius excubitor; *Northern Shrike; territoriality; winter ecology; radio telemetry; habitat use; minimum convex polygon; homerange; harmonic mean.*

INTRODUCTION

During the winter Northern Shrikes (*Lanius excubitor*) are only occasionally observed throughout much of North America north of 40°N latitude. In the summer, large portions of their breeding range in the taiga of northern Canada and river bottoms of the north slope of Alaska are also unoccupied by shrikes (T. J. Cade, pers. comm.). Why are there so few shrikes?

Northern Shrikes, along with their smaller congener, the Loggerhead Shrike (*L. ludovicianus*), are prolific breeders. Northern Shrikes often fledge seven young and this species has been known to be double and triple brooded (Miller 1931, Cade 1967, Yosef and Pinshow 1988). Such a prolific species might be expected to have dense populations; therefore, what happens to the young shrikes?

Several studies have addressed the alarming decreases observed in the Loggerhead Shrike populations of eastern and midwestern North America (Cadman 1985, Novak 1986, Luukkonen 1987, Brooks 1988, Gawlik and Bildstein 1990). In each, investigators reported successful reproduction, and yet breeding habitat appeared unsaturated. Limitation during the winter season has been invoked to explain a portion of the population decline (Cadman 1985, Brooks 1988). Possible factors that may limit shrike numbers during winter include pesticides, habitat alteration, predation, and competition for prey or suitable wintering habitat (Cadman 1985, Haas and Sloane 1989, Lymn and Temple 1991).

Little is known, however, of the biology, habitat requirements, and population status of Northern Shrikes in North America. Therefore, to assess the requirements of Northern Shrikes wintering in the western United States, I studied this species in the shrub steppe of southwest Idaho. Here, I present results of observations of color-banded and radio-marked shrikes, use of those habitats within their winter territories, characteristics of night roosts, and relative amounts of possible prey found in various habitats.

METHODS

STUDY AREA

This study was conducted in an area of approximately 25,000 ha 10 km to 35 km southeast of Boise and north into the foothills of the Danskin Mountains (43°30'N, 116°W) in southwest Idaho. Most of the region is typified by rolling hills dissected by small intermittent streams and is characterized by shrub steppe vegetation. Some areas are cattle ranches with portions converted

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to agriculture such as wheat and hay fields. The shrub steppe areas are vegetated by big sagebrush (*Artemisia tridentata*), perennial bunchgrasses (i.e., *Agropyron spicatum*), introduced annual cheatgrass (*Bromus tectorum*), and various forbs. Bitterbrush (*Purshia tridentata*) and balsamroot (*Balsamorhiza* sp.) are found on the hillsides, rabbitbrush (*Chrysothamnus* sp.) occurs on the flats, and willows (*Salix* sp.) are the predominate riparian shrubs. Along basalt rimrock areas and stream courses, scattered hawthorns (*Crataegus columbiana*), golden currant (*Ribes aureum*), and serviceberry (*Amelanchier alnifolia*) shrubs are found. Elevation is approximately 900–1,635 m.

Winters are moderate with minimum temperatures occurring during January. Although most of the 110–350 mm of yearly precipitation falls between November and April (Yensen et al. 1992), extended periods of deep snow cover are uncommon.

TECHNIQUES

During the winters of 1988–1989 and 1989–1990, I searched for Northern Shrikes by performing road surveys through the study area starting in late October of each winter. I chose survey routes based upon the advice of local observers well acquainted with the area (C. Sweeney, pers. comm.). From October to April, I performed one survey every 7–12 days alternating through the five major routes. Each survey was conducted at 20–25 km/hr and averaged 30 km in length. On each route I recorded the linear distances of each habitat type.

I trapped shrikes on bal-chatri traps baited with either house mice (*Mus musculus*) or Zebra Finches (*Peophila guttata*). During winter 1988–1989, I color banded six shrikes with aluminum bands. Additionally, each of six shrikes was outfitted with a small (<2 g) radio transmitter (Holohil Systems, Ltd.) in the 1989–1990 field season. I attached each radio to the two central retrices. Marked birds were followed throughout each winter through 2–4 hr observations recording behaviors continuously. I plotted locations of shrikes on United States Geological Survey (USGS) 7.5′ topographic maps and subsequently converted these points to UTM (Universal Transverse Mercator) coordinates.

I calculated territory size of radio-tagged and banded Northern Shrikes with the minimum convex polygon method (Samuel et al. 1985, Anderson 1982). To describe patterns of territory use, I calculated 85 and 50% harmonic mean contours (Dixon and Chapman 1980). These isopleths contain 85 and 50% of each shrike's utilization distribution.

I classified the study area into the following four major habitat types easily recognized from aerial photographs: (1) agriculture, (2) mesic areas (riparian areas, intermittent streams, and weedy lowlands), (3) grasslands (cheatgrass dominated burns as well as some native bunchgrass areas), and (4) shrub areas (primarily big sagebrush communities). I calculated proportions of each of the four habitat types occurring within approximately 200 m of the survey routes (the distance within which shrikes were usually initially sighted) through the study area by tracing Bureau of Land Management (BLM) aerial photographs onto acetate sheets which were then weighed. I adjusted my measurements for changes in vegetation caused by wildfire and farming practices that occurred since the 24 July 1976 photography by inspecting portions of the study area. I repeated this procedure within each of nine Northern Shrike territories outlined by the minimum convex polygon method and compared the arcsin transformed proportions of each habitat type within territories to the proportions of each habitat type contained within 200 m of study area roads with one-sample *t*-tests (Sokal and Rohlf 1981).

From aerial photos, I also measured the lengths of linear habitats, which include riparian areas, rimrock outcroppings, and gravel roads in the study area and within each territory. For each Northern Shrike, I converted the length of each linear habitat to the average length/ha by dividing the total length by the size of its territory (100% minimum convex polygon estimate). These values were then compared to the average length of habitat/ha for the overall study area with one-sample *t*-tests (Sokal and Rohlf 1981).

To ascertain patterns of habitat use, I compared the observed number of locations for each shrike occurring in each of habitat type to what would be expected based upon the proportion of each habitat that occurred within each territory (Bonferroni *Z*-test; Neu et al. 1974, Byers et al. 1984).

I located night roosts by following Northern Shrikes and by searching areas in which I had observed shrikes at dusk for accumulations of fecal material beneath shrubs. I measured the height and crown diameter of each roost shrub, distance to the nearest shrub, as well as the number of shrubs within 5 m. I characterized the roost by measuring the height of the roost perch, distance from shrub center, and diameter of the perch twig. Stem density was measured by spinning (parallel to ground) a 50 cm ruler in two circles; one centered at the perch and the other at 30 cm above the perch, and counting the stems with which it came into contact. This procedure yielded number of stems/0.79 m^2.

To assess potential availability of passerine prey, I recorded all songbirds observed while performing road surveys. In each of the following three major habitat types; (1) agricultural areas, (2) mesic and riparian areas, and (3) shrub steppe areas (including grassy burns), I tallied songbirds encountered and compared these frequencies to the expected frequencies based upon the proportions of each habitat type the survey routes intersected. To reduce problems associated with pseudoreplication and chi-square analysis (Hurlbert 1984), these data were analyzed using Bonferroni confidence intervals (Neu et al. 1974, Byers et al. 1984). Each bird observed was assigned body mass based upon averages reported in Dunning (1984). A two-way ANOVA was used to test whether the average body mass of observed passerines differed between habitats and seasons (early/mid winter and late winter corresponding to before and after 14 February, respectively).

To assess potential availability of small mammal prey, I censused populations in each of the above habitat types after further separating shrub steppe areas into either shrub-dominated communities or grasslands. Rodents were trapped using Shermann live traps. Twenty areas were censused during the study.

RESULTS

The earliest dates on which I observed Northern Shrikes on the study area were 9 November 1988 and 10 November 1989. Both of these earliest arrivals were young of the year, although most wintering shrikes in southern Idaho were adults. The latest dates that I observed Northern Shrikes on their winter ranges were 24 March 1989 and 28 March 1990. Northern Shrikes spend up to at least 120 days on their winter territories.

I observed in depth the activities of nine individually marked Northern Shrikes over the winters of 1988–1989 and 1989–1990, six of which were radio-tagged. Northern Shrikes often sang from powerpoles, tall deciduous trees, and other exposed perches upon their arrival on the study area. I observed six of the nine shrikes singing during the winter, including one first-year bird. Bouts of singing occurred until the third week of November (18 November 1989) and were reinitiated by early February (8 February 1990). Song bouts were long (up to 45 min) and quite variable, incorporating many calls and squeaks. Shrike singing was not limited to the dawn chorus. I observed shrikes to sing at any period of the day and during any weather conditions including driving snow and wind. Ten of 19 singing perches were located at or within 50 m of the edges of the shrikes' winter territories.

Territories were well-spaced through the study area and were separated on average by approximately 1.4 territory diameters (Fig. 1). Minimum convex polygon estimates for the nine observed shrikes ranged from 55.40 ha to 357.03 ha ($\bar{x}$ = 215.72, SD = 106.43). Eighty-five percent harmonic mean estimates were also large and variable and ranged from 24.76 to 453.57 ha ($\bar{x}$ = 179.30, SD = 134.59) (Table 1). Fifty percent harmonic means covered an area averaging slightly over 50 ha ($\bar{x}$ = 53.41, SD = 47.56). That is, one-half of the relocations of each shrike, occurred in less than one-fourth (23%) of its entire territory.

The nine winter territories contained a variable mixture of the four major habitat types (Fig. 2). The territories contained proportions of each habitat type not significantly different than the proportions available within the study area.

Analysis of actual Northern Shrike locations produced a different picture, however. Grassy areas were used (perched over or hunted within) significantly less than expected by four of nine shrikes whereas riparian areas were used significantly more than expected by five shrikes (Table 2). Additionally, when all shrike locations were lumped, mesic areas were still used more often than expected (Table 3).

In addition to the four major habitat types each territory contained two or three types of linear habitats. These narrow corridors included lengths of rimrocks, county roads, and riparian stretches. Northern Shrike territories contained significantly greater lengths of both riparian corridors and county roads than found per hectare of study area (one-sample *t*-tests; $0.02 < P < 0.05$ and $P < 0.001$, respectively). Lengths of rimrock contained within territories were quite

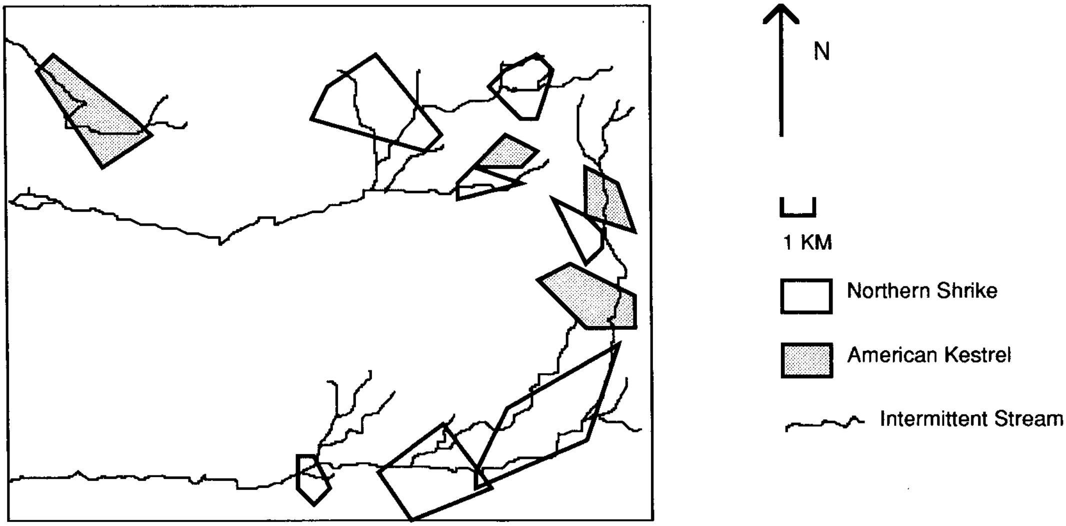

FIGURE 1. Distribution of Northern Shrike and American Kestrel winter territories in the study area during 1989–1990.

variable, ranging from zero in two territories to nearly 27 m/ha in one territory, and were not significantly different from the average length per hectare of study area.

Characteristics of the 10 night roosts I located are presented in Table 4. All roosts were in deciduous shrubs (or trees), four of which were willows (*Salix* sp.). Additionally, all roost shrubs were associated with mesic or riparian habitats, and the densest stands of shrubs were not chosen as roosts.

Shrikes perched on twigs that averaged over 150 cm from the ground and were located approximately halfway between the shrub center and the edge of the canopy. The roost twigs were variable in size, but all were surrounded by an area of many stems.

Fecal material had accumulated on branches below each roost perch, and I recovered up to 57 ($\bar{x}$ = 20.9, SD = 13.57, n = 10) pellets beneath each perch. These characteristics indicated that wintering shrikes reused certain night roosts during their residence on winter territories. I observed that the roosts were not necessarily used on successive nights; instead roost selection may have depended upon where the shrike found itself at nightfall. At that time, Northern Shrikes flew quickly and directly to their nearest roost site.

I observed a total of 2,510 passerines along the

TABLE 1. Winter territory sizes of Northern Shrikes in southwest Idaho.

Individual	# of relocations	100% minimum convex polygon (ha)	85% harmonic mean (ha)	50% harmonic mean (ha)	Distance to nearest shrike (m)*	Minimum residence time (d)
1	33	357.0	92.5	24.5	3,680	55
2	61	182.6	171.9	49.3	2,385	11
3	161	206.0	174.5	51.4	2,074	113
4	14	101.7	24.8	3.4	3,953	105
5	88	315.9	336.7	131.2	3,110	120
6	25	218.2	162.1	45.1	8,050	101
7	81	347.3	453.6	133.9	2,895	119
8	53	157.4	108.6	24.2	2,385	46
9	27	55.4	89.1	17.7	2,074	27
$\bar{x}$ =		215.7	179.3	53.4		
SD =		106.4	134.6	47.6		

* Distance between arithmetic centers of territories.

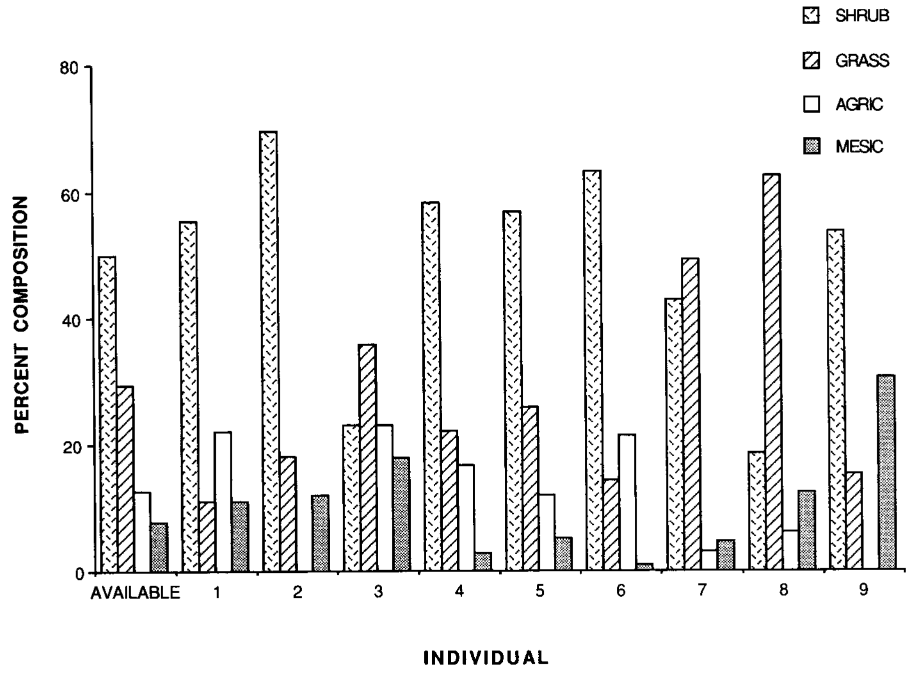

FIGURE 2. Proportion available and occurrence of four major habitat types in nine Northern Shrike winter territories: agricultural habitat, mesic habitat, grassland, and shrub-dominated areas.

survey routes through the study area over the winters of 1988–1989 and 1989–1990. Significantly more songbirds were recorded in agricultural habitat than expected (Fig. 3) (Bonferroni *Z*-test; observed proportion = 0.52, expected proportion = 0.26, $P < 0.05$). On the other hand, I tallied significantly fewer passerines in both mesic and shrub steppe areas than expected (observed proportion = 0.05, expected proportion = 0.09, $P < 0.05$ and observed proportion = 0.43, expected proportion = 0.65, $P < 0.05$, respectively). These distributions may reflect the relative ease of sighting a bird in areas of low vegetative cover such as hayfields rather than absolute abundances of songbirds.

The average body mass of observed passerines was significantly different among habitats and between seasons ($F_{2,2507} = 249.09$, $P < 0.0001$; $F_{1,2508} = 469.45$, $P < 0.0001$, respectively). Heavier songbirds were observed more in late winter than earlier in the season (Tukey's Studentized Range (HSD) Test) (Fig. 4). The largest bird species, on average, were observed in agriculture, the smallest in riparian areas. Only one combination (early/riparian) was not significantly different from other combinations owing to the small sample size in this combination.

Numbers of small mammals trapped per trapping effort differed significantly among habitat types (one-way ANOVA; $F_{3,16} = 3.99$, $P = 0.0267$) (Fig. 5). A Tukey's Studentized Range (HSD) Test showed that the mean number of rodents trapped in shrub communities was significantly higher than the mean number captured in agricultural areas ($P < 0.05$). On average, I trapped 17.5 times as many rodents in sagebrush areas as in hayfields. The majority of rodents trapped on all grids were deermice (*Peromyscus maniculatus*), followed by harvest mice (*Reithrodontomys megalotis*), and wild house mice. Unfortunately, voles (*Microtus* sp.), if present, were not enticed into live-traps by peanut butter, millet, and oats.

DISCUSSION

The timing of Northern Shrike migration in western North America (R. Drewien, R. Howie, C. Trost, pers. comm.; C. Rimmer, unpubl. data) is quite similar to that reported for Northern Shrikes (Great Grey Shrikes) in Sweden (Olsson 1984b). In both areas, shrikes spend at least one-third of their year on winter territories. The over-winter survival of Northern Shrikes is therefore undoubtedly tied to the quality of these wintering

TABLE 2. Results of Bonferroni Z-tests for each Northern Shrike observed comparing proportion of usage of each habitat type to the expected proportion of usage (based upon relocations). Observed proportion of locations is significantly different from expected if the expected proportion lies outside of the confidence interval.

	Habitat Type			
	Agriculture	Mesic	Grassland	Shrubs
Individual	Observed (Expected) Interval	Observed (Expected) Interval	Observed (Expected) Interval	Observed (Expected) Interval
1	0 (0.22) —	0.73[a] (0.11) $0.53 \le P \le 0.92$	0 (0.11) —	0.27[b] (0.56) $0.08 \le P \le 0.47$
2	0 (0) —	0.28[a] (0.12) $0.14 \le P \le 0.42$	0.02[b] (0.18) $0 \le P \le 0.06$	0.70 (0.70) $0.56 \le P \le 0.85$
3	0.03[b] (0.23) $0 \le P \le 0.06$	0.53[a] (0.18) $0.43 \le P \le 0.63$	0.10[b] (0.36) $0.04 \le P \le 0.16$	0.34[a] (0.23) $0.25 \le P \le 0.43$
4	0.29 (0.17) $0 \le P \le 0.59$	0.21 (0.03) $0 \le P \le 0.49$	0.14 (0.22) $0 \le P \le 0.38$	0.36 (0.54) $0.04 < P \le 0.68$
5	0.15 (0.12) $0.05 \le P \le 0.24$	0.34[a] (0.05) $0.21 \le P \le 0.47$	0.20 (0.26) $0.10 \le P \le 0.31$	0.31[b] (0.57) $0.18 \le P \le 0.43$
6	0.12 (0.21) $0 \le P \le 0.28$	0.12 (0.01) $0 \le P \le 0.28$	0.32 (0.14) $0.09 \le P \le 0.55$	0.44 (0.64) $0.19 \le P \le 0.69$
7	0 (0.03) —	0.54[a] (0.05) $0.41 \le P \le 0.68$	0.09[b] (0.49) $0.01 \le P \le 0.16$	0.37 (0.43) $0.24 \le P \le 0.50$
8	0.11 (0.06) $0.01 \le P \le 0.22$	0.25 (0.13) $0.10 \le P \le 0.39$	0.32[b] (0.63) $0.16 \le P \le 0.48$	0.32 (0.19) $0.16 \le P \le 0.48$
9	0 (0) —	0.19 (0.31) $0 \le P \le 0.37$	0.22 (0.15) $0.02 \le P \le 0.42$	0.59 (0.54) $0.36 \le P \le 0.83$

[a] Denotes observed usage significantly greater than expected usage at $P \le 0.05$.
[g] Denotes observed usage significantly less than expected usage at $P \le 0.05$.

areas which must provide an adequate prey base, adequate roosting habitat, and cover to escape predation. Areas that provide the above resources may be well worth defending from other individuals.

Territory size in Idaho was larger than the winter territories reported for the European races of *L. excubitor* (Robson 1954, Mester 1965, Halliday 1970, Hewson 1970), although the territories that I studied overlapped in size with those studied by Olsson (1984b) in southern Sweden. Habitats may be less productive in the shrub

TABLE 3. Results of Bonferroni Z-tests on pooled relocations of nine Northern Shrikes utilizing four habitat-types in southweest Idaho.

Habitat type	Expected use*	Observed use*	Bonferroni intervals
Agriculture	0.0237	0.0571	$0.0322 \le P_a \le 0.0819$[a]
Mesic	0.0382	0.4125	$0.3598 \le P_m \le 0.4652$[a]
Grassland	0.1737	0.1381	$0.1012 \le P_g \le 0.1751$
Shrubs	0.7645	0.3923	$0.3400 \le P_s \le 0.4445$[b]

* Proportion of usage.
[a] Indicates observed use is significantly greater than expected use at the 0.05 level of significance.
[b] Indicates observed use is significantly less than expected use at the 0.05 level of significance.

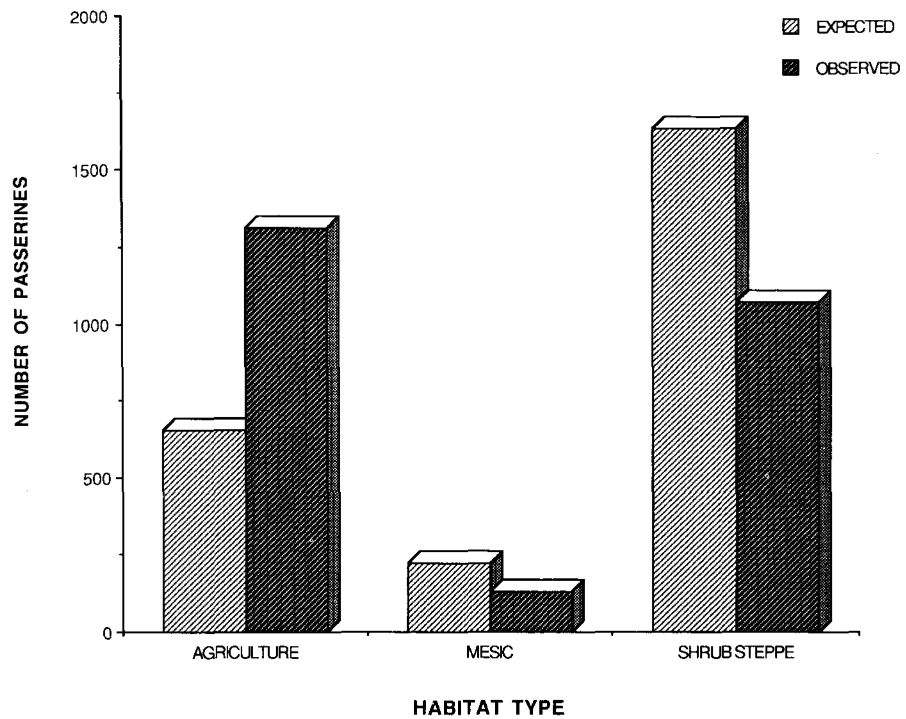

FIGURE 3. Numbers of passerines observed along survey routes through the study area by habitat type. Numbers observed within each habitat were significantly different at $P < 0.05$ [Bonferroni Z-tests (Neu et al. 1974, Randall et al. 1984)].

steppe areas of western North America and, hence, may necessitate increased territory size to include sufficient numbers of prey. The use of radiotelemetry also may contribute to the calculation of larger territory sizes, for this technique enables birds to be monitored in areas where visual tracking may be difficult or impossible.

Like the breeding population of Northern Shrikes in Alaska (Cade 1967) the wintering range in southwestern Idaho does not appear to be saturated with shrikes. Areas of apparently suitable

TABLE 4. Characteristics of winter night roosts used by Northern Shrikes in southwest Idaho (all measurements in centimeters).

Indiv.	Shrub species	Shrub ht.	Canopy diam.	Roost ht.	Dist. from shrub center	Roost diam.	Twigs at roost	Twigs above roost	Dist. to nearest shrub	# of shrubs within 5 m
10	SASP	350	200	73	75	3.13	39	38	120	7
10	SASP	375	300	108	98	1.66	39	37	278	14
9	AMAL	300	350	153	119	4.08	28	41	369	7
3	SASP	500	200	150	0	3.15	54	59	230	12
7	AMAL	450	300	163	63	5.76	17	16	250	18
7	RIAU	200	300	165	65	1.44	55	54	300	9
7	RIAU	200	300	152	68	0.71	78	76	210	9
5	CRCO	350	250	180	30	6.86	30	33	160	4
8	SASP	500	200	180	38	2.23	30	37	270	3
1	ELAN	900	800	215	185	1.19	27	37	440	11
$\bar{x}$ =		412.5	320.0	152.4	74.1	3.02	39.7	42.8	262.7	9.4
(SD)		(201.8)	(177.7)	(38.6)	(51.5)	(2.03)	(18.0)	(16.4)	(93.9)	(4.6)

SASP = *Salix* sp.; AMAL = *Amelanchier alnifolia*; RIAU = *Ribes aureum*; CRCO = *Crataegus columbiana*; ELAN = *Eleagnus angustifolia*.

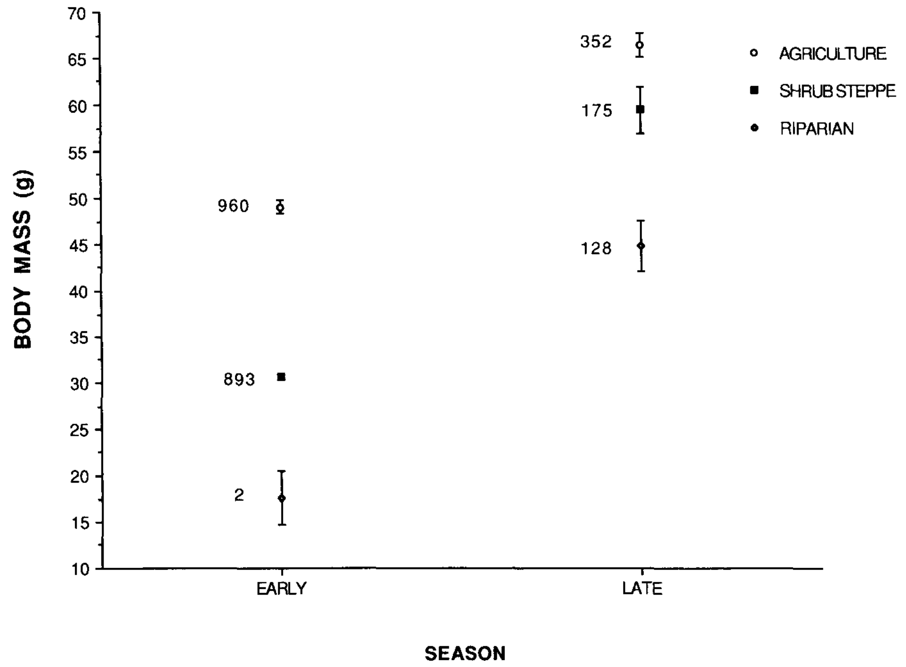

FIGURE 4. Body mass (mean ± SE) of 2,510 passerines observed along survey routes in each habitat type during early/mid and late winter. Numbers indicate sample size (number of birds encountered).

habitat appear to remain unoccupied. However, within one week of the death of a Northern Shrike in November 1989, its territory was occupied by another, suggesting that high quality areas may be in high demand. Occupation of territories by Northern Shrikes appears to be persistent from year-to-year in the study area, although I did not observe the return of marked birds in subsequent winters. The winter territories of Northern Shrikes also are used as breeding territories by Loggerhead Shrikes in the summer (pers. observ.) similar to the situation reported in southern Sweden between *L. excubitor* and the smaller Red-backed Shrike (*L. collurio*) (Olsson 1984a). Additionally, some of the areas uninhabited by shrikes are winter territories of American Kestrels (*Falco sparverius*) (Fig. 1, Atkinson 1991).

Linear habitats appear to be important for wintering Northern Shrikes. For example, in plotting the harmonic mean contours of the six most-studied territories it became apparent that much of the utilization pattern paralleled rimrocks or stretches of riparian vegetation (Fig. 6). Rimrocks contain many crevices which provide nesting areas for deermice. Nesting areas for deermice may be limited in structurally simple grassland communities. During January 1989, I was able to trap juvenile and lactating female deermice only along rimrocks, indicating that these rodents are able to reproduce year-round in these habitats. Rimrocks also provide shelter and warmth for arthropods on sunny days (pers. observ.), thereby increasing the availability of this prey type to Northern Shrikes.

Even though the nine territories did not contain significantly greater lengths of rimrock than found per hectare of study area, six of these did have larger amounts than the study area value. One territory contained over 40 times the expected value, and it was this individual that appeared the most vocal and aggressive during behavioral observations. On the other hand, both territories that contained no rimrock areas were occupied by shrikes in their first winter. These observations suggest that winter territories without rimrocks are less desirable.

Lengths of county road/ha were significantly greater within Northern Shrike territories than outside of them. This, however, may simply be an artifact of my methodology, since shrikes were captured along roads. It should be noted, however, that roads paralleled by powerlines may

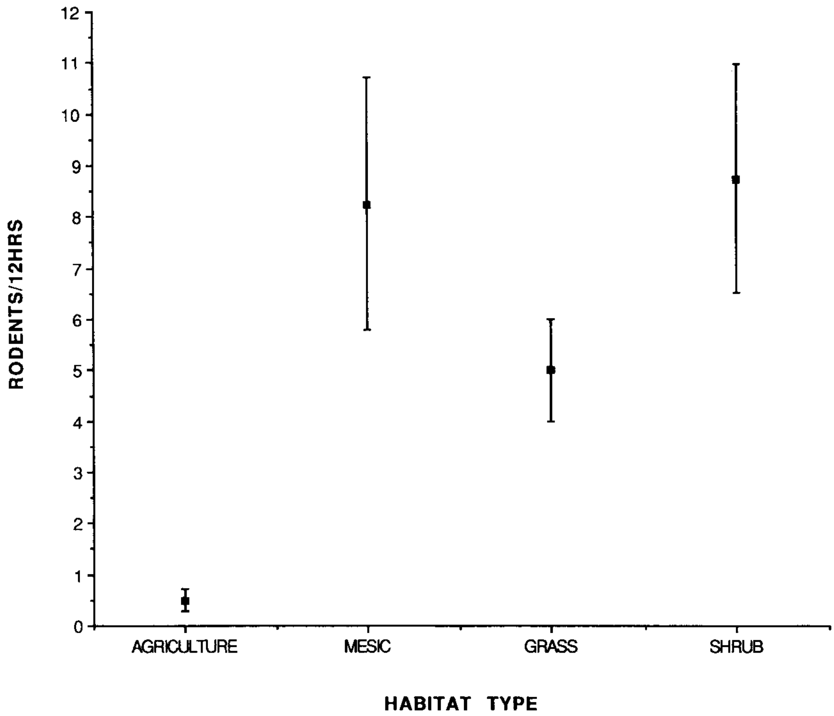

FIGURE 5. Number of rodents (mean ± SE) trapped per 12 hours in each of four habitat types. Numbers of areas trapped in agriculture, mesic habitat, grassland, and shrub habitat were 6, 4, 2, and 8, respectively.

benefit Northern Shrikes as they provide elevated perches from which to hunt. Mice and arthropods are very visible when they leave the grassy road margins and venture out upon the bare road surface. Conversely, roads may be a potential source of mortality (Cadman 1985; Luukkonen 1987, pers. observ.).

A final advantage that may accrue to Northern Shrikes defending winter territories is the initiation of pair-bonding. During the spring of 1990, I observed courtship activities which included follow-flights and perching side-by-side between a study bird and a previously unobserved Northern Shrike in second-year plumage. Such activity has not previously been recorded in North America.

Reports of wintering Great Grey Shrikes invariably associate these birds with riparian or other mesic areas (Halliday 1970, Hewson 1970, Olsson 1984a). These wet, tussocky areas provided good habitat for prey species in Sweden (Olsson 1984a). Similarly, I observed that Northern Shrikes in southwestern Idaho occupied territories that contained significant amounts of mesic or riparian habitat and did not occupy areas not containing mesic habitat (see Fig. 2). Even more importantly, over one-half of the shrikes used these areas significantly more than expected. These areas are probably important in supporting small mammal populations (Larrison and Johnson 1981) as well as insect prey. In addition, hunting perches and escape cover are abundant in these areas.

Bechard (1982) showed that Swainson's Hawks (*Buteo swainsoni*) foraged in areas of low vegetative cover even though rodent densities were greater elsewhere. He suspected that raptors responded more to vegetative cover than to actual prey densities. If the same argument applies to Northern Shrikes, I would predict that shrikes should forage more often than expected in areas of low cover, such as hayfields, even though nonvole rodent densities are lower there. The Northern Shrikes I observed, however, hunted very little within agricultural habitat, even though songbird numbers were high there. This may be due to the following: First, hunting perches are very limited in agricultural areas, a characteristic

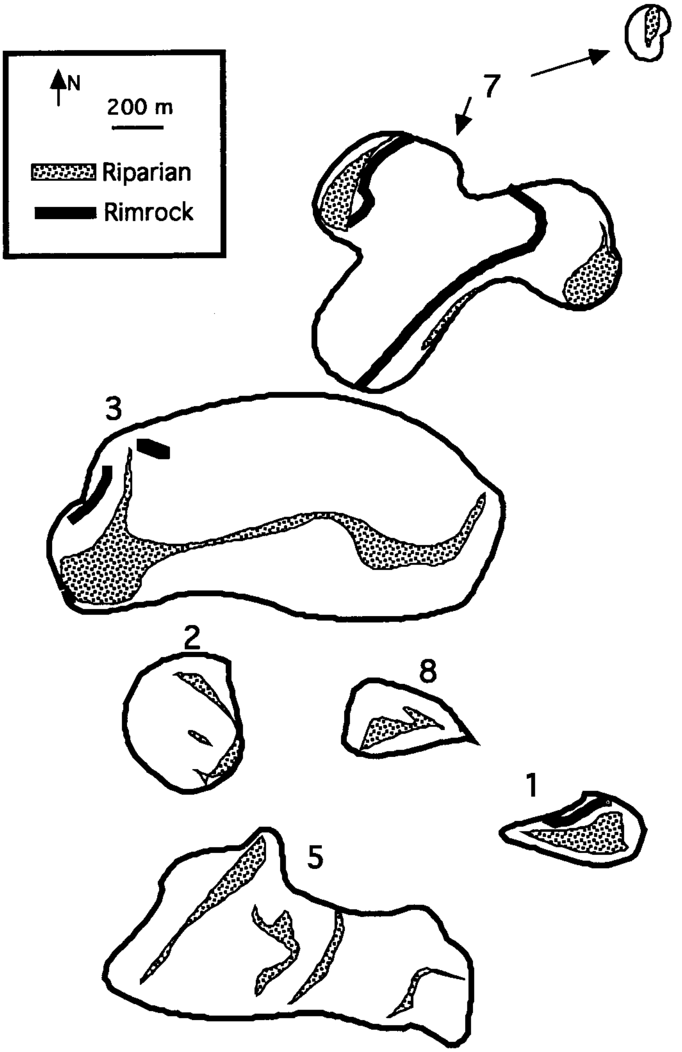

FIGURE 6. Fifty percent harmonic mean isopleths and riparian and rimrock areas for the six most-studied Northern Shrike winter territories. Size of territories is to scale whereas placement is not.

very important to shrikes (Yosef 1993). Suitable hunting perches are quite rare in agricultural areas.

Secondly, shrikes probably respond differently to cover than do Swainson's Hawks. For example, shrikes often hunt in a manner reminiscent of a small accipiter by flying low to the ground or by entering into shrubs or tall grass in order to flush out prey (Cade 1967, pers. observ.).

Thirdly, escape cover for the shrikes themselves is limited in agricultural areas; hence, shrikes that spend considerable amounts of time in this habitat may increase their risk of predation by raptors.

Fourthly, not only might shrikes prefer nonagricultural land for structural reasons, but prey is apparently more abundant in those areas. Nonmicrotine prey availability may be low in arable areas simply because hayfields do not support great numbers of deermice, whereas songbird availability may be low owing to the large size of most passerines in this habitat type (Fig. 6). The passerine species observed were substantially larger in agricultural areas than in other habitats. These species, such as European Starlings (*Sturnus vulgaris*), Brewer's Blackbirds (*Euphagus cyanocephalus*), and Red-winged Blackbirds (*Agelaius phoeniceus*) probably represent, at best, a marginal prey base for Northern Shrikes. Large songbirds are not prime prey for Northern Shrikes in Idaho since most birds that fall prey to shrikes are taken by surprise and are not usually taken while in flight (Cade 1962, 1967; Atkinson 1991; Atkinson and Cade 1993). Additionally, manipulating such large prey may be difficult for Northern Shrikes since shrikes usually carry their prey to a butchering site for dismembering (Cade 1967; Olsson 1985, pers. observ.).

Birds may become less important as potential prey late in the winter season because large birds were generally the rule by late winter in all habitats due to the influx into the study area of breeding populations of large-bodied birds such as Western Meadowlarks (*Sturnella neglecta*), Red-winged Blackbirds, and American Robins (*Turdus migratorius*), and the simultaneous disintegration of the large wintering flocks of Horned Larks (*Eremophila alpestris*), Dark-eyed Juncos (*Junco hyemalis*), and Pine Siskins (*Carduelis pinus*). As the season progresses, therefore, the potential songbird prey (namely, small-bodied birds such as larks, sparrows, and finches) may become a smaller proportion of the total songbird assemblage and concurrently a less available resource to Northern Shrikes.

Although habitat use of Northern Shrikes in southwest Idaho may respond more to small mammalian prey populations, songbirds may become more important as prey during periods of high snow cover (Olsson 1984b, 1986). Snow cover can severely decrease the availability of small mammals, especially microtines (Cade 1967). Therefore, on the rare occasions that heavy snow fall does occur on the study area, I would predict that shrikes would spend time in shrubby areas where deermice that venture out upon the snow are vulnerable and small-bodied songbirds have reduced cover in which to hide. The use of riparian areas should also increase since small passerines converge on this habitat to forage on food sources not covered with snow. Shrikes should spend less time in grassy and agricultural areas during these periods since voles would be unavailable and only large-bodied passerines are present. These predictions were realized: I observed shrikes only in sagebrush areas and brushy mesic habitats when snow cover exceeded approximately eight cm.

Riparian corridors, in addition to providing productive habitat for deermice and voles, provide shrubs of adequate size for night roosts. I found no night roosts in big sagebrush habitat, which covers the majority of the study area. This species seldom reaches the minimum size of the shrubs in which shrikes roosted, nor does it have the density of small twigs seen in such species as willows and Russian olives (*Eleagnus angustifolia*).

A high stem density surrounding a shrike's roost perch may be important in reducing wind and, hence, convective heat loss on cold and windy winter nights (Mugaas and King 1981, Webb and Rogers 1988). Using many-stemmed deciduous shrubs for roosting may be energetically the least expensive option available for shrikes since more benign roost sites, namely conifers (Thompson and Fritzell 1988), do not occur in the study area. In fact, *L. excubitor* in Sweden roosts exclusively in junipers (*Juniperus* sp.)., once deciduous trees drop their leaves (Olsson 1984a).

Twigs perched upon by shrikes averaged approximately 1.5 m from the ground, a height which is similar to the height of perches used by shrikes in Sweden (1.8 m) (Olsson 1984a). The similarity of these values, in addition to the fact that roost height was not correlated with the size of the roost shrub, indicate that Northern Shrikes apparently choose roost twigs based upon their height from the ground. This may be advantageous in reducing the shrike's vulnerability to nocturnal ground-dwelling predators such as red foxes (*Vulpes vulpes*), coyotes (*Canis latrans*), and mustelids.

Shrikes occasionally return to their night roosts during the day, indicating that these roosts may also provide relatively safe daytime retreats from predators. An advantage to the relative isolation of roost shrubs is that a disturbed shrike has a clear avenue of escape. Shrikes flush wildly and fly erratically when disturbed from a night roost after dark (Miller 1931; C. Haas, pers. comm., pers. observ.).

Predation by raptors clearly has the potential to be an important force in the winter lives of Northern Shrikes. During my study, one of the radio-tagged shrikes fell prey to a small accipiter. In addition, on several occasions I observed shrikes retreating into brushy cover at the sight of Cooper's Hawks (*Accipiter cooperii*), Northern Goshawks (*A. gentilis*), Prairie Falcons (*Falco mexicanus*), and occasionally Northern Harriers (*Circus cyaneus*). In each instance, the shrike left its perch well before the raptor came into my view and only left its protective cover after the raptor had left the area. Shrikes spend much of their time perched on exposed vantage points where they may be quite susceptible to predation, especially if their attention is directed toward searching for prey moving through the vegetation below them.

In conclusion, wintering Northern Shrikes must acquire territories that are capable of supporting adequate numbers of prey. Additionally, such territories should contain a mixture of habitat types, including linear stretches of riparian areas. Habitat diversity and linear habitat components appear to be important to shrikes for supporting prey populations, providing escape cover, and by providing suitable areas in which to roost.

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LITERATURE CITED

ANDERSON, D. J. 1982. The home range: a new nonparametric estimation technique. Ecology 63:103–112.

ATKINSON, E. C. 1991. Winter ecology of Northern Shrikes (*Lanius excubitor*) in Idaho: foraging, territories, and niche overlap with American Kestrels (*Falco sparverius*). M.Sc.thesis, Boise State University, Boise, ID.

ATKINSON, E. C., AND T. J. CADE. 1993. Winter foraging and diet composition of Northern Shrikes in Idaho. Condor 95:528–535.

BECHARD, M. J. 1982. Effect of vegetative cover on foraging site selection by Swainson's Hawk. Condor 84:153–159.

BROOKS, B. L. 1988. The breeding distribution, population dynamics, and habitat availability and suitability of an Upper Midwest Loggerhead Shrike population. M.Sc.thesis, Univ. of Wisconsin, Madison, WI.

BYERS, C. R., R. K. STEINHORST, AND P. R. KRAUSMAN. 1984. Clarification of a technique for analysis of utilization-availability data. J. Wildl. Manage. 48: 1050–1053.

CADE, T. J. 1962. Wing movements, hunting, and displays of the Northern Shrike. Wilson Bull. 74: 386–408.

CADE, T. J. 1967. Ecological and behavioral aspects of predation by the Northern Shrike. Living Bird 6:43–86.

CADMAN, M. D. 1985. Status report on the Loggerhead Shrike in Canada. Unpublished report prepared for the Committee on the Status of Endangered Wildlife in Canada-COSEWIC.

DIXON, K. R., AND J. A. CHAPMAN. 1980. Harmonic mean measure of animal activity areas. Ecology 61:1040–1044.

DUNNING, J. B. 1984. Body weights of 686 species of North American birds. Western Bird Banding Assoc. Monograph 1.

GAWLIK, D. E. 1988. Reproductive success and nesting habitat of Loggerhead Shrikes, and relative abundance, habitat use, and perch use of Loggerhead Shrikes and American Kestrels in South Carolina. M.Sc.thesis, Winthrop College, Rock Hill, SC.

GAWLIK, D. E., AND K. L. BILDSTEIN. 1990. Reproductive success and nesting habitat of Loggerhead Shrikes in north-central South Carolina. Wilson Bull. 102:37–48.

HAAS, C. A., AND S. A. SLOANE. 1989. Low return of migratory Loggerhead Shrikes: winter mortality or low site fidelity. Wilson Bull. 101:458–460.

HALLIDAY, K.C.R. 1970. Notes on a Great Grey Shrike wintering in Lanarkshire. Scottish Birds 6:22–23.

HEWSON, R. 1970. Winter home range and feeding habits of a Great Grey Shrike in Morayshire. Scottish Birds 6:18–22.

HURLBERT, S. H. 1984. Pseudoreplication and the design of ecological field experiments. Ecological Monogr. 54:187–211.

LARRISON, E. J., AND D. R. JOHNSON. 1981. Mammals of Idaho. Univ. Press of Idaho, Moscow, ID.

LUUKKONEN, D. R. 1987. Status and breeding ecology of the Loggerhead Shrike in Virginia. M.Sc.thesis, Virginia Polytechnic Institute and State University, Blacksburg, VA.

LYMN, N., AND S. A. TEMPLE. 1991. Land-use changes in the Gulf Coast region: links to declines in midwestern Loggerhead Shrike populations. Passenger Pigeon 53:315–325.

MESTER, H. 1965. Feeding habits of the Great Grey Shrike in winter. Brit. Birds 58:375–383.

MILLER, A. H. 1931. Systematic revision and natural history of the American shrikes (*Lanius*). Univ. Calif. Pubs. in Zool. 38:11–242.

MUGAAS, J. N., AND J. R. KING. 1981. Annual variation of daily energy expenditure by the Black-billed Magpie. Studies in Avian Biology. 5:1–78.

NEU, C. W., C. R. BYERS, AND J. M. PECK. 1974. A technique for analysis of utilization-availability data. J. Wildl. Manage. 38:541–545.

NOVAK, P. 1986. Possible factors influencing the distribution, status, and abundance of the Loggerhead Shrike (*Lanius ludovicianus*) in New York State. Kingbird Fall:176–181.

OLSSON, V. 1984a. [The winter habits of the Great Grey Shrike, *Lanius excubitor*. I. Habitat.] Var Fagelvarld 43:113–124.

OLSSON, V. 1984b. [The winter habits of the Great Grey Shrike, *Lanius excubitor*. II. Territory.] Var Fagelvarld 43:199–210.

OLSSON, V. 1985. [The winter habits of the Great Grey Shrike, *Lanius excubitor*. IV. Handling of prey.] Var Fagelvarld 44:269–283.

OLSSON, V. 1986. [The winter habits of the Great Grey Shrike, *Lanius excubitor*. V. Choice of prey.] Var Fagelvarld 45:19–31.

ROBSON, R. W. 1954. On the Great Grey Shrike in North Westmorland. Northwest Nat. 2:365–366.

SAMUEL, M. D., D. J. PIERCE, E. O. GARTON, L. J. NELSON, AND K. R. DIXON. 1985. User's manual for program HOME RANGE. Forest, Wildlife, and Range Experiment Station Tech. Rep. 15. Univ. of Idaho, Moscow, ID.

SOKAL, R. R., AND F. J. ROHLF. 1981. Biometry. W. H. Freeman, San Francisco, CA.

THOMPSON, F. R., AND E. K. FRITZELL. 1988. Ruffed Grouse winter roost site preference and influence on energy demands. J. Wildl. Manage. 52:454–460.

WEBB, D. R., AND C. M. ROGERS. 1988. Nocturnal energy expenditure of Dark-eyed Juncos roosting in Indiana during winter. Condor 90:107–112.

YENSEN, E., D. L. QUINNEY, K. JOHNSON, K. TIMMERMAN, AND K. STEENHOF. 1992. Fire, vegetation changes, and population fluctuations of Townsend's ground squirrels. Am. Midl. Nat. 128:299–312.

YOSEF, R., AND B. PINSHOW. 1988. Polygyny in the Northern Shrike in Israel. Auk 105:581–582.

YOSEF, R. 1993. Influence of observation posts on territory size of Northern Shrikes. Wilson Bull. 105:180–183.