Loggerhead Shrike (*Lanius ludovicianus*): A Technical Conservation Assessment

Prepared for the USDA Forest Service,
Rocky Mountain Region,
Species Conservation Project

February 10, 2005

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Peer Review Administered by
Society of Conservation Biology

Wiggins, D. (2005, February 10). Loggerhead Shrike (*Lanius ludovicianus*): a technical conservation assessment. [Online]. USDA Forest Service, Rocky Mountain Region. Available: http://www.fs.fed.us/r2/projects/scp/assessments/loggerheadshrike.pdf [date of access].

ACKNOWLEDGEMENTS

Susan Craig, Andrew Didiuk, and Ken De Smet provided a wealth of information on shrikes. I also thank the Colorado Division of Wildlife, the USDA Forest Service, and specifically Tom Peters, David Augustine, and David Klute for sponsoring my work on shrikes on the Comanche National Grassland in 2003 and 2004. Greg Hayward, Gary Patton, and two anonymous reviewers gave many useful tips for enhancing the structure and quality of this assessment.

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David Wiggins developed an early interest in Ornithology. During his high school years, he worked as a museum assistant under George Sutton and Gary Schnell at the University of Oklahoma. He later earned degrees from the University of Oklahoma (B.Sc. in Zoology), Brock University (M.Sc. – Parental care in common terns, under the supervision of Ralph Morris), and Simon Fraser University (Ph.D. – Selection on life history traits in tree swallows, under the supervision of Nico Verbeek). This was followed by a National Science Foundation Post-doctoral fellowship at Uppsala University in Sweden, where he studied life history evolution in Collared Flycatchers, and later a Fulbright Fellowship working on the reproductive ecology of tits (Paridae) in Namibia and Zimbabwe. He currently splits time between ecological research programs in Sweden and North America.

COVER PHOTO CREDIT

The loggerhead shrike (*Lanius ludovicianus*). Photograph by Steve Metz. Used with permission.

SUMMARY OF KEY COMPONENTS FOR CONSERVATION OF LOGGERHEAD SHRIKE

The loggerhead shrike (*Lanius ludovicianus*) is a widespread species in North America, occurring in open habitats such as deserts, sagebrush, grasslands, and pastures. Recent contractions in its range and declines in abundance have occurred in many areas of North America and in several different habitat types. Despite a relatively intensive research and conservation effort in recent years, the factors responsible for the species' near range-wide declines are not yet clear.

Direct loss and degradation of native grassland and sagebrush habitats have been cited as primary factors in the decline of loggerhead shrikes. In addition, several recent studies have suggested that continuing loss and degradation of wintering habitats in the southern United States are primary causes of low overwinter survival among migratory populations of shrikes. In the western half of USDA Forest Service Region 2, livestock grazing may negatively affect loggerhead shrikes. In shrubsteppe and shortgrass habitats, livestock grazing may reduce local prey availability by reducing or altering vegetation composition and structure. Also, if livestock damage or kill thickets or trees, they may eliminate shrike nest sites. Further east, in areas of mixed- to tallgrass prairie, light grazing may improve foraging conditions by reducing grass density.

Another factor that may be driving declines in loggerhead shrike populations is mortality due to collisions with vehicles. Loggerhead shrikes often perch on fences and powerlines along roads, and their foraging activity exposes them to fast-moving vehicles. The susceptibility of shrikes to vehicle collisions was raised as an issue as far back as 1930, and recent research has suggested that increasing volumes of traffic, higher speed limits, and increased numbers of roads may all be increasing the extent of shrike mortality due to collisions with vehicles.

Within USDA Forest Service Region 2, loggerhead shrike populations appear to be stable in eastern Colorado and Wyoming but declining elsewhere. Consequently, research on breeding populations in Colorado and Wyoming may provide valuable baseline data on the relationship between local land management practices and shrike reproductive ecology.

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INTRODUCTION

This conservation assessment is one of many being produced to support the Species Conservation Project for the Rocky Mountain Region (Region 2), USDA Forest Service (USFS). The loggerhead shrike is the focus of an assessment because it is listed as a sensitive species in Region 2 (**Figure 1**). Within the USFS, a sensitive species is a plant or animal whose population viability is identified as a concern by a Regional Forester because of significant current or predicted downward trends in abundance and/or in habitat capability that would reduce its distribution [FSM 2670.5 (19)]. A sensitive species may require special management, so knowledge of its biology and ecology is crucial. This assessment addresses the biology and conservation/management status of the loggerhead shrike throughout its range, with an emphasis on Region 2. This introduction defines the goal of the assessment, outlines its scope, and describes the process used in its production.

Goal

Species conservation assessments produced as part of the Species Conservation Project are designed to provide land managers, biologists, other agencies, and the public with a thorough discussion of the biology, ecology, conservation, and management of certain species based on current scientific knowledge. Assessment goals limit the scope of the work to critical summaries of scientific knowledge, discussion of broad implications of that knowledge, and outlines of information needs. These assessments do not seek to develop prescriptive management recommendations. Rather they provide the ecological background upon which management must be based and focus on the consequences of changes in the environment that result from management (i.e., management implications). Furthermore, they cite management recommendations proposed elsewhere and evaluate the success of those recommendations that have been implemented.

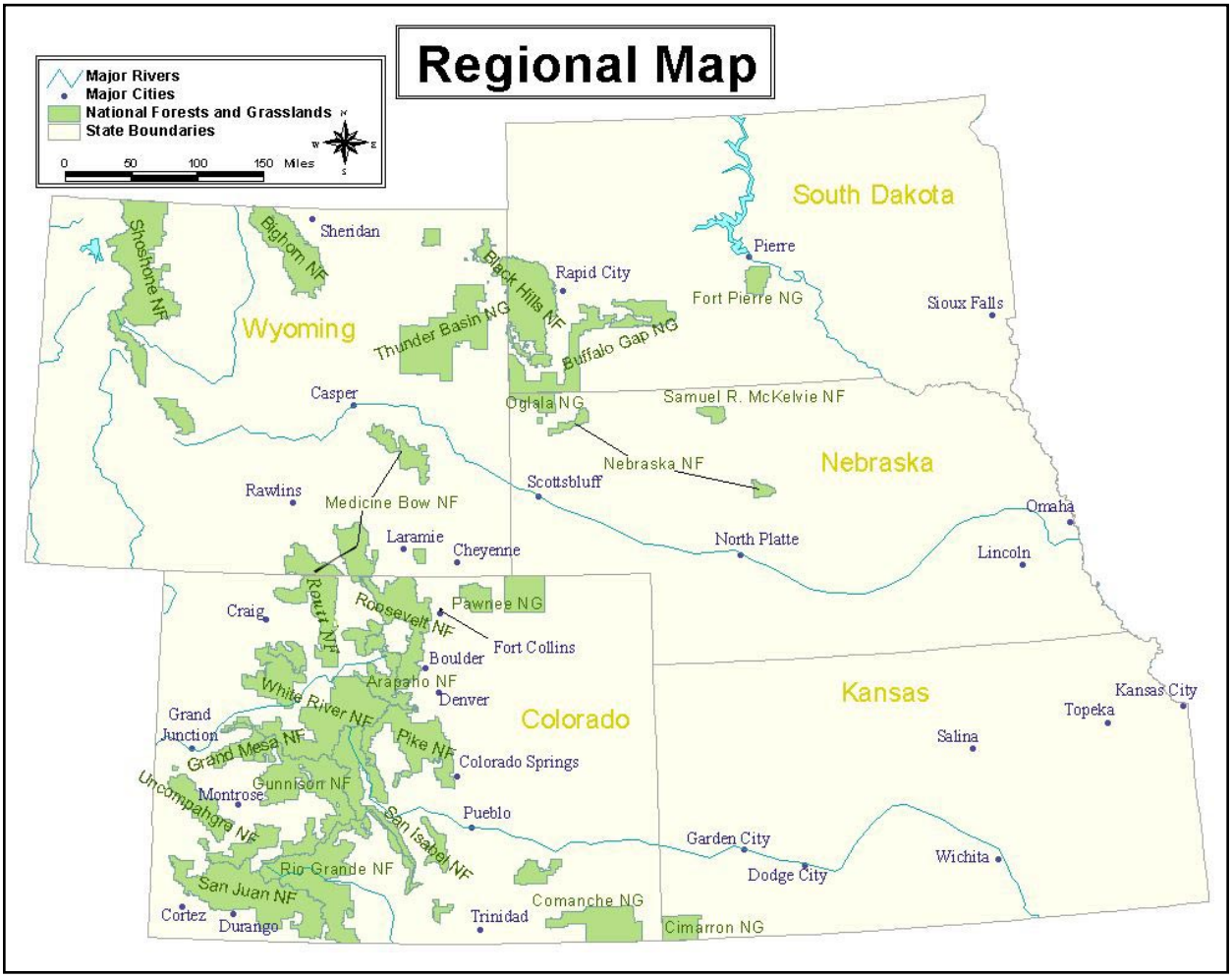


Figure 1. Map of National Forest System lands within USDA Forest Service Region 2.

Scope and Limitations of Assessment

This assessment examines the biology, ecology, conservation, and management of the loggerhead shrike, with specific reference to the geographic and ecological characteristics of the USFS Rocky Mountain Region. Although a majority of the literature on the species originates from field investigations outside the region, this document places that literature in the ecological and social context of Region 2. Similarly, this assessment is concerned with the reproductive behavior, population dynamics, and other characteristics of loggerhead shrikes in the context of the current environment. The evolutionary environment of the species is considered in conducting the synthesis, but placed in current context.

In producing the assessment, I reviewed refereed literature, non-refereed publications, research reports, and data accumulated by resource management agencies. Not all publications on loggerhead shrikes are referenced in the assessment, nor are all published materials considered equally reliable. The assessment emphasizes refereed literature because this is the accepted standard in science. Non-refereed publications or reports were used when refereed information was otherwise unavailable, but they were regarded with greater skepticism.

Treatment of Uncertainty

Science represents a rigorous, systematic approach to obtaining knowledge. Competing ideas regarding how the world works are measured against observations. However, because our descriptions of the world are always incomplete and our observations are limited, science focuses on approaches for dealing with uncertainty. A commonly accepted approach to science is based on a progression of critical experiments to develop strong inference (Platt 1964). However, it is difficult to conduct experiments that produce clean results in the ecological sciences. Often, we must rely on observations, inference, good thinking, and models to guide our understanding of ecological relations. In this assessment, we note the strength of evidence for particular ideas, and we describe alternative explanations where appropriate.

Publication of Assessment on the World Wide Web

Species conservation assessments are being published on the Region 2 World Wide Web site. Placing the documents on the Web makes them available to biologists, land managers, and the public more rapidly than publishing them as reports. More importantly, it facilitates their revision, which will be accomplished based on guidelines established in Region 2.

Peer Review

Assessments developed for the Species Conservation Project have been peer reviewed prior to their release on the Web. This assessment was reviewed through a process administered by the Society for Conservation Biology, employing two recognized experts on this or related taxa. Peer review was designed to improve the quality of communication and to increase the rigor of the assessment.

MANAGEMENT STATUS AND NATURAL HISTORY

Management Status

In Canada, the eastern population of loggerhead shrike (*Lanius ludovicianus migrans*) is listed as Endangered while the prairie population (*L. l. excubitorides*) is currently considered Threatened (Committee on the Status of Endangered Wildlife in Canada 2004). In the United States, the unique subspecies on San Clemente Island (*L. l. mearnsi*) is designated as Endangered by the U.S. Fish and Wildlife Service while other subspecies are not federally designated (http://endangered.fws.gov/wildlife.html#Species). Loggerhead shrikes were recently classified as a Bird of Conservation Concern by the U.S. Fish and Wildlife Service (2002) within Bird Conservation Region 10 (Northern Rocky Mountains).

Within Region 2, the USFS lists the loggerhead shrike as a sensitive species, and it is included in the Wyoming Bureau of Land Management State Director's Sensitive Species List (Bureau of Land Management 2001). A summary of the management status of loggerhead shrikes within state Partners in Flight (PIF) plans is presented in **Table 1**. It is listed as a Priority Species in the Colorado (Beidleman 2000) and Wyoming (Cervoski et al. 2001) PIF plans, but PIF plans for other states within Region 2 have not been published. Several other western state PIF plans list the loggerhead shrike as a Priority or Highest Priority species. Based on state natural heritage program assessments, The Nature Conservancy ranks the loggerhead shrike as Vulnerable in Colorado and South Dakota. Just outside of Region 2 it is listed as Imperiled in Minnesota, Critically Endangered in Missouri, and Vulnerable in Utah and Idaho (**Figure 2**).

Table 1. Management status of loggerhead shrikes within USDA Forest Service Region 2 and surrounding states, according to respective Partners in Flight (PIF) state Bird Conservation Plans. Region 2 states are bolded.

State	Status	Citation
Wyoming	Priority Species (Level II*; Shrub-Steppe)	Cervoski et al. 2001
Colorado	Priority Species (Semi-desert shrub)	Beidleman 2000
South Dakota	State PIF plan not published	
Nebraska	State PIF plan not published	
Kansas	State PIF plan not published	
Idaho	Priority Species (Sagebrush/salt desert shrub)	Ritter 2000
Montana	Priority Species (Level II*; Sagebrush shrubsteppe)	Casey 2000
Utah	Not a Priority Species	Parrish et al. 2002
Arizona	Not a Priority Species	Latta et al. 1999
New Mexico	Highest Priority Species (Great Basin desert shrub)	Rustay 2001

* Level II priority species are those for which monitoring and further research are needed.

Existing Regulatory Mechanisms, Management Plans, and Conservation Strategies

Existing management plans and conservation strategies for the loggerhead shrike focus on the declining populations in northeastern and north-central parts of its range, specifically the Canadian provinces of Ontario, Manitoba, Saskatchewan, and Alberta. A tri-lateral (Canada, United States, Mexico) collaboration focuses on declining shrike populations across North America. These strategies will be discussed under the respective headings below.

Ontario, Canada (*Lanius ludovicianus migrans*): As in the majority of the northeastern United States, loggerhead shrikes have been declining rapidly and are now Endangered in eastern Canada. Research on the rapidly dwindling Ontario population has concentrated on the following factors:

- Field studies on the reproductive biology of shrikes and their habitat use
- Extensive monitoring of the Ontario population
- Analysis of philopatry and dispersal
- Establishment of a captive breeding program, with release of captive-reared individuals.

Research findings indicate that the population is not limited by the number of habitat patches *per se* – rather, existing birds are disproportionately concentrated in areas of unfragmented habitat, suggesting that habitat fragmentation is contributing to declines (e.g., Cadman 1985, Telfer 1992).

Canadian Prairie Provinces (*Lanius ludovicianus excubitorides*): Loggerhead shrike populations in the Canadian Prairie region have been declining over the past 50 years, with the largest declines in Manitoba (where the species is now provincially Endangered) and at the northern periphery of the species' range in Saskatchewan and Alberta.

Management of loggerhead shrikes in the Canadian Prairie Provinces is ongoing, with a focus on the following factors:

- Assessment of the relative importance of large, federal grasslands as habitat for shrikes, compared to other portions of the breeding range
- Identification of any local-scale differences in productivity, which may indicate that some areas disproportionately contribute to population stability (i.e., source-sink dynamics)
- Identification of locations suitable for the establishment of monitoring areas
- Identification of and opportunities for protection, enhancement, or restoration of critical habitat.

Tri-lateral Loggerhead Shrike Working Group – This working group began forming in 2000 in an attempt to apply a range-wide management

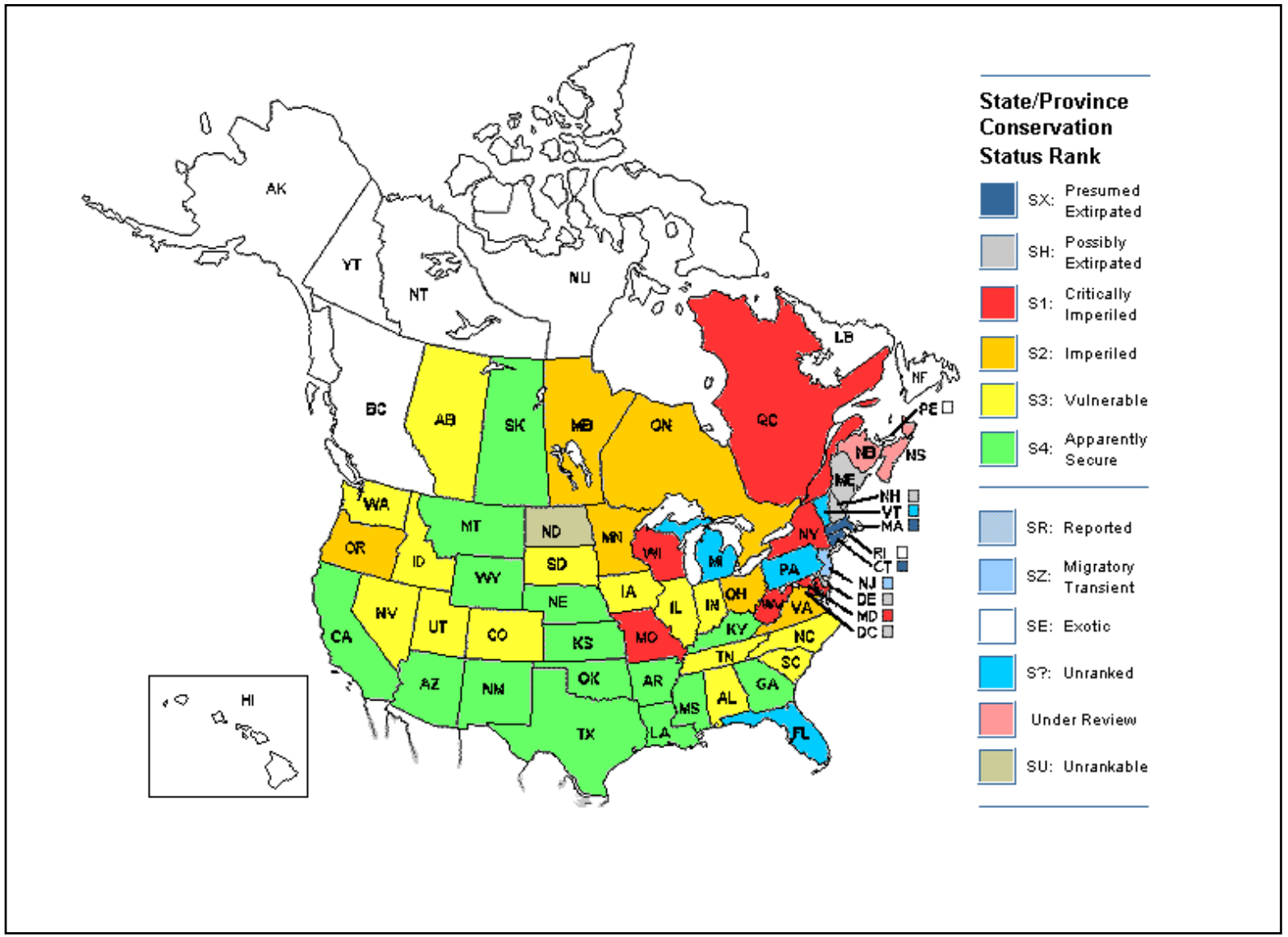


Figure 2. Status of loggerhead shrikes in North America based on the Natural Heritage Program (NatureServe Explorer 2003).

scheme to loggerhead shrike conservation. Although this group has not yet carried out any on-the-ground conservation efforts, they have outlined a collaboration plan that includes:

- ❖ Drawing up range-wide management and research plans
- ❖ Focusing more on the ecology of shrikes outside of the breeding season
- ❖ Developing a network of shrike researchers and interested land managers
- ❖ Conducting a range-wide analysis of the shrike subspecies complex, using DNA markers.

Specific management recommendations for loggerhead shrikes proposed by PIF and the U.S. Fish and Wildlife Service are given in **Table 2** and **Table 3**, respectively. Dechant et al. (2001) provide a comprehensive overview of management practices for loggerhead shrikes, with an emphasis on those breeding in grasslands.

Table 2. Summary of management recommendations for loggerhead shrikes from Partners in Flight state Bird Conservation Plans of states within and surrounding USDA Forest Service Region 2.

State	Recommendations	Presumed benefits	Source
Wyoming	Provide mosaic of vegetation heights.	Increase food availability and foraging success.	Cervoski et al. 2001
	Prevent large-scale fires/prescribed burning in sagebrush habitat. Limit small-scale fires to non-breeding season.	Maintain optimal habitat.	
	Minimize or eliminate insect control in nesting areas.	Increase food availability; decrease accumulation of toxins.	
	Minimize conversion of sagebrush/shrublands to non-native grassland or cropland.	Maintain optimal habitat.	
	Limit grazing in nest areas and protect nest trees from damage by browsers.	Prevent direct nest disturbance; maintain habitat.	
Colorado	Discourage conversion of greasewood/sagebrush habitats.	Maintain preferred breeding habitat.	Beidleman 2000
	Fully suppress wildfires in greasewood/sagebrush habitats.	Preserve habitat quality.	
	Disperse/restrict cattle grazing in habitats with tall, dense shrub stands (preferred nesting habitat).	Decrease physical threat to shrike nests.	
	Discourage/eliminate use of insecticides during years of grasshopper/mormon cricket outbreaks.	Increase food availability; decrease potential of toxic accumulation in shrikes.	
Idaho	Maintain diverse vegetative structure in sagebrush and salt desert shrub.	Maintain/increase prey availability and nest site availability.	Ritter 2000
	Avoid long-term and heavy grazing pressure in preferred shrike habitat.	Maintain/increase prey availability and nest site availability.	
New Mexico	Maintain or enhance grassland areas with large shrub component.	Maintain stable population of shrikes.	Rustay 2001
Montana	Maintain large (1 to 2 m tall) sagebrush habitat.	Maintain preferred breeding habitat.	Casey 2000
	Decrease/control application of pesticides.	Increase food availability and decrease potential of toxic accumulation in shrikes.	

Table 3. Summary of management recommendations for loggerhead shrikes as proposed in the U.S. Fish and Wildlife Service loggerhead shrike status assessment (Pruitt 2000) and in Dechant et al. (2001).

Recommendations	Presumed benefits	Sources
Preserve native prairie in breeding and wintering areas	Provide optimal habitat for birds in mid-continent area	Hands et al. 1989, Telfer 1992
Discourage policies that encourage conversion of prairie to cropland	Preserve optimal habitat	Hellman 1994
Use available land set-asides (e.g. Conservation Reserve Program) to protect habitat	Provide suitable habitat	Hands et al. 1989, Collister and Henry 1995
In areas with relatively tall grass, use prescribed burns, mowing, and grazing (primarily eastern portions of Region 2).	Maintain mid-succesional, medium and tall grasslands	Johnson et al. 1998
In areas of short-grass prairie or sagebrush, limit grazing, mowing, and prescribed burning.	Maitain suitable foraging habitat	Prescott and Collister 1993, Collister 1994
Use fencing or tree-cribs to protect trees and shrubs from damage by grazing/rubbing cattle	Preserve nest site quality	Yosef 1996
Plant low, thick trees and shrubs in open pastures and grasslands	Increase nest site availability	Kridelbaugh 1982
In sagebrush areas, avoid grazing by horses and cattle	Prevent degradation of habitat	Woods 1995
Reduce the use of biocides	Increase insect abundance, reduce accumulations of toxins	Hands et al. 1989, Hellman 1994

Biology and Ecology

Systematics

Eleven subspecies of loggerhead shrikes were originally recognized (Miller 1931), and subsequent taxonomic treatments (e.g., American Ornithologists' Union 1957, Rand 1960, Phillips 1986) have recognized from seven to 11 subspecies. Two subspecies breed within USFS Region 2: *Lanius ludovicianus excubitorides* on the Great Plains and *L. l. gambeli* west of the continental divide (**Figure 3**; Miller 1931). Although there has been considerable interest in re-assessing the range-wide, subspecific status of shrikes using modern genetic techniques, only eastern and California Channel Islands populations have been adequately sampled to date (Vallianatos 1999). A recent genetic study along a subspecific contact zone (between *L. l. migrans* and *L. l. excubitorides*) has provided evidence of intergradation (Vallianatos et al. 2001). For an excellent discussion of loggerhead shrike taxonomic issues, see Pruitt (2000).

Nominate race: *Lanius ludovicianus* Linnaeus.

Distribution and abundance

Global perspective

Loggerhead shrikes breed throughout a large portion of central and southern North America (**Figure 4**). Although historically common in most areas of their range (Coues 1874), shrike abundance has declined nearly continent-wide (Cade and Woods 1997). Data from Breeding Bird Surveys (BBS; Sauer et al. 2003) and Christmas Bird Counts (CBC; National Audubon Society 2002) show statistically significant declines in both breeding and wintering populations in many areas of the species' range (**Table 4**, **Figure 5**; see Population trend section). Several authors (e.g., Yosef 1996, Cade and Woods 1997) have noted that shrikes apparently expanded their distribution in the northeastern United States and Canada as forests were cleared for agricultural purposes.

Loggerhead shrikes winter throughout the southern tier of the United States, with northern limits in California, Nevada, Utah, Colorado (primarily west and south), southern Kansas, Arkansas, Tennessee, and Virginia (**Figure 6**). Although it is known that some individuals move south to winter in Mexico, the range and status of shrikes in that country are poorly known.

Regional distribution and abundance

Most historical works suggest that loggerhead shrikes were common breeding birds within and near Region 2. For example, Hayden (cited in Coues 1874) found it "quite abundant" in South Dakota and Wyoming, while Coues (1874) stated that it was "breeding abundantly in Northern Dakota". Thompson

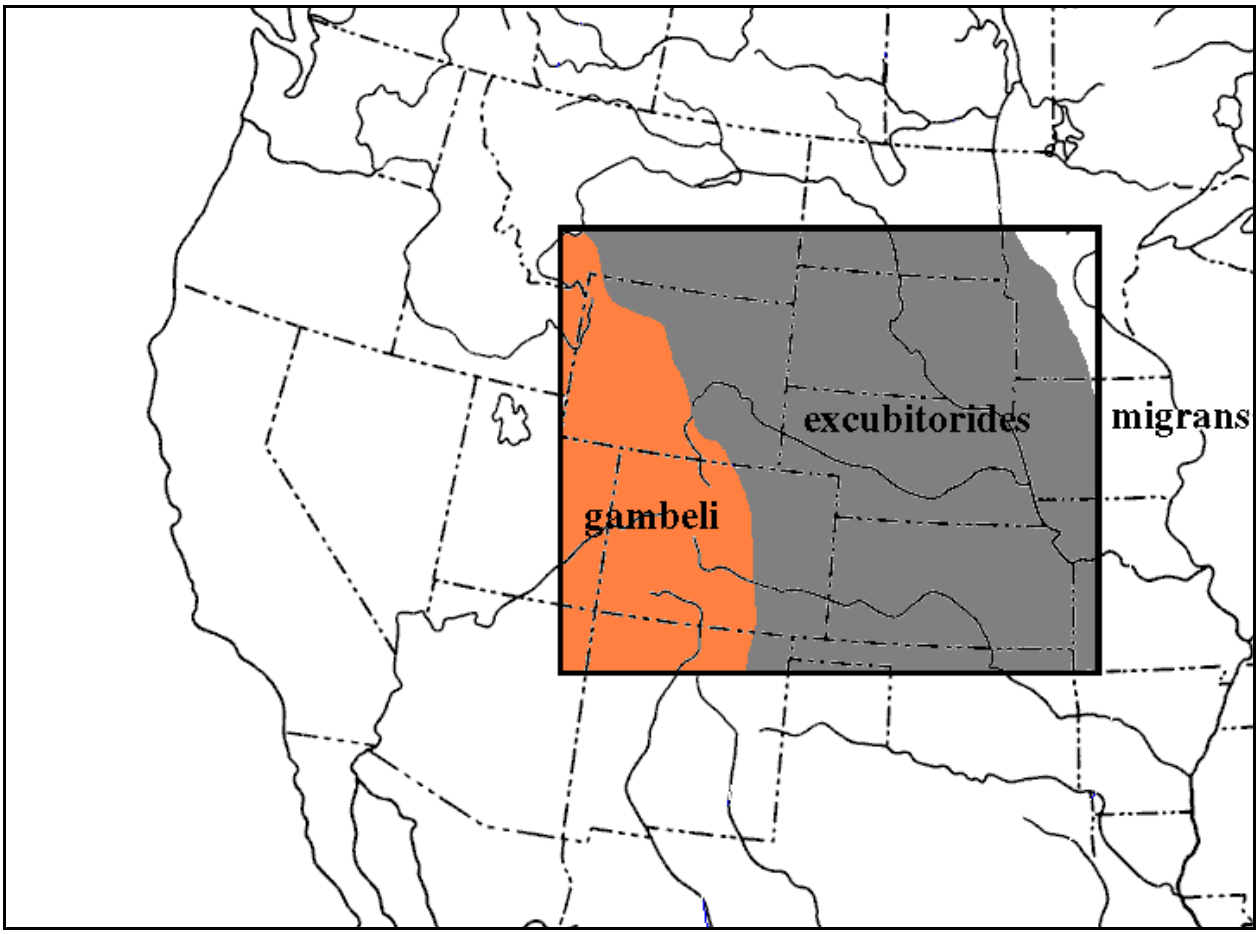


Figure 3. The approximate breeding distribution of the two main subspecies of loggerhead shrike within the boundaries of USDA Forest Service Region 2. *Lanius ludovicianus excubitorides* is found on the Great Plains while *L. l. gambeli* occurs west of the continental divide (after Miller 1931). Lanius ludovicianus migrans occurs east of the Great Plains and may intergrade with *L. l. excubitorides* in portions of eastern South Dakota, eastern Nebraska, and eastern Kansas (Burnside 1987).

(1891) considered it common in southern Manitoba. Similar comments apply to most regions within the species' historic breeding range (Yosef 1996, Pruitt 2000). As noted above, recent data from both breeding and wintering areas suggest widespread declines in abundance. Four of the five states within Region 2 have shown long-term, negative trends in breeding season abundance (BBS data), but the decline is statistically significant only in Kansas (**Table 4**). CBC data from Colorado and Kansas, the two Region 2 states with regular wintering populations of shrikes, show a significant decline in numbers (**Figure 5**). The proportion of this wintering population that is comprised of Region 2 breeding birds is unknown. Nonetheless, wintering populations to the south of Region 2, in Oklahoma and Texas, have undergone a similar, strong decline between the late 1950s and 2002 (**Figure 5**).

A map of the breeding density of loggerhead shrikes in North America, based on BBS abundance analyses (Sauer et al. 2003), is shown in **Figure 7**. Loggerhead shrikes currently breed throughout low elevation areas in Region 2 and are absent only in the higher elevation areas of Colorado and Wyoming. Shrikes breed throughout Kansas, Nebraska, and most of South Dakota (excluding higher elevation forests in the Black Hills).

The historical and current distribution and abundance of loggerhead shrikes in Region 2 is as follows:

South Dakota. In South Dakota, loggerhead shrikes breed almost statewide, with the exception of higher elevation forested areas in the west. They

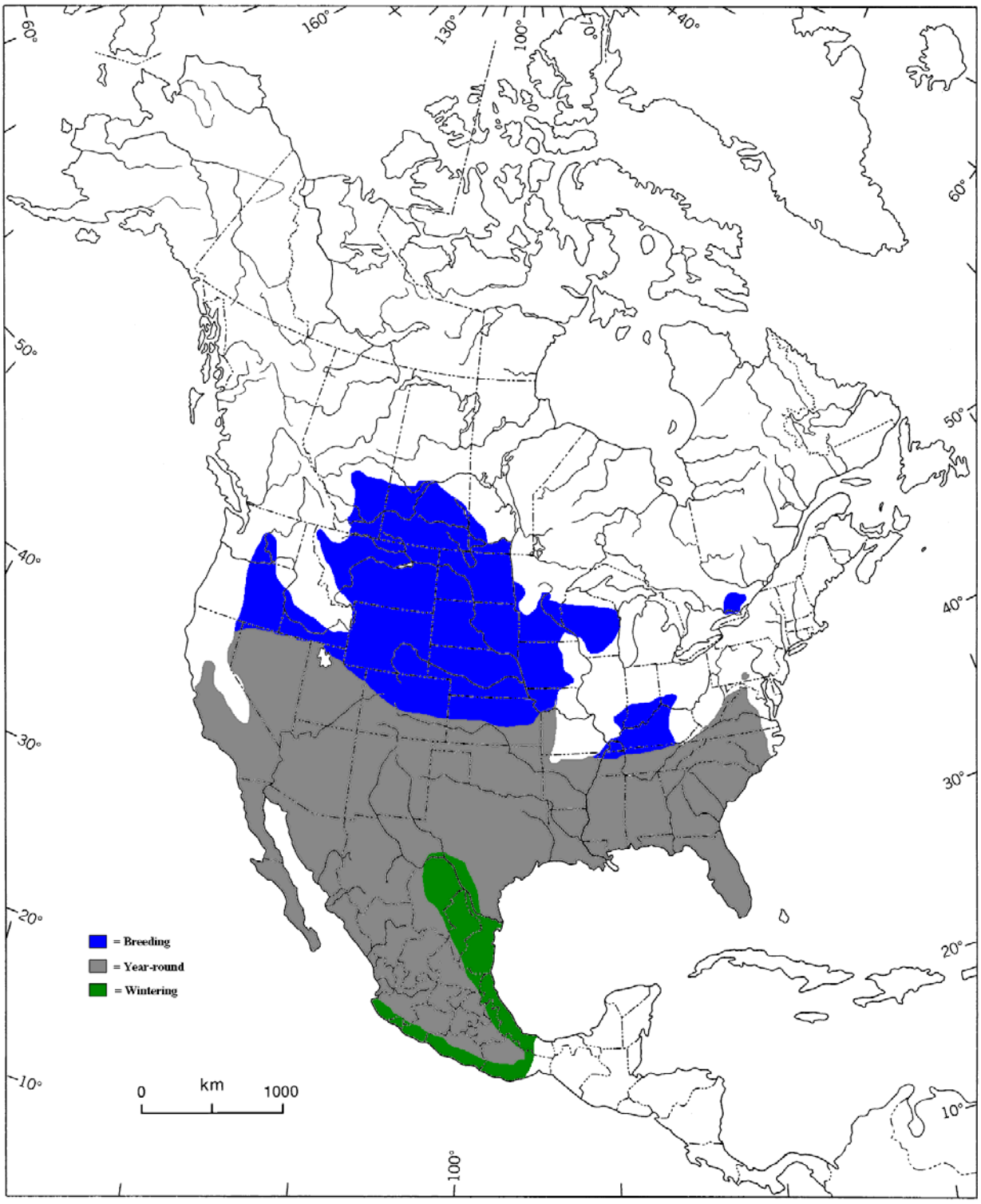


Figure 4. The range of loggerhead shrikes in North America. The figure was modified from Yosef (1996).

Table 4. Loggerhead shrike population trend results from North American Breeding Bird Surveys. Data were taken from Sauer et al. (2003) and focus on USDA Forest Service Region 2 states (bolded) and surrounding areas. Trend indicates the percentage change per year.

	1966-1979			1980-2002			1966-2002		
Region	***N***	**Trend**	***P***	***N***	**Trend**	***P***	***N***	**Trend**	***P***
Wyoming	17	- 2.1	0.63	60	1.3	0.40	63	- 2.2	0.19
Colorado	10	1.2	0.79	49	0.9	0.67	49	2.5	0.25
South Dakota	23	4.6	0.21	27	- 2.0	0.22	34	- 1.2	0.40
Nebraska	27	- 10.1	**0.03**	36	- 0.1	0.96	42	- 2.7	0.07
Kansas	34	- 5.0	**0.03**	43	- 4.3	**0.00**	44	- 2.8	**0.00**
Alberta	7	- 12.6	**0.02**	19	0.5	0.91	22	- 4.0	0.21
Saskatchewan	15	- 12.3	**0.00**	25	- 3.0	0.10	33	- 9.4	**0.01**
Manitoba	—	—	—	8	- 3.3	0.76	10	- 13.1	0.22
Montana	10	- 10.5	0.44	23	2.6	0.4	24	2.6	0.34
Idaho	—	—	—	10	- 4.0	0.39	11	- 5.8	0.12
Oklahoma	33	- 5.1	**0.00**	55	- 5.5	**0.00**	57	- 5.6	**0.00**
New Mexico	21	- 11.1	**0.00**	51	- 3.1	**0.02**	54	- 5.4	**0.00**
Arizona	13	- 9.1	0.52	41	- 7.3	**0.00**	49	- 5.3	**0.00**
Utah	—	—	—	40	- 0.4	0.85	40	- 2.7	0.06
Iowa	12	- 13.9	**0.01**	15	- 7.3	**0.01**	19	- 10.3	**0.00**
Missouri	35	- 6.6	**0.01**	43	- 6.9	**0.02**	50	- 8.1	**0.00**
Arkansas	26	- 10.9	**0.00**	27	- 6.7	0.13	29	- 6.7	**0.00**
U.S. Fish and Wildlife Service Region 6	134	- 3.8	**0.05**	305	- 0.5	0.52	324	- 0.7	0.29
United States	744	- 4.4	**0.00**	1225	- 2.6	**0.00**	1379	- 3.7	**0.00**
Canada	32	- 16.6	**0.00**	54	- 2.5	0.12	75	- 10.0	**0.00**
Survey-wide	776	- 4.5	**0.00**	1279	- 2.6	**0.00**	1454	- 3.8	**0.00**

are typically absent in winter. Most historical reports (e.g., Over and Thoms 1921) described the loggerhead shrike as a common species in the state, a status that has been confirmed until the mid 1990's (South Dakota Ornithologists' Union 1991, Peterson 1995). Currently, loggerhead shrikes are considered uncommon, especially in the eastern portion of the state (Tallman et al. 2002). Thus, although there have been no apparent shifts in distribution, the species has recently declined in abundance, especially in the east. Late fall and winter reports are considered unreliable due to identification problems (i.e., similarity in appearance to northern shrikes [*Lanius excubitor*]; Tallman et al. 2002).

Wyoming. Loggerhead shrikes breed statewide at lower altitudes but are generally absent in winter. No change in summer distribution has been noted. Knight (1902) described them as an abundant summer resident below 8,000 feet. More recently, Scott (1993) considered them a common summer resident while Dorn and Dorn (1999) described them as a "somewhat common" summer resident. Thus, the suggestion from these few historical references is that the species has declined somewhat in abundance since the early 1900's.

Nebraska. There are breeding records for loggerhead shrikes from throughout the state, but winter records exist only from the southeast (Ducey 2000). Molhoff (2001) suggested that there has been no historical change in distribution, but that the species was now much less common in the eastern part of the state. Loggerhead shrikes occur as a rare, but regular winter visitor in the southeastern corner of the state (Sharpe et al. 2001).

Colorado. Loggerhead shrikes have historically been noted as common breeders statewide at lower elevations (Cooke 1897, Sclater 1912, Bailey and Niedrach 1965). Recent treatments have reached different conclusions on summer distribution and abundance. Andrews and Righter (1992) described the loggerhead shrike as a fairly common summer resident

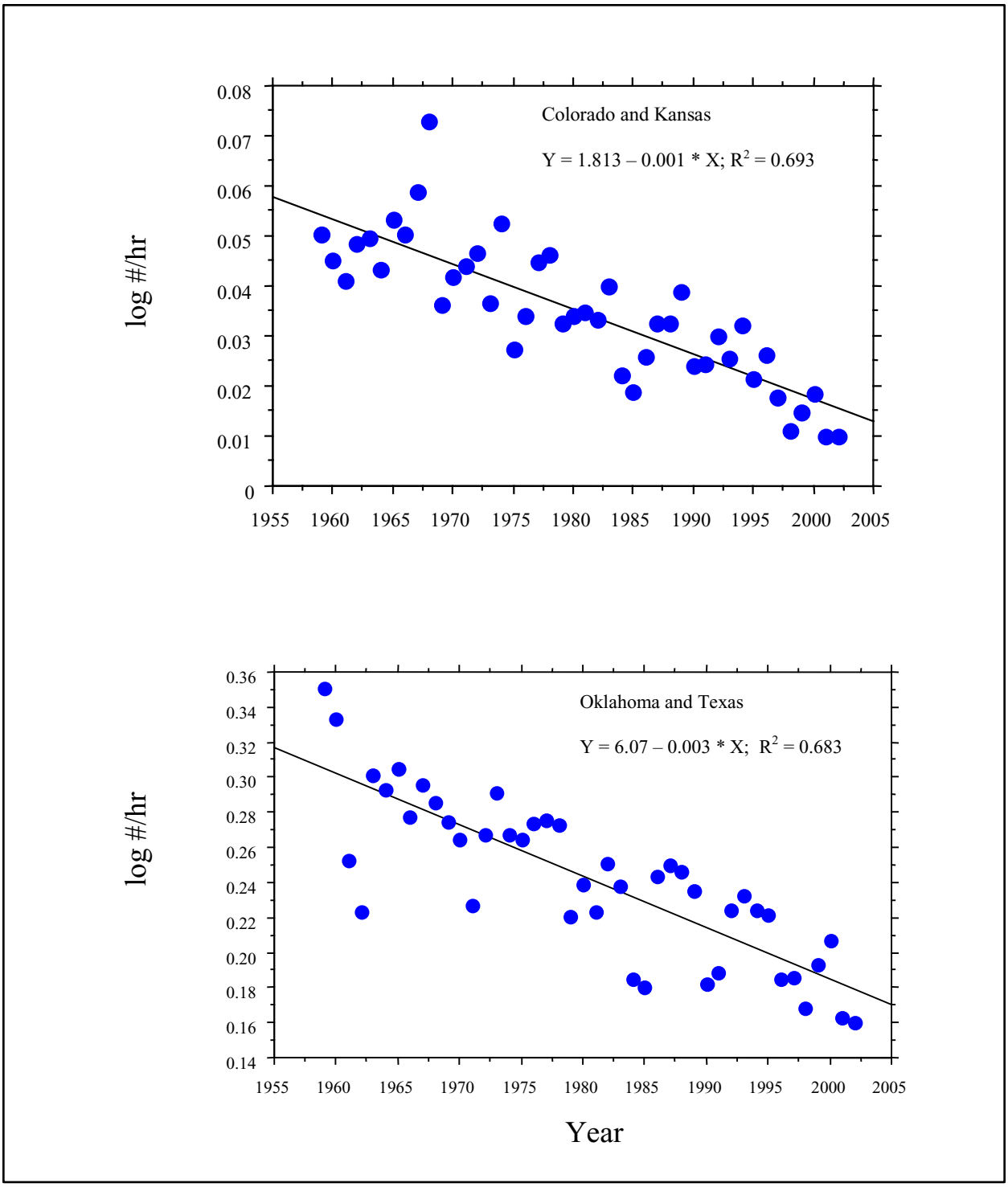
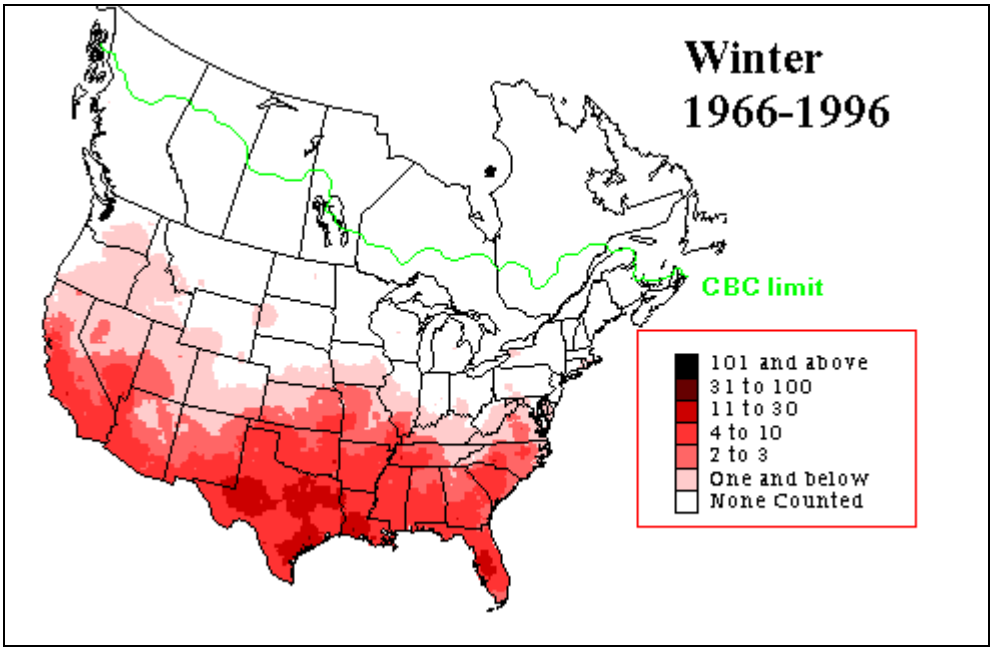


Figure 5. Pattern of abundance (log of # seen/party h) of loggerhead shrikes on annual Christmas Bird Counts in Kansas and Colorado (upper) and Oklahoma and Texas (lower). Note the similar patterns of decline despite the large difference in average abundance in the two regions. Data were taken from the Christmas Bird Count website http: //www.audubon.org/bird/cbc/hr/index.html.



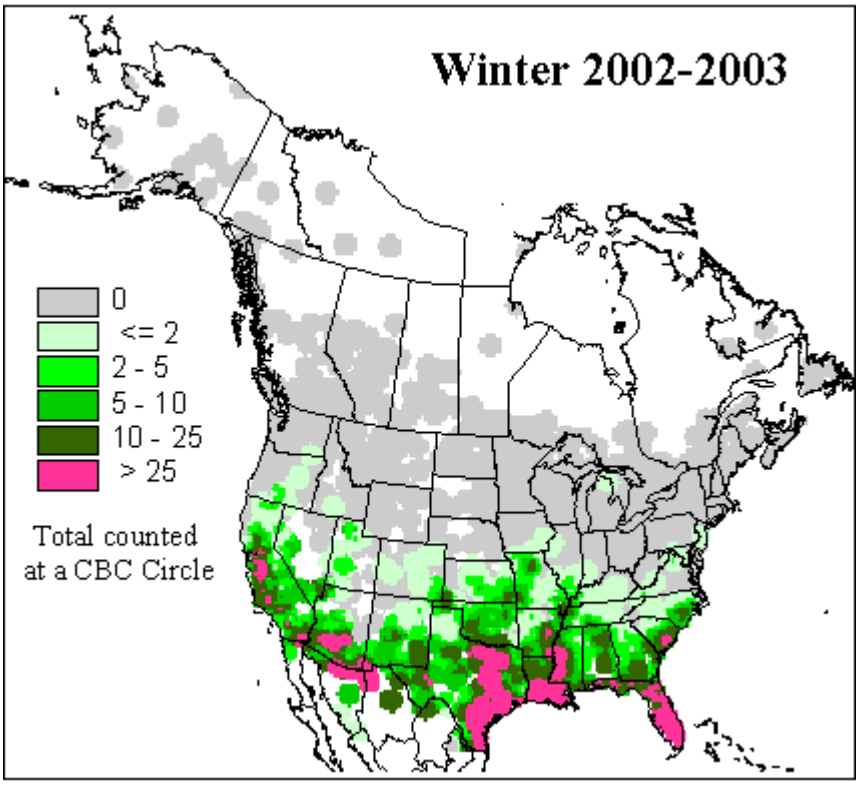


Figure 6. Winter distribution of loggerhead shrikes, based on North American Christmas Bird Count (CBC) data. The upper figure represents the average number of shrikes counted on CBCs for the period 1966 to 1996. The lower figure represents recent data from 2002 to 2003. Data are from the CBC website (www.audubon.org/bird/cbc).

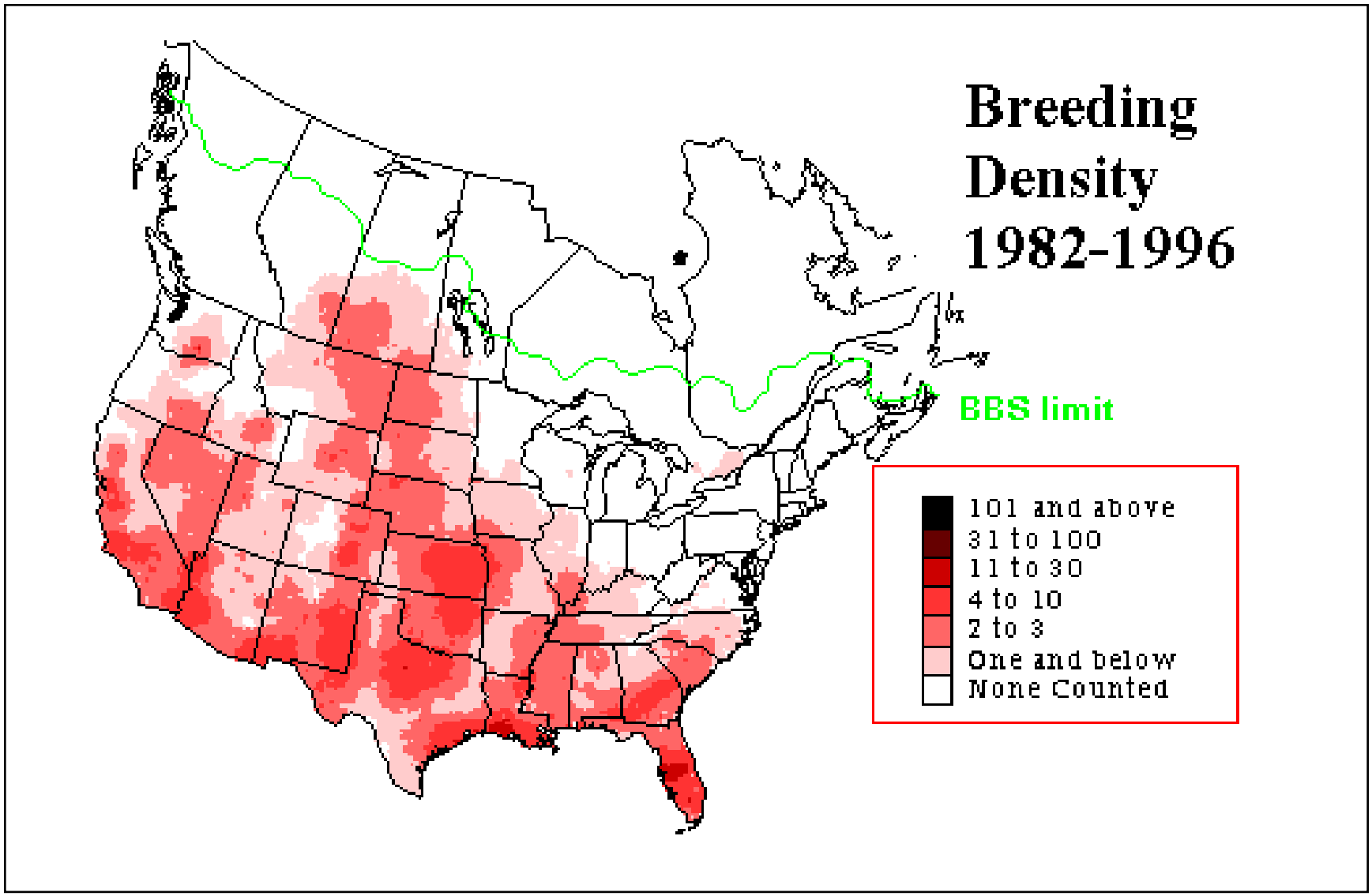


Figure 7. The mean number of loggerhead shrikes observed on Breeding Bird Surveys from 1982 to 1996.

in western valleys and in the San Luis Valley, but rare to uncommon locally on the eastern plains. However, recent breeding bird atlas data summarized by Carter (1998) showed a widespread breeding distribution on the eastern plains, but only spotty distribution in the southern and western valleys. In addition, the breeding bird atlas data suggested that loggerhead shrikes were relatively common on the eastern plains. Thus, eastern Colorado represents one of the few areas in North America where shrike populations appear to be stable (**Table 4**). The most recent work in western Colorado described the loggerhead shrike as an uncommon summer resident, primarily in river valleys (Righter et al. 2004). Loggerhead shrikes are rare to uncommon in Colorado in winter, being found mainly at lower elevations in the southern and western portions of the state (Andrews and Righter 1992, Righter et al. 2004).

Kansas. In Kansas, the loggerhead shrike has historically been a common breeding species statewide (Tordoff 1956, Thompson and Ely 1992). The recent breeding bird atlas project (Busby and Zimmerman 2001) found that the species apparently is more common in eastern than western Kansas, a pattern counter to that found in Nebraska and South Dakota.

Within Region 2, the distribution of loggerhead shrikes does not appear to have changed, as it has in many other regions in the species' range. However, the abundance of breeding shrikes has declined significantly in Kansas, and they are now much less common in eastern Nebraska (Mollhoff 2001) and South Dakota (Peterson 1995), relative to the central and western portions of those states. Studies from nearby states suggest that habitat degradation on the breeding (Graber et al. 1973, Tyler 1992, Woods 1994) and wintering grounds (Lymn and Temple 1991), as well as pesticide application (affecting shrikes directly, as well as reducing the food supply) may be contributing to declines (see discussions in Yosef 1996, Pruitt 2000).

Regional discontinuities in distribution and abundance

Currently, loggerhead shrikes are more common on the western portions of the Great Plains (e.g., eastern Colorado, eastern Wyoming, western South Dakota, and western Nebraska) than they are to the east. However, the pattern is apparently the opposite in Kansas, where shrikes remain more common in the east than in the west (Busby and Zimmerman 2001). BBS data suggest that populations of shrikes on the eastern Great Plains are declining more rapidly than those on the western Great Plains. West of the continental divide, shrikes are uncommon in Colorado (Righter et al. 2004) but apparently still relatively common in southwestern Wyoming (Dorn and Dorn 1999).

There are no discontinuities in the distribution of loggerhead shrikes on the Great Plains, but west of the continental divide their distribution is patchy, with most birds concentrated near low elevation riparian habitats (Righter et al. 2004). In Colorado and Wyoming, shrikes are largely absent from the higher elevation areas (with the exception of the San Luis Valley in Colorado). To some extent the Rocky Mountains appear to act as a buffer separating the presumed western subspecies: *Lanius ludovicianus nevadensis* to the southwest, *L. l. gambeli* to the northwest, and *L. l. excubitorides* to the east (see Figure 2 in Burnside 1987). Another area of apparent overlap among breeding subspecies occurs in the eastern Great Plains (in Region 2, eastern portions of South Dakota, Nebraska, and Kansas), where small numbers of *L. l. migrans* appear within the range of *L. l. excubitorides*. Recent genetic evidence from Manitoba suggests considerable intergradation between the latter two subspecies, and thus contact zones among the various subspecies may represent intergrading populations.

Population trend

North American BBS (Sauer et al. 2003) data clearly reflect declining loggerhead shrike populations over a broad portion of North America, with particularly strong declines to the south (Oklahoma, New Mexico, Arizona), east (Iowa, Missouri, Arkansas), and north (Canada) of Region 2 (**Table 4**). The overall negative trend apparent in the BBS data is mirrored by strong, steady declines on the wintering grounds in the southern Great Plains (**Figure 5**). The southern Great Plains is the presumed wintering area for some of the Region 2 breeding population (Burnside 1987), but the possibility exists that many Region 2 birds move south into Mexico for the winter. Within Region 2, BBS data suggest that shrikes have declined in abundance in Kansas and appear to be declining in South Dakota. However, shrike populations in Colorado, Nebraska, and Wyoming appear to have stabilized since 1980.

As loggerhead shrikes typically occur at relatively low densities on BBS routes, statistical power is relatively low and survey results are difficult to interpret. For example, while the range-wide decline in shrike abundance is clear, regional trends are more difficult to assess. As an example, BBS data for Manitoba suggest that populations have recovered somewhat since 1980 (**Table 4**). In contrast, dedicated shrike surveys in

Manitoba have provided a very different picture, with a steady decline from a high of 327 pairs in 1993 to a low of only 59 pairs in 2002 (Wiggins 2004).

Activity pattern and movements

The migratory behavior of loggerhead shrikes has not been well studied. While some southern (e.g., Florida) shrike populations are resident, the available data suggest that all of the Region 2 breeding populations are migratory. Shrikes apparently migrate solitarily during the day, moving short distances and lingering to forage when local conditions are good (Miller 1931, Yosef 1996). A summary of spring arrival and fall migration dates in Region 2 is presented in **Table 5**.

Safriel (1995) summarized the known migratory habits of all species of shrikes and concluded that both loop (different spring and fall routes) and step (between-site movements in fall/winter) migration patterns may be utilized. However, it is not known whether loggerhead shrikes use these patterns or not. Burnside (1987) summarized banding recoveries of loggerhead shrikes; for birds breeding in Region 2, two banded in South Dakota in May and August were recovered in eastern Texas in February, and a single Colorado shrike banded in June was recovered in northwestern Texas in April. Although scant, Burnside's data suggest that most shrikes breeding on the Great Plains migrate southeastward to winter in Texas, Oklahoma, and Kansas (and possibly Mexico). However, the wintering areas of shrikes that breed west of the continental divide are unknown. It is likely that these birds winter either in southwestern United States or in Mexico.

The extent to which populations in Region 2 are linked is unclear. The Great Plains population (i.e., those breeding east of the Rocky Mountains) appears to be a more or less homogeneous unit. Gene flow among adjacent populations is likely high due to the strong dispersal tendencies of 1st year breeders. Reported breeding site fidelity has varied widely among sites, with adult females showing lower site fidelity than adult males, and with particularly low fidelity of birds banded as nestlings (**Table 6**).

When breeding, shrikes typically spend the majority of their time in the vicinity of their territory. Family groups begin to disperse two to three weeks after the young have fledged, but the spatial and temporal extent of post-fledging movements remains uncertain.

Habitat

Nesting habitat

Loggerhead shrikes breed in a wide variety of open habitats including native and non-native grasslands, sage scrub, and other areas with a scattering of bushes and trees and bare ground. Pruitt (2000) summarized the nesting habitat requirements of loggerhead shrikes as follows:

- scattered trees, shrubs, or low bushes as nesting substrate
- elevated perches for hunting and courtship activities
- foraging areas comprised of open, short vegetation with some relatively bare areas
- thorny trees or barbed wire fences for impaling prey.

However, it should be noted that within Region 2 (and likely elsewhere) shrikes may nest in areas without obvious prey impaling sites, with nest tree/shrub availability being the most critical factor in determining nesting habitat (see discussion below).

Within Region 2, the only detailed study of shrike breeding ecology was in the Pawnee National Grassland, where shrikes nest in trees and shrubs in areas of shortgrass pasture, interspersed with fields of

Table 5. Approximate timing of loggerhead shrike arrival and departure dates on USDA Forest Service Region 2 breeding grounds.

Area	Spring arrival date	Fall departure date	Source
Wyoming	April-May (mid March earliest)	early October (14 November latest)	Dorn and Dorn 1999
Colorado	April	October	Andrews and Righter 1992
South Dakota	late April	mid October	Tallman et al. 2002
Nebraska	late April to early May	late August to late October (no observable peak)	Sharpe et al. 2001
Kansas	late April to early May	September to mid October	Thompson and Ely 1992

Table 6. Return rates of adult and fledgling loggerhead shrikes based on studies of banded individuals within migrant populations.

Study area	Percent males returning	Percent females returning	Percent fledglings returning	Source
Alberta	38	27	1.2	Collister and De Smet 1997
Manitoba	23	9	<1	Collister and De Smet 1997
North Dakota	28	5	<1	Haas and Sloane 1989
Minnesota	43	0	0	Brooks and Temple 1990b
Missouri	47	0	1.1	Kridelbaugh 1983
Indiana	55	26	—	Burton and Whitehead 1990

winter wheat (Porter et al. 1975). On the Comanche National Grassland in southeastern Colorado, shrikes breed in similar habitats, but appear to avoid areas that are not protected from grazing cattle (Wiggins 2003). Woods (1995) found that loggerhead shrikes in sagebrush areas of southeastern Idaho were sensitive to human disturbance and nested primarily in rural settings with limited human encroachment. However, this does not appear to be the case in southeastern Colorado (D. Wiggins, personal observation) nor in southern Arizona (Boal et al. 2003).

Nests are typically placed in trees or thick shrubs within pastures and grasslands. Nesting success is generally higher for nests placed in isolated trees, relative to those in shelterbelts or other linear formations, presumably as a result of decreased predation (Pruitt 2000 and references therein). Preferred nesting trees/shrubs depend on the local vegetation (**Table 7**), with *Crataegus* spp. (hawthorns) preferred in New York, *Juniperus virginiana* (Eastern red cedars) throughout much of the Midwest, *Elaeagnus angustifolia* (Russian olive) in Colorado (Porter et al. 1975), and *Artemisia tridentata* (big sagebrush), *Pursia tridentata* (bitterbrush), and *Sarcobatus vermiculatus* (greasewood) in Idaho (Woods 1994). On the Pawnee National Grassland in Colorado, the usual nest tree species were *E. angustifolia*, *Ulmus* spp. (elm), *Salix* spp. (willow), and *Populus* spp. (cottonwood) (Porter et al. 1975). On the Comanche National Grassland in southeastern Colorado, one of the most common nest trees is *Juniperus* spp. (juniper), which is typically planted along windbreaks and in farmyards (Wiggins 2003). It should be noted that *E. angustifolia*, *Juniperus* spp., and *Ulmus* spp. are typically planted around prairie homesteads (and in the case of juniper, as windbreaks) and that in some areas of the Great Plains, the abundance of potential nesting trees is likely much higher today than it was historically.

Shrikes prefer nest substrates that provide concealment, likely as a protection against nest detection/predation. Consequently, rather than the species of nest tree *per se*, the cover (e.g., foliage density) or defense (e.g., thorns) provided appears to be the critical component to nest site selection among shrikes.

Foraging habitat

Shrike foraging behavior has been poorly studied in Region 2. Consequently, foraging habitat choice is typically inferred from preferred nesting habitat (see above). An essential component of shrike foraging habitat appears to be exposed perches within open habitat. In the far western portions of Region 2 (western Colorado, southwestern and central Wyoming), such habitats are typically dominated by sagebrush. Across the Great Plains, the typical foraging habitat ranges from short- to tallgrass prairie, from west to east. In Kansas and Texas, foraging shrikes prefer areas of native grasslands (Michaels and Cully 1998, Chavez-Ramirez et al. 1994).

Several authors have suggested that short grassland is optimal shrike foraging habitat in central and eastern portions of the shrike's range. Consequently, grazed pastures are often cited as quality foraging areas (Kridelbaugh 1982, Luukkonen 1987, Novak 1989). However, it is important to note that all of these studies were conducted in midwestern and eastern states, where grass heights are typically much higher than in Region 2. To date, no studies have assessed the effects of grazing on loggerhead shrike ecology within the

Table 7. Primary tree and shrub species used by nesting loggerhead shrikes in USDA Forest Service Region 2 and adjacent areas. Region 2 states are in bolded font.

State	Nest location	Source
Colorado (n = 77)	Elm, willow, cottonwood, and russian olive	Porter et al. 1975
Nebraska (n = 12)	50% in Eastern red cedar and mulberry Remaining 50% in elm, willow, locust, and cottonwood	Mollhoff 2001
Kansas (n = 8)	50% in Osage orange, 25% in Eastern red cedar, 25% in white mulberry	Michaels 1997
Oklahoma (n = 133)	31% in Osage orange, 13% in hackberry, 11% in Chinese elm	Tyler 1992
Missouri (n = 60)	58% in Eastern red cedar, 12% in wild rose	Kridelbaugh 1982
Idaho (n = 162)	65% in sagebrush, 20% in bitterbrush, 12% in greasewood	Woods and Cade 1996

shortgrass prairie region. Prescott and Collister (1993) found that within shortgrass habitats in Alberta, shrikes preferred to nest (and thus forage) in relatively "tall" grass areas. Thus, the scant available evidence suggests that in shortgrass prairie, shrikes prefer ungrazed or lightly grazed grasslands, whereas in tallgrass areas, they prefer moderate to heavily grazed sites.

An important component of shrike foraging habitat is the availability of suitable perches. Shrikes are sit-and-wait predators, and thus spend the majority of their foraging time perched. Shrikes use powerlines, fence posts, barbed-wire fences, and a variety of natural perches such as *Yucca* stalks and small trees. Shrikes appear to prefer relatively low perches (<5 m; Yosef 1996) but frequently forage from telephone and powerlines when they are available. Yosef and Grubb (1993) found that loggerhead shrike reproductive success was positively influenced by the density of hunting perches in Florida grasslands. In their study, experimental addition of perches resulted in decreased territory size and significantly higher reproductive success relative to shrikes breeding in control areas.

Wintering habitat in southern portions of Region 2 is similar to that utilized during the breeding season. On the Comanche and Cimarron national grasslands, loggerhead shrikes are found foraging from telephone lines, fences, and *Yucca* stalks, typically around shortgrass fields and sand-sage areas (D. Wiggins, personal observation).

Food habits

Loggerhead shrikes feed primarily on insects and small vertebrates. Studies by Beal and McAtee (1912) in the eastern United States revealed that stomach contents were comprised of 68 percent insects, 4 percent spiders, and 28 percent vertebrates; in the western United States those percentages were 83, 2, and 12 percent respectively. Vertebrate prey, including mice (*Peromyscus* spp.) and other small mammals, various small birds and reptiles, appears to comprise a larger percentage of the diet in winter (Sprunt 1950, Graber et al. 1973, Kridelbaugh 1982).

While most studies have found that a high percentage of shrike prey items are insects, others have stressed the nutritional importance of the vertebrate component of the diet (e.g., Scott and Morrison 1995). Several authors have noted the high degree of flexibility in shrike foraging habits, whereby individuals are able to shift hunting techniques depending on local conditions.

In a Missouri study, over 60 percent of shrike pellets (regurgitated prey remains) contained grasshoppers and beetles (Kridelbaugh 1982). There have been no published studies of shrike food habits with Region 2, and this lack of information represents a gap that may constrain our ability to successfully manage regional shrike populations (see Information Needs section).

Breeding biology

Courtship and pair formation

The period of courtship and pair formation is not well understood. In sedentary populations, pairs may remain together through the year, while in migratory populations, pairs split up after the brood fledges and individuals migrate and winter alone (Yosef 1996). It is unclear how quickly pairs form after spring arrival (in migratory populations), but males apparently establish and defend a territory in late winter or early spring. Males perform a courtship flight and chase females during the courtship phase. Males feed females ("courtship feeding") during the pair formation period, as well as during incubation and the nestling stage (Smith 1973), but there are no data available on the frequency of such feeding.

Nest site selection

Both sexes appear to choose the nest site (Miller 1931, Burton and Whitehead 1990, Woods 1994), and although both sexes collect nesting material, there is conflicting evidence as to whether males help in next construction or not (Kridelbaugh 1982, Woods 1994, Pruitt 2000).

Shrikes are opportunistic in their nest site selection, nesting low to the ground in habitats that are primarily shrub dominated, but higher in areas where taller trees are available. Nests in shrubsteppe habitats are typically placed relatively low (0.8 m in Idaho, Woods and Cade 1996; 1.3 m in Alberta, Collister 1994). In shortgrass prairie areas of Colorado, Porter et al. (1975) reported an average nest height of 2.03 m on the Pawnee National Grassland, and Wiggins (unpublished data) found an average nest height of 2.06 m (n = 5 nests) on the Comanche National Grassland in southeastern Colorado. In both of these areas, nests are typically placed in trees in windbreaks and around homesteads. In mixed-grass prairie in Oklahoma, nest height averaged 2.97 m (Tyler 1992). In general, shrikes choose nest sites with dense, preferably thorny interiors, presumably as an aid in concealing the nest from predators (Porter et al. 1975).

Several authors have noted seasonal changes in the nest site preferences of shrikes. In some areas, shrikes show a preference for nesting in conifers (e.g., eastern red cedar, an introduced species) early in the season, then for deciduous trees later. This switch is thought to relate to a lack of nest concealment in deciduous trees early in the spring, and thus, higher predation at nests in such circumstances.

Comparison of nest site choice between years has shown that shrikes often reuse sites from the previous year. In Indiana, 69 percent of nest trees/shrubs were reused, and in one third of these, the same nest structure was utilized (Burton 1990). Although no quantitative data were provided, Porter et al. (1975) reported "frequent reuse" of nest sites on the Pawnee National Grassland in Colorado, likely as a result of a general lack of quality nest sites.

Clutch and brood size

Loggerhead shrikes lay one egg per day, with most egg laying occurring in the morning (Woods 1994). Clutch size is typically five to seven eggs (mean = 5.4), but ranges from one to nine (Yosef 1996, Pruitt 2000). **Table 8** shows the mean clutch size found in studies in Region 2 and surrounding areas. Clutch size typically increases with increasing latitude (Lefranc 1997), and it may also increase with increasing altitude (Porter et al. 1975). As in most passerine birds (Lack 1968), clutch size tends to decline later in the season (Luukkonen 1987, Woods 1994). An unusually low mean clutch size of 3.0 eggs (n = 8 clutches) from a study in the Platte River valley in Nebraska (Faanes and Lingle 1995) may have been due to the inclusion of incomplete clutches in the data set.

Table 8. Clutch size and reproductive success of loggerhead shrikes in USDA Forest Service Region 2 and surrounding areas. Region 2 states are bolded.

Study area	Clutch size	Hatching success[1]	Fledging success[1]	Citation
Colorado	6.4	80	60	Porter et al. 1975
Kansas	5.3	—	—	Johnston 1964
Kansas	5.0, 6.0[2]	53, 33	—	Bellar and Maccarone 2002
Idaho	6.1	83	61	Woods 1995
Oklahoma	5.8	84	60	Tyler 1992
Manitoba	6.1	—	25	De Smet 1993
Minnesota	5.7	—	73	Brooks and Temple 1990a
Iowa	5.6	91	35	DeGeus 1990

[1] Percentage of nests that successfully hatched/fledged at least one young.
[2] Two study areas in east-central Kansas.

Young shrikes hatch asynchronously (typically over a period of 48 hours), which may be an adaptation to promote brood reduction (Yosef 1996). Brood reduction, whereby some young (typically the youngest) in the brood die, is thought to increase the chances of raising at least some young during periods when food supplies are low or highly variable. Yosef (1996) summarized reported brood reduction rates and found between 9 and 28 percent of nestlings died of apparent starvation.

Parental care and offspring behavior

Only female shrikes incubate the eggs (Miller 1931). During this time males forage for the incubating female, provisioning her at the nest throughout the day (Burton 1990). The mean incubation period is 16 days (Miller 1931, Lohrer 1974, Porter et al. 1975). Females brood the nestlings for the first four to five days after hatching, during which time the male provides the majority of food (which is passed to the female). From that point on, both parents provide approximately equal shares of food to the young (Gawlik et al. 1991). At this point, parents no longer defend the nest site but instead defend the immediate area around the fledged young (Yosef 1996). Although parents are known to feed the young early during the post-fledging period, there are few data on post-fledging parental care patterns in shrikes.

Fledgling shrikes typically remain in loose company. When disturbed, they take shelter in dense bushes or undergrowth and remain still (Pittaway 1993). Young experiment with and refine their hunting behavior for the first two months after fledging (Smith 1973).

Nestling growth

Detailed studies of nestling growth in shrikes were made by Miller (1931) and Lohrer (1974). Newly hatched nestlings average 3.2 g and reach an asymptotic mass of 47.5 g (in Florida; Lohrer 1974). Wing and leg bones reach final length at 15 and 13 days post-hatch, respectively (Lohrer 1974). Young typically fledge 17 to 20 days after hatching (Miller 1931, Porter et al. 1975, Tyler 1992) and remain near the nest in undergrowth or dense vegetation. Disturbance at the nest site during the late nestling stage induces the young to fledge prematurely (Woods 1993). Fledglings are poor fliers and only begin longer flights about one week after leaving the nest (Yosef 1996).

Timing of breeding and breeding success

Table 9 provides a summary of the timing of major reproductive events. Shrikes at lower latitudes and lower altitudes generally begin breeding earliest. Shrikes may raise two broods, but this appears most prevalent in southern populations: 0 percent of pairs in Idaho raised two broods (Woods 1994), 10 percent in Minnesota (Brooks and Temple 1990a), 8 percent in South Carolina (Gawlik and Bildstein 1990), 14 to 37 percent (in different years) in Indiana (Burton 1990), 7 to 32 percent (in different years) in Oklahoma (Tyler 1992), 15 percent in Alabama (Siegel 1980), and 96 percent in Florida (Yosef 1996).

Hatching success of loggerhead shrikes typically exceeds 80 percent across their range (Yosef 1996), with similar findings from studies in Region 2 (**Table 8**). For reasons that are not clear, a recent study involving seven nests in east-central Kansas reported unusually low hatching success (45 percent; Bellar and Maccarone 2002). Reproductive success, measured as the percentage of nests that fledge at least one young, has varied widely between study areas (**Table 8**) and among years (within study areas). In shortgrass prairie habitat in Colorado, Porter et al. (1975) reported reproductive success ranging from 48 to 82 percent over four seasons. In Oklahoma, reproductive success ranged from 46 to 83 percent over four years. Brood size at fledging has ranged from 2.9 to 5.4 young per successful nest (Table 2 in Pruitt 2000). Survival of young is poor in the first 7 to 10 days after fledging, with 46 percent mortality reported from Indiana (Burton 1990) and 33 to >53 percent (during two years) in Alberta (Collister 1994).

Table 9. Approximate timing of breeding by loggerhead shrikes in USDA Forest Service Region 2.

State	First clutch date	Hatch date	Fledge date	Source
Colorado	late May to early June (peak)	mid June	late June	Porter et al. 1975; Carter 1998
South Dakota	late April to early May	May through July	May through July	Tallman et al. 2002
Nebraska	22 May - 8 June	31 May (earliest)	—	Mollhoff 2001
Kansas	1 April to 30 June (15 April peak)*	early May	late May-early June	Johnston 1964

* These data refer to "nesting records" and not to clutch initiations *per se*.

Demography

Genetic characteristics and concerns

Loggerhead shrikes are relatively widely distributed in North America, occurring in most low elevation, open habitats. Although philopatry to breeding areas can be relatively high, natal philopatry is very weak (**Table 6**). Thus, there are strong grounds to suspect relatively high gene flow among neighboring populations, as well as among neighboring subspecies (e.g., Vallianatos et al. 2001). Nonetheless, a number of authors have suggested that a comprehensive, range-wide genetic study be carried out to determine the degree to which shrike populations are phylogeographically structured.

Life history characteristics

Loggerhead shrikes lay relatively large clutches, typically renest following failed nest attempts, and may attempt to raise two broods in a season. Thus, reproductive potential is high. Individuals breed first when they are one year of age (Miller 1931). The available data suggest that post-fledging survival may be low, at least during the first one to two weeks following fledging. Despite a number of studies involving banded birds, there are no good estimates of adult or juvenile (from independence) survival rates among loggerhead shrikes. This is likely due to the difficulty in differentiating between survival and emigration, especially as females show little breeding site fidelity (**Table 6**).

Brooks and Temple (1990b) used a stochastic model to explore the relative importance of annual productivity, adult survival, and juvenile survival on the rate of population decline. Lacking robust estimates of adult and juvenile survival, they instead used an estimated rate of 47 percent for adult survival, based on return rates in Minnesota, and a rate of 19 percent survival among juveniles (based on relative survival rates of adult and juvenile Florida scrub jays [*Aphelocoma coerulescens*]). Their results suggested that shrike pairs must fledge an average of 5.5 young each year to maintain the local population size. During fieldwork, however, they found a mean value of 3.73 fledged young per pair, suggesting that their local population was undergoing a decline. They concluded that low overwinter survival was the key factor in the population decline of loggerhead shrikes breeding in Minnesota.

Social patterns and spacing

Loggerhead shrikes are strongly territorial, and territory size is relatively large for a passerine. Reported mean territory sizes (hectares) are as follows: 13.4 in Alberta (Collister 1994), 4.6 in Missouri (Kridelbaugh 1982), 7.5 in New York (Novak 1989), 8.4 in Florida (Yosef and Grubb 1993), and 8.9 and 25 in two study areas in Idaho (Woods 1994). Kridelbaugh (1982) showed that territory size fluctuated over the course of the breeding season, from 8 ha during the incubation period, to 3 ha during the nestling period, and then to 5 ha after fledging. On the Comanche National Grassland in Colorado, breeding territories are often far apart (>5 km or 3 miles; D. Wiggins, personal observation), but this may be a constraint due to a lack nest sites rather than a result of strong territorial behavior by breeding pairs.

Individuals from migratory populations are solitary during winter, while those in resident populations typically remain on or near the breeding territory (Bohall-Wood 1987, Gawlick and Bildstein 1990, Howry 1991). Prior to nesting, individuals may gather in small groups for short periods, either to promote pair formation or to reduce aggression among neighbors (Yosef 1996). When a potential predator approaches a nest, neighboring pairs may transgress territory boundaries and assist in driving away the predator. During the post-fledging period, broodmates and adults will often roost in close proximity to each other.

Factors limiting population growth

Although a number of factors limiting populations have been proposed in local studies (see summary in Pruitt 2000), it has proven difficult to determine which factors are the keys in limiting population growth of loggerhead shrikes on a range-wide basis. The factors most likely responsible for declines in Region 2 are (in order of presumed importance):

- loss and degradation of suitable habitat
- a lack of quality nest sites
- mortality of adults and (especially) recently fledged young due to collisions with vehicles
- low survival of shrikes on the wintering grounds.

To date, there are no data to suggest that pesticide applications are posing a problem for shrikes in Region 2, despite widespread applications of insecticides during grasshopper outbreaks.

Several authors (e.g., Knopf 1986, Johnsgard 2001, Bellar and Maccarone 2002) have suggested that the conversion of native prairie to row-crop agriculture has negatively affected many species of birds on the Great Plains. For loggerhead shrikes, loss of native prairie may negatively affect food abundance (and thus decrease reproductive success and survival) and may increase predation rate (especially at nests) as predators cue in on the remaining fragmented blocks of habitat.

Evidence for a lack of suitable nest sites comes from recent studies on the Comanche National Grasslands in southeastern Colorado (Wiggins 2003, 2004). Over two breeding seasons, only a single shrike nest was located in a pasture where livestock grazed during the breeding season. Rather, most nests were located in fenced exclosures, in farmyards, or in trees along roadways. Nests located along roadways may contribute to the numbers of shrikes killed by colliding with vehicles (Robertson 1930, Flickinger 1995).

Although only a few recoveries have been made of banded Region 2 shrikes during the winter, they suggest that the bulk of the population may spend the winter in the southern Great Plains and northern Mexico. Wintering populations on the southern Great Plains have declined significantly in recent years (**Figure 5**), and thus poor overwinter survival may be hampering the viability of Region 2 shrike populations.

All of these factors that potentially limit population growth are discussed further in the Conservation section.

Community ecology

Figure 8 presents a graphical representation of how loggerhead shrikes interact with key environmental factors. Predation on adults is apparently relatively rare, being more common in the winter. Blumton (1989) reported that 57 percent of shrike winter mortality was due to predation by raptors. Blumton's results, however, may have been biased by the use of radio-transmitters on shrikes, making them more vulnerable to predation. Predation on eggs and young is the leading cause of nest failure in shrikes, accounting for the relatively low reproductive success reported in some studies (e.g., Porter et al. 1975). Predators of shrike eggs and young were summarized by Pruitt (2000) and include feral cats (*Felis catus*), coyotes (*Canis latrans*), badgers (*Taxidea taxus*), long-tailed weasels (*Mustela frenata*), least chipmunks (*Tamias minimus*), Townsend's ground squirrels (*Spermophilus townsendii*), common ravens (*Corvus corax*), black-billed magpies (*Pica pica*), sharp-shinned hawks (*Accipiter striatus*), blue jays (*Cyanocitta cristata*), house wrens (*Troglodytes aedon*), black rat snakes (*Elaphe obsoleta*), gopher snakes (*Pituophis melanoceucus*), and Western diamondback rattlesnakes (*Crotalus viridis*).

As noted by Pruitt (2000), reported nest predation rates on shrikes are generally not higher than those reported for other passerines. However, shrikes nesting in linear habitats (e.g., shelterbelts along roadways) may be more susceptible to nest predation as predators typically use linear habitat strips as movement corridors. DeGeus (1990) suggested that roadside habitats were population sinks for loggerhead shrikes, as high nest predation in such areas led to low reproductive success. Given the prevalence of roadside trees throughout much of the breeding range, high rates of nest predation may be a significant factor in the decline of loggerhead shrikes. This is of particular concern in Region 2, where shrikes nesting on the Great Plains often forage near and nest in roadside trees. This proximity to roads also subjects shrikes to vehicular traffic, a factor known to be a significant source of mortality on the Great Plains (Flickinger 1995).

Although several species of birds, notably American kestrels (*Falco sparverius*) and eastern kingbirds (*Tyrannus tyrannus*) have been cited as competitors of loggerhead shrikes (Cadman 1985), no studies have documented negative effects of interspecific competition on shrikes. Interspecific competition with kestrels is thought to arise by competition over food resources and for access to perch sites. However, Bildstein and Grubb (1980) and Gawlik and Bildstein (1995) concluded that shrikes and kestrels were spatially segregated and that interspecific competition was not responsible for local population declines of shrikes. Several species, including northern mockingbirds (*Mimus polyglottos*), crested caracaras (*Caracara plancus*), and burrowing owls (*Athene cunicularia*), as well as neighboring conspecifics have been seen raiding shrike food caches (Yosef 1996).

Yosef (1996) provides an extensive list of endo- and ectoparasites. These include Mallophaga, roundworms, hippoboscid flies, and blowfly larvae (on nestling shrikes); none of these are thought to be a regular cause of mortality.

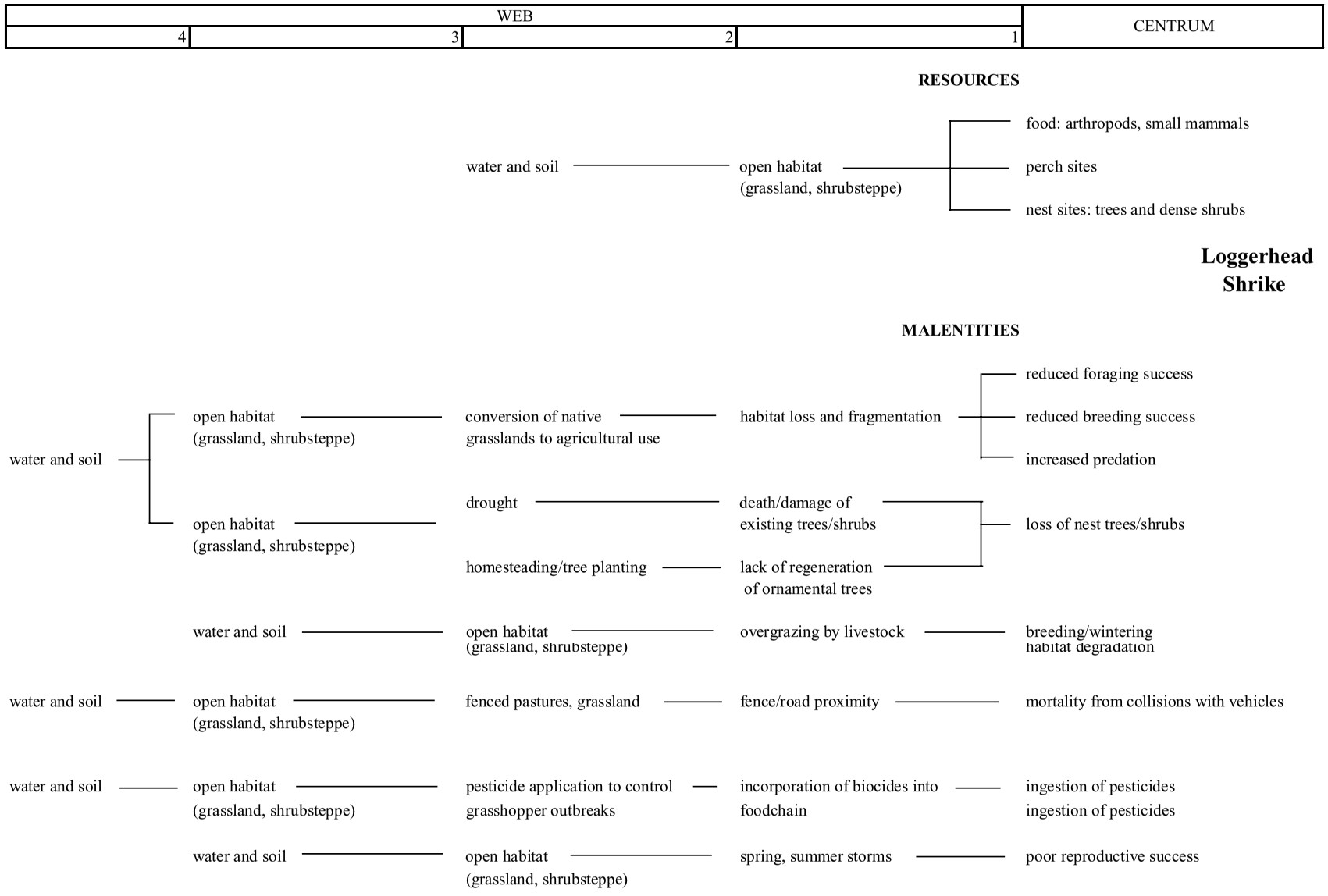


Figure 8. An envirogram depicting the web of linkages between loggerhead shrikes and their environment in USDA Forest Service Region 2.

CONSERVATION

Threats

Loggerhead shrikes have declined in many areas within Region 2, but they are still relatively common in eastern Colorado, western Nebraska, and central Wyoming. There are a number of threats to shrikes within the Region, including (in order of importance):

- loss of habitat due to agricultural conversion
- degradation and loss of nesting trees/shrubs
- degradation of foraging habitat due to overgrazing by cattle
- low reproductive success because of reductions in the prey base due to pesticides, or due to habitat fragmentation/degradation
- susceptibility to toxin accumulations derived from their main (summer) prey sources (grasshoppers, beetles).

Grassland conversion

Pruitt (2000) performed a thorough literature review and found over a dozen studies reporting significant losses of both nesting and wintering habitats due to conversion of old pastures to row-crop agriculture, as well as an overall increase in the size of agricultural plots. The reduction of prairie grasslands on the Great Plains has been even more extensive (e.g., Telfer 1992), with large proportions of tall, mixed and shortgrass prairie habitat now largely converted to agricultural use (Knopf and Samson 1997).

In Region 2, Bellar and Maccarone (2002) suggested that conversion of pasture and rangeland to row-crop agriculture may be responsible for the significant declines in shrike populations seen in Kansas in recent decades. Similar conclusions have been reached concerning declining shrike populations in Arkansas (Burnside and Shepherd 1985), Indiana (Burton 1990), and the entire northern plains region (Hands et al. 1989). In the western United States, elimination and degradation of sage-steppe habitat have become serious problems for many species of birds dependent on such habitat (Saab and Rich 1997). For example, Woods (1995) found a loss of 65 percent of *Artemisia tridentata* habitat in the Snake River Plain, and such losses are now common in the West, where conversion to agricultural and rangeland (exotic grasses) are typical (Rich 1997).

Aside from the direct loss of breeding habitat, conversion of native habitats also results in increased fragmentation of breeding habitat, with associated negative consequences (Herkert 1994).

Grazing effects

Analysis of the effects of livestock grazing on shrike habitats is difficult because such effects are largely inferred from observational rather than experimental studies. Nonetheless, the effects of grazing have been shown to depend on the local habitat types. In eastern portions of Region 2, grazing may improve foraging habitat by thinning and shortening tall, dense grasslands (e.g., Kridelbaugh 1982, Novak 1989). However, in shortgrass prairie and shrubsteppe habitats, anything more than light grazing may degrade the habitat by eliminating grass and thereby reducing prey populations (Prescott and Collister 1993). It is important to note that throughout Region 2, livestock grazing may pose a significant threat to loggerhead shrike nesting habitat, as cattle often seriously damage thickets and small trees. To more fully understand the effects of grazing livestock on the different habitats within Region 2, studies of shrike foraging behavior (as well as reproductive success) in various grazing treatments are clearly needed (see Information Needs section).

Pesticides

Application of pesticides has been cited by a number of authors as a significant problem for loggerhead shrikes (Collins et al. 1974, Cadman 1985, Yosef 1996, Pruitt 2000). Ingestion of pesticide-laden arthropods can lead to toxic effects on adults and in eggs, and it can significantly reduce the local availability of insects (especially grasshoppers). Pruitt (2000) reviewed the literature on toxin levels in shrikes and concluded that DDT and DDE residues were commonly found in adult shrikes and in eggs, in areas throughout its range in the United States. While toxin accumulation from pesticides is known to induce behavioral problems, as well as hatchability problems in eggs, there is a clear need for further studies of the role of pesticide ingestion on shrike reproduction and survival.

Environmental factors

Drought may be having a significant impact on loggerhead shrikes in some areas. Recent (2001

to 2002) drought conditions in Colorado have led to extensive mortality of and damage to trees and shrubs on the Comanche National Grassland (D. Wiggins, personal observation). Drought may negatively impact shrikes not only by killing/damaging trees and shrubs (nesting and perching sites), but also by negatively affecting the main food source (arthropods). Breeding success among the few pairs of shrikes found breeding on the Comanche National Grasslands in 2003 was relatively low (Wiggins 2003). Shrikes breeding in eastern Colorado are also susceptible to violent spring storms (Porter et al. 1975), and early nesting pairs are particularly susceptible to nest losses from violent weather (S. Craig personal communication 2003).

Collisions with vehicles

The problem of shrikes being susceptible to collisions with vehicles was raised over 70 years ago (Robertson 1930), and several recent studies have shown that shrikes are relatively prone to such mortality. Flickinger (1995) found that shrikes were particularly susceptible to collisions with vehicles along a highway in southern Texas, occurring in far greater proportion than their abundance in the area would have suggested. Blumton (1989) also found loggerhead shrikes recorded as road kills in Virginia and estimated that 29 percent of shrike mortality during the fall and winter was due to collisions with vehicles. The species' susceptibility to vehicle collisions stems from their habit of hunting along roadways, where perches are plentiful and their habit of flying low over the ground increases the chances of collisions with vehicles.

Other factors

There is no indication of any interaction with exotic species in Region 2, but Lymn and Temple (1991) found that fire ants may be a significant problem for shrikes in Texas. Although former public attitudes towards shrikes resulted in persecution (i.e., shooting; Yosef 1996), there currently appears to be much less animosity towards shrikes, and direct persecution by humans is not thought to be an important factor in their decline (Pruitt 2000).

Conservation Status of Loggerhead Shrikes in Region 2

The overall distribution of loggerhead shrikes does not appear to have changed recently within Region 2. However, analysis of BBS data suggests that the abundance of shrikes has declined in many areas of Region 2, with the exceptions of the plains of eastern Colorado and the shrubsteppe of central Wyoming. Shrikes now appear to be sparsely distributed in eastern Nebraska and eastern South Dakota while the species' overall abundance has declined statewide in Kansas. These declines, together with the strong declines in shrike abundance in neighboring areas (to the north, east, and south), suggest that immigration from neighboring areas will decrease, and as a result, similar population declines should be expected throughout Region 2 in the coming years.

In most of Region 2, loggerhead shrikes are present only during the warmer months, when insect prey is readily available. Loggerhead shrikes are largely absent from Wyoming, South Dakota, and Nebraska in winter. The origin of the wintering populations in southern Colorado and Kansas remains unknown – some individuals may remain in the latter areas year-round, but most of the Region 2 wintering birds probably breed in areas to the north of Region 2. The degree to which variation in habitat features affects the preferred food supply is not known, but the local distribution of birds suggests that grasslands and sagebrush habitats likely contain higher concentrations of prey.

On the Great Plains, loggerhead shrikes show a strong preference for nesting in dense, preferably thorny trees or shrubs. Consequently, a lack of such nesting substrates or a degradation of existing trees may be having significant negative consequences. For example, on the Comanche National Grasslands of southeastern Colorado, shrike nesting surveys in 2003 revealed only a single shrike nest (apparently abandoned) in a tree that was not protected from the effects of grazing cattle. Cattle typically congregate around trees and may rub against them, damaging the lower portions of the tree. Thus, in many areas of the Great Plains, damage to potential nesting trees by grazing cattle may represent a significant threat to loggerhead shrikes by reducing the quality of nesting vegetation.

Shrikes prefer areas of open grassland or sage scrub for foraging and nesting, and the availability of these habitats will thus influence local shrike abundance and breeding success. Pruitt (2000) cited a number of studies that made direct links between shrike habitat availability and declines in local shrike populations. While the majority of these studies concerned agricultural habitats such as active pastures and hayfields, similar declines in natural habitats such as prairie grasslands (Knopf and Samson 1997) and sage-steppe (Saab and Rich 1997) have also taken place. In addition to declines in habitat availability and habitat quality, several authors have suggested that remaining

areas of shrike habitat are highly fragmented with suitable patches occurring in small, isolated pockets (see summary in Pruitt 2000). Habitat fragmentation may lead to a number of problems including hampered recruitment/colonization, decreased juvenile survival, and increased predation at nests.

Although there have been a number of studies of shrike habitat choice (e.g., Brooks and Temple 1990b) outside of Region 2, there remains considerable uncertainty about the role of various factors in determining shrike habitat suitability (Pruitt 2000), and studies in Region 2 are therefore warranted. On the national grasslands, loggerhead shrikes appear to avoid nesting in trees within actively grazed pastures (Wiggins 2003). Rather, they choose areas where trees are protected from the detrimental effects of cattle (e.g., cribbed trees, enclosures). Given the rarity of such sites, the species is likely currently limited by a lack of suitable nest sites in shortgrass prairie.

Populations of loggerhead shrikes breeding in the sage-dominated landscapes of northwestern Colorado and southwestern Wyoming are probably being impacted by degradation and elimination of sagebrush habitat. Most species of birds that inhabit the sagebrush steppe of the Intermountain Region have undergone significant declines in recent decades (Saab and Rich 1997). Similarly, shrike populations have likely been significantly impacted by conversion of Great Plains grasslands to croplands (see summary in Pruitt 2000, pages 37-38). Although the introduction of programs like the Conservation Reserve Program (CRP) may improve habitat to some extent, such programs do not restore habitats to their native condition. Instead they typically result in grasslands dominated by alien species. In addition, land is typically enrolled in the CRP for a limited number of years, although renewal of CRP leases is possible.

Grazing of cattle on private and public grasslands can negatively affect loggerhead shrike populations in several ways. First, heavy grazing (especially in shortgrass prairie regions) may degrade (or eliminate) certain grasses such that the grasslands are less suitable for foraging shrikes. Second, grazing cattle typically seek shelter under and around small groups of trees and shrubs, and they can kill or damage such vegetation by rubbing against them. Finally, grazing (as well as grassland conversion) can exacerbate the existing perforated and fragmented nature of shrike habitat by increasing the areas of unsuitable habitat.

Collisions with vehicles have been noted as a significant source of mortality in areas east and south of Region 2. Although there are few data from Region 2, there is reason to believe that this factor is also significantly affecting population viability in Region 2. Craig (2002) noted that the only banding recovery of a loggerhead shrike away from her study area in eastern Colorado was of an adult killed by a car in winter in Texas. Although it has not been addressed by other authors, mortality due to vehicle collisions may be even more severe among juvenile shrikes. In eastern Colorado, Craig (2002) noted at least two recently fledged shrikes dead on roads in her small study area.

Loggerhead shrike populations in all parts of Region 2 are at risk, but it is important to note that factors driving the decline are not well understood. Aside from factors originating in Region 2, declining populations in adjacent areas may lead to decreased immigration and thus reduced local population viability. A population study in eastern Colorado and/or central Wyoming would be valuable as these two areas contain the core (stable) populations of shrikes in Region 2 (**Figure 9**). Comparison of population demography from those areas to areas undergoing population declines may help to identify the factor(s) responsible for local population declines (see Information Needs section).

Management of Loggerhead Shrikes in Region 2

Implications and potential conservation elements

The quantity and quality of grassland and shrubland habitats are among the primary factors that affect the abundance and reproductive success of loggerhead shrikes in Region 2. Destruction and degradation of these habitats have lead to an increasingly fragmented mosaic of suitable shrike habitat, a situation that may have a number of negative consequences for shrike population viability. Although recent land conservation practices such as the CRP may help to reverse such trends, no assessment of the effects of such programs has yet been carried out for loggerhead shrikes.

On the Comanche National Grassland in southeastern Colorado, shrikes appear to be limited by a lack of suitable nesting sites (Wiggins 2003, 2004). Almost all recent nesting attempts on the Comanche National Grassland have been in trees that were in

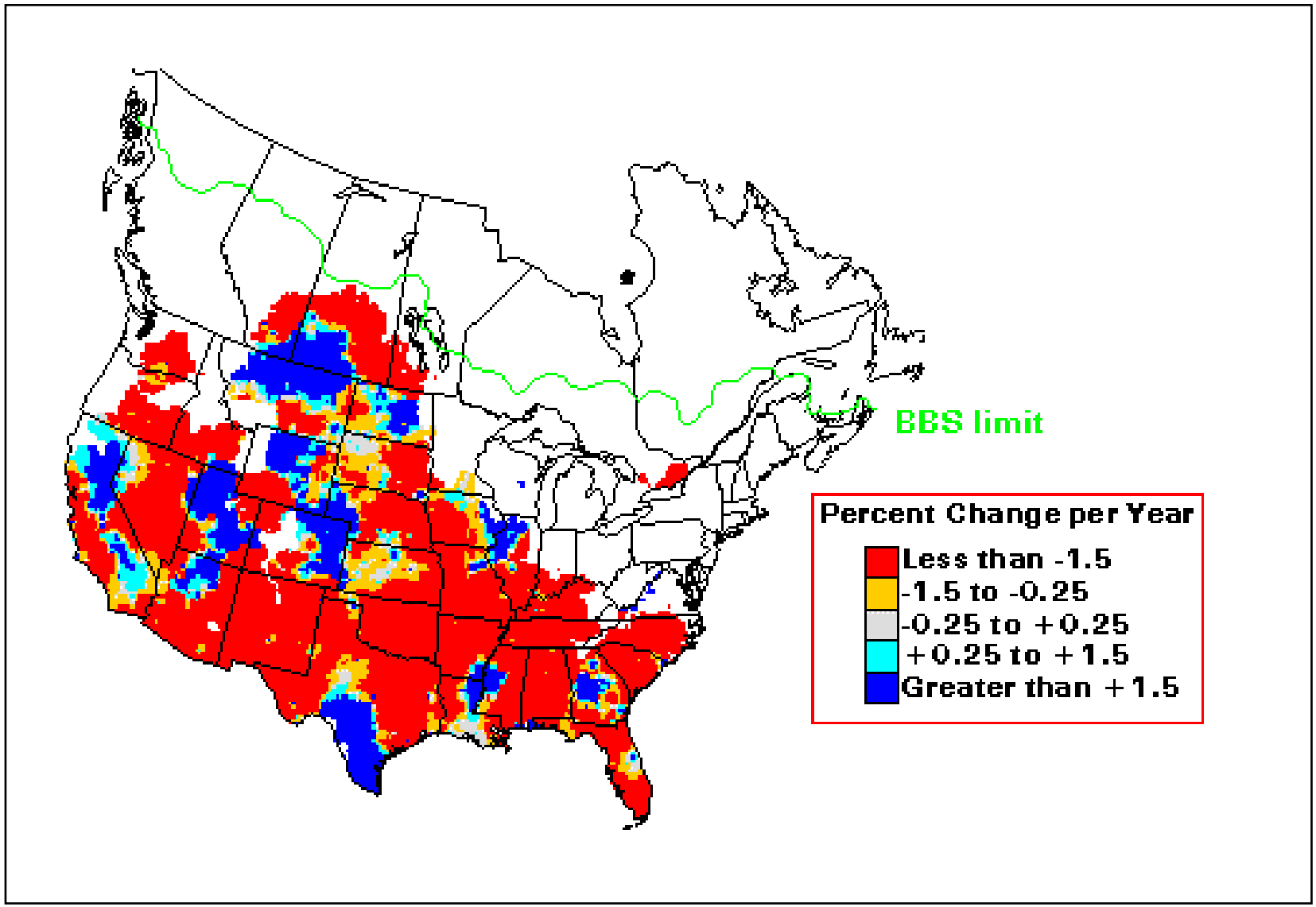


Figure 9. Changes in the number of loggerhead shrikes counted on Breeding Bird Surveys. Changes are expressed in percentage change per year over the period 1966 to 1996.

enclosures or that were otherwise protected from grazing cattle. Similarly, on adjacent private land, all shrike nests were located in areas where trees were not subjected to the effects of grazing livestock (e.g., abandoned homesteads, fenced windbreaks). If such results generally apply to other areas of shortgrass prairie in Region 2, then a lack of suitable nest sites may be the principal factor limiting population increases in the area.

The pattern of nest site selection by shrikes also suggests that collisions with vehicles may be a significant problem in Region 2. As mentioned above, many pairs nest in abandoned homesteads, windbreaks, and other trees along roadsides. Craig (2002) noted dead juvenile shrikes along roads in eastern Colorado, and several authors have suggested that foraging along roadways may lead to significant mortality among shrikes. A lack of suitable nest sites away from roads may force adults to nest along roads.

On the shortgrass prairie of eastern Colorado, western Kansas, and western Nebraska current nest site availability is likely higher for loggerhead shrikes than it was historically. The majority of current nest sites are in abandoned homesteads or other areas where trees were planted following land settlement in the 1800's and early 1900's. In addition to these sites, recent plantings of conifers as windbreaks have provided suitable shrike nesting sites. Thus, land managers in shortgrass prairie regions face a dilemma with respect to loggerhead shrikes – although shrike abundance is now low and may be declining as a result of declining nest site availability (among other factors), a restoration of shortgrass prairie habitat to historical conditions would not include planting ornamental trees. As an example, an attempt to restore historical habitat conditions on the Pawnee National Grassland has resulted in the removal of many trees that were planted within the past half-century (E. Humphrey personal communication 2004). The loss of trees has no doubt reduced the local abundance of loggerhead shrikes, as well as other tree-dependent species such as ferruginous hawks (*Buteo regalis*). The negative effects of such removals could be partially offset by protecting the remaining trees from cattle grazing (see Tools and practices section). In the absence of such a tree protection program, very few (if any) loggerhead shrikes would nest on the Comanche National Grassland (D. Wiggins, personal observation).

Drought is known to negatively affect the reproductive success of loggerhead shrikes (Tyler 1992). It may cause reduced prey abundance and reduced availability of nesting substrates for shrikes. These effects may be particularly important in the western portions of Region 2. Recent droughts in southern Colorado have damaged and/or killed a significant number of trees within the Comanche National Grasslands (D. Wiggins, personal observation), including those used by nesting shrikes. Although natural patterns of drought are uncontrollable, land managers can act to minimize drought effects by altering (or eliminating) cattle grazing during such periods.

Over the majority of their breeding range in Region 2, shrikes typically breed in habitats that have been altered by grazing. While light grazing may improve some grasslands in the eastern portions of Region 2, anything other than light, sporadic grazing may have negative effects in the shortgrass prairie regions of eastern Colorado, western Kansas, southeastern Wyoming, and western Nebraska. There is a clear need for a study of the effects of cattle grazing on shrike ecology in sagebrush habitat (where little information currently exists), as well as in short, mixed, and tallgrass prairie regions.

Tools and practices

Habitat management

Most of the current conservation work on loggerhead shrikes is taking place in Canada (i.e., Alberta, Saskatchewan, Manitoba, and Ontario). Shrikes breeding on the Canadian prairies utilize similar habitats as those in Region 2 (e.g., sagebrush, shortgrass and mixed-grass prairies); they are also migratory. Unfortunately, to date there is little information available on whether habitat manipulations underway on the Canadian prairies have positively affected the abundance and reproductive success of shrikes (A. Didiuk personal communication 2003). The primary habitat management technique being carried out in Canada is tree planting in areas with open grassland. While such a program could also be utilized in some areas of Region 2 (e.g., central and eastern portions of South Dakota, Nebraska, and Kansas), most of the shortgrass prairie in Region 2 was historically treeless. In addition, many of the tree species planted as ornamentals and currently utilized by shrikes (e.g., *Juniperus virginiana* and *Elaegnus angustifolia*) are not native to the area. In shortgrass prairie, planting trees in an attempt to increase nest site availability for shrikes may help to counter the loss of extant trees, but land managers must weigh the advantages of such a program against the fact that in most instances, trees are not a part of the ecological history of such areas.

Improving shrike foraging habitat could be accomplished by halting the conversion of native prairie and rangeland to row-crop agriculture. While the CRP is already helping to revert some former agricultural areas to grassland, CRP plots are often planted with relatively cheap alien grasses, and the value of alien grasses to the native fauna is dubious. However, in some states (e.g., Kansas, Texas), the Natural Resources Conservation Service is now actively promoting re-seeding with native species, and such plots may provide excellent shrike foraging habitat. The CRP may represent an opportunity to not only improve shrike nesting and foraging habitat, but to also create habitat patches that reduce the extent to which shrikes are exposed to vehicle collisions. First, to maximize prey availability, CRP plots should ideally be seeded with native grasses rather than alien species. Second, small trees and shrubs could be allowed to grow on some plots, especially in areas away from roads. Finally, CRP sites situated away from roadside power lines and fences should be especially beneficial to shrikes (again, by reducing vehicle collisions), and such areas could be prioritized during CRP enrollment. The value of CRP plots (whether seeded with alien or native grasses) to shrikes and other wildlife is clearly in need of further study (see Information Needs section).

Livestock grazing may benefit shrikes in eastern areas of Region 2, but it is likely detrimental to shrike habitat over the western half (**Figure 10**). Studies in mixed and tallgrass prairies to the east of Region 2 have shown that light to moderate levels of livestock grazing may improve grassland habitat for foraging shrikes (e.g., Kridelbaugh 1982). The only study to date in shortgrass prairie found that shrikes preferred areas with the tallest grasses, suggesting that anything other than light, sporadic grazing may significantly degrade the value of the grassland to shrikes (Prescott and Collister 1993). As mentioned elsewhere in this report, the effects of variation in grazing intensity on shrike nesting and foraging habitat need further study in Region 2. Given their known grazing histories and variation in grazing intensity on different pastures, national grasslands are excellent candidate areas for such a study.

In areas open to cattle grazing, two practices adopted by the USFS appear to benefit breeding shrikes. On the Comanche National Grassland in southeastern Colorado, small areas containing small trees and shrubs (including short shelterbelts) have been fenced off to exclude cattle. Such fencing not only provides a patch of relatively tall grass for shrike foraging, but it also

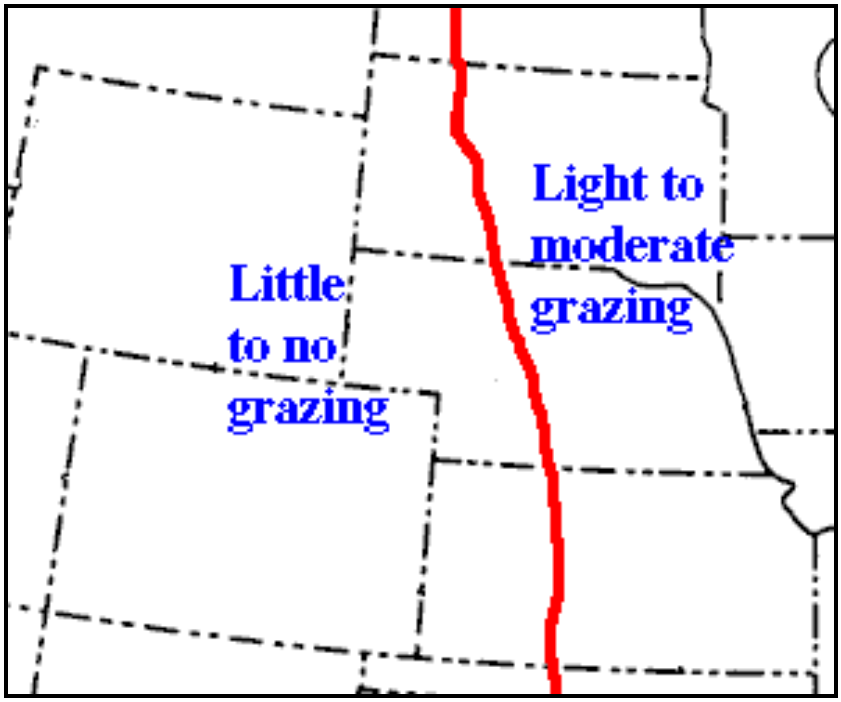


Figure 10. A map of USDA Forest Service Region 2 showing the line of demarcation dividing areas where livestock grazing is presumed to be detrimental to shrike foraging habitat (i.e., shortgrass prairie and shrubsteppe, west of the line) from areas where light to moderate grazing intensity may improve shrike foraging habitat (i.e., mixed and tallgrass prairie, east of the line).

protects the potential nesting trees from the effects of cattle rubbing. Another technique employed on the grasslands is to place metal or wooden "cribs" (**Figure 11**) around isolated trees and bushes, again to prevent cattle from killing or degrading such trees. During surveys in 2003, the only active shrike nests found on national grassland pastures open to cattle grazing were in fenced areas and in trees protected by cribs (D. Wiggins, personal observation). Several old shrike nests were also found within cribbed trees, suggesting that such management techniques may be critically important to shrikes breeding in shortgrass prairie regions.

Comprehensive summaries of known and proposed management techniques for loggerhead shrikes can be found in Pruitt (2000) and Dechant et al. (2001). In addition, several PIF regional and state plans have published management recommendations for loggerhead shrikes. Syntheses of these plans are presented in **Table 2** and **Table 3**.

Inventory and monitoring

Population monitoring is being carried out in Manitoba and Saskatchewan, where there is considerable concern over declining populations of shrikes (Committee on the Status of Endangered Wildlife in Canada 2004). However, a generally accepted survey protocol for loggerhead shrikes has not yet been developed.

The author's experience from surveying for breeding shrikes on the Comanche National Grassland suggests the following protocol for annual inventories of the number of breeding pairs:

- Surveys should be carried out in early to mid-May, when shrikes are settling on territories and when most migrant shrikes have already passed through the region. Repeat surveys for late and re-nesters should be carried out in early June.

Figure 11. An example of "cribbing" used to protect trees from the effects of cattle rubbing. The photograph was taken on the Comanche National Grassland, southeastern Colorado. Such cribs are also used on smaller trees that are preferred as nest sites by loggerhead shrikes.

- ❖ Surveys should be concentrated in appropriate habitat (grasslands, shrubsteppe, sand-sage) and in areas where small groups of trees or shrubs afford suitable nest sites.

- ❖ Adult shrikes are conspicuous during this period and typically can be easily observed in the vicinity of the nest. If nesting activity is a goal of the survey, nests should be searched for amid the densest areas of trees and shrubs.

- ❖ Standardized population monitoring in a given area could be carried out by designating transect routes along roads, and by slowly driving the transects while scanning for shrikes. Areas along the transect route with shrubs and trees should ideally be checked on foot, but they could also be observed for a set time period (e.g., 5 minutes) from a vehicle for any shrike activity.

Monitoring the reproductive success of loggerhead shrikes would be best achieved by first carrying out inventory work to identify all local nesting sites. Desired reproductive data are clutch initiation date, clutch size, hatching date (first egg to hatch), hatching success (% of eggs laid that hatched), and fledging success (% of eggs laid that resulted in fledged young). Eggs are usually laid on consecutive days, so if nests are first checked during the laying period, a good approximation of clutch initiation date can by determined by backdating (i.e., subtracting one day for each egg in the clutch). Fledging success can be determined by counting the number of unhatched eggs as well as any dead young in the nest after the brood has fledged.

Nests are often situated low enough that their contents can be checked without a ladder. In cases where nests are located above 2.5 m, an extendable mirror pole can be used to view the nest contents. This is a simple and relatively inexpensive method that also greatly reduces disturbance at the nest. Loggerhead shrikes generally tolerate brief disturbances at the nest during the incubation and nestling stages, but care should be taken when visiting the nest near fledging as young shrikes may leave the nest prematurely if disturbed late in the nestling stage (e.g., when they are 15 to 20 days old). As a result, one week is an appropriate time interval for checking nest contents starting from the point at which the nest is found and continuing until hatching, then at day 7, day 14, and a final check of the nest (and nearby area) at day 21, when all young should have fledged. Young shrikes typically stay in the immediate nest vicinity after fledging, but they generally remain quiet in concealed positions.

Information Needs

There have been few direct studies of shrike responses to changes in habitat. Thus, there is a clear need for monitoring shrike abundance and reproductive success within (for example) a mosaic of grassland or sagebrush treatment types. Areas with suitable habitat exposed to differing grazing regimes would be particularly useful.

Shrike demography has been studied in southwestern Manitoba, but demography in other areas (including Region 2) remains poorly understood. Shrikes show relatively low natal and breeding philopatry, and as a consequence, juvenile and adult survival rates are not well understood. Site fidelity is variable across the species' range, and thus tracking individuals between seasons is problematical. Finally, there is no information on age-related patterns of reproductive success. Because all of these data are crucial when carrying out population viability analyses, such analyses cannot be performed until further information is available.

Within Region 2, local populations of loggerhead shrikes appear to be stable in some areas (e.g., eastern Colorado) but declining in others (e.g., Kansas, eastern South Dakota). Local studies of reproductive success, including banding adults and young, would help to clarify the reasons behind such spatial variation in population dynamics. Such studies might also contribute to our knowledge of the factors responsible for the declining populations in some areas and the relative stability in others. Surveys for nesting shrikes on national grasslands can be completed quickly, as shrikes are typically conspicuous and nests are relatively easily located. A new study of shrike reproductive success on the Pawnee National Grassland could be compared to historical data collected by Porter et al. (1975) to provide an indication of whether shrike numbers or breeding parameters have changed over the past 30 years.

Current surveying methodology is still being fine-tuned in Canada and is not yet available in published form. Data from the declining population in Manitoba suggest that BBS methodology may not adequately sample shrike populations, at least in areas where shrikes are relatively uncommon. Detailed, long-term,

local studies of reproductive success (as are now carried out in Saskatchewan and Manitoba) would help to clarify the reasons for local population declines.

There is still a relatively poor understanding of the factors responsible for local variation in reproductive success in shrikes. This is one area where research in Region 2 may provide valuable baseline demographic data, especially in areas where loggerhead shrikes are not declining (i.e., eastern Colorado and Wyoming). Differences in reproductive success of shrikes breeding on different land-treatments would provide valuable insight into the effects of land management practice on breeding success. For example, local differences in grazing intensity on grasslands, or in sage-dominated habitats, may affect not only nest-site availability, but also prey populations. Comparison of reproductive parameters among populations breeding on heavily grazed, lightly grazed, and ungrazed areas would be particularly valuable.

Given the steady, significant decline in the wintering populations in Region 2, a study of residency and survival during the winter may help to clarify the origin and winter ecology of shrikes in the region. Pruitt (2000) also suggests that studies of the winter ecology of the migrant populations of shrikes are needed, as low overwinter survival is thought to be contributing to the strong population declines among migrant populations (e.g., Brooks and Temple 1990a). The most obvious area for such a study would be the Cimarron National Grassland, where shrikes have been relatively abundant during recent Christmas Bird Counts (**Figure 6**).

Shrike food habitats and foraging behavior have been studied in habitats outside Region 2, and there is a clear need for further studies in Region 2 habitats such as shortgrass prairie. Such information will provide important baseline data and may help to assess how shrikes may respond to habitat changes. Of particular interest would be studies comparing the use of various grassland types (rangeland, native grassland, and CRP plots seeded with alien and native grasses) by foraging shrikes. CRP plots have recently proliferated on the Great Plains, but their value as shrike foraging and nesting habitat remains unclear.

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