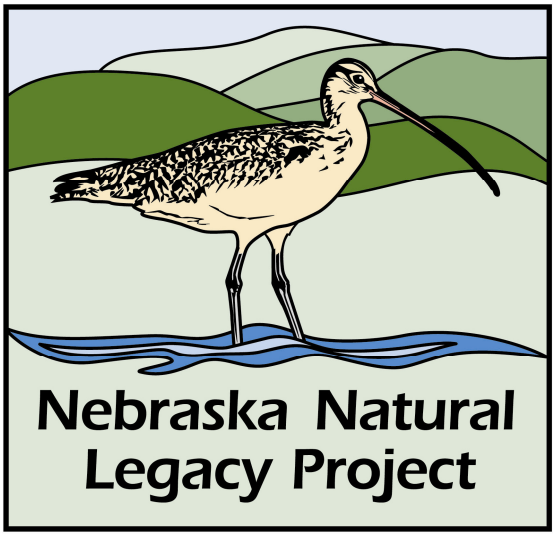
Loggerhead Shrike
(*Lanius ludovicianus*)

A Species Conservation Assessment
for
The Nebraska Natural Legacy Project



Prepared by Melissa J. Panella
Nebraska Game and Parks Commission
Wildlife Division
March 2013

The mission of the Nebraska Natural Legacy Project is to implement a blueprint for conserving Nebraska's flora, fauna, and natural habitats through the proactive, voluntary conservation actions of partners, communities, and individuals.

Purpose

The primary goal in the development of at-risk species conservation assessments is to compile biological and ecological information that may assist conservation practitioners in making decisions regarding the conservation of species of interest. The Nebraska Natural Legacy Project recognizes the Loggerhead Shrike (*Lanius ludovicianus*) as a Tier I at-risk species. Here, I provide some general management recommendations regarding Loggerhead Shrikes. However, conservation practitioners will need to use professional judgment for specific management decisions based on objectives, location, and site-specific conditions. This resource provides available knowledge of Loggerhead Shrikes that may aid in the decision-making process or in identifying research needs for the benefit of the species. Species conservation assessments will be updated as new scientific information becomes available. The Nebraska Natural Legacy Project focuses efforts in the state's Biologically Unique Landscapes (BULs), but it is recommended that whenever possible, practitioners make considerations for a species throughout its range in order to increase the success of conservation efforts.

Common Name	Loggerhead Shrike
Scientific Name	*Lanius ludovicianus*
Order	Passeriformes
Family	Laniidae
G-Rank	G4
S-Rank	S2S3
Goal	4
Distribution	Widespread
Criteria for selection as Tier I	Declining, PIF watch list
Trends since 2005 in NE	Declining
Range in NE	Statewide, although more common in areas with extensive grasslands
Habitat	Grasslands with scattered small trees or shrubs
Threats	Loss of grassland habitats, depletion of food resources (because of pesticides), organochloride pesticide may negatively impact reproduction, invasive species Climate Change Vulnerability Index: Not Vulnerable, Increase likely
Research/Inventory	Determine causes of population declines; determine conservation measures (habitat improvement) that can positively impact species
Landscapes	Central Loess Hills, Cherry County Wetlands, Dismal River Headwaters, Elkhorn River Headwaters, Keya Paha, Kimball Grasslands, Loess Canyons, Oglala Grasslands, Panhandle Prairies, Sandhills Alkaline Lakes, Sandsage Prairie, Sandstone Prairies, Southeast Prairies

Status

According to the last status review in 2001, the state of Nebraska Heritage status rank of Loggerhead Shrikes is S5, U.S. national status is N4, and global conservation rank is G4 (NatureServe 2009). From 1966–2010, Loggerhead Shrikes in Nebraska have exhibited a downward trend of -2.4, 95% CI (-3.8, -1.1); this decline may be more pronounced within the last decade (Sauer et al. 2011). The Rainwater Basin Joint Venture has identified the Loggerhead Shrike as a priority landbird for conservation (C. Jorgensen, pers. comm.). The Nebraska Natural Legacy Science Team set a goal of maintaining four populations in the state (Schneider et al. 2011), assuming there is little movement between populations and fates of populations are not correlated. Moderate viability (40% chance of survival) of each population gives >99% probability of at least one population surviving 100 years (Morris et al. 1999).

Principal Threats

For a number of years, birders have noted a decline in the population of Loggerhead Shrikes (Schneider et al 2011). This declining trend holds true for virtually every state/region within the species' range (Cade and Woods 1997, Sauer et al. 2011), with declines in agricultural areas of the Midwest the most severe (Chavez-Ramirez et al. 1994). Land-use changes that may impact Loggerhead Shrikes include decreases in pasture, urbanization, loss of tree rows, increase in tree invasion of grasslands, and increased pesticide use (Bellar and Maccarone 2002). In eastern Nebraska, many shelterbelts and roadside thickets have been removed in recent years to make way for more cropland and wider roads. Fewer suitable nesting sites for the species may exist because of the reduction of scattered trees such as plum and dogwood (C. Klaphake, pers. comm.). Loggerhead Shrikes that nested in a landscape characterized by >85% row crop in southeastern Illinois only achieved 26% nesting success; increased mammalian predation was implicated (Walk et al. 2006). Intense wildfires can decrease habitat for Loggerhead Shrikes too (Humple and Holmes 2006). A reduction in amount and quality of habitat is likely a major contributing factor to population decline of Loggerhead Shrikes, but it does not seem to be the only cause; the reasons are not entirely understood.

Pesticides could be another culprit (Robbins and Easterla 1992, Sharpe et al. 2001, Bellar and Maccarone 2002), but Herkert (2004) did not find evidence to support the theory that organochlorine pesticides alone are responsible for declines of Loggerhead Shrikes in Illinois. Pesticides that are regularly used today have the potential to diminish prey availability to Loggerhead Shrikes (Yosef and Deyrup 1998, Dechant et al. 2001). Loggerhead Shrikes are also highly susceptible to West Nile Virus (WNV); Bertelsen and others (2004) found that captive, demographically-diverse Loggerhead Shrikes at the Toronto Zoo breeding facility did not form antibodies to the virus, indicating the potential for 100% mortality in that population (the birds made antibodies only after vaccination). Furthermore, there may be other factors on wintering grounds and migration corridors of Loggerhead Shrikes that are contributing to their decline (Brooks and Temple 1990, Chavez-Ramirez 1994, Fornes 2004), including direct and indirect impacts from red imported fire ants (Allen et al. 2001).

Species Description

Loggerhead Shrikes have short, conical bills; a thick black mask marking through the eye; dark gray back; gray belly; white outer rectrices; dark wings with white patch clearly visible during flight (Sibley 2000). The head of a Loggerhead Shrike is proportionately large in comparison to its body. Loggerhead Shrikes have a grayer belly and are 25% smaller than Northern Shrikes (*L. excubitor*) (Yosef 1996, Sibley 2000). Note that the two species' ranges may overlap in winter with Northern Shrikes being much more common in Nebraska at that time of year (Yosef 1996, Sibley 2000).

FIGURE 1. Loggerhead Shrikes are birds of open grasslands with scattered small trees and shrubs. Occasionally, they have been found in park-like locations (in Arizona; Boal et al. 2003). This bird was photographed by Craig R. Allen on a deck at his rural residence not far (~15 mi) southeast from Lincoln, Nebraska.

Habitat and Range

Nebraska has breeding populations of Loggerhead Shrikes that migrate (mostly) out of the state to wintering grounds (Sharpe et al. 2001). They are birds of open country that require some scattered small trees for nesting (Sharpe et al. 2001, Schneider et al. 2011). Nesting locations may include landscapes with big sagebrush (*Artemisia tridentata*) (Humple and Holmes 2006), osage orange (*Maclura pomifera*) (Esely and Bollinger 2001), or plum thickets (J. G. Jorgensen, pers. comm.). Brooks and Temple (1990) found 61% of nests in isolated trees in Minnesota. Loggerhead Shrikes occur in higher densities in the panhandle than in the rest of Nebraska (Sauer et al. 2011). Breeding habitat is better when the effects of agriculture are minimized on the landscape (Esely and Bollinger 2001, Sharpe et al. 2001, Bellar and Maccarone 2002). Few Loggerhead Shrikes may winter in Nebraska, utilizing grassland habitat in southeastern Nebraska (Sharpe et al. 2001).

Breeding territories of Loggerhead Shrikes contain more grassland within 300 m of nests than random locations (Esely and Bollinger 2001). Fornes (2004) found that Loggerhead Shrikes nesting in tallgrass prairie of Illinois were positively associated with percent short grass within 25 ha, number of nesting sites within 50 ha, percent potential foraging habitat within 25 ha, number of huntable tree perches within 25 ha, and number of utility poles within 25 ha (all $P < 0.001$). Length of fence was also significant within 50 ha ($P < 0.05$) (Fornes 2004). Utility poles and fences offer perching and a vantage point that may aid foraging behaviors; however, fences may reduce the quality of breeding habitats, effectively reducing the reproductive success of Loggerhead Shrikes (Yosef 1994). Fornes (2004) demonstrated that percent potential foraging grounds within 25 ha was associated with number of young fledged ($r = 0.506$, $P = 0.01$) and length of hedgerows was negatively correlated with daily survival rate ($r = 0.464$, $P = 0.02$). Searching and capturing prey may be more difficult for shrikes in prairies with taller grasses (Mills 1979, Gawlik and Bildstein 1993, Yosef 1996).

Boal and others (2003) studied Loggerhead Shrikes in Tucson, Arizona and determined that the shrikes may find suitable nesting sites in trees growing in patches in urban environments, including playgrounds and residential yards. Urban nest sites offered trees >3 m in height, trees that were taller than those randomly available, and more bare ground, but breeding territories still consisted of open areas with native short-stature vegetation (Boal et al. 2003). Loggerhead Shrikes may tolerate an urban nesting environment (if they don't encounter increased predation risk) because of the availability of other resources, including water and prey (Boal et al. 2003). The threat to Loggerhead Shrikes from domestic pets or feral cats can increase in these urban environments (Gawlik and Bildstein 1990, Walk et al. 2006).

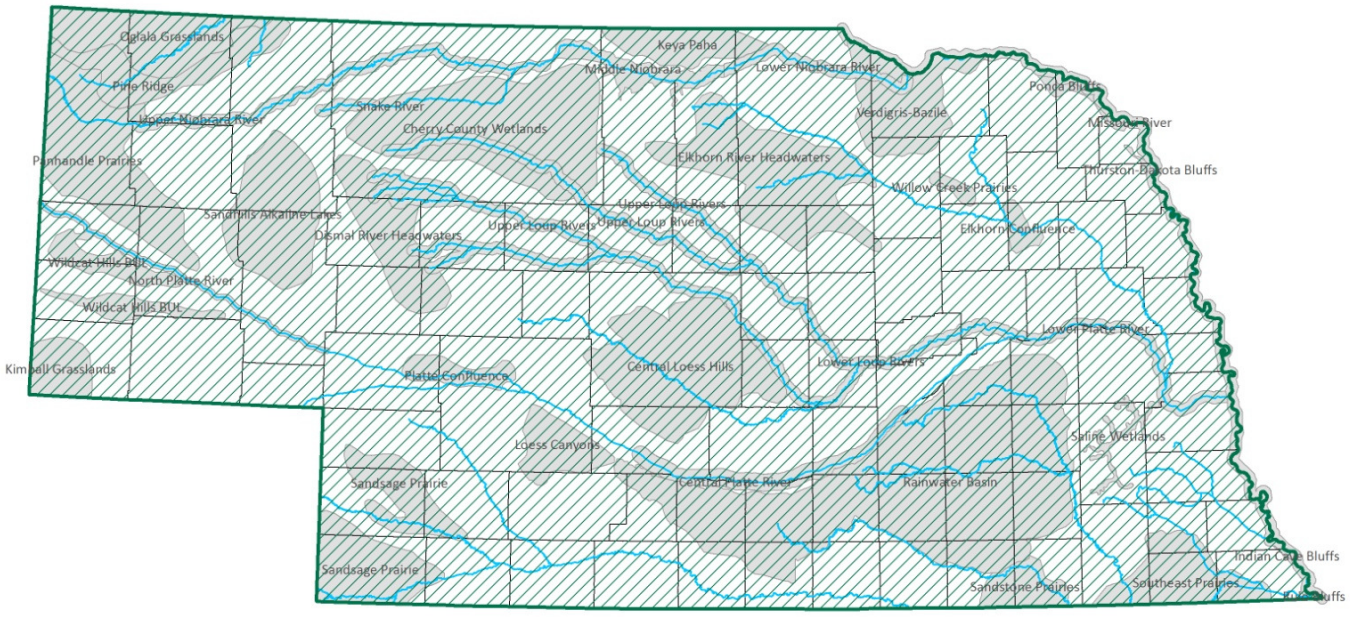


FIGURE 2. The current range of Loggerhead Shrikes in Nebraska spans the entire state based on field observations, museum specimens, and expert knowledge. Map courtesy of Nebraska Natural Heritage Program, Nebraska Game and Parks Commission.

Area Requirements

Loggerhead Shrikes normally establish a territory of 6–9 ha (Dechant et al. 2001). Kridelbaugh (1982) found average territory size in Missouri to be 4.6 ha. In Alberta, territory size was only ~2.7 ha (Collister 1994); whereas in Idaho, it was 25 ha (Yosef 1996). Bellar and Maccarone (2002) found a density of 3.0 ± 2.7 Loggerhead Shrikes/80 km (n = 72 individuals) in the Flint Hills of Kansas and 1.9 ± 1.9 Loggerhead Shrikes/80 km (n = 45 individuals) in lowlands in the southern part of the state.

Dispersal and Migration

Burnside (1987) reported that 104 of 151 Loggerhead Shrikes banded from 1923–1983 in the United States and Canada were recovered within 20 km of the site where they had been banded. Twenty-eight were recovered 21–99 km from the banding site and 19 had moved 100 km or farther, with average distance of 1349 km (range 238–2554 km). Average recovery time was 11.8 months (range 1–46 months) (Burnside 1987).

Arrival dates of Loggerhead Shrikes may vary in the panhandle of Nebraska (mid-March) from the rest of the state (mid-late February) (Sharpe et al. 2001). Loggerhead Shrikes begin departing Nebraska in October for their wintering grounds in Texas, Mexico, and Central America (Sharpe et al. 2001, Yosef 1996). During long migration of ~3,360 km (>2,000 mi) (Burnside 1987), an individual Loggerhead Shrike stops frequently to feed and rest and may remain in one area for a few days (Miller 1931, Yosef 1996).

Diet and Foraging

Loggerhead Shrikes feed on arthropods, amphibians, small to medium-sized reptiles, and small mammals and birds (Yosef 1996). They use their beaks to transport a relatively small food item and use their feet to carry a larger meal as heavy as individual body mass (Yosef 1993). They will also ingest carrion (Anderson 1976). They prefer to perch overlooking open areas in order to “sit and wait” while foraging (Yosef and Grubb 1994). It is more energetically efficient for shrikes to hunt in short vegetation (Brandl et al. 1986, Bohall-Wood 1987, Yosef and Grubb 1994). They frequently perch on fences and utility lines along roadways to search for prey (Yosef 1996). Beak design allows for caught animals to be dispatched efficiently with a bite to the back of the neck. Because Loggerhead Shrikes are predators, but also passerines lacking talons for holding prey during feeding, they have evolved the proficiency to impale their catches on natural and man-made sharp objects (Yosef 1996). Male shrikes may also impale and cache prey as part of a behavioral display to demonstrate fitness to potential mates (Yosef and Pinshow 1989). Young Loggerhead Shrikes learn to hunt vertebrate prey at ~40 days old (Smith 1973).

Reproduction

It is thought that both members of a pair search for their nest site and gather nesting material (Yosef 1996). The nest from the previous year (or plant) may be re-used for nesting (Burton 1990, Yosef 1996), or materials may be taken from the nest for new construction elsewhere (Yosef 1992, Woods 1994). Nesting can commence as early as late March but peak breeding occurs June–July (Sharpe et al. 2001). Over the course of 6–11 days (Graber et al. 1973, Kridelbaugh 1982), the female constructs the open cup nest in a tree or shrub, often

thorny, with adequate cover (Porter et al. 1975, Yosef 1996). The woven nest is lined with soft, natural material (e.g., grass, moss, hair, feathers, cloth) (Yosef 1996). Five oval eggs represent a typical clutch size (Novak 1989, Yosef 1996). Only the female, fed most meals by the male (Burton 1990, Yosef 1992, Woods 1994), incubates the eggs approximately 16 days (Miller 1931, Lohrer 1974, Porter et al. 1975). Hatching is asynchronous, completed within 48 hrs in most cases (Yosef 1996). Loggerhead Shrikes normally only nest once per season, but shrikes may construct up to two subsequent nests, particularly after failures, with new nests placed only a few hundred meters from the previous attempt (Atkinson 1901, Graber et al. 1973, Dechant et al. 2001). On average, Loggerhead Shrikes experience a high rate of nesting success (>80%) (as reviewed in Yosef 1986). In Ontario, Canada from 1991–1992, Loggerhead Shrikes hatched a mean of 4.2 and 5.4 eggs with a mean of <3 young surviving; nesting success of at least one fledgling was still 78–89% (Chabot et al. 2001). Nur and others (2004) estimated survival of nests (n = 137) to day 39: apparent nest success = 0.48 ± 0.043, Mayfield estimate (95% CI) = 0.41 (0.33–0.50), and Kaplan-Meier estimate (95% CI) = 0.40 (0.31–0.48) for 1995–1997 years pooled in north-central Oregon. An individual Loggerhead Shrike may live >11 years (Klimkiewicz et al. 1983).

Research and Conservation Strategies

A multitude of factors should be considered before implementing any conservation actions for species. Within the guidelines of state and federal law, the Nebraska Natural Legacy Project recommends: 1) consider, but do not limit options to, scenarios that benefit both the species of interest and property owners, 2) consider species dispersal and landscape context, 3) plan for multiple years, and 4) do no harm.

In Nebraska, conservation considerations should be made for Loggerhead Shrikes in several BULs: Central Loess Hills, Cherry County Wetlands, Dismal River Headwaters, Elkhorn River Headwaters, Keya Paha, Kimball Grasslands, Loess Canyons, Oglala Grasslands, Panhandle Prairies, Sandhills Alkaline Lakes, Sandsage Prairie, Sandstone Prairies, and Southeast Prairies. These landscapes offer the best opportunities for conservation of Loggerhead Shrikes within Nebraska based on current knowledge. Given the principal threats identified, conservation efforts for Loggerhead Shrikes (summarized in Table 1) may want to employ the following management strategies:

1. Because breeding habitat alone is likely not a limiting factor to Loggerhead Shrikes, habitat creation may achieve very little in increasing their populations. Rather, management efforts should be directed to any known 'hotspots' of activity for Loggerhead Shrikes (Fornes 2004). However, not all of this habitat should be along or within 15 m of roadways, because the nesting success of Loggerhead Shrikes may decline there (Esely and Bollinger 2001). Short grasslands within 300 m of nest sites have been found to offer suitable breeding territories (Esely and Bollinger 2001). Nesting success may increase when understory (ground cover and vegetation height) is low (Hellman 1994).

2. Management strategies in agricultural systems versus native grasslands versus semi-urban landscapes will vary. Chavez-Ramirez and others (1994) did not influence habitat use of Loggerhead Shrikes by mowing or manipulating perch availability in native grasslands of Texas; however, these strategies may be useful in agricultural or urban

landscapes. Inadvertently, one may increase predation of Loggerhead Shrikes by increasing perching that will be used by shrikes but also raptors (Chavez-Ramirez 1994).

3. Loggerhead Shrikes have been associated with big sagebrush (Humple and Holmes 2006); protection and restoration of big sagebrush habitats may benefit them. Establishing hawthorn may also benefit Loggerhead Shrikes because of documented positive associations with *Crataegus* species (Chabot et al. 1995, Dechant et al. 2001). Other beneficial plants for nesting, perching, and foraging include natives such as honey locust (*Gleditsia triacanthos*) (Kridelbaugh 1982), willow (*Salix* spp.), and buffaloberry (*Shepherdia* spp.) (Telfer 1992, Dechant et al. 2001). The allowance for some eastern redcedar (*Juniperus virginiana*) in low densities on the landscape can benefit nesting Loggerhead Shrikes (Kridelbaugh 1982, Gawlik and Bildstein 1990, Chabot et al. 1995).

4. Because Loggerhead Shrikes are associated with open areas offering some trees and shrubs, prescribed burning and grazing may be useful techniques to manage habitat for them. To prevent dense woody vegetation, burn patches while being careful not to eliminate all shrubs and trees (Hands et al. 1989, Poole 1992, Dechant et al. 2001). Loggerhead Shrikes appear to be more tolerant of pasture than row crops (Telfer 1992). Moderate haying and grazing showed potential in increasing productivity of Loggerhead Shrikes in Manitoba (Hellman 1994). However by leaving some patches of tall grass, land managers can offer refuge to small mammals (prey) for Loggerhead Shrikes (Collister 1994). Nesting and perching structures can be protected selectively from cattle grazing and rubbing (Yosef 1996).

5. Based on a project in Minnesota, Brooks and Temple (1990) found Loggerhead Shrikes to be well below carrying capacity. The fact that Loggerhead Shrikes were still declining despite plentiful breeding habitat, indicated that there may be a need to consider management options for the species outside its breeding range. A large portion of Loggerhead Shrikes overwinter along the Gulf coast in Texas, Louisiana, Mississippi, and Alabama (Root 1988).

6. Pesticide reductions may protect the invertebrate food source, as well as other prey, of Loggerhead Shrikes (Hands et al. 1989).

7. The infrastructure required for oil, gas, and wind developments can fragment wildlife habitat and affect many species. Potential negative effects on Loggerhead Shrikes have not been studied, but it is worthwhile to minimize these types of disturbances on this Tier I species (Knopf 1996, Sedgwick 2004). It is estimated that 82% of avian fatalities at wind turbines, excluding those in California, are of migratory passerines (Erickson et al. 2002). Applicable best management practices for prairie passerine interactions with wind development are available from the Colorado Renewables and Conservation Collaborative (CRCC 2010).

Information Gaps

The causes of the observed population decline of Loggerhead Shrikes are not clearly understood. A greater understanding of these primary threats would help determine conservation measures (e.g., habitat improvements) that can most positively impact the species (Schneider et al. 2011). Studies of habitat use, food resources, and the effects on Loggerhead

Shrikes from pesticides and grasshopper control measures may reveal the most important steps that can be taken for the species in Nebraska.

Considerations for Additional Species

At-risk species and other species (e.g., keystone species, indicator species) that share habitat with Loggerhead Shrikes should be considered in management plans. On-the-ground conservation for Loggerhead Shrikes may affect or be influenced by at-risk species that can be found in the same BULs as the shrikes. Because the range of Loggerhead Shrikes spans the entirety of the state, the list of additional at-risk species is not listed here. You can refer to Tier I at-risk species for each BUL of interest in the Nebraska Natural Legacy Project (Schneider et al. 2011).

TABLE 1. Summary of suggested management for Loggerhead Shrikes (LOSH) in Nebraska. The following are general guidelines based on the best available knowledge at the time of this publication. See Research and Conservation section of this document for more detail and Literature Cited section for sources of additional information.

FOCUS	STRATEGIES	MITIGATION and CONSIDERATIONS
Maintain existing habitat for LOSH	Work where they are known to occur. Short vegetation (with perching structures) within 300 m of nesting sites may be preferred if in agricultural systems.	LOSH are unlikely to benefit significantly from new habitat creation. It may not be wise to increase the number of perching structures in native grasslands because of a rise in predation risk.
Maintain and restore native sagebrush and thickets	Reduce invasives such as cheatgrass, and reduce fuel loads to decrease probability of catastrophic wildfires	LOSH are associated with native sagebrush, hawthorn, and thickets of plum and dogwood. Intense wildfires make conditions that reduce breeding habitat and nesting success.
Avoid grassland conversion to forest, but do not clear all trees in prairie restorations	Keep some woody vegetation and even a few eastern redcedars (ERC) in low density on the landscape.	While ERC can become a native invasive, the allowance of some isolated ERC on the landscape plays an important ecological role

TABLE 1. (Continued).

FOCUS	STRATEGIES	MITIGATION and CONSIDERATIONS
Maintain or improve nesting success of LOSH	Maintain or plant a patch of native willow (*Salix* spp.), buffaloberry (*Shepherdia* spp.), honey locust (*Gleditsia triacanthos*), or hawthorn (*Crataegus* spp.) in suitable areas per quarter-section (64.8 ha). Trim, mow, and keep understory low. Remove multiflora rose (*Rosa multiflora*); reduce understory (ground cover and vegetation height).	*R. multiflora* is inadequate in providing the structure necessary to consistently support nesting success of LOSH
Keep open habitat for LOSH	Use prescribed fire and grazing to limit growth of dense vegetation. Minimize development in important bird areas.	Work in patches, being careful NOT to eliminate all trees and shrubs. LOSH compete with development because open areas with some trees are prime areas for real estate and golf courses.
Habitat should not be limited to roadways or fencerows	Maintain open areas with short vegetation and suitable perching structure away from roadways	LOSH that nest along roadways experience reduced productivity. Predators of LOSH easily search fencerows.
Reduce the threat of WNV infection and mortality in LOSH	When WNV outbreaks are extreme, vaccinate (at least captive) LOSH in breeding facilities against the disease	LOSH (as carnivores of birds) are very vulnerable to contact transmission of WNV
Minimize development of energy infrastructure	Discourage oil, gas, and wind developments in hotspots for LOSH, especially in native prairies and major migration corridors	Prey of LOSH may be impacted also by energy infrastructure.

Acknowledgments

Craig Allen of the Nebraska Cooperative Fish and Wildlife Research Unit provided helpful information and suggestions that improved this document. Cathleen Fosler of the Nebraska Game and Parks Commission assisted in finding relevant literature.

Literature Cited

ALLEN, C. R., R. S. LUTZ, T. LOCKLEY, S. A. PHILLIPS, JR., AND S. DEMARAIS. 2001. The non-indigenous ant, *Solenopsis invicta*, reduces loggerhead shrike and native insect abundance. Journal of Agricultural and Urban Entomology 18:249–259.

ANDERSON, R. M. 1976. Shrikes feed on prey remains left by hawks. Condor 78:269.

ATKINSON, W. L. 1901. Nesting habitats of the California Shrike. Condor 3:9–11.

BELLAR, C. A. AND A. D. MACCARONE. 2002. The effects of prairie habitat loss and land-use changes on Loggerhead Shrike populations in Kansas. Transactions of the Kansas Academy of Science 105:51–65

BERTELSEN, M. F., R-A ØLBERG, G. J. CRAWSHAW, A. DIBERNARDO, L. R. LINDSAY, M. DREBOT, AND I. K. BARKER. 2004. West Nile Virus infection in the Eastern Loggerhead Shrike (*Lanius ludovicianus migrans*): pathology, epidemiology, and immunization. Journal of Wildlife Diseases 40:538–542.

BOAL, C. W., T. S. ESTABROOK, AND A. E. DUERR. Productivity and breeding habitat of Loggerhead Shrikes in a southwestern urban environment. The Southwestern Naturalist 48:557–562.

BOHALL-WOOD, P. 1987. Abundance, habitat use, and perch use of Loggerhead Shrikes in northcentral Florida. Wilson Bulletin 99:82–86.

BRANDL, R., W. LUBCKE, AND W. MANN. 1986. Habitat selection in the Red-backed Shrike. Journal of Ornithology 127:69–78.

BROOKS, B. L. AND S. A. TEMPLE. 1990. Habitat availability and suitability for Loggerhead Shrikes in the upper Midwest. American Midland Naturalist 123:75–83.

BURNSIDE, F. L. 1987. Long-distance movements by Loggerhead Shrikes. Journal of Field Ornithology 58:62–65.

BURTON, K. M. 1990. An investigation of population status and breeding biology of the Loggerhead Shrike (*Lanius ludovicianus*) in Indiana. Thesis. Indiana University Bloomington, USA.

CADE, T. J. AND C. P. WOODS. 1997. Changes in distribution and abundance of the Loggerhead Shrike. Conservation Biology 11:21–31.

CHABOT, A., R. D. TITMAN, AND D. D. BIRD. 1995. Habitat selection and breeding biology of Loggerhead Shrikes in eastern Ontario and Quebec. Pages 155-156 *in* Shrikes (Laniidae) of the world: biology and conservation (R. Yosef and F. E. Lohrer, Editors). Proceedings of the Western Foundation of Vertebrate Zoology, Volume 6.

CHABOT, A. A., D. M. BIRD, AND R. D. TITMAN. 2001. Breeding biology and nesting success of Loggerhead Shrikes in Ontario. Wilson Bulletin 113:285–289.

CHAVEZ-RAMIREZ, F. D. E. GAWLIK, F. G. PRIETO, AND R. D. SLACK. 1994. Effects of habitat structure on patch use by Loggerhead Shrikes wintering in a natural grassland. Condor 96:228–231.

COLLISTER, D. M. 1994. Breeding ecology and habitat preservation of the Loggerhead Shrike in southeastern Alberta. Thesis. University of Calgary, Alberta, Canada.

COLORADO RENEWABLES AND CONSERVATION COLLABORATIVE (CRCC). 2010. Best management practices: prairie passerines and other migratory birds. www.pljv.org/windandwildlife/co/bmp/BMP_Migratory_Bird.pdf (accessed 1 Jul 2012).

DECHANT, J. A., M. L. SONDREAL, D. H. JOHNSON, L. D. IGL, C. M. GOLDADE, M. P. NENNEMAN, A. L. ZIMMERMAN, AND B. EULISS. 2001. Effects of management practices on grassland birds: Loggerhead Shrike. Grasslands Ecosystem Initiative. Northern Prairie Wildlife Research Center, U. S. Geological Survey, Jamestown, ND 58401.

ERICKSON, W. P., G. D. JOHNSON, D. P. YOUNG JR., M. D. STRICKLAND, R. GOOD, M. BOURASSA, K. BAY, AND K. J. SERNKA. 2002. Synthesis and comparison of baseline avian and bat use, raptor nesting and mortality information from proposed and existing wind developments. Bonneville Power Administration, Portland, Oregon, USA.

ESELY JR., J. D. AND E. K. BOLLINGER. 2001. Habitat selection and reproductive success of Loggerhead Shrikes in northwest Missouri: a hierarchical approach. Wilson Bulletin 11:290–296.

FORNES, G. L. 2004. Habitat use by Loggerhead Shrikes (*Lanius Ludovicianus*) at Midewin National Tallgrass Prairie, Illinois: an application of Brooks and Temple's habitat suitability index. American Midland Naturalist 151:338–345.

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

GAWLIK, D. E. AND K. L. BILDSTEIN. 1993. Seasonal habitat use and abundance of Loggerhead Shrikes in South Carolina. Journal of Wildlife Management 57:352–357.

GRABER, R. R., J. W. GRABER, AND E. L. KIRK. 1973. Illinois birds: Laniidae. Illinois Natural History Survey Biological Notes 83:1–18.

HANDS, H. M., R. D. DROBNEY, AND M. R. RYAN. 1989. Status of the Loggerhead Shrike in the northcentral United States. U. S. Fish and Wildlife Service Cooperative Fish and Wildlife Research Unit, Columbia, Missouri, USA.

HELLMAN, S. L. 1994. Breeding habitat for the Loggerhead Shrike (*Lanius ludovicianus*) in southwestern Manitoba. Thesis. University of Manitoba, Winnipeg, Canada.

HERKERT, J. R. 2004. Organochlorine pesticides are not implicated in the decline of the Loggerhead Shrike. Condor 106:702–705.

HUMPLE, D. L. AND A. L. HOLMES. 2006. Effects of a fire on a breeding population of Loggerhead Shrikes in sagebrush steppe habitat. Journal of Field Ornithology 77:21–28.

KLIMKIEWICZ, M. K., R. B. CLAPP, AND A. G. FUTCHER. 1983. Longevity records of North American birds: Remizidae through Parulinae. Journal of Field Ornithology 54:287–294.

KRIDELBAUGH, A. L. 1982. An ecological study of Loggerhead Shrikes in central Missouri. Thesis. University of Missouri, Columbia, USA.

LOHRER, F. E. 1974. Post-hatching growth and development of the Loggerhead Shrike in Florida. Thesis. University of South Florida, Tampa, USA.

MILLER, A. H. 1931. Systemic revision and natural history of the American shrikes (*Lanius*). University of California Publications in Zoology 38:11–242.

MILLS, G. S. 1979. Foraging patterns of kestrels and shrikes and their relation to an optimal foraging. Dissertation. University of Arizona, Tucson, USA.

MORRIS, W., D. DOAK, M. GROOM, P. KARUEVA, J. FIEGERG, L. GERBER, P. MURPHY, AND D. THOMSON. 1999. A practical handbook for population viability analysis. The Nature Conservancy, Arlington, USA.

NATURESERVE. 2009. An online encyclopedia of life (Version 7.1). www.natureserve.org/explorer/index.htm (accessed 6 Jul 2012).

NOVAK, P. G. 1989. Breeding ecology and status of the Loggerhead Shrike in New York state. Thesis. Cornell University, Ithaca, USA.

NUR, N., A. L. HOLMES, AND G. R. GEUPEL. 2004. Use of survival time analysis to analyze nesting success in birds: an example using Loggerhead Shrikes. Condor 106:457–471.

POOLE, L. D. 1992. Reproductive success and nesting habitat of Loggerhead Shrikes in shrubsteppe communities. Thesis. Oregon State University, Corvallis, USA.

PORTER, D. K., M. A. STRONG, J. B. GIEZENTANNER, AND R. A. RYDER. 1975. Nest ecology, productivity, and growth of the Loggerhead Shrike on the shortgrass prairie. Southwestern Naturalist 19:429–436.

ROBBINS, M. B. AND D. A. EASTERLA. 1992. Birds of Missouri: their distribution and abundance. University of Missouri Press, Columbia, USA.

ROOT, T. 1988. Atlas of wintering North American birds: an analysis of Christmas Bird Count data. University of Chicago Press, Chicago, USA.
SAUER, J. R., J. E. HINES, J. E. FALLON, K. L. PARDIECK, D. J. ZIOLKOWSKI, JR., AND W. A. LINK. 2011. The North American Breeding Bird Survey, Results and Analysis 1966–2010. Version 12.07.2011USGS Patuxent Wildlife Research Center, Laurel, Maryland, USA.
SCHNEIDER, R., K. STONER, G. STEINAUER, M. PANELLA, AND M. HUMPERT. 2011. The Nebraska Natural Legacy Project: State Wildlife Action Plan. 2nd Edition. The Nebraska Game and Parks Commission, Lincoln, USA.
SHARPE, R. S., W.R. SILCOCK, AND J. G. JORGENSEN. 2001. Birds of Nebraska: their distribution and temporal occurrence. University of Nebraska Press, Lincoln, USA.
SIBLEY, D. A. 2000. The Sibley guide to birds. National Audubon Society. Chanticleer Press, Inc., New York, USA.
SMITH, S. M. 1973. Food manipulation by young passeriines and the possible evolutionary history of impaling by shrikes. Wilson Bulletin 85:318–322.
TELFER, E. S. 1992. Habitat change as a factor in the decline of the western Canadian Loggerhead Shrike, *Lanius ludovicianus*, population. Canadian Field-Naturalist 106:321–326.
WALK, J. W., E. L. KERSHNER, AND R. E. WARNER. 2006. Low nesting success of Loggerhead Shrikes in an agricultural landscape. Wilson Journal of Ornithology 118:70–74.
WOODS, C. P. 1994. The Loggerhead Shrike in southwest Idaho. Thesis. Boise State University, Boise, USA.
YOSEF, R. 1992. Territoriality, nutritional condition, and conservation in Loggerhead Shrikes (*Lanius ludovicianus*). Dissertation. The Ohio State University, Columbus, USA.
YOSEF, R. 1993. Prey transport by Loggerhead Shrikes. Condor 95:231–233.
YOSEF, R. 1994. The effects of fencelines on the reproductive success of Loggerhead Shrikes. Conservation Biology 8:281–285.
YOSEF, R. 1996. Loggerhead Shrike (*Lanius ludovicianus*). The birds of North America. Number 231.
YOSEF, R. AND M. A. DEYRUP. 1998. effects of fertilizer-induced reduction of invertebrates on reproductive success of Loggerhead Shrikes (*Lanius ludovicianus*). Journal of Field Ornithology 139:307–312.
YOSEF, R. AND T. GRUBB. 1994. Resource dependence and territory size in Loggerhead Shrikes (*Lanius ludovicianus*). Auk 111:465–469.
YOSEF, R. AND B. PINSHOW. 1989. Cache size in shrikes influences female mate choice and reproductive success. Auk 106:418–421.