Land-Use Changes in the Gulf Coast Region: Links to Declines in Midwestern Loggerhead Shrike Populations

Declining populations of Loggerhead Shrikes and other midwestern grassland birds that winter in the southern United States prompted this study of conditions on wintering ranges. We found loss of habitat was extensive because of changes in agriculture and forestry. Furthermore, the arrival and establishment of exotic fire ants renders many remaining patches of habitat unsuitable. Problems on wintering ranges may be more severe than those on breeding ranges.

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Many midwestern grassland birds have been declining for decades (Robbins et al. 1986). Among them, the Vesper Sparrow, Grasshopper Sparrow, Eastern Meadowlark and Loggerhead Shrike have shown particularly severe rates of decline. These birds share similar geographic ranges and habitat requirements both on their breeding and winter ranges. Loss of native grasslands to agricultural development and changes in farming practices on the breeding range in Wisconsin and other midwestern states have been blamed for the steady declines of grassland birds in the region (Blankespoor and Krause 1982, Vance 1976), but little attention has been directed to possible problems on the winter range. The winter ranges of midwestern grassland birds include the Gulf Coast region, which extends from Texas to Florida (Root 1988).

One bird of particular concern is the migratory midwestern population of the Loggerhead Shrike (*Lanius ludovicianus*). Loggerhead Shrikes are found as far north as southern Canada, across the entire U.S. continent, and down to Mexico. The Loggerhead Shrike is under consideration for placement on the federal Threatened and Endangered Species List. The shrike is already on Wisconsin's endangered species list. Fish and Wildlife Service Breeding Bird Surveys (Robbins et al. 1986) have recorded significant decreases in shrike populations throughout the bird's United States range. Their declines have been most

severe in Midwest, New England and Mid-Atlantic regions. According to Robbins et al. (1986), shrike populations in Wisconsin, Minnesota, Illinois, Michigan, Iowa and Indiana have dropped an average six percent annually over the last quarter century. If current rates persist, Wisconsin and nearby states could lose their shrike populations entirely within the next twenty or thirty years (Brooks and Temple 1990).

Although Wisconsin is near the northern edge of the shrike's breeding range, earlier this century shrikes bred across the southern, central and northwestern parts of the state (Kumlien and Hollister 1903). The birds began a slow decline in the 1930s. Although still fairly common summer residents in 1942, by the early 1960s few shrikes bred in the state each spring (Erdman 1970). Since then, Loggerhead Shrike numbers have continued to fall.

The factors behind the Loggerhead Shrike's decline in Wisconsin and neighboring states remain unclear. Inadequate reproduction because of pesticides, loss of suitable breeding habitat, and overwinter mortality have all been suggested as possible reasons.

When shrike populations in Illinois plummeted between 1957 and 1965, ornithologists speculated the grassland predator had fallen victim to pesticides. Anderson and Duzan (1978) found concentrations of the DDT metabolite, DDE, in Illinois shrikes. They suggested that the pesticides more likely were killing birds directly rather than interfering with their reproduction. Most organochlorines were banned in the U.S. by the 1970s. Yet shrike numbers continued to fall. Recent studies of shrike reproduction have found good reproductive success (Kridelbough 1983, Gawlik 1988, Brooks and Temple 1990).

Insufficient breeding habitat has also been suggested as a possible factor behind shrinking shrike populations. Midwestern land cover has changed from predominately small farms, with much pastureland, earlier in the century (Sample 1989), to large monocultures of alfalfa and corn. Yet a recent study in Minnesota (Brooks and Temple 1990) concluded that availability of breeding habitat was not limiting Loggerhead Shrikes. In fact, Brooks and Temple found suitable nesting areas vacant of shrikes. Breeding grounds in other midwestern and eastern states also seem to offer adequate nesting habitat. Where migrant shrikes are present, their reproductive rates appear normal. When breeding habitat is not limiting and reproduction is good, overwinter mortality may be behind the declines (Temple 1988).

Migrant shrikes leave midwestern breeding grounds between August and November. They spend the winter months in the Gulf Coast states of eastern Texas, Louisiana, Mississippi, Alabama, Georgia and Florida. In the wintertime, as during other times of the year, shrikes require open grassy areas such as pastures and old fields where they can spot and hunt prey (Brooks 1988). The Gulf Coast region has undergone tremendous changes in land-use patterns during the last 40 years: intensive rice cultivation in eastern Texas and in Louisiana, expanding forestry plantations in Mississippi, Alabama, Georgia and on Florida's panhandle, and the invasion of an aggressive exotic insect, the red fire ant. All these changes have reduced the area and carrying capacity of shrike habitat.

The negative effects of these changes would likely be felt most severely by migrant shrikes. If habitat becomes limiting, resident Gulf Coast shrikes—which are themselves declining—will defend the best quality habitat for themselves, forcing winter visitors to use marginal land. Resident shrikes defend year-round territories against other shrikes (Miller 1931), giving Gulf Coast residents a competitive edge. Reduced suitability of wintering habitat would decrease migrant shrikes' chances of overwinter survival (Brooks 1988).

In spite of reproductive success and nonlimiting habitat on breeding grounds in the Midwest, shrike numbers throughout the region continue their downward trend. Little research has been directed at possible problems migrant shrikes and other grassland birds face during the wintertime. This study focused on the Loggerhead Shrike. Its objective was to: (1) investigate and document habitat trends in the Gulf Coast region that could offer clues to the shrike's and other grassland birds' decline, and (2) statistically test for a link between these trends and changes in Loggerhead Shrike populations.

Quantitative Data Collection

Census of Agriculture—We used the Census of Agriculture, taken by the U.S. Department of Commerce, Bureau of the Census, "the nation's leading source of statistics on agricultural production," to track habitat available to shrikes in the Gulf Coast. The census is the only data source that provides consistent and comparable long-term data on a county-by-county level. Since 1925, the Department of Commerce has taken a census every five years. It covers roughly 90 percent of U.S. farms and can account for more than 96 percent of the nation's agricultural production. The census provides acreage figures, on a county level, for various agricultural land-uses.

In addition to native grassland habitats, Loggerhead Shrikes live on rangeland, pastures and along the edges of cultivated fields, and other so-called "waste" areas (Owens and Myres 1973). Accordingly, two of the census land-use categories were judged to provide useable shrike habitat for the purposes of this study. The two categories are defined by the census as follows: (1) cropland used only for pasture and grazing: "this category covers rotation pasture and grazing land that could have been used for crops without additional improvements" and (2) other land: "includes pastureland and rangeland other than cropland and woodland pasture, and house lots, barn lots, ponds, roads, wasteland, etc."

Land-use data were collected for the time period 1950 to 1987. The total area covered by the two land-use categories was determined for each county within the shrike's Gulf Coast wintering range. We regarded this total land area as available shrike habitat. For analysis purposes, areas of available shrike habitat for each county, for each year, were expressed as a percentage of a given county's total land area (also listed in the census).

Although the census provided the best available statistics on agricultural land-use changes, it did present some limitations. Land-use data were available only every five years. In addition, available shrike habitat, as we defined

it, did not include other possible areas inhabited by shrikes, such as parks, wildlife refuges, or private land other than farmland.

Christmas Bird Counts—To track wintertime Loggerhead Shrike populations in the Gulf Coast region, Christmas Bird Count (CBC) data were used. These counts include both year-round resident shrikes as well as migrant visitors. The National Audubon Society has sponsored the annual count since its inception in 1900. The counts take place within a 15-mile diameter circle on a single calendar day within two weeks of December 25. Data available from each CBC include the number of hours parties of observers spent counting birds and how many of a given bird species they counted. To reduce variation due to count effort, shrike abundance is expressed as the average number of individual birds counted per hour by parties of observers (Root 1988). All CBC data for each county were averaged to produce the number of shrikes per party-hour in each county each year.

We analyzed shrike data from CBCs for the states of Texas, Louisiana, Mississippi, Alabama, Georgia and Florida from 1950 to 1987. Counts taken in 1960 to 1987 were obtained from Bird Population Studies at Cornell Laboratory of Ornithology. CBCs published in *American Birds* were used for the years 1950 to 1959.

While it serves as a good index of bird populations, CBC data do have limitations. Observers possess different levels of expertise. The intensity of observer effort varies between sites and years, as do weather conditions. All these factors have an effect on the number of birds counted (Robbins and Bystrak 1974, Verner 1985).

Fire Ants—Since the 1930s, when introduced red fire ants first began their invasion of the South, the U.S. Department of Agriculture (USDA) has tracked the insects' annual movements on a county-by-county basis. Each year the department designated counties as either free of or infested with fire ants. Fire ants are, therefore, either absent from a county or present. Once fire ants invade a county, they become a constant; all efforts by USDA to eradicate the ants have failed.

Data Quality—Data availability was not uniform for all counties and years. Census data is available only every five years. Some CBCs did not start until the 1960s and not all counties within the shrikes' range had CBCs. A total of 103 counties had both Census of Agriculture and CBC data: eastern Texas (35), Louisiana (11), Mississippi (10), Alabama (7), Georgia (15), and Florida (25). The differences in the number of counties for each state are mainly results of variation in the number of CBC sites in each state.

Supplemental Data—Rice figures for the coastal plains of Texas and for Louisiana were obtained from each state's Agricultural Statistics Department. Agricultural Stabilization and Conservation Service (ASCS) offices in all gulf states and Wisconsin supplied information on the acres of land enrolled in the federal Conservation Reserve Program, which encourages farmers to shift marginal lands from crops to a permanent cover of grass or trees.

Qualitative Data Collection

In March 1990, a two-week trip to the Gulf Coast region was undertaken in order to gain a better understanding of these data by talking with wildlife and fisheries departments, ornithologists, agricultural economists, soil conservationists, and agricultural extension agents.

Results

Shrike Population Trends—Trends in winter shrike populations showed declines in eastern Texas, Florida, Alabama and Mississippi. Georgia and Louisiana winter shrike populations appeared relatively stable. Overall shrike abundances were highest in eastern Texas and Florida and lowest in Georgia. Louisiana shrike counts were equal to or higher than Florida's beginning in the mid-1970s. It should be noted that with the exception of eastern Texas and Florida, shrike counts in early years (1950–1955) were based on a low number of count sites.

Agricultural Land-Use—Land-use trends show increases in shrike habitat in all states in early years, particularly in Texas and Florida, and decreasing trends thereafter. Between 1964 and 1987, Louisiana lost 2.1 million and Mississippi 2.7 million acres of suitable habitat. Since 1954, suitable habitat acreage declined in Alabama by 1.5 million acres and in Georgia, since 1969, by 1.2 million acres. Texas had the largest area of available habitat (range: 81,193,646 to 106,020,210 acres). Florida comes next (range: 5,090,125 to 7,630,728 acres). The rest of the states had less habitat with the least shrike habitat in Georgia. Suitable habitat peaked in 1969 and began to decline thereafter in the Gulf Coast region. There was a significant correlation ($r = +0.382$, $n = 575$, $p < 0.001$) between the number of shrikes per party-hour observed in a county and the area of suitable habitat in the county between 1950 and 1987. There was a significant correlation ($r = +0.433$, $n = 53$, $p < 0.001$) between the number of shrikes per party-hour in counties aggregated to a state-level and the area of suitable habitat in counties aggregated to a state-level between 1950 and 1987.

Red Fire Ants—Accidentally introduced in Mobile, Alabama in the 1930s, the imported red fire ant probably arrived in ballast dirt onboard cargo ships from its native South America. It originated in the floodplains of the Pantanal, where frequent heavy floods scour the land. The ants are remarkably adept at colonizing disturbed ecosystems.

The warm, moist Gulf Coast, free of natural predators, suited the red fire ants, and they began to spread rapidly. Through mating flights, by hitchhiking in nursery or construction soil, or by forming "ant rafts" during floods, the insects had reached the southeast corner of Mississippi and the northwest tip of the Florida panhandle by the 1940s. Twenty years later, the insects had completely infested most of the Gulf Coast region (Vinson and Sorensen 1986).

Today the ants are found on 250 million acres of land; they are firmly entrenched in all Gulf Coast states except for Texas. The deserts of western Texas have slowed their progress, but entomologists expect the opportunis-

tic insect will continue to move west, taking advantage of natural water bodies and irrigated land (Vinson and Sorensen 1986).

Because they were considered a serious pest, fire ants sparked a huge eradication program. Between 1957 and 1977, World War II bombers sprayed the region with the insecticides dieldrin, heptachlor and mirex (Revkin 1989, Yoffe 1988, Vinson and Sorensen 1986). The deluge of toxics took a heavy toll on many insects, invertebrates, birds and mammals, and moved Rachel Carson to write *Silent Spring* (Vinson and Sorenson 1986). Meanwhile, the pesticides only temporarily controlled fire ants, who returned after each spraying in even higher numbers (Yoffe 1988). By 1977, the use of insecticides for controlling fire ants was curtailed (Revkin 1989). Today, fire ants are controlled mainly through localized treatments such as mound drenches, surface dusts, fumigants or baits. There was a significant correlation (r=—0.195, n= 575, $p< 0.001$) between the number of shrikes per party-hour in a county and the number of years since fire ants first invaded the county.

Rice Cultivation—Rice cultivation took off in the southeastern coastal prairies of Texas and in southwestern Louisiana in the early 1940s (Dethloff 1988). Advanced, new equipment, such as combines and dryers, gave farmers the tools to vastly expand their acreages. Texas rice acreage went from 110 acres in 1850 to a high of 642,000 acres in 1954 (Texas Almanac 1990). Between the 1940s and 1950s alone, rice acreage in the state jumped sixfold (DOC, 1959).

Historically, the natural land cover in these areas had been tallgrass prairie and small natural wetlands (D. Robertson, personal communication). In the 1940s, farmers planted pastureland and old fields to rice and began to remove natural hedgerows and fences previously used for cattle (Brooks 1988). According to Brazoria, Texas, agricultural extension agent John Wood: "Farmers have rotated rice acreage with cattle since the 1940s: rice one year, then cattle two years. In 1973, when the price of rice was real good, farmers got rid of cattle and took down all the fences that go with them."

After peaking in the 1950s, the amount of land devoted to rice declined, but the intensity of production remained high. Texas reported record production in 1981 (Texas Almanac 1990) and today grows two crops of rice in a season. Farmers harvest the first rice crop in late July and the second in October (A. Gerlow, personal communication). In Louisiana, rice plots are generally much smaller than in Texas and farmers rotate their rice fields with soybean crops every one or two years (A. Gerlow, personal communication). The see-saw trends of both Texas and Louisiana rice reflect federally driven market policies (Dethloff 1988, Daniel 1985).

Texas farmers rotate rice plots with low quality grazing land. Rice is grown on the plot one year, and the following two years, farmers run their cattle on the land (J. Engbrock, J. Wood, A. Gerlow, personal communications).

Only scattered weeds grow on recently abandoned rice fields, and fire ants rapidly colonize the bare soil (B. Dres, personal communication). As the fields become overgrown with weedy red rice and bermuda grass, grasshop-

pers and other insects gradually return, but the ant-infested land produces little food for shrikes. Fallow fields not grazed quickly become overgrown with tall vegetation that interferes with shrike hunting (D. Robertson, personal communication).

Forestry—The South has always been the nation's leading producer of pulpwood. Timber industries play an important economic role in the region (Barrett 1962). Over the past few decades pine monocultures have been planted on previously open land, as farmers converted their marginal agricultural land (mostly pastures and old fields) to slash pine (Jones and Mirarchi 1989). Much of the land in the region set aside under the federal Conservation Reserve Program (CRP) is now going into pine stands (J. Hartley, personal communication). With the exception of Texas, which plants virtually no trees on CRP land, the Gulf states plant the majority of CRP land to trees. In comparison, Wisconsin farmers convert most of their erodible cropland to permanent grass cover.

According to agricultural economist Bud Diller at Mississippi State University, many farmers opted to place erodible land in slash pine because the trees are more profitable than pastureland: "Just fifteen years ago [in Alabama], you had little ol' part-time cattle farms. Now much of that land has gone to trees. The cattle just can't pay for building fences."

Commercial forestry has also expanded onto formerly open land. In Mississippi, commercial forestry is a big business that has turned former pastureland and old fields to pine plantations (B. Diller, W. Couvillion, J. Waldrop, personal communications). Between 1934 and 1953, commercial forestland in Georgia increased by 12 percent, or 2.6 million acres. Most of the land came from abandoned farmland (Georgia Forestry Commission 1953). Today, 64 percent—23.6 million acres—of the land area in Georgia is covered with forestland. Tree planting and natural succession on abandoned farmland has made up nearly 94 percent of timberland increases since 1982 (Thompson 1989).

As of 1987, forestland in Florida covered 43 percent of the state. Pine plantations made up 27 percent of the state's forests—the highest proportion of any state in the Southeast (Brown and Thompson 1987). As farmers in Florida have moved orange groves in the state further south, pine monocultures have replaced areas formerly planted in orange groves (J. Cox, personal communication).

Discussion

The winter range of migratory Loggerhead Shrikes from Wisconsin and other midwestern states has clearly undergone many changes during the past 50 years. Many of these changes have resulted in reduced areas of habitat being available to migrant shrikes and reduced carrying capacities of even those areas that remain suitable. Agriculture and forestry have reduced the area of shrike habitat, and fire ants have reduced prey populations on areas of potential habitat.

Fire ants and loggerhead shrikes often share the same habitats, especially pasturelands, old fields, and fallow croplands. Fire ants are a direct food competitor with shrikes. Shrikes eat mainly grasshoppers, crickets, beetles and other insects but also feed on rep-

tiles, amphibians, small mammals and the occasional small bird (Howell 1928).

Fire ants are aggressive predators that feed on whatever prey is readily available (Wilson and Oliver 1968). The larvae of grasshoppers and a host of other insects make up the bulk of their diet (Hays and Hays 1958). Fire ants have been known to attack and sometimes kill newborn pigs, calves, and birds. They also destroy seedling corn, soybeans and even girdle young trees (USDA n.d.). Fire ants present a threat to a plethora of flora and fauna. When they invade an area, the ants reduce the abundance and diversity of potential shrike prey (R. Mount, H. Thorvilson, personal communications).

The enormous amount of insecticides used to control fire ants probably posed a greater threat to Loggerhead Shrikes than the ants themselves. By killing off many insects and other small animals, the insecticides reduced shrikes' prey. The poisons may also have directly killed loggerhead shrikes. Collins et al. (1974) found that out of two dozen bird species found on ant-control areas, Loggerhead Shrikes accumulated the highest concentrations of mirex. The possible affects of the pesticide on shrikes were not well researched. At two parts per million, the insecticide dieldrin killed shrikes. At lower doses it negatively affected their hunting ability (Busbee 1977).

The presence of the introduced red fire ant is probably a major but so far largely overlooked factor affecting migrant shrikes and other grassland birds. Because of expanding agriculture, a growing portion of shrike habitat in the Gulf Coast region is fallow croplands, the most preferred habitat for fire ants, where 40 ant mounds per acre have been recorded (Vinson and Sorensen 1986). As shrikes come to depend more and more on fallow cropland, fire ants have become an increasing threat.

Shrikes lost habitat when grassland areas in the Gulf Coast region were converted to rice or pine plantations. Cereal crops provide poor foraging opportunities for shrikes, particularly when hedgerows and fences are absent. The birds need perches to employ their "sit-and-wait" strategy when hunting for prey. It is also questionable how much use Loggerhead Shrikes can get out of rotation pastureland that is only available for one to two years between crops. Initially devoid of animal and plant life, then colonized by fire ants, these areas have low carrying capacities for shrikes. Grazed fallow land may actually be more useful to shrikes than non-grazed idle land. Shrikes require low vegetation in order to locate and capture prey on the ground. If ungrazed, fallow rice fields rapidly grow into a dense and high cover of weeds that precludes use by shrikes.

Shrikes are able to utilize pine plantations only in their earliest stages. However, once tree cover becomes dense, the birds are no longer able to hunt for prey (Engstram et al. 1984). Slash pines grow very rapidly, and quickly close up open areas. The rapid, federally encouraged conversion of pasturelands, old fields, and marginal croplands to pine plantations in recent years (since 1988) portends large losses of shrike habitat in the coming years as trees mature.

Conclusions—Profound changes in agricultural practices in Wisconsin and

other midwestern states have drastically altered the habitat for breeding populations of Loggerhead Shrikes and other grassland birds (Sample 1989). Row-crops replaced native upland prairies and grasslands reducing the quality and quantity of habitat for many grassland bird species. Vesper Sparrow, Grasshopper Sparrow, Eastern Meadowlark, and other grassland bird populations have probably suffered as a result (Sample 1989). Meanwhile grain-eating birds such as the Red-winged Blackbird are able take advantage of row-crops and are thriving. The land acreage set aside as pasture or returned to native grassland under the federal Conservation Reserve Program marks a positive trend for grassland birds in midwestern states.

Similar agricultural changes have taken place on the wintering range of Loggerhead Shrike and other grassland bird populations. Again, grasslands and pasturelands gave way to row-crops. Monocultures of rice and soybeans eliminated many fenced pastures and thereby perch sites and prey availability for Loggerhead Shrikes (Brooks 1988). Faced with large expanses of row-crops, Loggerhead Shrikes are frequently found along the roadsides and edges of these fields. These narrow strips of pesticide-free land, where vegetation is often kept short by mowing, probably serve as a last hunting haven for shrikes in many highly developed agricultural areas (R. Hamilton, personal communication). As in the Midwest, populations of grain-eating birds are climbing.

Other changes in the Gulf Coast region are very different from changes that have occurred on midwestern breeding grounds. The strong trend toward vast monocultures of pine plantations have reduced the amount of available habitat for shrikes and other grassland birds. This trend seems likely to continue as marginal agricultural land in the Gulf states goes predominately into trees under CRP. Further, the infestation of the aggressive red fire ant has lowered the quality of range and pastureland on which shrikes and other bird species have come to depend. Some areas that appear to offer suitable habitat are sparsely populated by animal life when fire ants are present, which lowers the carrying capacity of these areas for shrikes and other grassland birds (R. Mount, personal communication). The results of this study show that the Loggerhead Shrike and other midwestern grassland birds that winter in the Gulf Coast region have lost large areas of habitat and that even remaining areas of habitat are of reduced value because of fire ants.

As in the Midwest, these alterations probably negatively affect breeding grassland bird populations. For such ground nesters as the Eastern Meadowlark, the presence of the red fire ant may be particularly problematic (R. Mount, personal communication). Local Loggerhead Shrike populations may be limited by inadequate roost sites and hunting areas. These limitations affect migrant shrikes more severely. Prey availability is already reduced in the winter months and migrant shrikes must contend with lower quality habitat than their resident Gulf Coast counterparts.

Habitat loss and, probably more importantly, degradation on Gulf Coast wintering grounds are likely contributors to the decline of midwestern Loggerhead Shrike and other grassland bird populations. The correla-

tions between shrike CBCs and suitable habitat and between shrike CBCs and years since fire ants were significant but somewhat weak, probably because of the nature of the data used. Suitable habitat, as defined by the two census land-use categories, probably includes habitat that shrikes and other grassland birds can not use. Varying ranges of habitat quality between regions were lost under this very broad definition. For example, although certain apparent patterns emerged: Texas had both the highest percent available habitat as well as the highest shrike abundance, while Georgia had the lowest percent available habitat and lowest shrike abundance, shrike counts in Louisiana were relatively high and stable, in spite of apparently declining habitat.

The uncertainties associated with CBCs may also have clouded any connection between Loggerhead Shrike declines and habitat changes. Many CBC count sites take place near wildlife refuges and parks or near cities. The birds observed near such areas may not be a fair representation of how populations are faring in strictly agricultural areas. Breeding Bird Surveys of Gulf Coast Loggerhead Shrikes may yield more conclusive cause-effect relationships between changing habitat and bird populations.

Yet in spite of data limitations, we still found a significant positive correlation between Loggerhead Shrike abundance and habitat, and a significant negative correlation between shrike numbers and the presence of fire ants. It seems likely that agriculture, forestry and the presence of the imported red fire ants are factors that limit Loggerhead Shrikes in the Gulf Coast region.

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