SPECIES ASSESSMENT FOR LOGGERHEAD SHRIKE (*LANIUS LUDOVICIANUS*) IN WYOMING

prepared by

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Conservation Summary

The loggerhead shrike (*Lanius ludovicianus*) is widespread in North America, where it generally occurs in open habitats with abundant insect prey and perches for hunting. Examples of suitable habitat are grasslands, sagebrush, and a variety of shrub-steppe habitats. However, it has demonstrated a substantial contraction in distribution and declines in abundance throughout North America. The reasons for these declines are not fully known, although reduction in quality and quantity of native grassland and shrub-steppe communities is a major contributing factor, particularly on wintering grounds in the southern United States and Mexico. Other threats include livestock grazing (decreased prey availability and altered habitat structure), pesticide use (decreased prey availability and direct mortality) and invasive species (feral predators, non-native plants). Management in Wyoming should focus on habitat preservation and restoration, with an active monitoring effort and research to uncover the reason behind apparent population declines.

Natural History

Morphological Description

The Loggerhead Shrike (Fig. 1) is a predatory songbird that is dark blue-gray above and gray-white below depending on the subspecies (Hall and Legrand 2000). It has an overall length of between 8 and 10 inches, a wingspan of 12 to 13 inches, and generally weighs less than 1.7 ounces (48g) (Sibley 2000, Hall and Legrand 2000, Yosef 1996). It has a large, stocky head in proportion to its body (Sibley 2000), but still has slender legs and feet like other perching songbirds (Hall and Legrand 2000). It is gray above with a black facial mask (extending above the eyes and around the forehead), and has a pale breast (sometime with faint barring) and a white throat and rump (Sibley 2000, Yosef 1996). The wings, eye-mask, tail, bill, legs and feet are all black except for a white patch at the base of primary feathers on the wing and white on the tip and outer edges of the tail (Hall and Legrand 2000). The bill has a short hook and tomial teeth (notches on each side of the beak) which allows it to prey on vertebrate species (Winner 1995, Yosef 1996). Bill can become lighter colored at the base in fall and winter (Hall and Legrand 2000, Yosef 1996).

Given their wide range, color variation can be expected based on geography and subspecies. The back can be dark gray to pale gray. Birds with darker gray tend to have less white on the rump, uppertail coverts, scapulars and flanks. White in the tail tip and at base of primaries varies, as does bill size, tail length and wing length (Yosef 1996). The *L. l. Migrans* subspecies is paler above but grayer underneath than *L. l. ludovicianus* subspecies.

There is little sexual dimorphism, so both males and females look similar (Hall and Legrand 2000), although some report that females are slightly smaller and have browner primaries than males (Yosef 1996). Yosef (1996) suggests that females have a significantly higher wing chord to tail length ratio than males (Collister and Wicklum 1996), which can be used as part of the following equations to differentiate the sexes with 77.4% accuracy. To do this, place the measurements in both of the following equations; if $y_m > y_f$, the bird is a male, and if $y_f > y_m$, the bird is a female.

$$y_m = -896.673 + 72.72(WP) + 55.14(TL) + 1013.8(BD)$$

$$y_f = -841.070 + 69.01(WP) + 53.39(TL) + 991.1(BD)$$

where: WP = white on primaries from distal edge of basal white area to wrist
TP = tail length
BD = bill depth

Juveniles are lighter gray above and have faint gray barring on the breast (Sibley 2000, Hall and Legrand 2000). Eggs are smooth, oval, grayish buff, have dark colors (e.g., neutral gray to yellowish brown) on the large end (sometimes on small end also), and light-gray spots on layers beneath surface. Egg measurements are as follows: length = 23.16 - 26.81 mm; breadth = 17.86 - 19.85 mm; mass (fresh, whole egg) = 3.69-5.00g; mass (shell) = 0.219 - 0.280 g (Yosef 1996).

Loggerhead shrikes often perch with a horizontal body posture (Yosef 1996). They typically drop from perches and fly low over the ground, swooping upwards (and sometimes hovering) before landing on a new perch (Yosef 1996). Short flights are at low levels with fast wing beats and head held up (Hall and Legrand 2000, Yosef 1996), while long flights are more undulating with bursts of rapid beating (Yosef 1996).

Voice

Song includes a sharp, two-syllable phrase (*krrr-DI, JEE-uk,* or similar) repeated over short intervals. Calls are variable and may contain bits similar to song phrases interspersed with scolding notes (e.g., *jaaaaa* or *teeen raad raad raad raad*) (Sibley 2000). The calls of mated and unmated males are different; the mate-attracting spring song has more high, clear notes and fewer harsh screeches than territorial songs made once pair has been formed (Yosef 1996). Shrikes will ruffle head and body feathers and give a buzzing/clicking call when predators are detected (Yosef 1996).

Similar Species

The Loggerhead Shrike is commonly confused with the northern shrike (Fig. 2), whose ranges overlap in winter. In most cases during the breeding season the Northern Shrike does not overlap in location with the Loggerhead Shrike, as Northern Shrikes prefer colder areas and migrate further north for breeding (Hall and Legrand 2000). The two species can be distinguished by their size, shape, and patterning on the head and breast. Loggerhead Shrikes are smaller (25%); darker gray above; have a smaller white rump; broader black mask extending above eye and on forehead (northern shrike mask doesn't extend above bill and eyes); deeper black mask (never dusky or grayish as in northern shrike); usually has less barring on underside (Yosef 1996, Fraser and Luukkonen 1986). In winter the northern shrike has a paler lower mandible. In juvenile plumage the loggerhead shrike lacks the brown tones that are strong in the juvenile northern shrike's primaries and secondaries (Sibley 2000, Yosef 1996). Northern shrikes also have shorter wings and tail than the Northern Shrike (Sibley 2000), but this is difficult to distinguish in the field.

They are also sometimes confused with Northern Mockingbirds (*Mimus polyglottos*) (Winner 1995). The Northern Mockingbird lacks a black face mask, lacks contrasting black wings, lacks a hooked bill, lacks a rich gray color, and does not exhibit horizontal perching posture (Yosef 1996). Also, it has a smaller head in proportion to its body (Fraser and Luukkonen 1986).

Taxonomy and Distribution

Taxonomy

Eleven 11 subspecies of loggerhead shrike have been described, although those recognized have changed over time: 11 subspecies were initially described by Miller in 1931; 7 by Phillips in 1986 (including *L .l. miamensis* not originally described by Miller); and 9 by the American Ornithologists' Union in 1957 (excluding *L.l. mexicanus* since it is found outside the US and dropping Miller's *L. l. nevadensis* and Phillips' *L. l. miamensis*) (Yosef 1996). Most of these subspecies are western, *L. l. migrans* and *L. l. ludovicianus* being the only ones found east of the Mississippi River (Hall and Legrand 2000). *L. l. gambeli* is the only shrike to breed in Wyoming (Winner 1995). Although found irregularly throughout the state, it can be reliably found in the Lance Creek area of Niobrara County, in the shrub-steppe habitats roughly 10 miles northwest of Douglas, near Boysen Dam-Shoshoni in Fremont County, roughly 10-20 miles south of Buffalo along Highway 196, and around Flaming Gorge Reservoir in Sweetwater County (Dorn and Dorn 1999). Most Loggerhead Shrike migrate to southern states and Mexico in winter months (Winner 1995), but migration characteristics seem to differ by subspecies, much of which is unclear (Yosef 1996).

The complete list of currently recognized subspecies is as follows:

1. *L. l. Migrans* ranges from Alberta to New Brunswick and south to northern Mississippi (Hall and Legrand 2000). It is paler above but grayer underneath than *ludovicianus*.
2. *L. l. Ludovicianus* ranges from Virginia south to Florida, along the Atlantic shoreline, west to Louisiana along the Gulf Coast (Hall and Legrand 2000) and is resident from southern Louisiana to central North Carolina, south to central Florida east of the Appalacian Mountains (Yosef 1996). It is dark gray above, white below, with large bill.
3. *L. l. migrans* is an eastern/central species, found in southeastern Manitoba, east to the Maritime Provinces and south to eastern Texas, central Louisiana and western North Carolina and Virginia. Isolated populations occur in the western and northeastern lower peninsula of Michigan, southern Ontario and south-central Pennsylvania (although it no longer breeds in New England or the Maritime Provinces). It winters in the southern portion of its breeding range. *L. l. migrans* is medium gray above, and is different from *L. l. ludovicianus* by the wing being longer than the tail, the tail being washed with gray below, and the bill being smaller (Yosef 1996).
4. *L. l. Miamensis* is resident in southern Florida, but is not found in the Keys. It is the palest gray of any subspecies, and has more white on the scapulars and secondary-tips than *L.l. migrans* (Yosef 1996).
5. *L. l. excubitorides* breeds in southeastern Alberta and southern Saskatchewan south to central Texas, and from there west to northeastern Idaho, southeastern California, and western Texas. It winters in the southwestern U.S. as far north as Utah and Colorado and as far east as southern Louisiana and south to Sinaloa and Veracruz. It is pale gray above, has conspicuously white uppertail-coverts and scapulars, is whiter below than *L. i. migrans*

This subspecies combines *L. l. nevadensis* and *L. l. sonoriensis* originally described by Miller (Yosef 1996).

6. *L. l. gambeli* breeds from south-central Washington and southern Idaho, south to southwest California (but west of *L.l. excubitorides*), including Idaho, Montana, Wyoming, British Columbia and in the Pacific Coast states (Woods 1995a). It is a year-round resident south of north-central California, but the migratory winter range of other areas is not known. It is generally medium gray above, whitish on uppertail-coverts, chest often with undulations. Phillips included this subspecies with *L. l. migrans* under *L. l. mexicanus* (Yosef 1996).

7. *L. l. mexicanus* is resident in western Mexico from Nayarit and Coahuila south to central Oaxaca and the southern half of Baja. It is fairly dark gray above with white uppertail-coverts and flanks tinged gray. It is indistinguishable from Miller's (1931) *L. l. nelsoni* and therefore includes this formerly distinct subspecies (Yosef 1996).

8. *L. l. anthonyi* is only found on the Santa Rosa, Santa Cruz and Santa Catalina Islands off of southern California. It is dark gray above with scapulars, rump, uppertail-coverts and flanks grayish and a hairy forehead (Yosef 1996).

9. *L. l. mearnsi* is only found on San Clemente Island off the coast of California. There are substantial genetic differences between it and all the mainland subspecies (Yosef 1996). It is darker gray above than other subspecies, has white scapulars and uppertail-coverts, and is whiter below than *L. l. anthonyi*.. *L. l. mearnsi* has shown drastic declines in the 20th century and remains as an isolated and scarce population now listed as Endangered by USFWS (Yosef 1996).

10. *L. l. grinnelli* is resident from San Diego County, California south to north-central Baja. It is dark gray above with reduced white in the scapulars, rump, and uppertail-coverts. It has no white on the forehead or supercillium and less white on tail tips than other subspecies (Yosef 1996).

Distribution

As suggested above, the Loggerhead Shrike range is very large, extending from southern Canada to Mexico and from the Pacific to Atlantic coasts (Figs. 3, 4) (Hall and Legrand 2000), including all of Wyoming (Fig. 5). The breeding range in the United States is bordered to the north by the Blue Ridge Mountains, Cumberland Plateau, Great Lakes Plain, Driftless Area, and closed boreal forest. It is dissected by the Rocky Mountains, Cascade Mountains, southern Pacific forests and California foothills (Sauer et al. 1995) and is rare to absent over most of the northern and eastern portions of the coastal plain (Hall and Legrand 2000). Regionally, the range can be described as follows (Yosef 1996):

- *Western North America*: se. Alberta, w. Montana, nw. WY, s. Idaho, s-central Washington, e Oregon, California (not nw), **south to** s Baja California (up to 3,000m), Channel Is., Santa Rosa, Santa Catalina, Santa Cruz and San Clemente Islands.
- *Central North America*: s Saskatchewan, sw Manitoba, North Dakota (not ne corner), parts of s Minnesota, e Iowa, sw and se Missouri, n Arkansas **south to** Louisiana, Texas (not s-central), New Mexico, Arizona, and Mexico (south to n Sinaloa on Pacific slope and Oaxaca in interior, not found on Atlantic slope; found between elevations of 1,500-2,400m).
- *Eastern North America*: s Wisconsin, se Illinois, s Indiana, sw Ohio, e West Virginia, Virginia (not far east), North Carolina (not far east) **south to** Gulf Coast (not extreme southern Florida). Small remaining populations in w and ne lower peninsula of Michigan, s-central Penn, amd parts of s Ontario (3 isolated populations in s Ontario may be connected with limestone plains).

The brushlands and deserts of the southwestern and south-central U.S. may have been the Loggerhead Shrike's primary range, because it is still relatively abundant there (Fraser and Luukkonen 1986). Shrike range shows a remarkable association with the edges of physiographic strata (Sauer et al. 1995). Logically, it can therefore be assumed, since the shrike prefers open habitats, that it was rare in historic eastern North America and the mountainous West, which were primarily forested (Fraser and Luukkonen 1986). Further, the range probably expanded somewhat following European settlement as forests were cleared by settlers (Fraser and Luukkonen 1986) and was at its greatest extent around 1900 (Cade and Woods 1997).

The Atlantic slope of Mexico as well as most of southern Mexico, Bermuda, Guatemala, and Bahama represent solely wintering areas of the Loggerhead Shrike, while northern mexico and parts of the far southern United States are year-round residence areas. Most individuals winter south of 40^{o}N - 45^{o}N latitude (Morrison 1981, Sauer et al. 1995), which roughly cuts across the northern edge of the High Plains Border (Sauer et al. 1995). The central part of this winter range becomes more southerly depending on temperature and snowfall (Sauer et al. 1995).

Habitat Requirements

Breeding Habitat

Loggerhead shrikes are generally found in open country with scattered trees and large shrubs (Yosef 1996, Dorn and Dorn 1999), often at lower elevations relative to the surrounding topography (Hall and Legrand 2000). The most important habitat feature seems to be the presence of dense shrubs or trees for nesting with nearby open herbaceous areas for foraging (e.g., grasslands or pastures). It is the intermixing of these components in a mosaic that is consistently important to shrikes, and nests tend to be on the edge of patches, rather than in the middle of heavily wooded areas. This maximizes foraging efficiency for the adults (who forage in open areas and transport food to nests in wooded areas), as is evidenced by the fact that nests within 100m of pasture have been shown to be more successful than those farther away (Yosef 1996). Further, suitable breeding territories generally have many perches of varying heights; perch density is inversely related to territory size and positively related to nutritional condition (i.e., the more perches, the better chances for finding food and the smaller the territory has to be to support a successful nest) (Yosef 1996). Nests almost always occur in woody trees and shrubs, which are chosen more based on the degree of cover than on the tree or shrub species, with nest trees often being less than 6 meters tall (Yosef 1996). All else being equal, trees with thorns may be preferred for nest sites, possibly for increased protection, and trees with widely spread branches are sometimes avoided (Yosef 1996). If suitable trees/shrubs are lacking, Loggerhead Shrike may build nests in brush piles, tumbleweeds, or hardwood debris (Yosef 1996), but this is not common or preferred. Reproductive success has been shown to be higher on territories containing medium-height (9.1-18.0 cm) grass than on territories consisting of either shorter or taller grass (Yosef 1996), presumably due to insect availability and capture success.

Species of tree/shrub is not the main criteria for nest-site selection, so popular species for nest sites vary throughout the range of Loggerhead Shrike. They have commonly been documented nesting in hawthorns (New York), red cedar (Missouri, southern Illinois, Virginia, Alabama, South Carolina, Indiana, Minnesota and Oklahoma), osage orange (Alabama, Oklahoma), Russian olive (Colorado), sagebrush (Idaho), bitterbrush (Idaho), greasewood (Idaho), cabbage palms (Florida), and blackberry (Florida), hackberry (Oklahoma), chinese elm (Oklahoma) (Tyler 1992, Yosef 1996). The *L. l. mearnsi* subspecies has been shown to nest in shrubs more than 2 m tall, including lemonade berry, Catalina cherry, and Toyon (Yosef 1996). At least one study has suggested nests in red cedars fledge more young than nests in other tree species (Yosef 1996).

Under certain circumstances (see list below) suitable shrike habitat can included numerous anthropogenic features such as pastures with fencerows, old orchards, mowed roadsides, cemeteries, golf courses, agricultural fields and riparian areas (Yosef 1996). However, despite the prevalence of literature suggesting Loggerhead Shrike nest along man-made (and often linear) features such as hedgerows and fencelines, at least one study (Yosef 1994) suggests that such habitats are not necessarily optimal or even adequate nesting habitat. Rather, conversion to pasture increases linear habitats and reduces natural vegetation, forcing most tree and shrub nesting birds to use the only remaining habitat (i.e., fencelines and hedgerows). Such fencelines are travel corridors for predator species, thus increasing the predation frequency on nesting songbirds and decreasing nest success (Flickinger 1995, Yosef 1994). Moreover, if habitat away from such linear features as roads is similar to those near them, fewer shrikes are observed along roads (Flickinger 1995), suggesting that they prefer less "linearized" habitat.

A summary of results from numerous local studies is listed below, to give the reader a better sense of the similarity and variation of shrike breeding habitat across its range:

- In Washington, shrikes nested only in shrub-dominated plant communities (highest rates in mixed shrub, lowland sagebrush and bitterbrush communities) and were rare in grasslands, riparian zones, areas dominated by exotic plants, upland sagebrush, and rabbitbrush communities (Poole 1992). Nests were in: 46% in lowland sagebrush, 32% in mixed shrub, 15% in bitterbrush, 5% in upland sagebrush, 1% in upland mesic, and 1% in rabbitbrush/sagebrush; no shrikes were found in greasewood or riparian communities. Preferred habitats had greater interspersion of shrub patches and openings, including open grassland and sand dunes. Shrikes preferred areas of flat topography, deep soils, and relatively high horizontal and vertical structural diversity (occurs in late seral big sagebrush and bitterbrush communities that had been patchily burned. Densities seemed to be limited by scarcity of shrub patches (esp. in bitterbrush communities) and by the lack of openings (esp. in upland sagebrush).
- Of studied nests in Washington, 97% of nests were in shrubs, 2% in trees and 1% in wind-lodged tumbleweeds and vines (Poole 1992). Nesting shrikes preferred big sagebrush and antelope bitterbrush, used mock orange in proportion to its availability and avoided spiny hopsage, gray rabbitbrush and green rabbitbrush, although nesting success was independent of the species of nest shrub. Shrubs containing shrike nests were on average 178.4±2.2 cm taller than other shrubs, larger (more volume), had fewer main stems, and

were closer to an edge than were non-nest shrubs, although usually part of a continuous clump with other shrubs. The vicinity of the shrike nests had greater canopy cover of tall shrubs (big sagebrush; antelope bitterbrush; spiny hopsage, and mock orange), less annual grass cover, less gray rabbitbrush and dead bitterbrush, and taller shrubs than non-nest sites. Further, there was greater variability in the density and height of shrubs than on non-nest sites.

- In the short-grass prairie of north-central Colorado, Loggerhead Shrikes were observed nesting in the prairie where trees were only found in places like creek beds and homesites (Porter et al. 1975). Elms, willows, cottonwoods and Russian olive were used in 70% of all nesting attempts, while 10% were found in four-wing saltbush. However, as with other studies, nest sites seemed to be selected based on the degree of cover a plant provided, not the species. These Nests were bulky, woven from large twigs, had a well-defined cup of grasses, were often lined with cattle hair, and were generally placed about 2 meters meters above the ground within the periphery of the tree or shrub. Height of nests in trees ranged averaged 2.23 m above ground (range 0.92 - 7.52 m), while height in non-woody plants was somewhat less 2.03 m. If several acceptable nest sites were available, trees with thorns (Russian olive or honey locust) were used first (maybe because they provided more protection for the nest). Shrikes used suitable nest sites in grassland areas more frequently than in cultivated areas. There was frequent reuse of a previous year's nest site, although it is unknown if individuals came back to the same nest, and old black-billed magpie nests were sometimes used.
- Shrikes in southwest Idaho nested primarily in sagebrush, bitterbrush and greasewood (Woods 1993). In this study, degree of cover was not the main factor in deciding on a nesting site; many times birds chose open sagebrush even though greasewood shrubs (with superior cover) were available. Also, unlike in Washington (Poole 1992), greasewood was frequently used. The natal nest site did not seem to be a factor in adult nest site selection, because only one out of four banded nestlings used the same substrate as their natal nest (Woods 1993); although this is a very small sample size. Suitable habitat in Idaho is primarily in the Snake River Plain characterized by low elevation (< 1675 m) and effects of volcanic activity, with mountains along the perimeter (Woods 1995a). Another study in southwest Idaho (Woods and Cade 1996) found breeding to be a mix of sagebrush,

sometimes in large monotypic stands, with greasewood, bitterbrush, saltbush and rabbitbrush in lower elevations, and juniper and mountain mahogany in higher areas. Exotics, like cheatgrass (which can occur in large, shrubless tracts), replaced the native grasses in many cases. Shrikes nested in shrubs encompassing a wide range of sizes. Breeding territories usually contained many shrubs suitable for nesting; suggesting that variables broader than the nesting shrub/tree (e.g., abundance of foraging perches in an area) may be important in defining appropriate shrike habitat.

- In Minnesota, agricultural fields and pasturelands, historically tallgrass prairie and savannah, where used for nesting sites (Brooks and Temple 1990a). As with other studies, nest sites were frequently in trees that had shrubby or bushy growth and a variety of species were used: 44% in eastern red cedar trees, 21% in deciduous trees bearing thorns or spines (*Prunus americana, Crataegus* sp., *Elaeagnus angustifolia*), 12% in spruce trees (*Picea pungens* and *P. glauca*), and 23% in one of seven other tree species. Preference for edge was also shown in that 61% of nests were in isolated trees (with no overlapping canopies), 32% were in either a hedgerow or windbreak (only one tree wide), and only 7% were in a copse. Further, occupied sites seemed to have a larger grassland component (including pastureland) than random sites, and nest success (juvenile growth rate and fledging success rate) was positively related to the percentage of grassland near the nest. Shrikes seem to not only pick good nest shrubs, but also select areas that have high densities of such shrubs relative to the surrounding landscape. Also analogous to other studies, nest height was just over two meters above the ground (mean: 2.3 m; range: 1.0m-5.5m.

- In central Missouri, Loggerhead Shrikes were found in rolling agricultural areas with a mixture of row-crops, wheat, hayfields, pasturelands, woodlots and hedgerows. Nests were found in a variety of species including eastern red cedar (58%), multiflora rose (12%), honey locust (8%), and osage orange (7%), with occasional use of slippery elm, hawthorn, black cherry, scotch pine, and lombardy polar. The majority of nests (62%) were along fence lines or hedgerows, of which most were in pastureland (67%), followed by old fields (20%), urban areas (6%), hayfields (5%) and wheat fields (2%). This confirms other studies conclusions that dense nesting sites (e.g., cedars and thorny vegetation) in open grasslands (i.e., pastures) are important for breeding shrike.

- In Alberta, Canada, Loggerhead Shrike have been found mainly in shrubby areas consisting of thorny buffalo-berry (*Shepherdia argentea*) and willow (*Salix* sp.) interspersed with areas of grass and forbs (Collister and Henry 1995). Habitat was commonly found within 100m of an abandoned railway embankment where these shrubs are more prominent than in the surrounding cultivated land and pasture, from which it had been eliminated. The occurrence of cropland had no significant affect on occupied vs. unoccupied breeding territories. Unlike other studies, occupied territories had significantly lower proportions of overall grassland. However, they had higher levels of thorny buffalo-berry, higher mean height of herbaceous cover, higher mean height of grass and forbs and higher proportion of the territory containing grass ≥ 20 cm tall. The single best discriminate between occupied and unoccupied sites was the prevalence of tall grass.
- In the northern Chihuahuan Desert (southern New Mexico and Texas), shrikes were found in open, shrub dominated areas with common plants being creosote bush, Torrey yucca and honey mesquite (Reid and Fulbright 1981).
- In North Carolina, shrike were often found in shrubby pastures or fields from late March to June (Hall and Legrand 2000).
- In Indiana, Loggerhead Shrike occurs only in the south-central portion, where Amish farmers retain hedgerows and do not use pesticides on crops (Yosef 1996).
- In South Carolina, shrikes used disturbed grassy habitats during the breeding season (Gawlik and Bildstein 1993). The height of the shrub/tree in which nests occur and the presence of canopy cover were found to be important for Loggerhead Shrikes (Yosef 1996).
- Shrike locations in Illinois most frequently contained ungrazed pasture, hedgerows, cornfields and residential houses and buildings with well kept yards (Smith and Kruse 1992). Shrike locations were negatively related to the percent of harvested cropland and total woodland, but positively related to the percent of hay and alfalfa and cover crops. Most successful nests in Illinois were above 3 m in conifers, were within 100m of

occupied buildings, high-lines and impaling sites, and were in areas containing at least 50% short grass cover used for foraging (Lane and Hunt).

- Shrikes in Kansas were significantly associated with savannah habitat (more than 15 shrubs or trees in 250m radius circle), but did not contain continuous wooded riparian habitat (Michaels and Cully 1998).
- In Ontario, hawthorn, red cedar, white cedar, buckthorn and ash were used for nest sites (Chabot et al. 2001, Chabot et al. 1995). Breeding areas often consist of unimproved pasture over shallow soils with sparse ground cover and scattered trees, shrubs, thickets, and hedgerows, and active nests may be associated with cattle grazing, which maintains low ground cover (Cuddy 1995). One study found that 83% of nests observed were in isolated trees and only 13% were in hedgerows, while 86% of breeding sites were in pastures of various grazing levels (Chabot et al. 2001), suggesting that optimal breeding habitat in Ontario may include a mix of short and tall grass, which grazers can create by having short grass where they graze and tall tufts were the droppings are. Further, grazed areas could be suitable because they do not receive pesticide applications like farmlands and therefore have a higher abundance of insects. No evidence found that shrikes tended to nest close to roads; on average the distance to the nearest road was well over 100 m.

Foraging Habitat

Loggerhead shrikes forage in a variety of habitats that are slightly different than nesting habitat, which further stresses the need for a habitat mosaic (see the preceding section and that on *Landscape Pattern*, below). In general, foraging habitat is more open than nesting habitat and has a variety of high perches from which shrikes can hunt (see the following section on *Roosts and Perches*). More specifically, these habitats consist of low vegetation (e.g., short to medium grasses, forbs or bare ground) with interspersed shrubs or short trees, including areas often described as scrub lands, steppes, deserts, savannas, prairies, agricultural lands (esp. pastures and meadows), and some suburban areas (Yosef 1996). They may use roadways as foraging sites, due to the clear view and many possible perches (e.g., utility lines and poles), that such locations provide (Yosef 1996), although no information is available on the foraging success along roads. Studies show that shrikes hunt well over pastures (which mimic natural grasslands), but do not do well over cropland, which is cut regularly and doused with chemicals (Graham 1993).

Some specific study results are reported below:

- In Alberta, during breeding season Loggerhead Shrike foraged in grasslands of medium (15-35 cm) and tall (>35 cm) height more often than other types (Yosef 1996). Another Alberta study found that tall grass was more important to shrikes than shorter grass, which the authors hypothesize was due the taller grass having higher insect density than short grass (Prescott and Collister 1993). These results contrast with several other studies, some presented here, recognizing the importance of short (< 9 cm) and medium-height (9.1 - 18 cm) grasses, presumably because detection and capture of insects is higher in short grass. Coincidentally, most areas of short grass in the Alberta study area were the result of heavy grazing by cattle, somewhat confounding the grass-height issue because birds also appeared to forage most frequently in areas where the grass was relatively undisturbed; this also contradicts previous studies where shrikes appeared to prefer grazed areas. The authors suggest shrike choice of forage area is thus driven more by availability of prey, and that this is not solely a function of grass height; heavily grazed areas often have fewer insects than comparable areas of moderate grazing intensity.
- Yosef and Grubb (1993) found extensive use of Bahia grass (*Paspalum notatum*) pasture for foraging in Florida (Yosef and Grubb 1993). A controlled experiment in this environment wherein some pastures were mowed suggested the height of vegetation did not limit prey capture, but it increased the amount of time spent in flight, much of which was energy-intensive hovering. It seemed that shrikes caught comparable levels of food in both vegetation types, but their metabolic expenditure was higher in tall vegetation; thus, their net energy gain was probably lower in tall vegetation than in short vegetation. This suggests that shrikes incurred greater hunting costs when territories were not mowed.

- In coastal Texas, Chavez-Ramirez et al. (1994) found grasslands (dominated by marshhay cordgrass, gulfdune paspalum, and seacoast bluestem) with scattered woody vegetation (usually mesquite and false willow) to be the primary foraging habitats used by shrikes in their winter range Chavez-Ramirez et al. 1994). Shrikes did not show differential use of mowed vs. not mowed patches in natural grasslands (i.e., lands maintained through processes such as fire and low-intensity grazing).
- In South Carolina, most foraging occurs in coastal sagebrush scrub (Yosef 1996), but other habitat types are also used. Gawlik and Bildstein (1993), observed that shrikes were perched over undisturbed grass more than other habitat types and areas of tall, dense vegetation were avoided (Gawlik and Bildstein 1993). Use of disturbed grasses (e.g., residential lawns, hay fields, and grazed pastures) was found to be highest in spring, while cropland (cultivated fields that contained crops or were plowed in preparation for planting) was used more during autumn. This shift from grassy areas in the breeding season to croplands in the non-breeding season may be attributed to the seasonal shift in food availability.
- In Florida, Grubb and Yosef (1994) found shrike populations to be densest in pastures, which suggests that short grass combined with abundant fence-post hunting perches may provide suitable foraging habitat (Grubb and Yosef 1994). Further, shrikes captured in pastures had excellent feather growth compared to those in citrus groves, which the authors hypothesize may be due to the reduction of insect prey and/or bioaccumulation of toxins from regular pesticide application in citrus groves.In the eastern US, shrike territories seem to have more pasture land and greater amounts of fences, utility wires, water sources, and right-of-ways and less land in old fields than expected (Yosef 1996). Further, territories located in areas of permanent pasture were more likely to be reoccupied the next year than territories in areas where pastures lay idle and grasses grew tall by the end of the summer.
- In Kansas, shrikes were found in native tall-grass prairie and preferred sites with lower total vegetation cover, lower litter cover, more bare ground, taller vegetation, standing dead vegetation and deeper litter than random sites (Michaels and Cully 1998). They suggest that native prairie is structurally more heterogeneous than pastureland and thus better meets these preferences; it has tall vegetation (for perches and insect diversity)

interspersed with areas of bare ground, which together provides shrikes with adequate foraging habitat at the fine-scale.

Roosts and Perches

Loggerhead shrikes are diurnal hunters (see *Movement and Activity* below), so there are two important perching types: diurnal foraging perches and nocturnal "resting" roosts. Both types are repeatedly used by individuals.

Not much data is available on selection and importance of night roosts. Shrikes reach night roosts about 1 hour after sundown and leave them about 40 min before sunrise (Yosef 1996). Roosts are generally above ground level, in tall, dense, live shrubs, within a screen of overhanging limbs, and are often marked by large fecal deposits (Yosef 1996, Poole 1992). When juveniles are still young (i.e., pre-fledgling), parental roosts tend to be in the nest tree (Yosef 1996). In Washington, roosting shrikes preferred live bitterbrush, but also used live sagebrush and dead bitterbrush, and avoided everything else (Poole 1992). Mean shrub height for roosting was 210.4 ± 6.2 cm, which was taller than the mean shrub height for the area.

Shrikes search for prey from high vantage points, from which they swoop directly into hunting attacks, making perches of varying heights critical habitat components (Winner 1995, Yosef 1996). Perches of varying heights are important to allow hunting of a wider size range of prey; as perch height increases, average size of prey caught increases (i.e., shrike cannot see smaller prey items from high perches) (Yosef 1996). Perch density on agricultural lands is inversely related to territory size and positively related to nutritional condition (i.e., the more perches, the better chances for finding food, the smaller the territory has to be to support the bird). Such perches can take a variety of forms, both natural (e.g., shrubs, trees, stumps) and artificial (e.g., fence lines, utility lines, utility poles) and are generally more exposed than night roosts (Yosef 1996). Studies have suggested that habitat offering more abundant and evenly distributed perches is more suitable than habitat with scattered or clumped perches (Chabot et al. 2001). Yosef and Grubb (1994) added perches to areas of shrike territory within a cattle ranch that was not previously used for hunting. Following the addition of perches, territory size becoming significantly smaller and new pairs settled into areas vacated by existing shrikes (Yosef and Grubb 1994), suggesting perches were the limiting factor in habitat suitability.

Some additional research on foraging perches is noted below:

- Shrikes in tallgrass prairie habitat in Kansas were often seen perching on woody vegetation, prairie grasses and forbs at heights from 0.5-2 m (Michaels and Cully 1998). This suggests that the heterogeneity of tallgrass prairie provides perching and foraging substrates in addition to woody vegetation, which contrasts with the homogeneous nature of pastureland.
- In coastal Texas, perches are seen as a necessary habitat component of shrikes foraging areas, and density of elevated perches directly reflects territory quality Chavez-Ramirez et al. 1994). In natural grasslands (i.e., lands maintained through processes such as fire and low-intensity grazing) shrikes used abundant non-woody perch structures (e.g., sunflowers, partridge pea and sesbania) more than other substrates. In agricultural systems (i.e., crop cultivation, intensive grazing, lawns, roadsides, hayfields), hunting perches used by shrikes were primarily fence posts, utility lines and woody vegetation located in strips near the edge of fields. Data suggested shrikes may limit their use of foraging substrate to within 10 m of elevated perches, making much potential foraging substrate in areas of low perch density unusable. This demonstrates the value of "natural grasslands," which generally have non-woody perches distributed evenly throughout and high vegetation diversity, thus allowing shrikes to use a high proportion of the vegetation as foraging habitat. This contrasts with agricultural habitats where perches tend to be concentrated on patch edges.
- In Texas and southern New Mexico, Torrey yucca was commonly used for impaling their prey once captured (see *Food Habits*, below) (Reid and Fulbright 1981).

- In Washington, shrikes preferred bitterbrush and dead sagebrush for hunting perches, but also used live sagebrush and avoided rabbitbrush (Poole 1992). The mean shrub height in for perching was reported as 168.3 ± 4.2 cm, which was taller than mean shrub height for area.
- In Florida, Loggerhead Shrike seemed to use perches that were less than 5.5 m above ground (Yosef 1996).
- In Utah, shrike were reported hunting and storing food in large greasewood shrubs (Grant et al. 1991).
- In South Carolina, Gawlik and Bildstein (1993) observed that Loggerhead Shrike perched mostly on utility lines during summer months, but in winter would use trees and shrubs more, but they suggested this may have been a sampling bias, because shrikes in trees were easier to see in winter (Gawlik and Bildstein 1993).

Area Requirements

Loggerhead Shrike are highly territorial, with a pair defending a territory for the whole breeding season and, in some areas (e.g., Florida, South Carolina) maintaining a breeding territory throughout year (Yosef 1996). In other areas where shrikes are resident year-round (e.g., California) pairs break apart and defend separate winter territories, often adjacent to each other, which may be due to lack of sufficient food in old breeding territory in winter.

Yosef (1996) summarized mean estimates of territory size from around North America as ranging from roughly 4.6 hectares to over 30 hectares, as follows: Alberta = 13.4 ha (range 6.5 - 23.5), South Carolina Islands = 34 ha, Missouri = 4.6 ha, New York = 7.5 ha (range 5.7 - 9.3), Florida = 8.35 ha (range 5.3 - 9.6), California = 8.5 (range 4.4-16), southern Idaho = 8.9 or 25 (2 different areas). A similar metric often used in area requirement discussions is the distance between adjacent nests, some reports of which are as follows: 800 m in Nevada, 400 m in Colorado, 160 m in Alabama, 37 m in Indiana, and 80 - 200 m in Alberta. Both of these metrics demonstrate a fair amount of variation with no apparent trend with geography, suggesting that range limits *per se* do not seem to be a predictor of territory size. Rather, territory size seems to be roughly correlated with fine-scale habitat quality, where high-quality habitat results in smaller territory sizes, and therefore a greater density of nests.

Habitat quality, as it effects territory size, is determined by several factors (see *Habitat Requirements*, above), primarily relating to insect availability, foraging perch abundance and distribution, and presence of suitable nesting sites. Perches in particular seem to be an important determinant of territory size. Potential foraging sites can be considered a concentric circle centered on a perch, the radius of which is a function of perch height, vegetation height, and plant density (Yosef and Grubb 1994), likely extending less than 10 m from a suitable perch. Perch density (at least on agricultural lands) is inversely related to territory size and positively related to nutritional condition of the resident birds (i.e., the more perches, the better chances for finding food, the smaller the territory has to be to support the bird). Therefore, territories that are sparsely vegetated are usually larger. For example, birds in dunes have territories 2 - 3 times larger than birds in moderately wooded sites (Yosef 1996) and addition of perches to formerly unused foraging habitat within existing territories resulted in a reduction in territory size and an increased density of nesting pairs (Yosef and Grubb 1994). Moreover, it seems that shrikes may use the dispersion of trees as an indicator of habitat quality when selecting territories.

Results of some specific studies are listed below:

- In Idaho, Nest density was 1 pair per 8.9 ha in an isolated 89 ha stand of sagebrush and bitterbrush, with an average nearest neighbor distance of 203 m (Woods 1995a). In the same general area, nest density was 1 pair per 25 ha in a rugged 475 ha bowl of sagebrush and the average nearest neighbor distance larger (328 m) (Woods 1995a). This difference was attributed to habitat characteristics, since the site with smaller territories had larger mean shrub height. Further, this study found that shrikes usually nested in proximity to other shrikes, even in large areas of sagebrush, which may offer additional awareness of nearby predators and/or increase the ability of individual shrike to find mates.

- Alberta has no seasonal difference in territory size (Yosef 1996). Those shrike documented breeding in Alberta generally nest within 150 - 200 m of each other, which roughly corresponds to 200 m in diameter around the nesting location, but have been documented down to 50 meters apart (Prescott and Collister 1993).
- Florida also has no seasonal territory variation, and territories were shown to be 5.3 - 9.6 ha (range 5.3 - 9.6).

Landscape Pattern

As suggested in the previous sections on habitat use, the interspersion of habitat features at fine and meso-scales is just as important as the features themselves. At the very least, suitable territories for breeding shrikes must include several hectares of quality foraging habitat with distributed perches in proximity to woody vegetation for nest sites (Yosef and Grubb 1994). Further, there must be sufficient contiguous territories for shrikes to reliably find mates (Woods 1995a). Among other results, the above noted studies found:

- Structurally heterogeneous natural tall-grass prairie habitat in Kansas provided better perching and foraging substrate than homogeneous pastureland (Michaels and Cully 1998).
- Shrikes are usually associated with landscapes characterized by spaced shrubs and low trees, usually interspersed with short grasses, forbs, and bare ground (Cade and Woods 1997), with used habitats including suitable nesting shrubs/trees and hunting perches interspersed over a grassy/herbaceous ground cover with some bare areas.
- Preferred habitat consists of a mosaic of relatively small habitat patches with non-woody perches distributed evenly throughout (rather than concentrated on edges, as in agricultural fields) and high vegetation diversity allows shrikes to use a high proportion of the vegetation as foraging habitat (Gawlik and Bildstein 1993).

- All else being equal, fewer shrikes were documented using linear, corridor habitat (e.g., along roads and fencerows) than in heterogeneous, nonlinear habitat far from roads (Flickinger 1995), where predation frequency in increased and nest success is decreased (Yosef 1994).
- Based on perch availability, hedgerow habitat or habitat with just a few isolated trees appears less suitable than habitat with scattered trees and shrubs (Chabot et al. 2001).

Movement and Activity Patterns

Migration

Loggerhead shrike migration is not well understood. Northern populations are generally migratory, breeding in the north and moving southern states and Mexico during winter (Winner 1995, Yosef 1996). All shrike in Wyoming are migratory, as well as those in northern California, northern Nevada, northern Utah, central Colorado, Kansas, Missouri, and eastern populations roughly north of Kentucky (Yosef 1996). Other areas in the southern United States are have year-round residents, which are supplemented in winter by migrant arrivals. Shrikes are only present in Atlantic slope of Mexico, southern Mexico, Bermuda, Guatemala, and Bahama during winter (see *Distribution* and Fig. 3) (Yosef 1996). CBC data suggest that the highest concentrations of wintering Loggerhead Shrike are found in the gulf coast states (Texas, Louisiana, Mississippi, and Alabama) (Brooks and Temple 1990b).

It is not known what triggers migration; possibly food availability since in years of high vole abundance they have been known to stay in northern Utah and southern Idaho. It seems that shrike from with >10 days of snow cover for the year will migrate (Yosef 1996). Shrike are found year-round in Hanford, Washington; but most are migratory, arriving by March and departing by September (Poole 1992).

Birds migrate individually and diurnally, moving short distances and feeding en route, sometimes remaining in an area for a few days to feed (Yosef 1996). Mortality during migration is unknown. Distances traveled vary greatly, up to 3,360 km for *L. l. excubitorides* traveling from the northern Prairie Provinces to Texas or Mexico (Yosef 1996). It is not known where specific populations of western migrating shrike spend the winter, although it appears that populations east of Rockies migrate mostly to southeastern states, while those in Alberta and Saskatchewan migrate to southern Texas and Mexico (Yosef 1996). *L. l. excubitorides* have been found wintering in southern Mexico with resident *L. l. mexicanus* and in south Texas with resident *L. l. excubitorides*, but never in Arkansas or Louisiana suggesting there is no eastward component to migration.

Fall migration occurs from September through November, with the following local times reported:

- Oregon: return in March, leave by late September (few stay till November).
- Kansas: return in early March, leave by late November.
- Minnesota: arrive mid-march to late April and leave in August through late October.
- Ohio: arrive mid March to late April and leave late July through late September.
- Massachusetts: arrive in April and leave from late August to early October.

<u>Activity Patterns</u>

Loggerhead Shrikes are largely diurnal. They typically forage during the morning hours, particularly in hot environments (e.g., Florida), but as days get shorter and colder an increasing amount of time is spent hunting later in the day. This shift is probably due to decreases in prey activity that necessitate longer bouts of foraging to obtain the same nutritional intake (Yosef 1996). As much as 80% of the time shrikes are perching (i.e., looking for prey, handling prey, resting, preening) (Yosef 1996). Although most daylight hours are spent hunting, Morrison (1980) found 15% were spent in non-hunting activities, which is likely larger during breeding season when defending territories, attracting mates, and constructing nests. About 2 hours per 24hour period are spend preening; more during molting (Yosef 1996). Singing most frequently occurs when it is sunny out in the morning.

Shrikes roost during the night, usually from about 1 hour after sunset to 40 minutes before sunrise. During this time their metabolic rate lowers and body temperature decreases by about 2.3ºC. However, they are still alert and easily disturbed while roosting, readily flying in darkness if alarmed.

There is some difference in activity between the sexes. Males typically impale and cache more prey items, particularly early in the breeding season when pair bonds are forming (see *Breeding Behavior*, below) (Winner 1995, Yosef and Pinshow 1989). Females incubate the eggs, while males spend more time foraging and make more feeding trips to the nest (Kridelbaugh 1983, Hall and Legrand 2000). Males also provide most of the post-fledgling care. Females often abandon the nesting site find another mate before fledglings are independent (Hall and Legrand 2000, Kridelbaugh 1983), which is more evident in areas where multiple-brooding is common. Males spend more time calling and singing to attract mates, defend territory, and warn against predators, which likely makes them more susceptible to predation.

Dispersal

Patterns of natal dispersal of Loggerhead Shrike is virtually unknown. In one study, only four of 171 shrikes banded as nestlings were found the following year and of those four 3 bred within 5 km of their natal site (Woods 1995a). Adult males are more faithful to territories than females, often returning to the same breeding site in subsequent years (Haas and Sloane 1989, Kridelbaugh 1983), suggesting that dispersal may be different among the sexes.

Reproduction and Survivorship

Breeding Phenology

Shrikes are one of the earliest nesting passerines (Kridelbaugh 1983). Experienced adult males were the first to arrive and establish territories and later led females to potential nest-sites (Kridelbaugh 1983). Given their wide range, the timing of Loggerhead Shrike breeding varies geographically, with nesting seasons at higher latitudes and elevations being shorter and later (Yosef 1996).

1. **Migratory Arrival:** Adult males arrive at breeding grounds as early as the begging of February across their range, with earliest dates usually being in the south and at low elevations.
2. **Territory Formation - Pair Bonding:** Pairing and territory formation begins with the arrival of females, from mid-February through March and can extend through May.
3. **Nest Construction - Egg Laying**: Nests are usually begun by early April and take 6-12 days to complete, after which egg-laying occurs. Nest initiation can continue sporadically through early June, particularly if pairs are re-nesting after a failed attempt. If second broods occur, there is 1-3 weeks between first brood and first egg of second brood (Yosef 1996).
4. **Incubation - Hatching**: Incubation commences when the final egg of the clutch is laid, usually in early May. Incubation lasts 15 - 20 days (Tyler 1992, Hall and Legrand 2000, Porter et al. 1975, Kridelbaugh 1983, Chabot et al. 1995) and eggs usually hatch within 48 hours of each other, but sometimes up to 60-70 hours apart. Thus, hatching is generally complete by late May or early June, with late clutches possibly taking until July.
5. **Fledging - Independence:** Young stay in the next for 16 -20 days after hatching and reach independence about 4 weeks after fledging, which equates to roughly mid-August.

Regional specifics are noted below:

- In the southeast, (e.g., South Carolina) mating begins in February or March (Hall and Legrand 2000). Incubation is 16-20 days (avg.=17). Peak egg laying in North Carolina is in April. In NC migratory pops head north in April and May, and return in late summer or early fall. Fledging takes place after 17-21 days (avg=19.1). Post-fledging dependency lasts 3-4 weeks. Year-long resident birds may remain paired during the winter to keep reproductive cycles synchronized and allow them to nest in early spring (Yosef 1996).
- In southwest (e.g., Oklahoma): pairing took place late-Feb to mid-March, eggs laid from mid-March to early-May, incubation took 16/17 days, and time to fledging was 16/17 days (Tyler 1992). From the time of initial nest construction until the last fledglings were on their own averaged 11 weeks in Oklahoma (Yosef 1996).
- In the midwest (e.g., Missouri, Ontario): Establishes territories mid-Februrary to mid-March; completes nest march to early June with most nests started in late April in Missouri (similar dates for central Illinois, Virginia, Oklahoma and Iowa) (Yosef 1996). In Ontario, shrikes were first seen on breeding territories during the last week of April or first week of May: egg-laying was initiated soon after (Chabot et al. 1995).
- In the west (e.g., Colorado, Montana): Shrikes began arriving the first week of April (Porter et al. 1975), but males began arriving in mid-February in parts of Montana (Kridelbaugh 1983). Colorado males established and defended territories by the first of May. North-central Colorado birds mostly start nests in late May, while in Montana peak nest initiation occurred during late April, with a second peak in late May (although complete nests have been found from March 23 - June 12). Egg laying was initiated in the first week of May, peaking in the third week of May. Pairs which lost their first nest would usually renest; renesters began laying eggs as late as the third week in June (usually with smaller clutches). Incubation lasted 16 days and fledging time was 17 days after hatching. In Montana, all breeding birds and young had left their breeding area by June 30th except for those that were renesting: those renesting had left by July 31.
- In the northwest (e.g., Washington): Peak number of adults in Washington was during May; peak number of juveniles in July (Poole 1992). Shrikes initiated nesting in March and egg laying started in late March. Clutch initiation in 1988 peaked during early May

with a second peak in mid-June; in 1989 there was a single peak in mid-April; last clutches were initiated by mid-July. Fledgling shrikes were first seen on May 6th (1988) and May 7th (1989).

Breeding Behavior

The Loggerhead Shrike is primarily monogamous, but polygyny has occasionally been reported (Yosef 1996). Most vocalizations are associated with breeding and nest defense; much less vocal in other seasons. Loggerhead Shrike are highly territorial during breeding season (see *Habitat Requirements*, especially the sub-section on *Area Requirements*, above) (Hall and Legrand 2000), although in some areas year-round residents may maintain breeding territory throughout year.

Males attract mates through song and maintenance of large food caches (Yosef and Pinshow 1989). Caches will often include colorful inedible items (e.g., string, cellophane), presumably to increase the attractiveness the cache to possible mates (Winner 1995). Males with more prey in their cache have been shown to attract more females, and their mates laid more eggs and subsequently fledged more young (Goodman 2000). Males with artificially enhanced caches seemed to pair before control males, and males which were deprived of their caches failed to pair (Yosef and Pinshow 1989). Cache size of male shrikes increased prior to the breeding season, peaked when nests were completed and eggs laid, and declined sharply when eggs hatched (Yosef and Pinshow 1989).

Song includes short trills and clear notes in varied combination, tone and volume, usually repeating the same song every few seconds (see *Voice*, above) (Yosef 1996). Males may also execute a display mimicking impaling prey in order to drive away rivals and to court females (Sloane 1991). This is followed by courtship displays where the male feeds the female and performs a bowing dance, and song and sometimes flight displays about 7 m from the female. The female will accept prey from male when she is ready to copulate, holding the food and lowering her upper body (Woods 1995b).

The calls of males shift toward territorial defense once pair bonds have been formed. The mate-attracting spring song has more high, clear notes and fewer harsh screeches than territorial songs (Yosef 1996). Both males and females will give territorial warnings consisting of 4 - 10 harsh screeches (Yosef 1996). At this time, groups of neighboring shrikes may gather at the margins of territories and call/dance for each other, which is thought to help establish pairs, reduce aggression, define territories, and show where open territories are (Cade and Woods 1997). They may fight other birds to establish territory, but marinating boundaries is usually done solely with vocalizations. Encounters with intruders involve a bowing, flutter display (i.e., body horizontal, wings droop and flutter rapidly, fluff back feathers, lower head, pecks ground, spread tail and gives a harsh call) and stamping. They will face away from each other and whirl to face each other and start the bowing again. If one bird does not retreat, there can be brief fighting involving loud, rasping calls, feet grappling, and occasionally biting.

Nests are often build one or two meters above the ground and the exact sites seem to be selected based on structural aspects of cover, not the species of vegetation *per se* (see section on *Breeding Habitat*, above). Nests may be reused from year-to-year, but it is more common for the old nest to be dismantled and the materials used in a new nest nearby. Both sexes gather nest material, but female will generally construct the nest, taking 6 to 12 days to complete the project (Fraser and Luukkonen 1986, Kridelbaugh 1983). Size is variable, but nests are roughly 150 mm outside diameter, 100 mm inside diameter, and 75 mm deep. In general, nests are tightly woven, bulky, open cups lined with soft material (Yosef 1996). Nest materials are usually large pieces of vegetation (e.g., rootlets, twigs, forbs, and bark) and nest lining is highly variable (e.g., flowers, annuals, lichens, grasses, moss, feathers, fur, cattle hair, string, cloth) (Brooks and Temple 1990a, Porter et al. 1975), but shrike are able to alter nest-building behavior to fit the environment. Nests are usually very well insulated with low thermal loss; a possible adaptation to cool, wet weather (Yosef 1996). When re-nesting occurred in the same season (e.g., due to nest failure or pre-breeding disturbance), shrikes generally tend to nest higher off the ground on their second attempt (Woods and Cade 1996, Kridelbaugh 1983).

Eggs are laid one-per-day over the course of a week (clutch size 5-6 eggs, see *Fecundity and Survivorship*, below) and incubation begins with last egg laid (sometimes with second to last). Females incubate the eggs and males forage, but females generally loose weight during incubation, which lasts 15 - 20 days. Eggs decrease in mass by about 18% over the course of incubation (Yosef 1996). The females turn eggs 6 - 10 times a day during incubation, often more frequently on hot days. Parents show little defense of eggs, but defensive behavior increases as young grow (Yosef 1996).

Hatching may be slightly asynchronous if incubation began before the full clutch was laid (Porter et al. 1975). In the first 4 - 5 days after eggs hatch, the female feeds the young; the male feeds her and she reaches under herself to feed the young. After about 4 days, the female will spend more time foraging and less time incubating and the male feeds the female less and starts to feed the young directly. Adults deliver 3-17 prey items per hour to young, with higher rates in morning than afternoon.

Development

Loggerhead Shrike are born altricial (naked, blind, helpless, pinkish orange skin, orange-yellow bill, white egg tooth), weighing 3-4 g on the first day and gaining over 3 g/day until the 12th day, when growth slows until fledging at roughly 40 g between days 17 and 21 (Hall and Legrand 2000, Porter et al. 1975). They have completely developed wings by 15 days. After fledging the young remain in the nest tree for 2-3 days before flying to other perches (Kridelbaugh 1983). They perch in heavily foliated trees or undergrowth, very close together, and quiet (only begging for food when parents arrive). Around 1 week after leaving the nest, they are able to fly increasing distances, and begin to follow parents (to learn hunting skills). They begin to show impaling movements at 20-25 days old and can successfully impaling food at 33-35 days old, but the ability to attack and kill vertebrate prey takes ~ 40 days to fully develop. Young remain dependent on adults for 3-4 weeks after fledging, then they began to successfully forage on their own (Kridelbaugh 1983). The rate of prey delivery by parents increases from day 6 - 12, decreases from 12 - 18 days, and is highest on day 18 when the young fledged (Gawlik 1991). Dispersal in Utah happened in August (Grant et al. 1991), but happens earlier in other areas; by June 30th except for those that were renesting (Kridelbaugh 1983).

Population Demographics

The ability of a population to persist can be seen in its demographics, with viable populations being able to produce enough offspring to maintain or increase the size of the breeding pool. Thus, two key components of demography are fecundity (how many successful offspring an adult produces) and survivorship (how many individuals survive to reproduce). Existing information on these metrics are summarized below. When reviewing these numbers, we encourage the reader to consider the results of Brooks and Temple (1990b), which suggest that, based on a reasonable estimate of 47% adult annual survival and 19% juvenile annual survival, Loggerhead Shrike must produce 5.5 young per pair per year to insure a stable population. This is incredibly high; almost requiring a 100% nest success.

Fecundity

Two key aspects of fecundity are age of first reproduction and reproductive output. Like most other songbirds under good conditions shrike initially reproduce the first spring after hatching (Yosef 1996, Hall and Legrand 2000). Reproductive output is more variable. It has been suggested that clutch size varies with latitude and longitude, with larger clutches more common at higher latitudes and western locations (Kridelbaugh 1983), although data are variable. Yosef (1996) summarized reported clutch sizes from historical records at the Western Foundation of Vertebrate Zoology, which resulted in an average reported clutch size of 5.4 eggs (range 1 - 9); 36% 6-egg clutches, 34.2% 5-eggs, 13.4% 4-eggs, 12% 7-eggs, 2.8% 3-eggs, 0.7% 2-eggs, 0.6% 8-eggs, 0.4% 1-egg and 0.1% 9-eggs (Yosef 1996). Location-specific estimates are in line with these results:

- In Wyoming, one article reported 4 - 8 chicks in each brood (Winner 1995).
- In Oklahoma clutch size was reported as 5.8 (Tyler 1992).
- In the east, clutch size ranged from 3 - 7, usually being 5 or 6 (Hall and Legrand 2000). When multiple clutches where produced in a season, the first clutch was the largest with one egg generally subtracted from each following clutch.
- In Washington average clutch size was 5.9 ± .2 eggs (Poole 1992).
- In Colorado mean clutch size was 6.39 eggs per nest (range 5 - 8) (Porter et al. 1975).
- In Montana clutch size ranged from 3 to 7 eggs, with 5 - 6 being typical (Kridelbaugh 1983).

- In Minnesota mean clutch size was 5.65 eggs (range 3 - 7, mode 6) (Brooks and Temple 1990b).
- In Ontario mean clutch size was between 4.91 and 5.56 eggs per nest (range 4 - 7) (Chabot et al. 1995).

Most Loggerhead Shrike will have single-broods and only re-nest after a failure in the first try. However, Shrikes have been known to raise up to 3 broods per year, largely based on climate, where warmer, longer growing seasons result in more broods (Winner 1995, Tyler 1992, Hall and Legrand 2000). For instance, no second nests were reported in Idaho, ~5% produced two broods in Washington, < 6% produced two broods in Ontario (Chabot et al. 1995), 10% attempted two broods in Minnesota (Brooks and Temple 1990b), 15% of pairs re-nested in Alabama, 18.4% of successful pairs attempted a second nest in Missouri (Kridelbaugh 1983), and 96% re-nested in Florida (Poole 1992). Further, non-migratory shrike are more likely to attempt second broods (Yosef 1996) and high nest success increases the probably of re-nesting attempts (Tyler 1992). Shrike nesting in Wyoming are highly unlikely to have more than one brood per year.

<u>Survivorship</u>

Some estimates exist for survival of young through fledging, but survival after this (e.g., through the first migration and as breeding adults) is largely unknown. There are a few different ways to report survivorship of juveniles: hatching success (the percent of eggs laid that hatch), nest success (the proportion of nests producing at least one fledgling), and the number of young fledged per nest (where, as noted above, most nests begin with 5 or 6 eggs).

Yosef (1996) summarized hatching success as normally above 80%, with specific studies noted as follows: 79.5% in Colorado, 84.3% in Oklahoma, 84.7% in Alabama, 91% in Iowa, 94.7% in S. Carolina, 52.2% in Indiana, 82.6% in s Idaho (Yosef 1996). Another summary study reported hatching success rates of 79.5% - 84.7%, fledging success rates of 50 - 88% per hatched egg, and nest success (number of nests producing at least 1 fledgling) of 43.2 - 80% (Hall and Legrand 2000).

Average nest success across North America was reported as 56% (Yosef 1996): 43.2% in Alabama, 50% in New York, 51% in California, 59.5% in Oklahoma, 60.3% in s Idaho (Yosef 1996), 76% in Minnesota (Brooks and Temple 1990b), 57% in Washington (Poole 1992), 78%-89% in Ontario (Chabot et al. 1995). In Oklahoma, the probability of survival from the start of incubation until fledging was 46%, which is low compared to studies in other areas (Tyler 1992), but the percent of nests that produced fledglings was somewhat higher, 59.5% (Yosef 1996). Further, nest success can vary greatly from year to year at the same site, as demonstrated by a study in Missouri where success decreased from 82.1% in 1980 to 55.5% in 1981 (Kridelbaugh 1983).

The number of young fledged per nest varies from less than one to over 4: 4.6 in Iowa, 3.9 in s Idaho, 3.6 in Colorado, 3.4 in Florida, 3.0 in S. Carolina, 2.8 in Indiana, 2.07 in Minnesota, 2.0 in Alberta, 1.33 in Oklahoma, 0.95 in Manitoba, 3.5 in New York (Yosef 1996), 5.1 ± 0.3 in Washington (Poole 1992), 4.18 in Minnesota (Brooks and Temple 1990b), 3.9 - 4.2 in Ontario (Chabot et al. 1995).

Mortality from fledging through independence is rather high. For example: 46% mortality during first week after fledging in Indiana, 33% - 53% mortality during first 10days after fledging in southern Alberta, 33% mortality from fledging to independence in Virginia (Yosef 1996). In western shrub-steppe communities, survival decreased from 5.1 ± 0.3 fledglings per nest at the time of fledging to 2.3 ± 0.2 two weeks later (Poole 1992). Similar results were found in Ontario, were fledglings per nest were about 4 at the time of fledging and ≤ 2.5 when young became independent (Chabot et al. 1995).

As noted above, survivorship of adults is uncertain. Individual, banded shrike have been documented living as long as 6 years (Hall and Legrand 2000). Survivorship is generally much lower for juvenile birds than for adults. Work on scrub jays suggests that passerines' juvenile survival are ½ to ¼ of adult survival rates (Brooks and Temple 1990b). Given post-fledging juvenile survival of 47% - 77% (Yosef 1996), this implies adult survival of greater than 95%. Brooks and Temple (1990b) suggest that mortality at wintering grounds is the reason for observed reductions in abundance, which is also suggested by (Woods 1995a) based on low return rates of first year shrikes. However, Haas and Sloane (1989) caution that low return rates cannot be taken as evidence of high winter mortality without considering breeding-site fidelity (Haas and Sloane 1989).

Metapopulation Dynamics

The metapopulation structure for Loggerhead shrikes in not known. Individuals from various populations undoubtedly interact on wintering rounds, but the extent to which gene transfer occurs has not been studied. Some studies suggest that shrike are faithful to breeding sites, which would imply little exchange of individuals between populations. On the other hand, shrike are known to range widely during migration and perhaps other times, particularly during their first year after hatching. For instance, *L. l. gambeli* from mainlland California will visit San Clemente Island (off the California coast), but do not stay to breed (Yosef 1996). Similarly, populations in Alabama and Florida are larger in the winter, presumably because birds return from their northern breeding grounds. However, it is not known whether these "northern birds" nest again in the south.

Migratory *L. l. excubitorides* have been found wintering in Mexico with resident *L. l. mexicanus* and in southern Texas with resident *L. l. excubitorides*.

Food Habits

Throughout their range, the principle food of Loggerhead Shrike in warmer months seems to be arthropods (esp. grasshoppers where they are abundant), but small vertebrates (e.g., amphibians, reptiles, small mammals, other passerines) are regularly taken (Tyler 1991, Hall and Legrand 2000, Yosef 1996). Importance of vertebrate prey is greatest in colder months when arthropod abundance declines, sometimes comprising 50% - 76% of shrike diet (Yosef 1996). Herptiles are mostly taken in the spring when the herptile populations are high (due to hatching events) and the juvenile shrikes are learning forage. Other birds are usually taken in winter and spring, which are both energetically intense periods. These birds are usually the same size or smaller than the shrike, but larger prey have been taken (e.g., robins, morning doves). Mammals are also captured primarily in winter, although with less frequency than birds, probably due to their inaccessibility during temperate winters (e.g., being under snow).

Yosef (1996) notes dietary components by number of prey items as 68% insects, 4% spiders, 28% vertebrates, although vertebrates may comprise a greater portion of biomass consumed due to their larger size. A list of specific prey items reported in the general literature includes: meadow voles, sagebrush vole, white-footed mice, pocket mice, kangaroo rats, shrews, 13-lined ground squirrels, one record of a full-grown cotton rat, chimney swifts, sparrows, warblers, buntings, finches, a single record of a northern cardinal, mourning dove, horned lark, green tree frogs, spring peepers, grasshoppers, crickets, beetles, butterflies, moths, bees and spiders (Yosef 1996, Hayes and Baker 1987, Fraser and Luukkonen 1986, Chapman and Casto 1972, Ingold and Ingold 1987, Conley 1982). On a South Carolina island, shrike diet was recorded from pellets as earwigs (17.1%), ants (13.9%), crickets (13.1%), grasshoppers (8.7%), and sideblotched lizards (6.7%) (Yosef 1996). In New Mexico, a shrike was carrying (and presumably killed) a desert massasauga rattlesnake (0.41m long, 35g), but this is likely abnormal.

In general, it seems that when available shrikes select smaller, easier-to-catch prey and attack larger prey opportunistically and in times of food scarcity (Hayes and Baker 1987, Slack 1975). Shrikes have occasionally taken carrion and scavenged meat scraps left by raptors (Fraser and Luukkonen 1986), which may be a "last-resort" food source in winter months when prey is scarce (Hayes and Baker 1987). It seems that there is some individual variability in prey choice, where specific shrike show preference for specific types of prey. Also, shrike have been shown to develop adaptive techniques for "difficult" prey. For instance:

- They have been recorded "de-stinging" venomous insects, such as bumble bees, by rubbing the abdomen against a perch and squeezing out the poison (Sloane 1991).
- In Florida, they will regularly impale lubber grasshoppers for 1-2 days, then eat the head and abdomen, while and discarding the thorax containing the poison glands (Yosef 1996).
- They will impale toxic prey, such as monarch butterflies and eastern narrow-mouthed toads, for ≤ 3 days before consumption; supposedly allowing the toxins time to degrade (Yosef 1996).

Particularly during breeding season, shrikes defend territories within which they conduct foraging activities (Yosef 1996, Hall and Legrand 2000). Shrike generally forage by perching on high vantage points (see *Habitat* section, above) from which they can observe prey. When a prey item is found, a shrike swoops down from the perch and grabs the prey behind the head, often hovering momentarily to insure a rear attack. Shrikes significantly favor prey on ground (79-95%)

to prey in flight (e.g., flying insects 5-21%) (Morrison 1980). Shrike have adapted to human encroachment by hunting at bird feeders (Winner 1995).

After capture, shrikes transport the prey to a perch. Smaller prey items (9-58% of the shrikes body weight) are carried in the beak while larger prey (61-131% of body weight) are carried in the feet (Yosef 1993). Once at the perch, the shrike snaps the neck using the tominal notch of its beak or a sharp blow to the back of the head (Winner 1995). To facilitate handling of prey, shrikes will impale captured items on a sharp projection (e.g., thorn, twig, or barb) or wedge it into a forked branch, a seemingly "crewel" practice that has earned it the nickname "butcher bird" (Yosef 1996). This impaling behavior may have been evolved to compensate for the shrike's lack of talons and strong feet when handling prey items (Fraser and Luukkonen 1986). During the breeding season, many impaled prey items will be stored to form a food cache to attract mates and allow females to feed during incubation without leaving nest vicinity or expending a lot of energy (Fraser and Luukkonen 1986). Impaled prey are usually over 60 cm from the ground (Reid and Fulbright 1981). The type of impaling implements at hand during the learning period of a young shrike will determine its impaling tendencies for life; shrikes raised in the vicinity of thorns favor impaling on thorns, while those that become accustomed to forked sites prefer to wedge their prey (Sloane 1991).

Peak foraging times seem to be in the morning (see *Activity Patterns*, above), but as days get shorter/colder an increasing amount of time in the afternoon is spent hunting, probably because prey activity decreases (Yosef 1996). Shrikes typically make 8 - 12 capture attempts per hour, which is highly variable. Capture success varies widely (e.g., 28% - 85% of attempts resulting in captures) depending on habitat, prey availability, time of year, and experience (Yosef 1996). Shrikes increase their attack rate and capture rate during the breeding season (Morrison 1980).

Community Ecology

Predator-Prey

Given that shrikes are predators, they are bound to affect populations of their prey species, but the impact of such is generally unknown (Fraser and Luukkonen 1986). Once study observed Loggerhead Shrike feeding on nestlings of other passerines, likely resulting in nest loss for those birds, which lead Reynolds (1979) to conclude that although birds comprise only a small percentage of the annual diet of shrikes, the timing of predation on passerines could result in a profound negative influence on the annual production of the avian community (Reynolds 1979). However, when considering community level impacts of Loggerhead Shrike, one must consider the broader interactions of predator-prey relationships, competition, and habitat structure. For instance, if short vegetation and increased perch density increases shrike presence and we witness a decline in broader bird community declines, this decline is not necessarily attributable to shrikes. On the contrary, the increased perch density may attract higher numbers of raptors, which could have a negative impact the entire bird community and eventually on shrikes as well through increased predation and competition Chavez-Ramirez et al. 1994). Much more research is required to speak with any confidence regarding the impact of Loggerhead Shrike on the bird communities of which they are a part.

Conversely, prey populations are known to have a direct influence on shrike populations, with decreasing abundance of prey species (e.g., insects, small mammals) leading to reductions and or elimination of local shrike populations (Grant et al. 1991, Hayes and Baker 1987). Also, predation on shrike by other animals is often the greatest cause of nest failure for shrike, barring overt anthropogenic impacts (Hall and Legrand 2000). However, it is unknown if this has serious impacts at the population level. Documented predators of shrike include Black-billed Magpie, American Crow, Northern Harrier, Swainson's Hawk, Red-tailed Hawk, Red-shouldered Hawk, Swallow-tailed Kite, Crested Caracara, snakes (e.g., bull snake, indigo snake, rat snake, corn snake), feral cats, weasels, raccoons. Adults will hide in dense vegetation when raptors approach their territory, but most predation occurs on young in nests. To deter nest predators, adults will scream, bill click and even peck intruders; occasionally neighboring adults will cross territory boundaries to join the attack (Yosef 1996). Territory defense has also been shown toward Brown-headed Cowbird, Brewer's Blackbird, Eastern Kingbird, Western Kingbird, Eastern Meadowlark, Western Meadowlark, Northern Mockingbird, Boat-tailed Grackle, Brown Thrasher, Sage Thrasher, Common Nighthawk, and others that seem to be a threat (Yosef 1996).

<u>Other Interactions</u>

A variety of birds (e.g., Scissor-tailed Flycatcher, American Robin, Eastern Meadowlark, Common Grackle, and Brown Thrasher) attack recently fledged shrike without feeding on them. This action is apparently reciprocated by shrike, which can harass other passerines, especially during territory formation as most involve the shrike chasing the other animal off its territory (Yosef 1996). This may cause other birds to move, thus lowering overall nest density in shrike territory (Reynolds 1979). Moreover, the nesting success rate and nesting density for other passerines nesting in big sagebrush communities in Idaho were significantly lower when a shrike nest was found within the same area (although the temporal sample size of this study was very low) (Reynolds 1979).

A type of commensalism is shown between Loggerhead Shrike and other birds who are known to steal food from shrike caches, including Northern Mockingbirds, Crested Caracaras, Burrowing Owls and conspecifics (Yosef 1996). Brown-headed cowbirds can parasitize shrike nests (e.g., studies in Iowa (Yosef 1996)). Shrikes can reuse the nests of other shrikes and other species (black-billed magpies, brown thrashers, common grackles, northern mockingbird, and gray catbird) (Haas and Sloane 1989), although this is apparently opportunistic and the presence of such nests does not enhance habitat quality for shrikes.

Conservation

Conservation Status

Federal Endangered Species Acts

The San Clemente Loggerhead Shrike (*L. l. mearnsi*) was listed as endangered on August 11, 1977 (USFWS 1977). The eastern migratory race (*L. l. migrans*) was designated as a category 2 candidate for protection under the US Endangered Species Act in 1985, and the entire species was so designated in 1991 (Cade and Woods 1997), but category 2 candidates where dropped from listing consideration in the restructuring of 1995. As of 1986, the Loggerhead Shrike was federally recognized as a national species of special emphasis by the USFWS (Fraser and Luukkonen 1986, USFWS 1982).

The Committee on the Status of Endangered Wildlife in Canada listed the eastern subspecies *L. l. migrans* as endangered and the western subspecies *L. l. excubitorides* as threatened (Collister and Wicklum 1996, Prescott and Collister 1993, Telfer et al. 1989).

The Loggerhead Shrike is listed as a migratory non-game bird of management concern by the Office of Migratory Bird Management of the USFWS (Yosef 1996) and is protected under the Migratory Birds Convention Act (passed pursuant to the Migratory Birds Convention of August 16, 1916) in Canada, United States and Mexico (Collister and Henry 1995).

Bureau of Land Management

The Wyoming Bureau of Land Management lists the Loggerhead Shrike on its sensitive species list (BLM 2001).

Forest Service

Region 2 of the Forest Service (encompassing Colorado, Nebraska, Kansas, South Dakota, and Eastern Wyoming) lists the species on its sensitive species list (USDA Forest Service 1994).

State and Provincial Wildlife Agencies

The Loggerhead Shrike was listed as endangered in Indiana, Michigan, Ohio, and Wisconsin; listed as threatened in Illinois and Minnesota; listed as Of Special Concern in North Carolina; and listed as a Species in Need of Conservation in Kansas (Michaels and Cully 1998, Yosef 1996, Fraser and Luukkonen 1986).

The Canadian province of Ontario designated the Loggerhead Shrike as Endangered in November, 1992 (Chabot et al. 1995).

Heritage Program Ranks

The Natural Heritage Network assigns range-wide and state-level ranks to species based on established evaluation criteria. At the national level, the full species is ranked as apparently secure (G4) based on evidence in 2001 that although declining throughout North America, it is still widespread and common in some areas (NatureServe 2005). Four subspecies have been given a special T-rank at the national level: *Lanius ludovicianus excubitorides* (Prairie Loggerhead Shrike; T4), *Lanius ludovicianus ludovicianus* (Loggerhead Shrike; T4), *Lanius ludovicianus mearnsi* (San Clemente Loggerhead Shrike; T1), *Lanius ludovicianus migrans* (Migrant Loggerhead Shrike; T3Q).

Heritage programs in 45 states and 7 Canadian provinces have ranked the Loggerhead Shrike within their boundaries (Fig. 6). 14 of these units rank it as imperiled (S2) or critically imperiled (S1) and 9 list it as historically present in the state, but potentially extirpated. Most of the states and provinces with high ranks are in the northeastern portion of the species' range (i.e., New England and the Midwest); it is now extirpated from most of the Northeast, and is nearly extirpated from Minnesota, Wisconsin, and Michigan.

Biological Conservation Issues

Population Trends

Abundance and Abundance Trends

There are clear associations between shrike relative abundances from the BBS and physiographic strata: shrikes tend to be of higher abundance in prairie strata and are not found in the heavily forested northeastern part of the continent, while in the west, they appear to be limited to prairie or scrub areas (Sauer et al. 1995). The local abundance of shrikes varies greatly throughout their wide range, but is generally rather low for a passerine (Fig. 7). There are several areas with consistently higher relative abundances than the rest of the species' range: the Osage-Plain-Cross Timbers, Rolling Red Prairies, East Texas Prairies and Rolling Red Plains in the central United States (Texas, Oklahoma, Kansas, and Missouri); the Upper Coastal Plain in Georgia, Alabama, and South Carolina; the Coastal Prairies in Texas; and the Floridian and Subtopical regions in Florida (Sauer et al. 1995).

Yosef (1996) compiled the following density estimates: 1 pair/2.4km (Missouri), 1 pair/1.6km (Alabama), 1 pair/7.7 km (Iowa, Missouri, Florida), 1 pair/10km (Texas), 1 pair/50km (Saskatchewan, Manitoba) and 1 pair/ 143 km (Alberta) (Yosef 1996). Other studies have found

0.4 birds per 1km in Utah greasewood and shadscale habitat (Grant et al. 1991), “low densities” in Minnesota (Brooks and Temple 1990b), and “ locally abundant” in southern Idaho (Woods and Cade 1996). Saskatchewan has a substantial breeding population of shrikes, where densities of more than 10 breeding pairs per 100 km were found in 7% of areas studied (Telfer et al. 1989). Smaller (and contracting) contracting populations occur in Alberta, Manitoba and other parts of Saskatchewan, with more moderate densities of 2 –10 breeding pairs per 100km and areas of sparse and patchy occurrences (Telfer et al. 1989).

Rangewide, the Loggerhead Shrike has experienced notable declines and is one of the few species to show a statistically significant downward trend in abundance across states, provinces, and physiographic strata based on Breeding Bird Survey (BBS) data (Table 1, Fig. 8) (Cade and Woods 1997, Yosef 1996). In short, BBS data has shown a 4% annual decline (range 3.5 – 5) in continental shrike populations from 1966 – 1986, with the most severe declines in central, Midwestern, and northeastern states (Peterjohn and Sauer 1995, Brooks and Temple 1990b). During this period, 37 of 43 states and provinces of the US and Canada showed negative population trends; 25 of these were statistically significant; only Colorado, Montana, the Dakotas, Louisiana and Texas had stable or increasing populations (Yosef 1996). For the period from 1966-1982, BBS data showed decreasing trends over 71% of the current range and were stable or increasing on only 29%. Declining trends were evidenced for 5 Canadian provinces and 31 states (statistically significant in 2 provinces and 15 states) (Cade and Woods 1997). Only one state, South Dakota, showed a significant increase and (from 1966-1991) only 4 states showed non-significant increases (i.e., Colroado, Lousisana, Montana, and South Dakota). The continental decline averaged 2.9% per year over 1966-1991 with particularly large declines from 1976-1979 and lessening declines (and even increases in some areas) since then (Sauer et al. 1995). In fact, 41% of the BBS routes showed increased (non-signifiant) numbers in the period 1982-1991, which is better than over the previous decades.

A later analysis of BBS data found similar results (Peterjohn and Sauer 1995, Sauer et al. 1995). Peterjohn and Sauer (1995) found that all subspecies showed declines from 1966 - 1993: 2.4% - 2.6% for *L. l. ludovicianus* and the western subspecies and 5.7% for *L. l. migrans* (found throughout the east). These declines began in the 60s, peaked in the 1976 – 1979 after which they lessened. The largest region of relatively stable populations consists of the High Plains and Great Plains Roughlands (along the western portion of the Great Plains from Montana and western South Dakota to eastern Colorado), while the Edwards Plateau of Texas and the state of Louisiana also support fairly stable populations (Peterjohn and Sauer 1995, Sauer et al. 1995).

This is roughly consistent with CBC findings showing a landscape of decline, with serious declines in eastern populations and isolated areas of positive abundance trends, which are, however, smaller and in different regions than the positive trends observed in the BBS (Sauer et al. 1995, Fraser and Luukkonen 1986). CBC data showed 14 states with significant declines, the largest being the Carolinas, Maryland and Virginia, while no states showed significant increases. For the period from 1955 – 1979, CBC data indicate a slight decline in Loggerhead Shrike populations on the Pacific Coast, generally stable populations in the southwest (e.g., Nevada, Utah, Arizona, and New Mexico), a significant decline in populations in the southern great plains (e.g., Kansas, Oklahoma, and Texas), fluctuating populations in the central-eastern states (e.g., Missouri, Kentucky, Arkansas, Tennessee, Louisiana, Mississippi, Alabama, and southern Illinois), and a severe decline in the southeast (e.g., Virginia, North Carolina, South Carolina, Georgia, and Florida) (Morrison 1981). Moreover, CBC and BBS data combined suggest that while winter ranges remained consistent, the number of birds spotted in those ranges declines and that regions with higher-than-average winter densities had declining trends of >2%; (largest declines in the Carolinas, Georgia, New Mexico, Arizona, Utah and California), which supports the need for more studies on winter survival.

In most cases, the large-scale declines seem to follow 3 stages: a slow decline from 1900 through 1950s (often attributed to habitat loss), a rapid decline from 1957 through the mid 1960s (for largely unknown reasons), and a continued decline since then (Yosef 1996). In 1978, it was listed as the most critically declining species on the National Audubon Society's Blue List (Yosef 1996). Population decline and range contractions are declines have been most severe in eastern North America, although more variable declines have also been seen throughout the prairie regions (Telfer et al. 1989, Yosef 1996). Moreover, the widespread decline of shrikes is not uniform throughout the country, but even currently healthy populations are being threatened by habitat alteration (e.g., southern Idaho sagebrush population are stable, but sagebrush in that area is being lost), which poses concern for future trends in shrike populations (see *Extrinsic Threats*, below) (Graham 1993).

Further data points are as follows:

- Declines average 3.6% yearly since 1966 according to US Geological Survey figures (Goodman 2000).
- Loggerhead Shrike was once common in central Saskatchewan, but its present breeding range only includes southern Saskatchewan (Telfer et al. 1989, Yosef 1996). While there are substantial populations still breeding in Saskatchewan, numbers are down considerably from those recorded by the BBS in the late 1960s and reported prior to the 60s (Telfer et al. 1989). In both Alberta and Manitoba, the core breeding ranges have contracted substantially, and there were probably fewer than 1000 breeding pairs in each in the late 1980s (Telfer et al. 1989). Breeding populations in Southeastern Alberta have declined at an annual rate of 3% from 1966 to 1989 (Prescott and Collister 1993).

- Oklahoma populations have shown a steady decline over the past decades (Tyler 1992).
- In the eastern part of their range, Loggerhead Shrike have been in slow over much of the century, which has accelerated recently to a 4% annual decline overall since 1978, with pockets of extreme decline (e.g., 60% decline in Missouri between 1967-1979) (Hall and Legrand 2000).
- In Quebec shrikes were common until 1940, but have exhibited a slow decline through the 70s and a drastic decline since then, which roughly follows the trends in pastureland (Yosef 1996).
- The total Ontario population of Loggerhead Shrike was estimated to be less than 75 pairs in 1992 (Cuddy 1995).
- Loggerhead Shrike was commonly seen in New England before the 1960s, after which small declines were noticed that peaked in the 1970s. It no longer breeds in most of northeastern range and was last verified nesting in New England in1978 (Vermont) (Yosef 1996).
- Number of shrikes killed due to automobile encounters was highest in the early 1970s, but decreased dramatically by the mid eighties. It is believed that in the 70s the shrikes were fairly common, but by the 80s, shrikes were rare in Victoria Texas (Flickinger 1995).
- A March 1991 survey estimated the SC population at 14-20 adult birds (Kuehler et al. 1993).
- Shrike populations in Idaho seem stable, with evidence that those populations in Idaho's semi-arid, cold desert region may have larger clutches, more nestlings per nest, and higher estimated productivity per successful nest and per nesting pair than shrikes nesting in other areas (Woods 1995a).
- Some shrike populations west of the Rocky Mountains appear to have remained stable, but shrikes in the Canadian prairie provinces have undergone a southward retraction in range since the 60s mirrored by a significant reduction in breeding range and diminished numbers described for states Minnesota, Illinois, Missouri, and Oklahoma (Cade and Woods 1997).

Dorn and Dorn (1999) list the Loggerhead Shrike as a “common summer resident” in Wyoming from roughly March through September (Dorn and Dorn 1999). BBS data show an 8% increase in Wyoming’s Loggerhead Shrike abundance from 1980 – 1994 (Winner 1995), and Mundy et al. (1996) showed an increase in breeding shrikes for Wyoming, North Dakota and South Dakota (Cade and Woods 1997). However, the same period shows a decline of nearly10% in the Laramie plains region, possibly due to the decline of insect prey (Winner 1995). All things considered, we tentatively describe the Loggerhead Shrike abundance in Wyoming as sparse but stable, but offer strong cautions that future trends could change drastically to reflect other areas of the country and that shrike populations are therefore deserving of regular monitoring (see *Conservation Elements*, below).

Habitat Trends

Following European settlement of North America, there may have been an increase in Loggerhead Shrike habitat as formerly forested land was cleared for small-plot agriculture, although such habitat may have been marginal in nature (see *Habitat* section, above). This trend, however, has reversed for several reasons: 1) the nature of agriculture has changed to larger fields with less suitable perching habitat (e.g., fewer shrubs and shelter belts) (Prescott and Collister 1993), 2) the increase in pesticide use has reduced insect prey necessary to support shrike, and 3) formerly suitable shrublands are now becoming less inhabitable for shrike because areas that are a mixture of grassy plains and woody plants are considered prime real estate for suburbs, farming, ranching, golf courses, etc. (Yosef 1996). The evidence for this is seen largely in specific studies:

- Gulf Coast states have lost much winter habitat and a lot of what remains has red fire-ants (and the associated pesticide programs) (Yosef 1996). The extensive conversion of pastureland and old fields to cereal-crop production has resulted in the elimination of large areas of grassland habitat throughout the gulf coast and adjacent regions (Brooks and

Temple 1990b). This has apparently caused resident shrike populations to be limited by habitat availability, which suggests that migrant shrikes wintering in the same area are being forced to occupy marginal habitats that are not being held by territorial residents, thus reducing over-winter survival to low levels.

- In the prairie and aspen parkland potion of Alberta, 39% of unimproved pasture was lost between 1946 and 1986 while up to 79% of pre-settlement grassland has disappeared, mostly converted to cultivated crops (Collister and Henry 1995).
- Densities of shrike in Washington were limited by the scarcity of suitable shrub patches (esp. in bitterbrush communities) and by the lack of openings (esp. in upland sagebrush) (Poole 1992).
- In Minnesota, areas that were once tallgrass prairie and savannah during presettlement times has been replaced with agricultural fields and pasturelands; leaving less than 1% of the original area as prairie (Brooks and Temple 1990a).
- In the southeastern U.S. pastureland acreage (i.e., grassland) and shrike numbers have both declined, and the extent of declines in short grassy vegetation is correlated with the extent of declines in shrike populations; grassy habitats may be more limiting than cropland (Gawlik and Bildstein 1993).

However, despite figures such as these, there seems to be sufficient breeding habitat in many areas to support larger shrike populations (Yosef 1996). This suggests that it may be impacts on winter grounds that have tipped the balance against shrike. For example, in Oklahoma, nesting habitat seems to be available, but not used; as yet untested hypotheses include use of pesticides, loss of hedgerows in fields, and non-native grass species (Tyler 1992). Similarly, of 139 apparently suitable breeding sites in Minnesota, only 20 were occupied by shrikes and 119 were unoccupied, suggesting that shrikes are probably well below carrying capacity in the area (Brooks and Temple 1990a).

However, this could be misleading, since “apparently suitable” sites are often not rigorously defined, so there may be a difference between occupied and unoccupied sites that of which we are unaware. For instance, in southeastern Alberta 54 out of 119 apparently suitable sites were unoccupied (Prescott and Collister 1993). Further investigation revealed some significant differences in vegetation, the most substantial being that occupied sites had a much greater percentage of tall grass that unoccupied sites (24.1% compared to only 2.5%). As it turns out, areas of taller grass where refugia in a landscape of shorter grass maintained by cattle grazing (see *Extrinsic Threats*, below), which was formerly thought to be compatible with shrike. Further, Novack (1995) suggests that shrikes are area sensitive, so fragmentation could also explain the absence of shrikes in some structurally suitable habitats (Cade and Woods 1997). The main message here is that many areas that we currently perceive as suitable may in reality be unsuitable, leading to vast overestimates of habitat available to breeding shrike.

Extrinsic Threats

Local declines can often be attributed to proximate causes, but the synchronous range-wide decline in Loggerhead Shrike populations is difficult to explain. Part of the decline can likely be attributed to loss of open habitat and, to some extent, reforestation in some northern states and provinces, thus representing a return to pre-settlement conditions when shrikes were probably absent from much of the heavily forested northern states. However, the decline goes well beyond what can be explained by habitat loss, because there may be much suitable habitat currently unoccupied and declines have occurred in all regions, even those with much open habitat. CBC data showed that while winter ranges remained consistent (when compared from surveys in 1962-63 and latter in 1986-87), the number of birds spotted declined (Yosef 1996). The proximate cause for such declines is likely loss of suitable wintering and/or breeding habitat, either through destruction or reduction in quality. A variety of specific factors, mostly anthropogenic but also natural, interact to cause this. Some of these are discussed below.

Anthropogenic Impacts

Direct Mortality

Anthropogenic impacts fall into a few major categories: direct mortality and habitat reduction. Combination of pesticide effects and habitat loss seem to be a strong possibility in declines (Hall and Legrand 2000). Both breeding and wintering habitat has apparently been declining in most areas of North America, primarily because of intensive agricultural practices that have resulted in the removal of shrubs and shelterbelts (Prescott and Collister 1993). Pesticides may affect eggshell thickness or behavioral development and hunting ability of young shrikes; however, it is more likely the effects of pesticides are indirect (long-term reduction of insects) (Cade and Woods 1997).

Loggerhead Shrike were hunted at one time because of their reputation for killing songbirds. Extermination campaigns were even started in major urban areas (Winner 1995). The species' most drastic decline coincided with the introduction of organochlorines in 1940s-70s. Pesticides and other organocholrines (e.g., DDE, DDT) have been found in the tissues of adults and to cause eggshell thinning (Hall and Legrand 2000). Dieldrin poisoning has been shown to effect both adults and juveniles, but young given daily doses of Dieldrin had a mean age death of 16-78 days (Hall and Legrand 2000). Therefore immature shrikes may be dying from pesticides at an age that does not affect the reproductive success (i.e. after fledging) and may even be causing mortality when it is hard to observe (e.g., during migration). Spraying Mirex to control red fire-ants produces high residue concentrations in shrike (8ppm after 3 months of a single treatment, while most vertebrates were found with levels of >1ppm) (Yosef 1996). Since Dieldrin has been shown to affect development of key survival behaviors (e.g., hunting); it may not affect reproductive or fledging success rates, but rather juvenile or first year survivor rates. Major declines of LS on prairies corresponds with Dieldrin treatment of grasshoppers (30-75% of diet) (Yosef 1996). Because roadsides are frequently used for nesting habitat and Loggerhead Shrike fly low to the ground, fledglings, juveniles and even adults are frequently hit by cars. One study in Virginia showed vehicle collisions accounted for 29% of shrike fall and winter mortality in Virginia, second cause of mortality after predation. This effect is likely increasing as more shrike are forced to use roadside breeding habitats and vehicle traffic has been increasing exponentially since the 1940s (Flickinger 1995, Cade and Woods 1997).

Habitat Reduction

Habitat reduction can be through overt elimination of habitat (e.g., urban sprawl) or through more subtle changes in habitat structure. Areas that are a mixture of grassy plains and woody plants are prime real estate for many human uses (e.g., suburbs, farming, ranching, golf courses). Urban areas and extensive cultivation has been shown to be only marginally useable by shrikes, and intensive, chemically treated and row-crop monocultures are not advantageous to shrikes, so the dispersed growth of human population centers (urban sprawl) and the reduction in agricultural lands combined with a switch in farming toward large areas of cultivated row-crops has reduced habitat available to shrikes (Winner 1995, Cade and Woods 1997). Further, use of pesticides has caused long-term reduction in insect prey that makes structurally suitable habitat unfit for shrike (Winner 1995, Cade and Woods 199). Cattle grazing has had mixed impacts, but is currently thought to be detrimental to shrike in Wyoming where natural grasslands are shorter and sparser than in the east (Wiggins 2004). Some areas have been studied specifically and are noted below; unfortunately Wyoming populations have no received such attention:

- Decrease of pastureland in the northeast is likely more impacting on shrike populations than total acreage in farmland (Cade and Woods 1997). In New York, total farm land area declined from 9.16 million ha in 1900 to 3.72 million ha in 1982; total area in hay crops dropped from 2.05 million ha to <1.0 million ha; pasture area dropped from 2.15 million ha in 1900 to <0.7 million ha in 1982. Further, hedgerows have been taken out of remaining agricultural areas, decreasing breeding habitat (Yosef 1996).
- Declines in some high desert regions have been associated with extensive loss of big sage (Cade and Woods 1997). In one two year study area in Idaho, horse and cattle grazing eliminated several shrike and sagebrush eradication practices destroyed 4 shrike territories, crowding shrikes into increasingly smaller areas (Woods 1995a). Almost 70% of sage-steppe habitat in southern Idaho has been destroyed by human activity (Yosef 1996).
- The extensive conversion of pastureland and old fields to cereal-crop production has resulted in the elimination of large areas of grassland habitat throughout the gulf coast and adjacent regions (Brooks and Temple 1990b). In Texas, native grassland is the habitat most selected by shrikes, but in 1979 only 17% of the region remained in native grassland (Yosef 1996). Midwestern populations declines may be partially caused by declining adult and juvenile over-winter survival in these areas, because migrant birds are forced into marginal habitat where resident birds already have set territories already (i.e., lack of enough suitable habitat in winter could be thinning nationwide populations) (Brooks and Temple 1990b, Cade and Woods 1997, Yosef 1996).
- It is believed that shrikes are limited in southeastern Alberta due to limited availability of suitable breeding habitat (Collister and Henry 1995). In Alberta cattle grazing reduced grass height on otherwise suitable habitats, causing many “visually suitable” areas to be unoccupied because they lacked sufficient quantities of tall grass, so subtle habitat limitation might be an important factor in population declines (Prescott and Collister 1993).
- In the northeast, habitat destruction may be the main factor of decline, since pastures were reduced, larger fields used, and some areas reverted to forest (Fraser and Luukkonen 1986).

- Surface and strip mining of coal in Indiana has been shown to destroysuitable habitat (Yosef 1996).

Invasive Species

Invasive species have been particularly problematic on island populations of shrike, such as that on San Clemente Island, California (Cade and Woods 1997, Yosef 1996, Kuehler et al. 1993, Poole 1992). Habitat loss on San Clemente Island is partially caused by overgrazing by introduced feral livestock, especially domestic goats (present from 1800s until recently). Further, high nestling and incubating adult mortality has been attributed to feral domestic cats and the coastal sage scrub vegetation of the island is now being replaced with introduced annual grasslands and exotic plants that decrease the quality of foraging land.

This should be seen as a foreshadowing of what could happen more broadly in the continental populations if invasive species continue to alter native shrub-steppe habitats. Overgrazing and monoculture crops reduce insect abundance and diversity. Exotic grass species grow in solid masses and make for harder hunting than native varieties that grow in bunches and let shrikes spot prey (Goodman 2000). Invasive plants (e.g., cheatgrass) cause sagebrush to grow in small stands surrounded by the exotic plants. It was found that shrikes in this type of area might be forced to breed closer together than normal due to the suitable habitat limitations. This may explain higher shrike densities in some areas (Idaho) (Woods 1995a).

Natural Threats

Some of the contraction in Loggerhead Shrike range and population declines may stem from natural successional change in habitats (e.g., reforestation) (Cade and Woods 1997), but the relative import of this versus anthropogenic changes is unclear. Other natural, primarily predation and stochastic weather events, have been shown to cause nesting failure and local declines in abundance. However, these factors are not thought to be responsible for declines at larger scales, except as they contribute to the pressures on already stressed populations. For example, lower nest success is associated with roadside and fence-line habitats, where predators are more common and shrikes are often forced to nest because suitable natural habitat has been converted to cultivation or pasture (Yosef 1994, 1996). Further, spread of some key nest predators (e.g., feral cats, magpies, coyotes) has been enhanced by patterns of human settlement.

Predation and parasitism: In Colorado, 52% of nest failures were due to predation, most of which were magpies (Porter et al. 1975), while a study in Idaho documented predation as causing 54% of nest losses (Woods 1995a). Other areas show even higher rates, such as one area in Alabama that exhibited 71.4% nest failure proximately caused by predation (Yosef 1996). On San Clemente Island, 44% of nest failures were attributed to predation by feral cats, foxes and ravens, while majore predators in Washington were gopher snakes, magpies, ravens and coyotes. Nests within 1 km of active raven nests failed more often (51%) than did nests located farther away from ravens (23%) (Poole 1992). Brown-headed Cowbirds are known to parasitize shrike nests and shrikes have been seen chasing brown-headed cowbirds away from nesting areas, but the extent of nest parasitism as a factor in population declines is not known (DeGeus and Best 1991).

Inclement weather events have been known to cause nest failure when they occur during key times in the breeding season, mainly by damaging nests or reducing food supplies. Fledging success in 1981 (stormy: 41.9%) was significantly lower than 1980 (warm and dry: 77.1%) (Kridelbaugh 1983). Frequent rain, storms and cold temps coincided with the loss of 8 broods and brood reduction in 9 other nests in Missouri; the year before (with warm, dry weather) only one nest of 27 was lost. Brood reduction occurred in 28.2% of nests during a wet spring, compared to 13% during a dry spring in s Idaho, shows that precipitation greatly affects nest success (Yosef

1996). During severe thunderstorms in Colorado, 9 of 12 nests were knocked down (Yosef 1996). success can be affected by extreme weather conditions. In Oklahoma, years with extreme periods of drought or rain had lower nesting success (Tyler 1992).

Other

A few other threats, mostly of a local or regional nature, have been suggested for populations of Loggerhead Shrike, but their range-wide importance has not been evaluated:

- Potential competition with other species, especially those more adaptable to human disturbance, may contribute to decline (e.g., American Kestrel, European Starling, and red fire-ant) (Yosef 1996). Predation on arthropods by fire ants may result in less available prey and therefore lower quality habitat in wintering grounds (Cade and Woods 1997).
- Possibly as suitable habitat becomes fragmented, factors related to site fidelity and dispersal in shrikes may further exacerbate strains placed on already declining populations. Shrikes do not usually stay in groups, this could lead to reduced success in locating a mate when breeding aggregations are widely separated and scarce (i.e. when habitat becomes patchy) (Cade and Woods 1997).
- Fire can be both positive and negative: it often creates or maintains suitable grasslands; however, it is one of the principal factors involved in the conversion of sage shrub-steppe (optimal) to exotic cheat grass stands with no shrubs (very bad) (Cade and Woods 1997).

Intrinsic Vulnerability

Loggerhead shrike appear to be vulnerable to extirpation for two main reasons: they are sensitive to habitat disturbance and have high site fidelity. Seemingly subtle changes in habitat structure (e.g, perch density, grass height, configuration of habitat patches; see *Habitat*, above) can cause apparently suitable sites to be unused by shrike.

Loggerhead Shrike have been reported as highly faithful to breeding territories, but this has been questioned in recent literature. Summary statistics of the percent of breeding sites reused from year-to-year are (Yosef 1996): 73% in southern Idaho, 68% in Indiana, 60% in Virginia, 54% in Missouri, 57% in Iowa, 41% - 59% in Minnesota, 30% - 90% on San Clemente Island. Unfortunately many reports don't consider whether the same individuals or their relatives are occupying the sites (Haas and Sloane 1989), nor to they separate site fidelity from the possibility of population declines causing low re-use rates. In a study of banded birds in Idaho only 30% of banded adults returned, but all of those returning came back to their former territories (Yosef 1996). This low return rate and high-fidelity of returning birds is also seen in other studies of migrating shrike (Yosef 1996). There is further evidence for innate fidelity in that resident birds, both females and males, tend to hold territories year round (Haas and Sloane 1989). However, there is also evidence that female shrikes are less faithful than males to territories within a breeding season, and thus probably do not exhibit substantial site fidelity between breeding seasons (Haas and Sloane 1989). Further, shrikes do not usually form groups, which could lead to reduced success in locating a mate when breeding aggregations are become separated and scarce due to habitat fragmentation (Cade and Woods 1997). In general, shrike fit into model of some adults being faithful to nest-site areas while most juveniles disperse widely (Yosef 1996).

In light of current knowledge on shrike, it is also worthwhile to mention two other aspects that make some species intrinsically vulnerable: susceptibility to disease and low reproductive capacity. At this time Loggerhead Shrike to not appear exceptionally vulnerable to disease, but there is very little data on disease or parasites in shrikes, so this cannot be ruled out as a contributing factor in their decline. Of those parasites reported (Mallophaga, *Acuaria* worms, *Lemdana*, ectoparasites, hippoboscid flies, blow-fly larvae, round worms) none regularly cause death of the host. Reproductive capacity of shrike seems normal and studies have suggested it is not a contributing factor in population declines (Chabot et al. 1995, Brooks and Temple 1990b, Kridelbaugh 1983). However, when considering current rates of territory reoccupancy and first year survival, productivity would have to be much higher than witnessed in the wild for populations to remain stable or increase (Yosef 1996). It is believed that survival after fledging, not reproductive capacity, is the limiting factor in shrike population demography, which is primarily caused by the above noted threats, foremost among them being habitat disturbance.

Conservation Action

Conservation Elements

It is hard to assess a clear method for preservation when the cause of the decline is still unclear (Hall and Legrand 2000), however, in the advent of better information, conservation of shrike in Wyoming should focus on three areas: habitat preservation and restoration, inventory and monitoring, and research on reasons for decline. Much of this draws from the first International Shrike Symposium held in January of 1993 (Graham 1993, Holden Eds. 1993), which brought together many experts to clarify existing knowledge of shrike decline and conservation, and on subsequent conservation summaries (e.g., Yosef 1996 and Wiggins 2004).

Currently, there is a captive population of *L. l. mearnsi* that is a reasonable genetic representation of the wild population, but the reintroduction program has shown mixed success (Yosef 1996). At this time no captive propagation and reintroduction is recommended for any other areas of the species range, where conservation efforts would be more fruitfully spent addressing habitat quantity and quality, particularly in wintering areas.

Habitat Preservation and Restoration

East of the Rockies, focus should be on increasing medium and perhaps tall grass habitats with regular perches for shrike (Yosef 1996). Moreover, since the whole shrub-steppe community is important to maintaining shrike populations, moving toward an ecosystem or landscape-based approach to conservation (rather than a single species approach) is likely to be productive (Yosef 1996), both in terms of results and in the support that can be encouraged from agencies and the public. An experimental habitat-management program was begun in 1991 at the Presque Isle National Wildlife Refuge in Virginia (Bartgis 1992) and other ideas have been presented by shrike experts (e.g., Cade and Woods 1997, Yosef 1996). These sources should be obtained by managers in Wyoming and carefully reviewed. Herein, we present some ideas derived from these and other sources.

Particular conservation priority should be given to areas within 400 m of known nests and no disturbance to natural habitat should occur within 100 m of a nest. Perch density is very important, since shrikes may limit their use of foraging substrate to within 10 m of elevated perches Chavez-Ramirez et al. 1994). Management recommendations include providing short grassy habitat interspersed with scattered elevated perches (Michaels and Cully 1998), but Prescott and Collister recommend that use of grazing as a management practice to "improve areas by increasing the amount of short grass" should be controlled, because it is easy to over-graze shrike habitat and eliminate critical areas of medium and tall grasses with distributed perches (Prescott and Collister 1993).

Extensive preservation of the natural scrub desert, shrub-steppe, sagebrush-scrub, and western and southern savanna vegetation types (optimal, core habitats) is very important (Cade and Woods 1997, Woods and Cade 1996). In natural grasslands, the relatively small habitat patches (that occur at the scale of several meters with non-woody perches distributed evenly throughout) and high vegetation diversity allows shrikes to use a high proportion of the vegetation as foraging habitat (there are more non-woody perches available located throughout the habitat instead of just on the edge like in agricultural habitats) Chavez-Ramirez et al. 1994). Efforts to maintain and restore natural woody vegetation in suitable areas by planting and/or protecting existing shrubs and trees may be beneficial (Wiggins 2004). Conversion of natural grassland to pasture should be avoided as it increases linear habitat features and reduces natural vegetation, forcing most tree and shrub nesting birds to use the only available habitat (the remaining fencelines and hedgerows) which are major travel corridors for predators, thus increasing the predation frequency on the nesting species and decreasing the success of the nests (Yosef 1994). No evidence that mowing vegetation or manipulating density of man-made perches affects shrike use of habitat patches in a natural grassland, although such manipulation may be successful in otherwise human-altered landscapes, see below.

A shift toward smaller agricultural fields, hedgerows, rotation of crops with pasture, and decreased pesticide use (particularly broad spectrum pesticides) would lead to increased shrike habitat (Hall and Legrand 2000). Gawlik and Bildstein (1993) suggest to intersperse small monocultures of rowcrops and pastureland such that patchiness results from among-field diversity OR larger blocks of pastureland could be managed to provide sparse bare areas and short grasslands with in fields (Gawlik and Bildstein 1993). Chabot, Titman and Bird (2001) suggest open communication with landoweners of shrike habitat and incentive programs that encourage landowners to maintain grazers and “unimproved” nature (Chabot et al. 2001). Farmers should restrict pesticide use and maintain burned or mowed open areas adjacent to thicker ones according to the Northern Prairie Wildlife Research center in North Dakota. It is best to maintain brush along fence-lines, scattered trees and shrubs in pastures and fields, and shelterbelts that are free from grazing pressure (Yosef 1996). In homogeneous areas, the preferred habitat mosaic might be achieved by using common techniques like grazing, burning, plowing, and mowing (Cade and Woods 1997). Study shows that by adding perches to unused foraging area (within territory boundaries) shrikes can utilize more foraging area and thus constrict their territory allowing other shrikes to settle (Goodman 2000, Yosef and Grubb 1994).

Roadside habitats should be incorporated into management plans encouraging to leave shrubs there and eliminating or reducing the use of biocides (Yosef 1996). Flickinger suggests that we need to protect shrikes from roadways by maintaining attractive habitat away from roadways, routing new highway construction away from critical habitat, and reducing the maximum speed to 70 km/hr in these areas. Maybe in places of high incident of vehicle collision, roadside habitats could be make less attractive to shrikes (Flickinger 1995).

Inventory and Monitoring

An accepted survey protocol for loggerhead shrikes is not available (Wiggins 2004). Several studies have used roadside surveys to evaluate shrike densities (Hall and Legrand 2000, Yosef 1996, Poole 1992, Telfer et al. 1989); however we feel that inventories relying such methods do not give a good look at shrike populations, especially when compared between different types of habitat. Not only can driving transects give small sample sizes and large variances (Poole 1992), but they can introduce sampling bias. Roadways can be lined with shrubs, tall grass, hedges and/or fence lines that can inflate counts in habitat that is otherwise more open with limited perches (e.g. a heavily grazed or mowed areas) (Yosef 1994). In contrast, a habitat that is dotted with trees and shrubs or tall non-woody plants, such as natural prairie, or savanna, will have perches throughout and shrikes will not be concentrated along roadways. In fact, in these habitats roadways might be considered less favorable due to higher predation. For example, using a roadside survey to compare a natural prairie and a heavily grazed pasture may result in estimates of the pasture having a higher population when in actuality, the populations could be very similar, or perhaps higher in the prairie. The results of research based on roadside surveys should be looked at carefully, especially when looking at broad conservation plans that suggest altering natural habitat.

Walking transects, rather than driving transects, may provide more realistic information on shrike distribution, abundance and habitat use (Poole 1992). However, when road-side surveys are logistically impractical, they should be confined to lightly traveled roads on which it is possible to drive slowly and make stops. In all cases, surveys should be discontinued when the ambient temperature exceeds 25^{o}C and continued in the evening when temperatures have dropped. Surveys should be conducted when the majority of broods have just fledged, because shrikes are most visible then (young are moving and adults must feed them often). Since fledging varies between regions, so will the time of optimal survey.

Stratifying survey effort by habitat type may facilitate sampling and provide cues as to what might be causing declines. In Minnesota, habitat are split into row crops, non-row crops, pasture, grassland (e.g., prairies, cedar glades, and lawns), woodlots, wetlands (e.g., standing water, marshes and riparian zones), residential land, and miscellaneous (e.g., non-herbaceous cover like buildings) (Brooks and Temple 1990a). Further, point counts were done for 5 minutes at 800 m intervals along transects, which should be sufficient if the country is more-or-less open. To find the suitability of habitat for breeding, number of potential nesting sites, number of discrete perch sites and linear length of continuous perch sites, distance from nest site to the nearest building and total area of each habitat type might be measured around each nest location. Since Loggerhead Shrike are conspicuous passerines that frequently occupy roadside habitats, they should be adequately sampled by the BBS secondary roadside surveys (Peterjohn and Sauer 1995). In areas where suitable habitats are changing more rapidly along roadsides than over the landscape as a whole, the BBS trends may overestimate the true rates of decline. However, in areas where most remaining suitable habitats are restricted to roadsides, the BBS trends may underestimate regional population declines (Peterjohn and Sauer 1995).

Surveyors must also understand that detectability of shrike can vary depending on habitat structure. For example, shrikes nesting in sagebrush communities tend to be shy and somewhat inconspicuous and do not readily nest near human habitations (Woods 1995a) and shrike in dense, tall grass can be harder to see than those perching on exposed fenceposts. No only might this bias abundance estimates between habitat types, but it could change the timing of survey efforts. For example, in Alberta nests are easily seen so surveys could be effective in early June, while in Manitoba, nests are hard to see and surveys should take place after the young have fledged (Telfer et al. 1989).

Once baseline population estimates have been determined based on a thorough survey of the area, monitoring should be conducted on a regular basis. For areas experiencing declines, checking nest site yearly is highly recommended (Hall and Legrand 2000), since nest territories are often reused and changes can be swift. Ontario conducts regular monitoring with a province-wide survey every 5 years (Cuddy 1995).

To determine side fidelity and/or reproductive success, capture, marking, and recapture can be conducted using modified Bal-Chatri or Potter traps with lab mice or Zebra Finches as bait (Yosef 1996, Brooks and Temple 1990b, Kridelbaugh 1983). Banding may affect survival of young, since wing-tags can get entangled in vegetation (Yosef 1996), but nestlings can be marked with fingernail polish on their talons or colored dye on their breast feathers (Porter et al. 1975). Nests should be visited at least every couple of days to determine survivorship.

Research

Several key research objectives to facilitate management have been noted by other sources, most of which seek to elucidate causes for the wide-spread decline of the species (Yosef 1996):

1. Regional Differences: Certain geographic regions (Coastal Flatwoods, Highland Rim, Ozark-Oachita Plateau, Intermountain Grasslands, Eastern BBS Region, and the Western BBS region) and specific time periods (76-79) were shown to have large declining trends. The largest region of relatively stable populations consists of the High Plains and Great Plain Roughlands strata along the western portion of the Great Plains from Montana and western South Dakota to eastern Colorado; the Edwards Plateau of Texas and the state of Louisiana also support fairly stable populations. Studies should focus on these areas/times to provide an insight into the causes of the decline (Peterjohn and Sauer 1995). Comparing different populations is the best method of finding where the problems are, and will allow identification of regions that are population sources and those that are sinks. For example, it would be useful to conduct further studies comparing declining populations to stable populations with respect to habitat-use, fragmentation, nest success, pesticide use, and resident versus migratory ecology.
2. Migratory and Wintering Habitat: CBC and BBS data suggest that regions with higher than average winter densities had declining trends of greater than 2%, which supports the need for more studies on winter survival (Yosef 1996). However, since we do not know where breeding birds winter, it is impossible to directly relate wintering to breeding populations (Sauer et al. 1995, Yosef 1996). Therefore it is important to determine migration routes, stopover and wintering areas, and susceptibility to human disturbance. For instance, why do some areas have higher return rates than others?
3. Pesticides and Toxins: Further studies are needed to access the affects of pesticides and toxins on Loggerhead Shrike, especially the concentration levels that produce direct health affects (Yosef 1996) and those that reduce prey levels to critically low levels.

4. Food Availability: evaluate shrike dietary needs and how weather, season, land use, and biocides influence food availability.
5. Biology: We still know relatively little about what contributes to mortality across the life stages of shrike and there has been no systematic study on life span and adult survivorship due largely to difficulties from undetermined levels of dispersal between breeding seasons (Yosef 1996). It is therefore important to determine mortality rates of fledged juveniles and adults throughout the annual cycle in different habitats, at the same time elucidating factors contributing to mortality and to causes of decline. Also, few data on disease and body parasites, which may be an important link in the wide-spread decline of shrikes (Yosef 1996). Finally, it would be valuable to determine degree of niche overlap between Loggerhead Shrike and potential competitors to see whether shrike productivity is correlated with the presence or absence of these species.

Tables and Figures

Table 1: Abundance trend estimates for Loggerhead Shrike by Bird Conservation Region taken from the Breeding Bird Survey (Sauer et al. 2004). All regions but one show negative trends over the 1966-2003 period (* 18 out of 24 being statistically significant).

		1966-2003 trends						1966-1979			1980-2003		
Credibility	Region	Trend	P	N	(95% CI	)	R.A.	Trend	P	N	Trend	P	N
Red	Great Basin	-2.3*	0.00	109	-3.8	-0.8	1.21	-5.4	0.00	35	-0.4	0.71	93
Yellow	Northern Rockies	-9.2*	0.01	37	-15.4	-3.0	0.33	-9.4	0.25	14	-6.3	0.14	35
Red	Prairie Potholes	-4.2*	0.01	112	-7.3	-1.1	0.69	-10.0	0.00	46	-0.3	0.84	93
Yellow	Lower Great Lakes/ St.	-22.0*	0.01	9	-33.5	-10.4	0.03	-19.0	0.12	6	-34.2	0.01	3
Yellow	Southern Rockies/colora	-8.3*	0.01	58	-14.1	-2.4	0.77	-9.3	0.01	13	-0.4	0.89	55
Blue	Badlands and Prairies	-0.5	0.64	80	-2.4	1.5	1.63	0.0	1.00	34	0.9	0.61	73
Blue	Shortgrass Prairie	-0.5	0.78	89	-3.7	2.8	2.05	-4.3	0.20	23	-0.2	0.82	87
Blue	Central Mixed Grass Pra	-4.4*	0.00	88	-6.1	-2.7	2.64	-5.1	0.00	58	-2.8	0.00	80
Yellow	Edwards Plateau	1.2	0.74	12	-5.5	7.9	0.76	24.9	0.30	5	-9.0	0.00	12
Blue	Oaks and Prairies	-5.7*	0.00	61	-8.3	-3.1	3.40	-3.8	0.06	38	-5.2	0.00	59
Blue	Eastern Tallgrass Prair	-5.7*	0.00	107	-7.8	-3.7	1.19	-7.4	0.00	65	-4.7	0.00	96
Yellow	Prairie Hardwood Transi	-8.0	0.54	2	-26.1	10.1	0.01	--	--	--	--	--	--
Yellow	Central Hardwoods	-7.2*	0.00	86	-9.0	-5.5	0.96	-4.5	0.01	66	-8.5	0.00	77
Blue	West Gulf Coastal Plain	-7.7*	0.00	52	-10.6	-4.8	1.34	-10.3	0.00	42	-7.4	0.00	45
Blue	Mississippi Alluvial Va	-0.7	0.67	43	-3.8	2.4	3.80	0.3	0.88	22	0.8	0.75	42
Blue	Southeastern Coastal Pl	-4.2*	0.00	187	-6.0	-2.3	1.84	-2.2	0.05	118	-3.0	0.00	171
Yellow	Appalachian Mountains	-5.2*	0.02	42	-9.3	-1.1	0.16	-9.1	0.00	26	-4.1	0.06	27
Yellow	Piedmont	-12.5*	0.00	48	-15.7	-9.3	0.70	-15.4	0.00	32	-9.8	0.00	32
Blue	Peninsular Florida	-3.7*	0.00	46	-5.5	-1.9	6.16	-0.4	0.86	21	-3.6	0.02	40
Blue	Coastal California	-2.9*	0.01	66	-5.0	-0.8	2.32	-6.9	0.04	49	0.5	0.71	56
Blue	Sonoran and Mojave Dese	-1.9*	0.04	58	-3.6	-0.2	3.31	-5.1	0.18	24	-3.8	0.00	52
Blue	Sierra Madre Occidental	-2.1	0.29	16	-6.0	1.7	1.29	-3.6	0.75	6	-3.5	0.15	14
Red	Chihuahuan Desert	-3.1*	0.01	34	-5.0	-1.1	3.32	-11.8	0.00	16	-2.7	0.09	31
Yellow	Tamaulipan Brushlands	10.0	0.08	8	0.6	19.5	0.25	10.0	0.61	2	-2.7	0.83	7
Blue	Gulf Coastal Prairie	-2.6*	0.03	26	-4.8	-0.4	9.42	-0.1	0.98	11	-3.4	0.03	24

Credibility measures:

Red (●) reflects data with an important deficiency (e.g., regional abundance is less than 0.1 birds/route; few routes (very small sample size), or results too imprecise to detect at 5%/year change.

Yellow (●) reflects data with a minor deficiency (e.g., regional abundance is less than 1.0 birds/route; not many routes (small sample size); results too imprecise to detect a 3%/year change; or inconsistency in trend over time).

Blue (●)reflects data with at least 14 samples in the long term, of moderate precision, and of moderate abundance on routes.

Figure 1: Photo of Loggerhead Shrike (*Lanius ludovicianus*); note the large eye mask that extends above the eye and the faint or absent barring on underparts. Photo by Chan Robbins

Figure 2: Photo of Northern Shrike (*Lanius excubitor*); note the smaller eye mask that does not extend above the eye and the noticeable barring on underparts. Photo by Jack Binch.

Figure 3: Rangewide distribution map for the Loggerhead Shrike

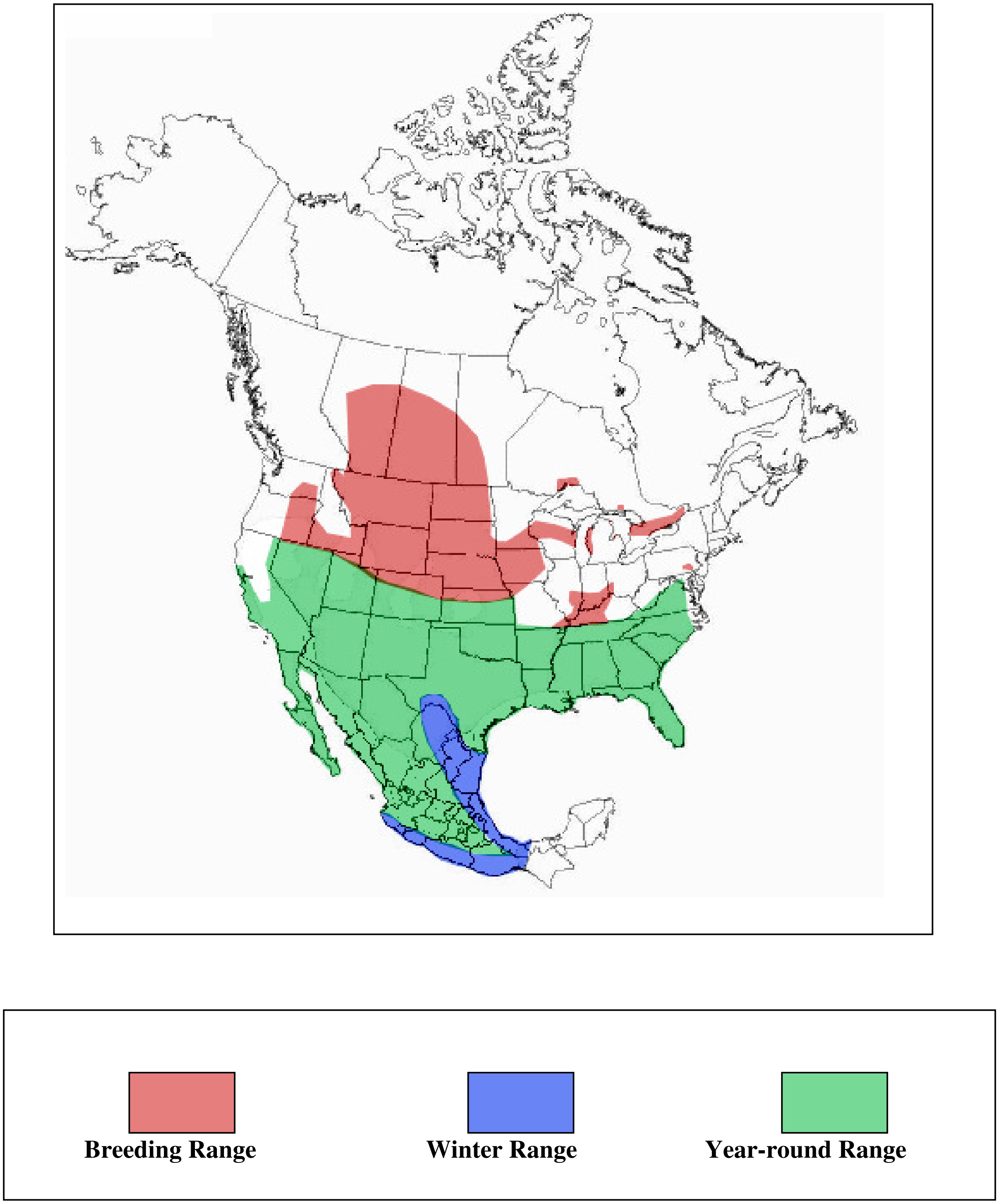


Figure 4. Estimated change in distribution of Loggerhead Shrike based on Cade and Wood (1997).

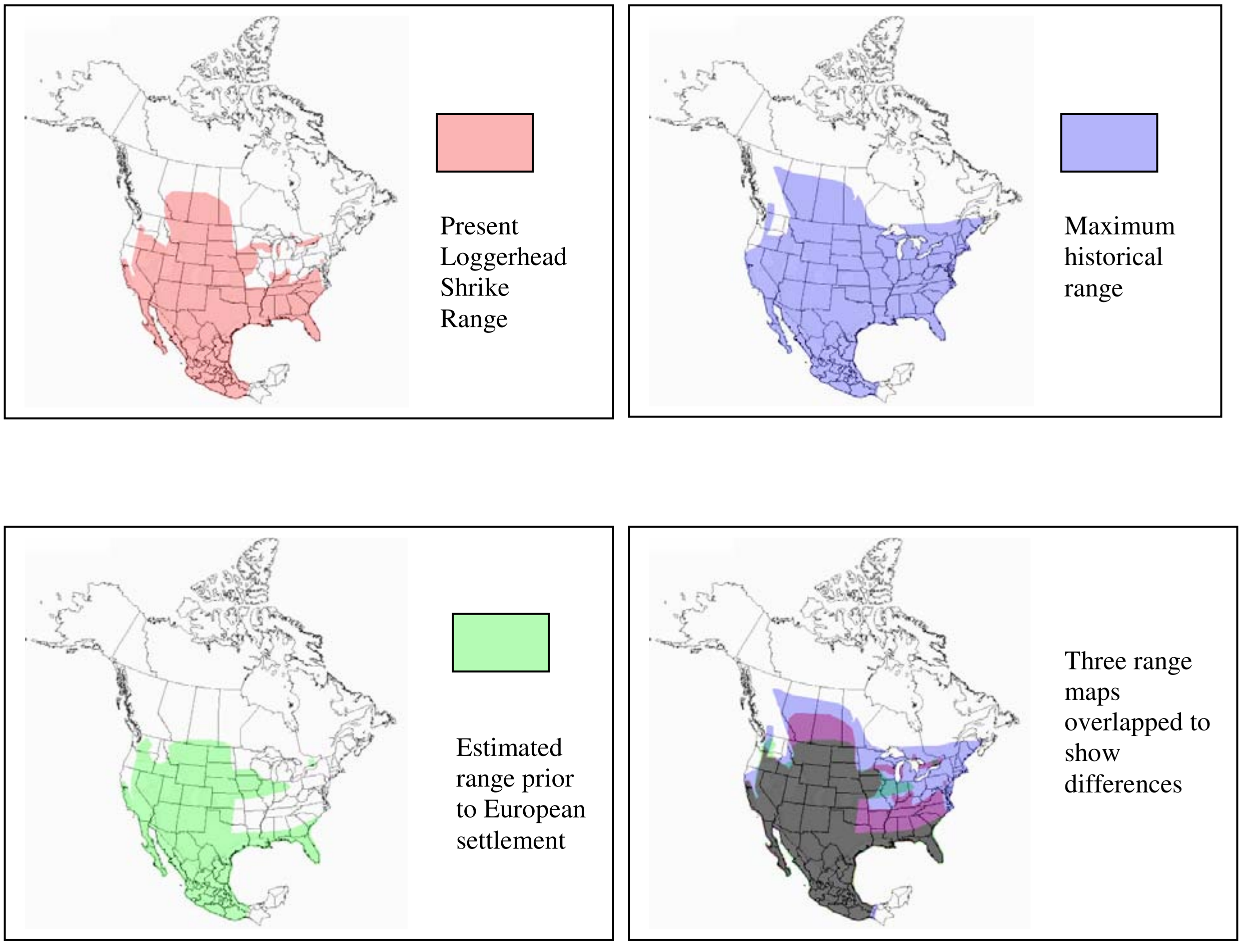


Figure 5: Distribution of Loggerhead Shrike in Wyoming.

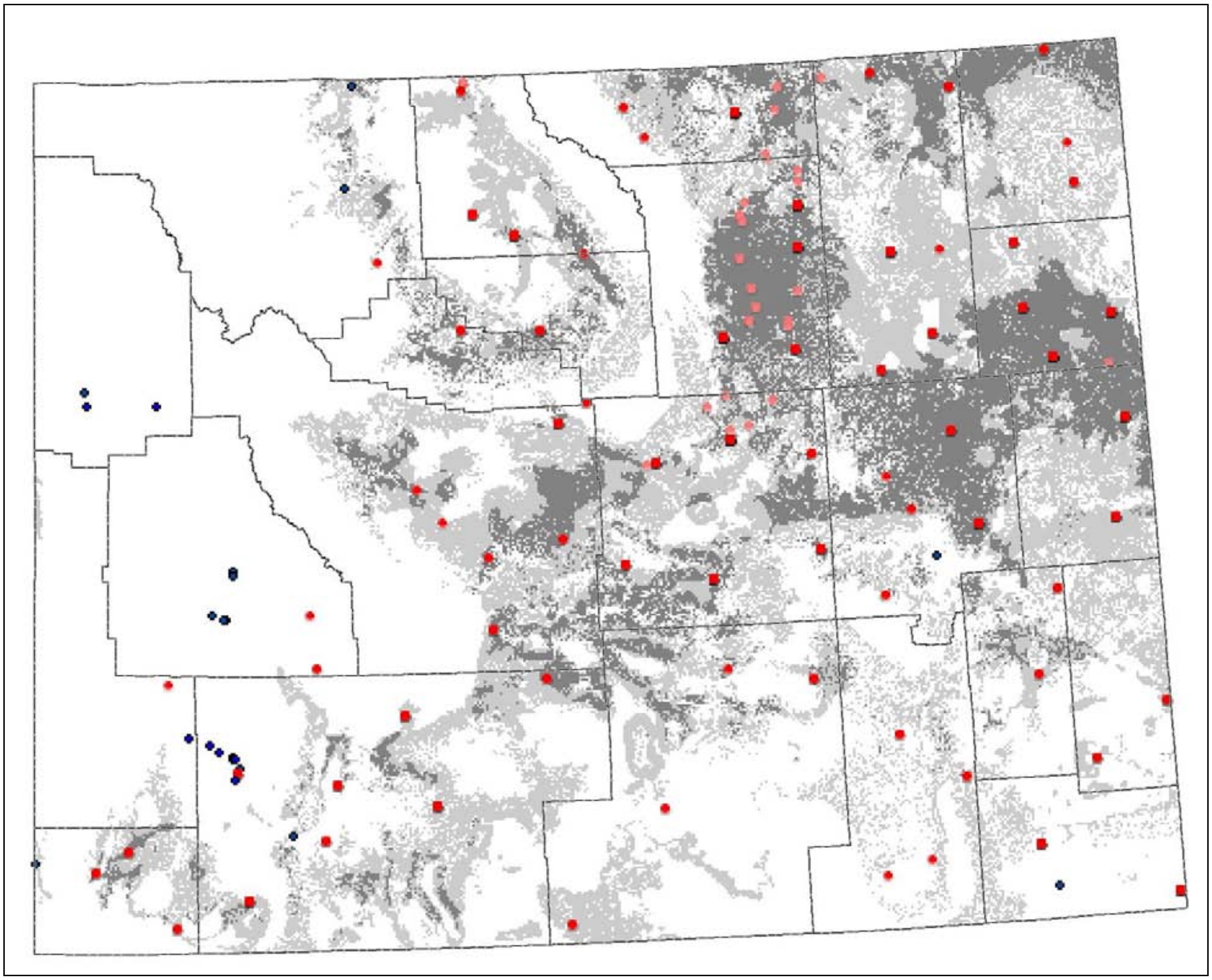
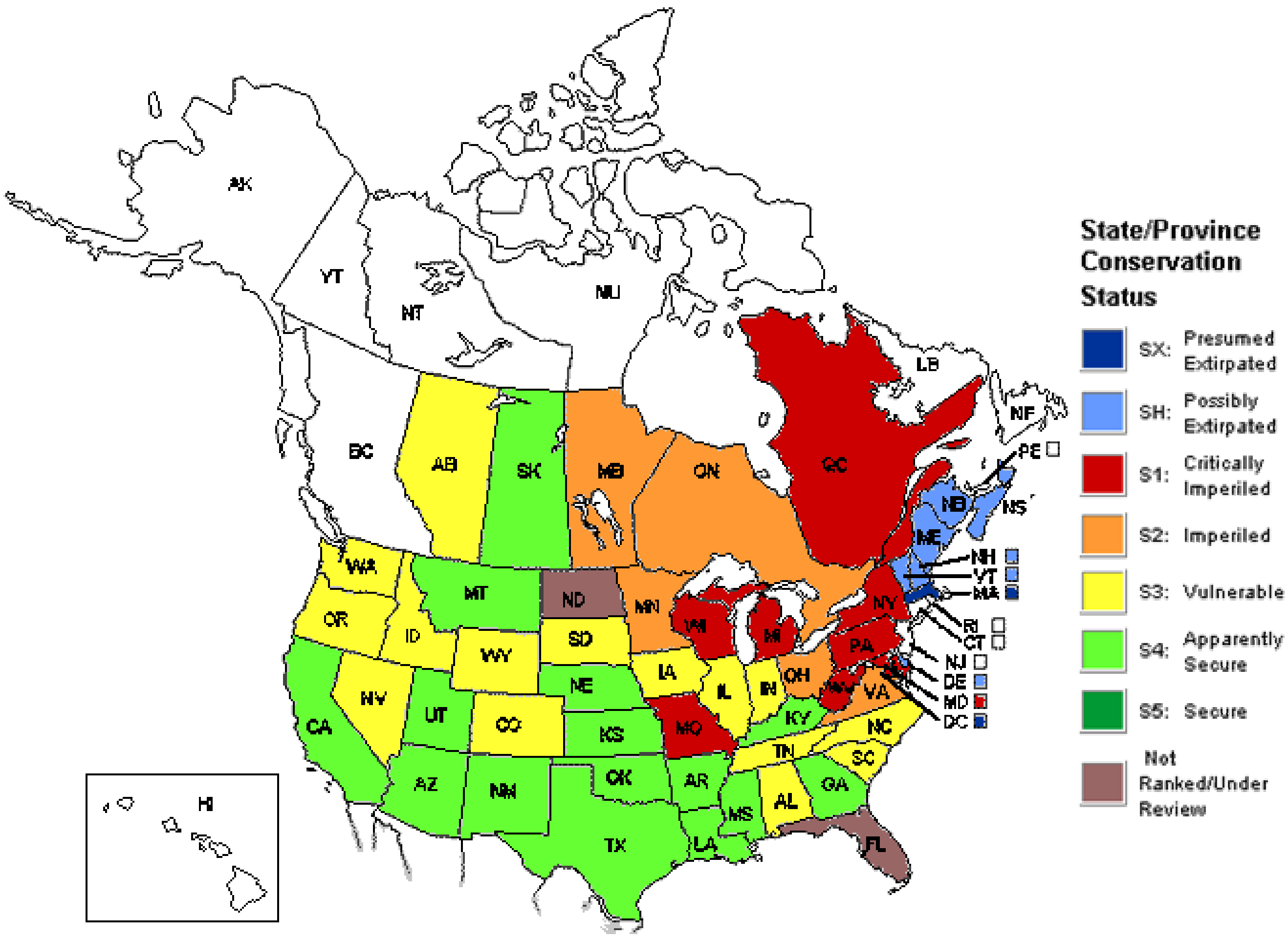


Figure 6: State Heritage Ranks of Loggerhead Shrike and its subspecies.



United States Ranks: Alabama (S3B,S5N), Arizona (S4), Arkansas (S4), California (S4), Colorado (S3S4B), Connecticut (SXN), Delaware (SHB), District of Columbia (SHN,SXB), Florida (SNR), Georgia (S4), Idaho (S3), Illinois (S3), Indiana (S3B), Iowa (S3B,S3N), Kansas (S4B), Kentucky (S4B,S4N), Louisiana (S4), Maine (SHB), Maryland (S1B,S1N), Massachusetts (SX), Michigan (S1), Minnesota (S2), Mississippi (S4B), Missouri (S1S2), Montana (S4), Navajo Nation (S4), Nebraska (S4), Nevada (S3), New Hampshire (SHB), New Jersey (SNA), New Mexico (S4B,S4N), New York (S1B), North Carolina (S3B,S3N), North Dakota (SU), Ohio (S2), Oklahoma (S4), Oregon (S3B,S2N), Pennsylvania (S1B), South Carolina (S3), South Dakota (S3S4B), Tennessee (S3), Texas (S4B), Utah (S4B,S3S4N), Vermont (SHB), Virginia (S2B,S3N), Washington (S3B), West Virginia (S1B,S2N), Wisconsin (S1B), Wyoming (S3).

Canadian Ranks: Alberta (S3B), Manitoba (S2S3B), New Brunswick (SHB), Nova Scotia (SHB), Ontario (S2B), Quebec (S1), Saskatchewan (S4B).

Figure 7: Loggerhead shrike distribution and abundance in summer based on Breeding Bird Survey data from 1994 – 2003 (Sauer et al. 2004).

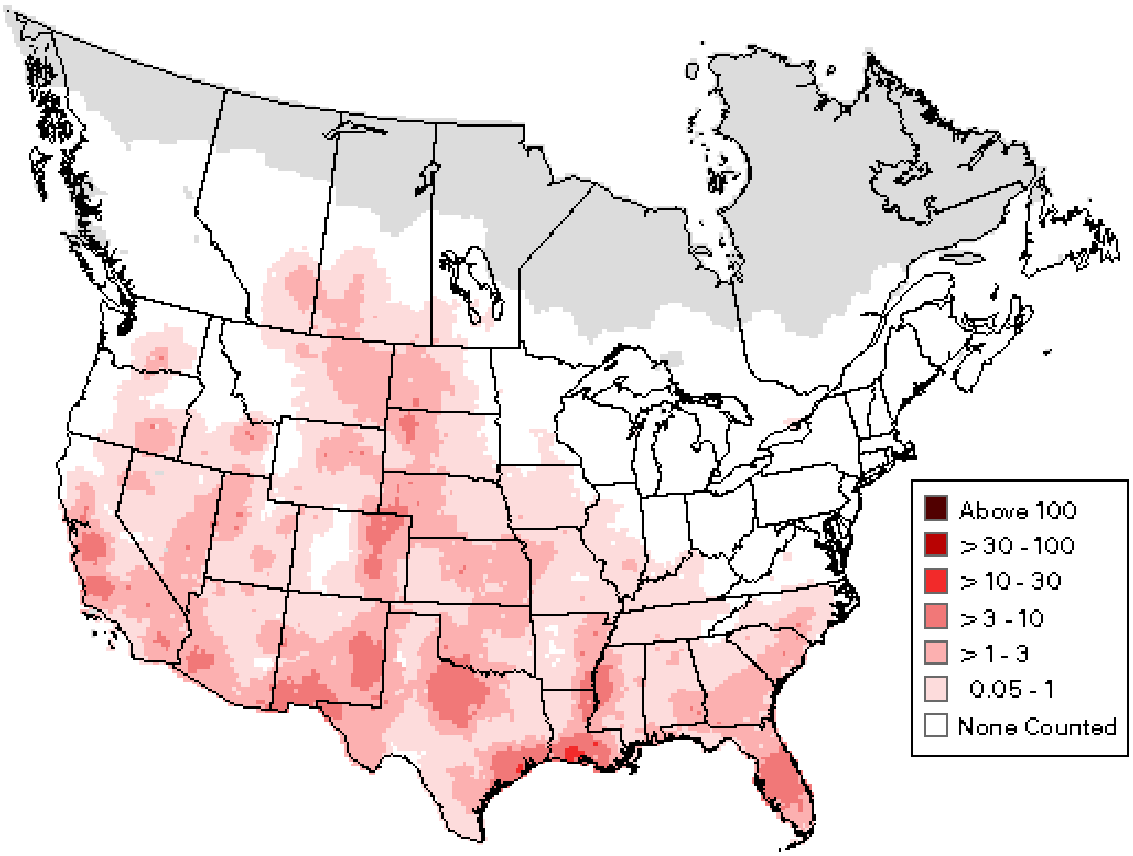
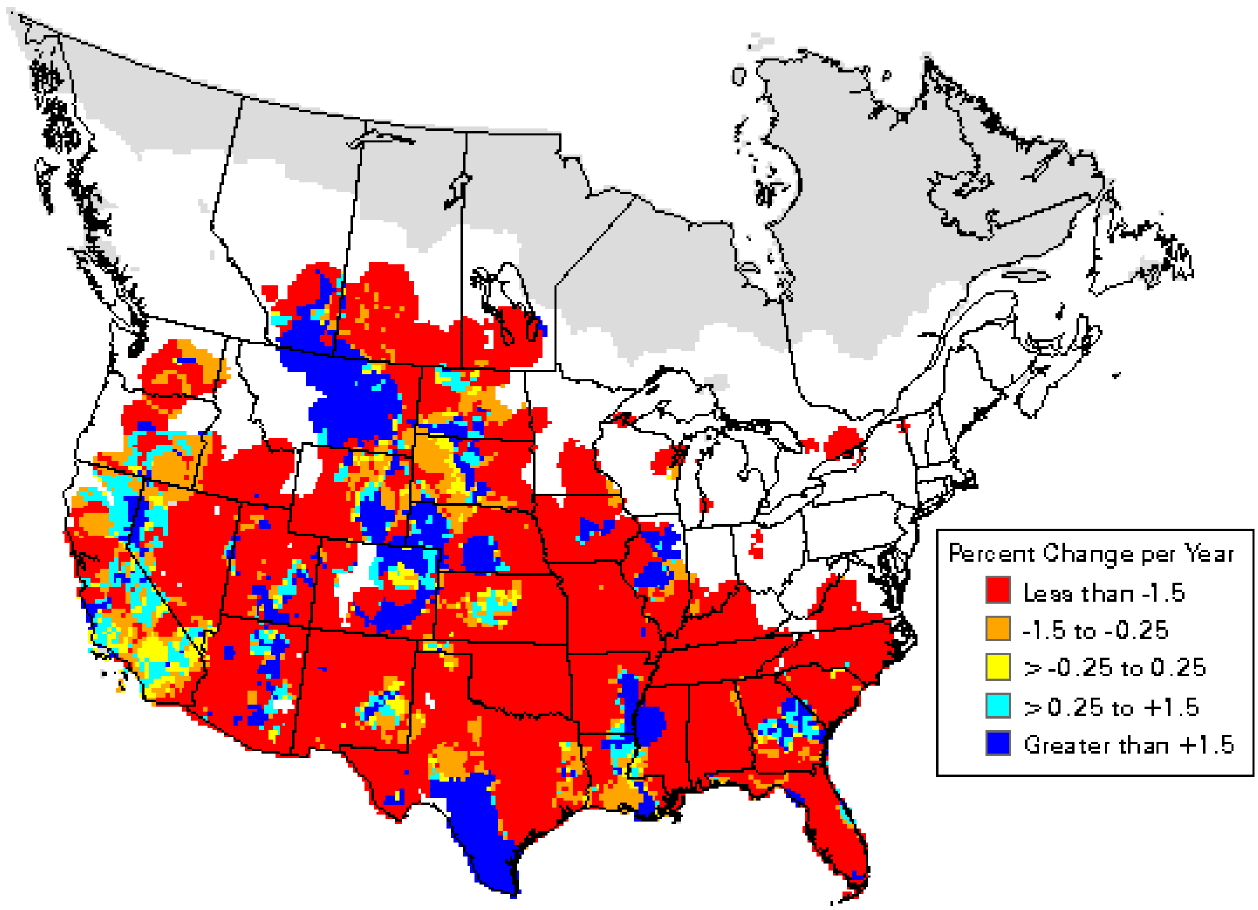


Figure 8: Trends in Loggerhead Shrike abundance from Breeding Bird Survey data over the period 1966 – 2003 (Sauer et al. 2004). The trend at any point was estimated as a weighted average of trend information from nearby survey routes containing information from the species.



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