

No evidence for observer effects on Lark Sparrow nest survival

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ABSTRACT. Methods for monitoring bird nests might influence rates of nest predation, but the effects of various methods (e.g., visual markers and observer visitation rates) are often separately investigated among disparate avian taxa and geographic regions. Few investigators have explored the potential effects observers might have on nest success of grassland birds, despite concerns regarding population declines of these species in North America. We examined the possible effects of three monitoring techniques on daily nest survival of Lark Sparrows (*Chondestes grammacus*): (1) presence or absence of visible markers near nests, (2) observer visitation frequency, and (3) presence or absence of data loggers in nests. We monitored 113 Lark Sparrow nests during the 2009 breeding season. Of these nests, 88.5% failed due to predation, abandonment, weather, or unknown causes, yielding an overall nest success estimate of 9.8% based on daily survival estimation. Main effects of each monitoring technique appeared in top ($\Delta AICc < 2$) logistic exposure models. However, 95% confidence intervals around parameter estimates for each technique included zero, indicating no significant effects on daily nest survival. Our results suggest that the nest-monitoring techniques we used had no effect on Lark Sparrow nest success and, if true, nest survival of other songbirds in arid grasslands of the Great Plains may also be unaffected by cautious nest monitoring. However, we cannot rule out the possibility that any effects of the various techniques in our study were masked by locally intense nest predation. Therefore, additional study is needed to determine if there may be observable variation in nest survival among various nest-monitoring treatments in other areas of the southern Great Plains where nest predation is less frequent.

RESUMEN. Sin evidencia del efecto del observador en la sobrevivencia de *Chondestes grammacus*

Los métodos para monitorear los nidos de aves pueden influir en la tasa de depredación, pero el efecto de varios métodos (ej. marcadores visuales, tasa de visita del observador a los nidos) usualmente se investiga por separado entre los diferentes taxones de aves y regiones geográficas. Pocas investigaciones han explorado los efectos potenciales que los observadores puedan tener en el éxito de anidamiento de aves de hierbazales, pese a preocupaciones relacionadas con la reducción de estos en Norte América. Examinamos los posibles efectos de tres técnicas de monitoreo en la sobrevivencia diaria de individuos de *Chondestes grammacus*: (1) presencia o ausencia de marcadores visuales cerca de los nidos, (2) la frecuencia de visitas por observadores y (3) la presencia o ausencia de recopiladores electrónicos de datos en los nidos. Monitoreamos 113 nidos de *Chondestes* durante la temporada reproductiva del 2009. De estos nidos el 88.5% fracasaron debido a depredación, abandono del nido, las inclemencias del tiempo, o causas desconocidas, arrojando un éxito de anidamiento estimado en 9.8%, basado en un estimado de supervivencia diaria. El efecto principal de cada técnica de monitoreo apareció en el tope de un modelo de exposición logística ($\Delta AICc < 2$). Sin embargo, el intervalo de confianza de 95% sobre los parámetros estimados para cada técnica incluyó el cero, lo que indica que no hubo un efecto significativo en la sobrevivencia diaria de los nidos. Nuestros resultados sugieren que las técnicas de monitoreo de nidos que utilizamos no tuvieron efecto en el éxito de anidamiento de las aves. Si esto es correcto, la sobrevivencia de nidos de aves canoras en hierbazales áridos de las Grandes Planicies, pudiera también ser inafectada por el monitoreo cuidadoso. Sin embargo, no podemos dejar fuera la posibilidad de que algún efecto del monitoreo haya quedado opacado por la alta depredación. Por lo tanto, se necesitan estudios adicionales para determinar si hay variaciones observables en la sobrevivencia de nidos entre diferentes formas de monitoreo en otras áreas de las Grandes Planicies en donde la depredación no sea tan frecuente.

Key words: *Chondestes grammacus*, Lark Sparrow, nest markers, nest survival, observer effects, shortgrass prairie

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Nest success is an important driver of avian life history evolution (Martin 1995) and is a commonly studied demographic parameter in avian conservation biology (e.g., Herkert et al. 2003, Stephens et al. 2004, With et al. 2008). Nest success is often estimated using periodic visits to nests by human observers (Martin and Geupel 1993), whereby nests are commonly monitored every 3–4 d (Martin and Geupel 1993) until nest failure or the successful fledging of young. Predation is the most common cause of nest failure (Ricklefs 1969, Martin 1993) and some research suggests that predation may be more frequent when there is human activity near nests (Westmoreland and Best 1985, Gotmark 1992, Whelan et al. 1994; but see Olson and Rohwer 1998, Skagen et al. 1999, Weidinger 2008). Other investigators, however, have found nest predation to be negatively related to human activity near nests (MacIvor et al. 1990).

Human disturbance may influence nest predation rates in several ways. Nest locations are commonly marked with flagging placed near nests (Morton et al. 1993, Hanski et al. 1996, Jensen and Finck 2004, Winter et al. 2004), and flagging might serve as a visual cue for predators. Picozzi (1975) found that artificial nests marked with cane sticks placed nearby suffered higher rates of predation by Carrion Crows (*Corvus carone*) than unmarked nests. Similarly, Hein and Hein (1996) found that survival of artificial duck nests was negatively affected by the presence of orange flagging used to mark nest locations. However, evidence for negative effects of nest markers on nest survival is inconsistent. Wooden-stake nest markers did not affect the success of waterfowl nests (Armstrong 1996) and the presence of flags near nests did not appear to affect predation rates on Willow Ptarmigan (*Lagopus lagopus*) nests (Hannon et al. 1993).

Predation rates may also be influenced by the frequency of nest visits by investigators. Visits to nests by investigators can create trails that, via disturbance of vegetation (Esler and Grand 1993) or human odors (Whelan et al. 1994), could potentially attract nest predators. Predators may visit nests with greater frequency when observer trails are present (Esler and Grand 1993, Olson and Rohwer 1998). For example, Major (1990) found that nests of White-fronted Chats (*Epthianura albifrons*), a near-ground nesting species, were predated more often when visited more frequently by observers.

Alternatively, some investigators have found that frequent nest visits (Sandvik and Barrett 2001, Weidinger 2008, Alamo 2010) and close approaches by observers to nests sites (MacIvor et al. 1990) deter some nest predators. Galbraith (1987) found that nest survival was similar for Lapwing (*Vanellus vanellus*) nests visited by observers and nests observed from a distance. In lieu of frequent nest monitoring or distant observation of nests, temperature data loggers have been used to remotely determine the time of nest completion and thus nest survival (Jackson and Green 2000, Hartman and Oring 2006, Weidinger 2008, Libsch et al. 2008). Weidinger (2006) found that such data loggers did not influence nest success, but the impact of data loggers on nest survival has not been widely studied.

Effects of monitoring techniques (e.g., markers and visits) on nest survival must be inferred from studies conducted among disparate taxa, habitats, and geographic regions (1975, Mayer-Gross et al. 1997, Hartman and Oring 2006, Weidinger 2006), which may be of limited utility in predicting the local impact of nest monitoring on nest survival. Some investigators have found negative effects of nest markers on nest survival (Picozzi 1975, Hein and Hein 1996) whereas others found no effect (Galbraith 1987, Armstrong 1996). Some researchers have found that human scent negatively affects nest survival (Whelan et al. 1994), whereas others have found no such effect (Skagen et al. 1999). Olson and Rohwer (1998) found that observer trails increased predation rates on artificial duck nests only in certain types of herbaceous cover and these effects were observed only in some years in some habitats. Alamo (2010) performed an informative meta-analysis on observer effects on nest survival of 26 species, revealing some general patterns (e.g., positive effect of nest monitoring activity on nest survival in passerines). However, Alamo (2010) encouraged system-specific research of observer effects on nest survival due to apparent geographic variation in these effects. In addition, many studies of the effects of various monitoring treatments have involved the use of artificial nests (Picozzi 1975, Major 1990, Whelan et al. 1994, Hein and Hein 1996, Olson and Rohwer 1998, Skagen et al. 1999). Because the results of such studies may not accurately represent patterns of survival of natural nests (Wilson et al. 1998, Davison

and Bollinger 2000, Moore and Robinson 2004, Thompson and Burhans 2004), further examination of observer effects on nest success using natural nests is warranted (Alamo 2010).

Grassland-nesting birds in the Great Plains region of North America have been understudied with regard to observer effects on nest survival. This dearth of information is particularly troubling because grassland birds have experienced widespread population declines, and studies of patterns in nest success have figured prominently in research to understand these declines (Vickery and Herkert 2001). In studies to date in the Great Plains, O'Grady et al. (1996) found no effect of human visitation frequency on the nest success of Chestnut-collared Longspurs (*Calcarius ornatus*) in Alberta, and Skagen et al. (1999) found that human scent did not attract predators to artificial nests in the shortgrass prairie of northeastern Colorado. Although these studies are informative, their results may have limited applicability elsewhere in the Great Plains. They were conducted in more open shortgrass prairie at mid- and higher latitudes in the Great Plains where mammals appeared to be the most important nest predators (O'Grady 1996, Skagen et al. 1999). Snakes are apparently important nest predators, especially in some shrub-encroached areas of the southern Great Plains (Klug et al. 2010), and may respond differently to observer activity around nests than mammals (e.g., due to differences in sensory capabilities and daily patterns of activity). Moreover, O'Grady (1996) and Skagen et al. (1999) used artificial nests and focused on just two nest-monitoring attributes (visitation frequency and scent effects).

We examined the possible effects of several nest-monitoring techniques on the survival of Lark Sparrow (*Chondestes grammacus*) nests in the shortgrass prairie of the Texas panhandle. This is a shrub-encroached grassland, characteristic of much of the southwestern Great Plains (Long 2010) where, to our knowledge, there have been no previous studies of possible observer effects on nesting success.

METHODS

We conducted our research at the U.S. Bureau of Land Management's 4811-ha Cross Bar Cooperative Management Area (CCMA) located ~20 km northwest of Amarillo, Texas

(Potter County; 35°N, 101°W). The CCMA is shortgrass prairie, composed primarily of graminoid species such as blue grama (*Bouteloua gracilis*), hairy grama (*B. hirsuta*), and buffalo grass (*Buchloe dactyloides*), with an overstory dominated by two shrub species, honey mesquite (*Prosopis glandulosa*), and cholla (*Opuntia* spp.). Based on our observations, potential nest predators at the CCMA included several species of snakes, e.g., Great Plains rat snakes (*Elaphe emoryi*) and coachwhips (*Masticophis flagellum*), small rodents, e.g., thirteen-lined ground squirrels (*Ictidomys tridecemlineatus*) and deer mice (*Peromyscus maniculatus*), larger mammals, e.g., coyotes (*Canis latrans*), white-tailed deer (*Odocoileus virginianus*), and American badgers (*Taxidea taxus*), and birds, e.g., Greater Roadrunners (*Geococcyx californianus*) and Chihuahuan Ravens (*Corvus cryptoleucus*).

In 2002, nine experimental units (hereafter plots; 120–220 ha) were established at the CCMA to examine the effects of varying fire frequency (dormant-season fires every 2, 4, or 10 yr) on mesquite density. Nests in our study were found across these plots as part of a larger study of birds at the site (Long 2010).

Nest searching and monitoring. We systematically searched for nests across each plot from 19 May to 31 July 2009 using visual and auditory cues (Martin and Geupel 1993). Only nests monitored from 8 June to 31 July were used in our analyses because all monitoring techniques were used during this period. Three monitoring techniques resulted in six factorial combinations: presence or absence of marker flagging nearby, frequency of nest visits, and the presence or absence of temperature data loggers (Table 1). All infrequently monitored nests had data loggers embedded in nest material, but data loggers disappeared from some of these nests. Each observer used a predetermined, systematic order of consecutive monitoring techniques (Table 1) to which newly found nests were assigned (i.e., the seventh nest found would begin another treatment rotation). Sample sizes of data-logged nests were smaller than those for conventionally monitored, flag-marked nests (Table 1) because the latter were not limited by data-logger availability and were widely available across the study site.

Some nest locations were marked with a 10 to 20-cm × 2.5-cm segment of blue-vinyl flagging

Table 1. Sample sizes of Lark Sparrow nests among six nest-monitoring techniques used at the Cross Bar Cooperative Management Area near Amarillo, Texas.

| Monitoring technique | N^a Lost data loggers ^b | |
|---------------------------|--------------------------------------|---|
| Frequent monitoring | | |
| Flagged, no data logger | 31 | - |
| Flagged, data logger | 18 | 7 |
| Unflagged, no data logger | 19 | - |
| Unflagged, data logger | 17 | 3 |
| Infrequent monitoring | | |
| Flagged, data logger | 13 | 4 |
| Unflagged, data logger | 15 | 2 |

^a N is the number of nests per monitoring technique.

^bNumber of data loggers missing from nests.

tape tied to a shrub branch within 5 to 10 m of nests; flagging was placed 1 to 2 m above ground and labeled with nest identification code and nest orientation from the flag. Other nests had no visible marker. We relocated nest flags and nests using Global Positioning System (GPS) coordinates.

We monitored nests either frequently (every 3–4 d) or infrequently (every 8–13 d, but 93% were monitored every 9–10 d) until nest completion. We limited dead-end trails to nest sites by approaching and leaving nests from varying directions (Martin and Geupel 1993). We determined nest fate using evidence at nest sites (e.g., age of offspring in nests on previous visits, presence of fledglings, parental behavior, and feces around nest sites; Martin and Geupel 1993). We considered nests to have failed if nest contents were missing prematurely. We considered nests abandoned if consecutive visits to nests with eggs (9–12 d for nests monitored frequently, and 18–20 d for nests monitored infrequently) provided no indication of incubation (neither adult flushed from nest or were nearby).

To maximize the precision of estimating time of completion (failure or fledging) of infrequently monitored nests, we monitored nest activity using ThermoChron iButton Temperature Sensors (hereafter, data loggers; Maxim Integrate Products, Sunnyvale, CA; Hartman and Oring 2006) in addition to visual inspection. These data loggers are chrome-colored, flat, cylindrical (16.3 mm × 6.4 mm) devices. We programmed data loggers to record temperatures (°C) every 10 min. These devices were placed beneath the first layer of nest material and were not in contact

with eggs during incubation. We retrieved data loggers from nests after nest completion and downloaded temperature data using a special reader device. Temperature–time profiles from such data reveal patterns of nest activity and nest completion which can be determined by examining abrupt changes from incubation to ambient temperatures (Jackson and Green 2000, Weidinger 2006). Temperature changes resulting from nest exposure to ambient conditions indicate that a female or nestlings are no longer regulating nest temperature, indicating nest completion (Jackson and Green 2000, Hartman and Oring 2006). We recorded nest completion prior to reasonable nestling periods (9–10 d) as nest failure. Data loggers were not in contact with eggs so absolute temperatures could not be evaluated relative to the normal range of passerine incubation temperatures (30–40°C; Webb 1987). Therefore, relative fluctuations in baseline temperature were used to determine nest activity. Baseline temperature–time profiles were obtained for each nest by examining nest temperature records while each nest was known to be active. To assess effects of data loggers on nest success, frequently monitored nests were categorized as having or not having data loggers.

Data analysis. We modeled daily nest survival rate (DSR) using the logistic exposure method of Shaffer (2004), as coded for Proc GENMOD in SAS (SAS Institute, Cary, NC). This analysis models the probability of nest survival during intervals between nest checks that may vary in length (i.e., days). Intervals for infrequently monitored, data-logged nests were 24-h days, where nests were coded as having survived or failed based on nest temperature profiles as described above. We found data loggers missing from some infrequently monitored nests and, in these cases, the entire interval between the last two nest checks was considered as the period of exposure. We caution that there may have been some uncertainty in determining the fate of these nests, but we decided to retain them in our analyses because this (1) provided nest samples that might have revealed informative patterns in DSR, and (2) allowed data logger presence to vary with nest monitoring frequency, thus allowing for a complete factorial (2 × 2 × 2) among the three monitoring techniques. Intervals for frequently monitored nests with data loggers were the 3 or 4 d intervals between nest visits. Overall DSR was calculated using a

constant model (i.e., including no explanatory variables). We then used information-theoretic model selection (Burnham and Anderson 2002) to investigate additive and interactive effects of the three monitoring techniques on DSR. This was done in a step-wise fashion similar to model selection used by Winter et al. (2006). In the first round of candidate models, we modeled DSR as: (1) being constant, and as functions of (2) each monitoring treatment separately, (3) all pairwise combinations of additive monitoring treatments, (4) including all monitoring treatments as additive effects, (5) including all pairwise interactions among monitoring techniques, and (6) including a three-way interaction among all monitoring techniques. Model fit was ranked using Akaike's Information Criterion corrected for small sample size (AIC_c) and ΔAIC_c and Akaike weights (w_i) were used to assess model support (Burnham and Anderson 2002). Models with $\Delta AIC_c < 2$ were considered to be similarly plausible, best-fit models. After selecting the best-fit model(s) for monitoring techniques, we then added the covariate burn frequency (2, 4, 10, i.e., continuous) as an additive effect in a second round of candidate models. Burn frequency may influence DSR at our study site because reduction in burn frequency can result in increased shrub cover and elevated activity of nest predators (Long 2010). Best-fit models lacking the burn covariate were also included in this second candidate model set. As for the first round of candidate models, model selection using AIC_c was used to determine the best-fit model(s) from the second candidate set. Because date of the nesting season was related to nest survival (Long 2010), a last round of models added Julian date to the best fit model(s) determined from step 2 (i.e., best fit models from step 2 were included in this last step with and without the Julian date covariate). Model-averaged estimates for parameters included in the final best fit models ($\Delta AIC_c < 2$) were then calculated and their effects compared to zero using 95% confidence intervals.

RESULTS

We monitored 113 Lark Sparrow nests during the 2009 breeding season, with 100 (88.5%) failing as a result of predation, abandonment, weather, or unknown causes. Of the failed nests,

92 (92%) were likely predated. The DSR estimate (Shaffer 2004) from the constant model was 0.904, yielding an overall nest success estimate (Mayfield 1975) of 9.8%, assuming a 23-d nest period for Lark Sparrows. Data loggers were not recovered from 16 (25.4%) of 63 nests where they had been placed (Table 1).

Best-fit models ($\Delta AIC_c < 2$) for Lark Sparrow DSR in the first candidate set (constant and monitoring techniques) included the constant model (highest w_i) and single-factor additive effects of each monitoring technique (Table 2). Adding burn (fire frequency) as a covariate to these top models in a second candidate set (Table 2) revealed the burn-only model, and separate models of burn and each monitoring technique as additive effect, to be the best fit ($\Delta AIC_c < 2$). Adding Julian date improved model fit of the best burn models in step 2 (i.e., the top four models from step 2 with Julian date added had $\Delta AIC_c < 2$ in model step 3). The 95% confidence intervals of all model-averaged parameter estimates for all monitoring techniques included zero (Table 3), revealing no significant effects of any monitoring technique. Model-averaged estimates for burn treatment and Julian date were significantly negative (Table 3), indicating that nest survival decreased with interval length between burning of habitat and over the course of the nesting season.

DISCUSSION

Investigators studying avian nest success must use methods least likely to introduce sampling bias (Gotmark 1992, Alamo 2010). In the shortgrass prairie of Texas, we found that Lark Sparrow nest survival was not affected by nest-site markers, nest visitation frequency, or the presence of temperature data loggers. We also found no evidence for interactions among these variables in explaining variation in nest survival. Daily nest survival was only found to be negatively related to prescribed burn frequency and date of the nesting season (these patterns are discussed in Long 2010).

Strategically placed flagging can help observers locate nests being monitored with repeated visits, especially in uniform landscapes found in the Great Plains. Although some nest predators on our study site (e.g., Greater Roadrunner; Hughes 1996, Long 2010) could potentially learn to associate regularly encountered

Table 2. Model selection results among three, sequential candidate sets of models for DSR of Lark Sparrow nests. Set 1 contains ranked (ΔAIC_c) models including effects of monitoring techniques: presence of flagging (flag), frequency of visitation (freq), and presence of temperature data logger (logger). Explanatory variables were included as additive effects (separated by comma) or interacting with one another (*). Best fit models ($\Delta AIC_c < 2$) from each set are italicized and were built upon in subsequent model sets (2 and 3) using additional explanatory variables: burn frequency of habitat (burn) and Julian date (jdate). See text for a full explanation.

| Model | K | AIC_c | ΔAIC_c | w_i |
|--|-----|----------|----------------|-------|
| Candidate set 1: Monitoring techniques | | | | |
| <i>Constant</i> | 1 | 647.46 | 0.00 | 0.287 |
| <i>Freq</i> | 2 | 648.86 | 1.40 | 0.143 |
| <i>Logger</i> | 2 | 648.97 | 1.51 | 0.135 |
| <i>Flag</i> | 2 | 649.20 | 1.74 | 0.120 |
| Freq, logger | 3 | 650.76 | 3.30 | 0.055 |
| Freq*logger | 3 | 650.76 | 3.30 | 0.055 |
| Flag, freq | 3 | 650.76 | 3.30 | 0.055 |
| Flag, logger | 3 | 650.92 | 3.46 | 0.051 |
| Flag*logger | 4 | 651.13 | 3.67 | 0.046 |
| Flag*freq | 4 | 652.30 | 4.84 | 0.026 |
| Flag, freq, logger | 4 | 652.71 | 5.26 | 0.021 |
| Flag*freq*logger | 6 | 654.91 | 7.45 | 0.007 |
| Candidate set 2: Adding burn covariate | | | | |
| <i>Burn</i> | 2 | 643.20 | 0.00 | 0.399 |
| <i>Flag, Burn</i> | 3 | 644.98 | 1.78 | 0.164 |
| <i>Freq, Burn</i> | 3 | 644.99 | 1.80 | 0.163 |
| <i>Logger, Burn</i> | 3 | 645.02 | 1.82 | 0.161 |
| Constant | 1 | 647.46 | 4.26 | 0.047 |
| Freq | 2 | 648.86 | 5.66 | 0.024 |
| Logger | 2 | 648.97 | 5.77 | 0.022 |
| Flag | 2 | 649.20 | 6.00 | 0.020 |
| Candidate set 3: adding Julian date | | | | |
| <i>Burn, jdate</i> | 3 | 640.5(0) | 0.00 | 0.342 |
| <i>Logger, burn, jdate</i> | 4 | 641.8(0) | 1.23 | 0.185 |
| <i>Flag, burn, jdate</i> | 4 | 642.3(0) | 1.77 | 0.141 |
| <i>Freq, burn, jdate</i> | 4 | 642.4(0) | 1.90 | 0.132 |
| Burn | 2 | 643.2(0) | 2.66 | 0.090 |
| Flag, burn | 3 | 645.0(0) | 4.44 | 0.037 |
| Freq, burn | 3 | 645.0(0) | 4.46 | 0.037 |
| Logger, burn | 3 | 645.0(0) | 4.48 | 0.036 |

visual cues at nest sites with foraging opportunities, the presence of flagging near (5–10 m) nests did not affect nest survival. Other investigators in grassland systems have reported conflicting results concerning effects of visible nest markers. Galbraith (1987) found that markers near Lapwing nests did not affect nest success, whereas Picozzi (1975) found that presence of nest markers increased nest predation rates, particularly by Carrion Crows. Similar markers (cane sticks) were used in both studies. Others have found conflicting evidence concerning the use of flagging near artificial and natural nests

of waterfowl. Hein and Hein (1996) found that flagged, artificial nests were predated more frequently than unmarked nests during late periods of nest exposure. Armstrong (1996) found higher levels of nest failure at marked than unmarked nests of one species of Arctic-nesting anserine, but no such pattern for another species. Such conflicting results may be due to subtle differences in habitat, differences between artificial and natural nests (e.g., parental nest defense), or differences in the cognitive ability and activity patterns (nocturnal or diurnal) of predators at different study sites. The type of

Table 3. Model-averaged parameter estimates for explanatory terms included from the top ($\Delta AIC_c < 2$) candidate set of models in step 3 of Table 2. Lower and upper 95% confidence limits of parameter estimates are included. See Table 2 for definition of model terms.

| Model term | Unconditional | | | |
|------------|---------------|-------|--------|--------|
| | Estimate | SE | Lower | Upper |
| Intercept | 4.520 | 0.950 | 2.619 | 6.421 |
| Burn | -0.083 | 0.031 | -0.146 | -0.020 |
| Freq | -0.014 | 0.055 | -0.123 | 0.096 |
| Jdate | -0.011 | 0.005 | -0.022 | -0.001 |
| Logger | 0.043 | 0.092 | -0.141 | 0.228 |
| Flag | -0.018 | 0.055 | -0.127 | 0.091 |

nest marker (most were sticks or stakes, with the exception of Hein and Hein [1996] who flagged small shrubs, as we did) does not appear to explain this variation.

Frequency of visits to nests had no effect on nest survival in our study, a finding consistent with previous studies of Mourning Doves (*Zenaidura macroura*; Nichols et al. 1984) and Chestnut-collared Longspurs, an obligate grassland bird (O'Grady et al. 1996). Although previous research has demonstrated that nest predators may either be deterred (MacIvor et al. 1990, Mayer-Gross et al. 1997, Weidinger 2008) or attracted (Westmoreland and Best 1985, Major 1990, Esler and Grand 1993) by human activity near nests, taxonomic patterns of predators that were either deterred or attracted were not clearly evident. Predator identity was not verifiable in our study, but if different predator species exhibited different responses to observer disturbance (i.e., some deterred and some attracted), this could conceivably have resulted in no net effect of observer activity on nest survival. Because human presence is infrequent in our study area, predators may not learn to associate human scent with nests (Skagen et al. 1999). Additionally, arid conditions on the shortgrass prairie in our study area may not have been conducive for the development of either scent trails (due to low moisture and scent retention) or physical paths in vegetation (because vegetation is short and not readily furrowed with foot traffic). Moreover, any such disturbances were likely minimized by our adherence to standardized precautions for checking nest contents (Martin and Geupel 1993).

Our results support other evidence (Hartman and Oring 2006, Weidinger 2006) that tem-

perature data loggers can be successfully used to monitor nest activity without apparent, negative consequences to nest survival. The devices we used were likely no more or less conspicuous than the wire probes and external loggers used by Weidinger (2006) and our devices were easily transported and installed in about 1 min. A drawback of our data loggers was that 25% of them disappeared from nests, presumably due to removal by parent birds or some other animal.

Observed success of Lark Sparrow nests was low (9.8%) and most nests (92%) that failed were likely predated. Other researchers have found similarly low rates of nest success in the shortgrass prairie (Howard et al. 2001, Skagen et al. 2005, Yackel Adams et al. 2007). Nest predation was likely regardless of how nests were monitored, and perhaps perturbations introduced by our monitoring techniques were too subtle to influence the community of nest predators. Observer disturbance may deter some nest predators (Weidinger 2008, Alamo 2010), but even nests under our most intensive perturbation (marking flags, frequent monitoring, data loggers) were no more likely to survive than less perturbed nests. In other areas of the southern Great Plains or elsewhere where nest predation is less frequent, there may be observable variation in nest survival among various nest-monitoring treatments.

We conclude that standard methods of nest monitoring (every 3–4 d) and marking of nest locations had no effect on daily nest survival, and thus no effect on overall nest success of Lark Sparrows. Because Lark Sparrows are abundant and nest in a variety of strata in the shrub-steppe of the southern Great Plains (Martin and Parish 2000, Long 2010), our results might also apply to other species in shortgrass prairie region that are exposed to a similar community of nest predators. However, additional studies are warranted for species in other taxa or with different nesting habits (e.g., seasonal) or habitats than Lark Sparrows. Generally warranted are additional studies of observer effects on nest survival of grassland birds across the Great Plains, a region where much research has been conducted to better understand population declines of grassland birds (Vickery and Herkert 2001). Despite published evidence for, or a lack of, observer effects on nest survival, precautions for minimizing observer disturbance of nest sites

(Martin and Geupel 1993) are warranted to minimize potential bias in estimates and patterns of nest success.

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