

**NESTING ECOLOGY OF DICKCISSELS ON RECLAIMED SURFACE-MINED
LANDS IN FREESTONE COUNTY, TEXAS**

A Thesis

by

THOMAS PINGUL DIXON

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

December 2004

Major Subject: Wildlife and Fisheries Sciences

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December 2004

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ABSTRACT

Nesting Ecology of Dickcissels on Reclaimed Surface-mined Lands in Freestone

County, Texas. (December 2004)

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Chair of Advisory Committee: Dr. Roel Lopez

Surface mining and subsequent reclamation often results in the establishment of large areas of grassland that can benefit wildlife. Grasslands have declined substantially over the last 150 years, resulting in declines of many grassland birds. The dickcissel (*Spiza americana*), a neotropical migrant, is one such bird whose numbers have declined in the last 30 years due to habitat loss, increased nest predation and parasitism, and over harvest (lethally controlled as an agricultural pest on its wintering range in Central and South America). Reclaimed surface-mined lands have been documented to provide important breeding habitat for dickcissels in the United States, emphasizing the importance of reclamation efforts. Objectives were to understand specific aspects of dickcissel nesting ecology (i.e., nest-site selection, nest success, and nest parasitism, and identification of nest predators) on 2 spatial scales on TXU Energy's Big Brown Mine, near Fairfield, Texas, and to subsequently provide TXU Energy with recommendations to improve reclaimed areas as breeding habitat for dickcissels. I examined the influence of nest-site vegetation characteristics and the effects of field-level spatial factors on dickcissel nesting ecology on 2 sites reclaimed as wildlife habitat. Additionally, I developed a novel technique to identify predators at active nests during the 2003 field season. During 2002–2003, 119 nests were monitored. On smaller spatial scales,

dickcissels were likely to select nest-sites with low vegetation, high densities of bunchgrasses and tall forbs, and areas with higher clover content. Probability of nest success increased with nest heights and vegetation heights above the nest, characteristics associated with woody nesting substrates. Woody nesting substrates were selected and bunchgrasses were avoided. Oak (*Quercus* spp.) saplings remained an important nesting substrate throughout the breeding season. On a larger scale, nest-site selection was likely to occur farther from wooded riparian areas and closer to recently-reclaimed areas. Nest parasitism was likely to occur near roads and wooded riparian areas. Results suggest reclaimed areas could be improved by planting more bunchgrasses, tall forbs (e.g., curly-cup gumweed [*Grindelia squarrosa*] and sunflower [*Helianthus* spp.]), clover (*Trifolium* spp.), and oaks (a preferred nesting substrate associated with higher survival rates). Larger-scale analysis suggests that larger tracts of wildlife areas should be created with wooded riparian areas comprising a minimal portion of a field's edge.

DEDICATION

*I dedicate this to the parental units for allowing and trusting a propagule to
pursue his interests and passions unconditionally.*

ACKNOWLEDGEMENTS

First and foremost, I would like to thank my advisors, Roel Lopez and Nova Silvy, for teaching me many crucial lessons, many of which have nothing to do with applied ecology. The way these individuals handle graduate students, human resource management, and research will forever be an example that I will attempt to follow. They understand the value and concepts of working hard, having fun, and promoting positive energy with colleagues.

Secondly, my personal growth during the graduate program was only possible by interacting with the outstanding young scientists that make up the graduate student body in the Department of Wildlife and Fisheries Sciences (WFSC). These individuals served as friends, mentors, technicians, co-authors, basketballers, WFSC socialites, and fishing buddies. Many fall into these categories, but I would like to personally thank A. C. Kasner, K. A. Kosciuch, R. A. Powell, L. P. Fontaine, H. A. Mathewson, D. H. Lafever, N. D. Perry, R. S. Jones, K. E. Millenbach, R. E. Butzler, A. Braden, S. Locke, R. McCleery, A. Gandaria, S. Brandes, D. Marx, D. Sherry, E. Juarez, S. Werner, G. Proudfoot, M. Byerly, R. Murray, and A. Munoz for making my experiences in the program that much better. Additionally, I would also like to thank Professors M. Peterson, M. Tjoelker, S. Davis, F. Smeins, and S. Whisenant for rearranging and supplementing my perspectives on various aspects of ecology and research. If a new student is reading this, take a course from these individuals.

Additionally, I would like to thank the individuals who were always willing to get out and experience nature with me from childhood to present (and hopefully into the

future). To C. T. Everett, C. D. Everett, B. W. Hulsey, J. Capeheart, L. Harris, R. A. Grassmuck, and T. Hayes, thanks for the good times in the woods (and cheers to more to come).

Lastly, I am incredibly grateful for being part of the TXU Environmental Research Program. The individuals I encountered from TXU Energy, as well as professors associated with the program, have all been outstanding and welcoming people. I would like to especially thank P. Zweiacker, C. Ivy, R. Hart, R. Mersinger, J. Swinson, and P. Berry of TXU Energy for helping me in various ways that were vital during the course of this study.

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CHAPTER I

INTRODUCTION

Surface mining for mineral extraction is a land use that drastically alters landscapes (Gorsira and Risenhoover 1994). Impacts due to surface mining include changes in vegetation (Wray et al. 1982, Harris 1990), permanent changes in topography (Reynolds 1989), alteration of soil and subsurface geological structures (Askenasy 1977, Pitt 1984, Harris 1990, Doolittle 1991, Yao 1994, Gutierrez 2001), and disruption of surface and subsurface hydrologic regimes (McKnight 1991, King 1994). For the most part, reclaimed habitats are both physically and spatially different than pre-mined habitats (Klimstra and Nawrot 1984, Reynolds 1989, Viert 1989, Gorsira and Risenhoover 1994). However, surface coal mining and subsequent reclamation often results in the establishment of large areas of grassland habitat (Brothers 1990) that benefit certain species of wildlife (Brenner 1973). Grasslands (native or otherwise) have declined substantially over the last 150 years (Noss et al. 1995). Over 99% of the original tall-grass prairies have been lost in the last century (Sampson and Knopf 1994). Between 1982–1997, over 10 million ha of pasture and rangeland were lost in the United States (Natural Resource Conservation Service 2000). In Texas, grasslands also have declined significantly from the conversion to agricultural land and urban centers, have been degraded due to heavy grazing, and have succumbed to brush encroachment due to fire suppression (Scifres 1980, McPherson et al. 1988). These vegetation changes undoubtedly impact many wildlife species.

Grassland bird populations have declined over the last 3 decades, more than any other avian group in North America (Knopf 1994, Peterjohn and Sauer 1999).

According to the Breeding Bird Survey, populations of 13 species of North American grassland birds declined significantly during 1966–1996 (Peterjohn and Sauer 1999). Loss of native grasslands (Knopf 1994, Noss et al. 1995, Natural Resource Conservation Service 2000) and nest predation (Ricklefs 1969) attribute to these declines.

Interestingly, many avian species historically associated with these native grasslands now use other land resources such as the grasslands created by reclamation practices, an extraction practice that is arguably environmentally disruptive. Many are considered species of concern such as the interior least tern (*Sterna antillarum athalassos*), dickcissel, horned lark (*Eremophila alpestris*), and the grasshopper sparrow (*Ammodramus savannarum*) (Carter et al. 2000). Such species are disturbance-dependent and may be relatively scarce in surrounding natural landscapes but extremely abundant in reclaimed grasslands (Hunter et al. 2001, Kasner and Slack 2002).

Reclaimed grasslands and other disturbed areas can serve as avian habitat islands or refugia, which these disturbance-dependent species may utilize in the early stages of succession (Whitmore 1980, Hunter et al. 2001, Kasner and Slack 2002). The aforementioned species of concern all have been documented to nest on reclaimed grasslands at TXU Energy's Big Brown Mine (BBM), Fairfield, Texas (Cantle 1978). Indeed, several of these species (e.g., interior least tern, dickcissel, horned larks) are considered uncommon to rare in this region (TOS 1995, AOU 1998) of the Post Oak Savannah Ecoregion (Gould 1975). This suggests the importance of reclaimed

grasslands in the conservation of grassland avian assemblages (Allaire 1978); however, the significance of these areas to these species of concern has not been evaluated.

The dickcissel, a neotropical migrant (Figure 1.1), is a species of concern whose numbers have declined in the last 30 years due to habitat loss, increased nest predation and parasitism, and over harvest (lethally controlled as an agricultural pest on its wintering range in Central and South America; Basili and Temple 1998, Temple 2002). Reclaimed surface-mined lands have been documented to provide important breeding habitat for dickcissels in the United States (Cantle 1978, DeVault et al. 2002, Scott et al. 2002), which emphasizes the importance of reclamation efforts. Previous studies have examined vegetation characteristics in relation to dickcissel abundances on reclaimed lands (DeVault et al. 2002, Scott et al. 2002); however, no studies have examined the nesting ecology of dickcissels on these surrogate habitats.

STUDY AREA

The study was conducted on the Big Brown Mine (BBM; 5,800 ha) owned and operated by TXU Energy in Freestone County, 16 km east of Fairfield, Texas (Figure 1.2). The mine is within the northern portion of the Post Oak Savannah vegetation region of Texas wedged between the Pineywoods on the east, Blackland Prairies on the west, and Coastal Prairies and Marshes on the south (Gould 1975). Topography is gently rolling to hilly. Historically, this region was characterized by post oak (*Quercus stellata*) and blackjack oak (*Q. marilandica*) in the overstory, and climax grasses (e.g., little bluestem [*Schizachyrium scoparium*], Indiangrass [*Sorghastrum nutans*], switchgrass [*Panicum virgatum*]) in the understory (Gould 1975).

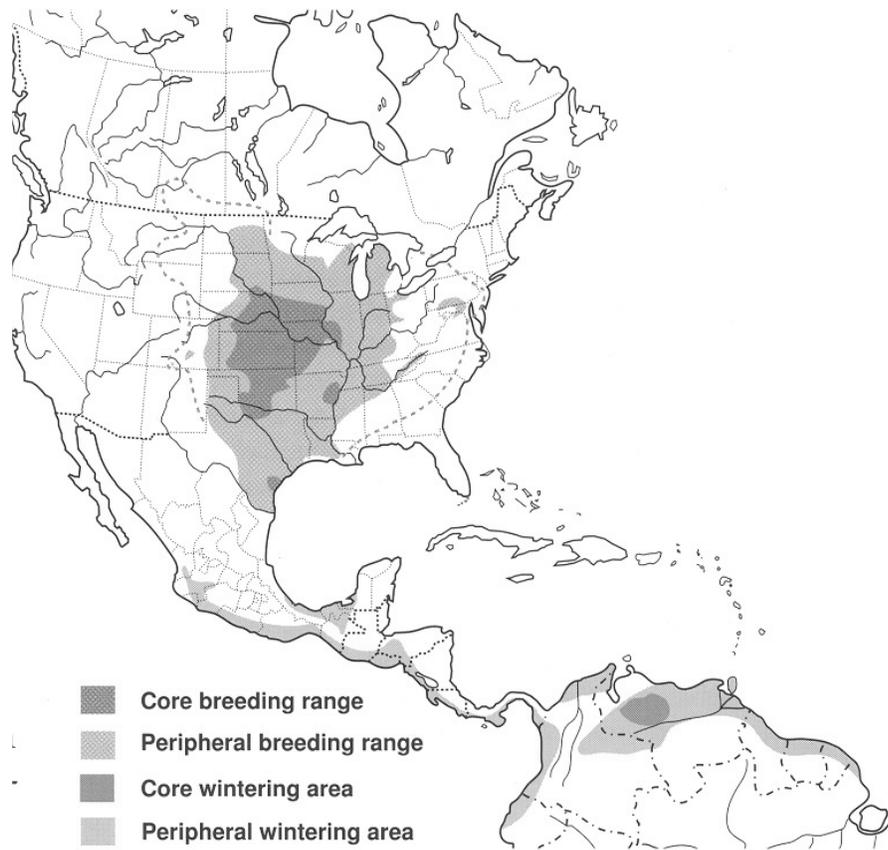


Figure 1.1. Breeding and wintering range of dickcissels across the Americas (Temple 2003).

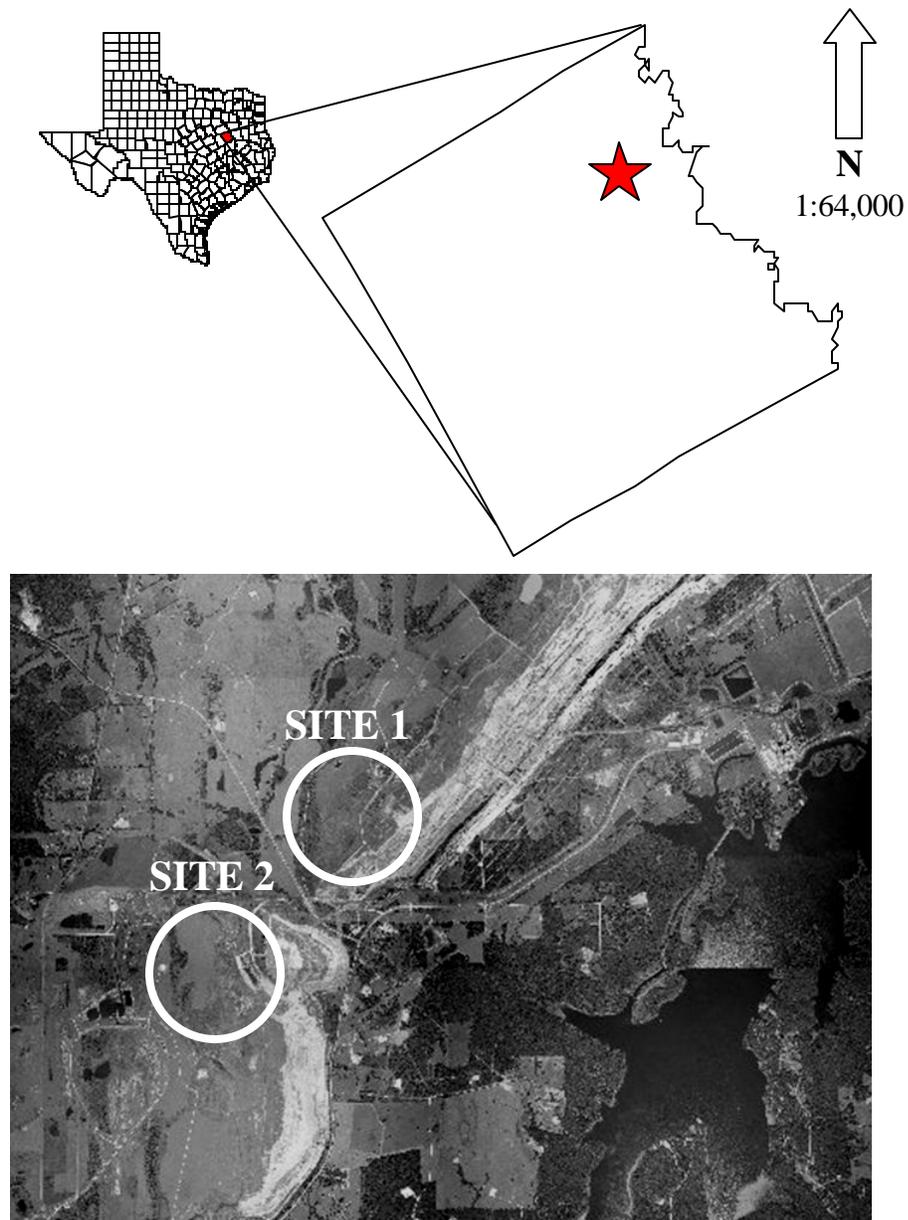


Figure 1.2. Study sites used in evaluating nesting characteristics of dickcissels on reclaimed lands created as wildlife habitat on TXU Energy's Big Brown Mine, Fairfield, Texas, 2002–2003.

Since 1971, TXU Energy has reclaimed surface-mined lands to create a variety of habitats (e.g., wildlife habitat, riparian areas, hayfields, grazed pastures, timber plantations, and wetlands) that all began as early successional grasslands. I evaluated the nesting ecology of dickcissels on 2 study areas designated as wildlife habitat areas (i.e., no mowing or grazing allowed; site 1 = 52 ha; site 2 = 64 ha, Figure 1.2) managed by TXU Energy and reclaimed in 1993. Vegetation in these areas was characterized by various young oaks, willow baccharis (*Baccharis salicina*), Chickasaw plum (*Prunus augustifolia*), grasses such as bushy bluestem (*Andropogon glomeratus*), Wilmann's lovegrass (*Eragrostis superba*), switchgrass, Bermudagrass (*Cynodon dactylon*), and clover (*Trifolium* spp.).

RESEARCH OBJECTIVES

Thesis chapters are written as individual scientific publications. Thus, specific research objectives are presented in each chapter, with some redundancy of background information between chapters.

I addressed 3 objectives which examined the nesting ecology of dickcissels on 2 sites reclaimed as wildlife habitat on the BBM. Specifically, I evaluated the (1) effects of vegetative characteristics and (2) influence of field-level spatial features on the nesting ecology (i.e., nest-site selection, nest success, and nest parasitism) of dickcissels. Additionally, I addressed a third objective in which I (3) developed a novel technique to photograph predators depredating active dickcissel nests during 2003.

CHAPTER II
VEGETATION CHARACTERISTICS AND DICKCISSEL NESTING
ECOLOGY

SYNOPSIS

Reclamation involves the restoration of surface-mined lands to early-successional grass and shrub lands that can provide important wildlife habitat for a suite of species. Declines in disturbance-dependent birds have been observed in the last 30 years more than any other bird group; however, the importance of reclaimed lands for many of these bird species have long been recognized. Nest-site characteristics can ultimately influence nest success, and understanding the influence of these variables can provide reclamation biologists with insight to increase species numbers via habitat management practices. I evaluated the nesting ecology of dickcissels, a species of concern whose numbers have declined in recent years, on surface-mined reclamation areas on the Big Brown Mine, owned and operated by TXU Energy. Specifically, I evaluated (1) nest-site selection, (2) nest success, and (3) nest substrate use of dickcissels. I monitored 119 nests during the 2002 and 2003 nesting seasons, and found dickcissels were likely to select nest sites that had low vegetative ground cover (visual obstruction), higher bunchgrass densities and perch sites (tall dead forbs), and more clover. Nest height and vegetation height above the nest best predicted nest success. Oaks and pines (*Pinus* spp.) planted by TXU were a preferred nesting substrate for dickcissels, whereas bunchgrasses were avoided. Reclamation efforts on the BBM designated as wildlife habitat areas provided breeding dickcissels with important nesting

habitat. Study results suggested that conservation of grassland birds like the dickcissel could be achieved through the reclamation process.

INTRODUCTION

Surface-mining involves the removal of seam lignite used in generating electricity and other energy products (National Research Council 1981). Subsequent reclamation involves the restoration of surface-mined lands as mandated by state and federal laws (Brothers 1990). Furthermore, the reclamation plans approved for most mining operations include the development of both terrestrial and aquatic wildlife habitats as a part of the post-mine land use. (Paul Zweiacker, Environmental Permitting Manager, TXU Energy, *personal communication*). Initially, these reclaimed lands are typically early-successional grasslands and eventually shrub-scrub lands that provide important wildlife habitat to a suite of species (Gorsira and Risenhoover 1994, Olsen et al. 2000). Understanding the benefits of reclamation processes with regards to vegetation characteristics (i.e., stem density, coverage, composition, or diversity) is imperative in managing target wildlife populations on reclaimed lands (Brenner 1973).

Early successional grasslands are important for many disturbance-dependent avian species (e.g., grassland and shrub birds, Hunter et al. 2001). In the last 30 years, precipitous declines in grassland birds have been observed, more than any other bird group (Peterjohn and Sauer 1999). Generally, these steep declines are attributed to increased nest predation, brood parasitism, and loss of habitat from fragmentation and conversion (Johnson and Temple 1990). Since reclamation of surface-mined lands offers large contiguous tracts of different vegetation types in various stages of

succession, the importance of reclaimed lands for disturbance-dependent bird species have long been recognized (Allaire 1978, Wray et al. 1982, Knopf 1994, Bajema et al. 2001). In many cases, reclaimed surface-mined lands can be very different from surrounding areas and have been described as island habitat refugia, especially with regards to disturbance-dependant grassland birds (Whitmore 1980, Kasner and Slack 2002). If reclaimed lands have implications for conservation by providing surrogate habitats for disturbance-dependant grassland birds, then there exists a need to evaluate these created habitats in regards to targeted wildlife species.

In North America, dickcissels, a neotropical migrant, are a species of concern whose numbers have declined in the last 30 years due to habitat loss, increased nest predation and parasitism, and over harvest (lethally controlled as an agricultural pest on its wintering range in Central and South America; Basili and Temple 1998, Temple 2002). Reclaimed surface-mined lands have been documented to provide important breeding habitat for dickcissels in the United States (Cantle 1978, DeVault et al. 2002, Scott et al. 2002). Previous studies have examined vegetation characteristics in relation to dickcissel abundances on reclaimed lands (DeVault et al. 2002, Scott et al. 2002); however, no studies have examined nest-site characteristics and nest success of dickcissels on reclaimed areas. Nest-site characteristics (e.g., nest concealment, horizontal and vertical structural diversity) can influence nest site selection and nest success (Marzluff 1988, Martin 1993), and understanding these relationships can provide reclamation biologists with insight into increasing species numbers via habitat management practices. Here I describe a study evaluating the nesting ecology of

dickcissels on surfaced-mined reclaimed lands created as wildlife habitat. Specifically, I evaluated (1) nest-site selection, (2) nest success, and (3) nest substrate use of dickcissels on surface-mined lands in relation to vegetation characteristics.

METHODS

The study was conducted on the Big Brown Mine (BBM; 5,800 ha) owned and operated by TXU Energy in Freestone County, 16 km east of Fairfield, Texas (Chapter I, Figure 1.2). The mine is within the northern Post Oak Savannah vegetation region of Texas wedged between the Pineywoods on the east, Blackland Prairies on the west, and Coastal Prairies and Marshes on the south (Gould 1975). Topography is gently rolling to hilly. Historically, this region was characterized by post oak and blackjack oak in the overstory, and climax grasses (e.g., bluestem, Indiangrass, switchgrass in the understory (Gould 1975). Since 1971, TXU Energy has reclaimed surface-mined lands to create a variety of habitats (e.g., wildlife habitat, riparian areas, hayfields, grazed pastures, timber plantations, and wetlands) that all began as early successional grasslands. I evaluated the nesting ecology of dickcissels on 2 study areas designated as wildlife habitat areas (i.e., no mowing or grazing allowed; site 1 = 52 ha; site 2 = 64 ha; Chapter I, Figure 1.2) managed by TXU Energy and reclaimed in 1993. Vegetation in these areas was characterized by various young oaks, willow baccharis, Chickasaw plum, grasses such as bushy bluestem, Wilmann's lovegrass, switchgrass, Bermudagrass and clover.

Nest Monitoring

Dickcissel nests were located and monitored from April–July 2002 and 2003 using guidelines suggested by Martin and Geupel (1993). Eight systematically-placed plots (50 x 200 m) for each area were searched once every week. In 2003, less-intensive systematic searches were performed over entire study areas every 2-3 days in addition to the nest search plots. Once a nest was found, its location was marked with a global positioning system (GPS) waypoint, and subsequently revisited every 2-3 days thereafter to monitor success (Martin and Geupel 1993). I determined and categorized nest fate (successful [fledge = 1], failed [depredated or abandoned], parasitized) for each nest monitored.

Vegetation Sampling

Immediately following nest completion, I recorded (1) nest placement characteristics (i.e., substrate species and height, nest height, vegetation height above nest, nest concealment), and (2) nest-site characteristics (i.e., lateral cover [explained below], vegetation height, ground cover, shrub and bunchgrass densities, perch sites) for each dickcissel nest. Relative nest concealment was estimated by observing the nest from the 4 cardinal directions and estimating the percentage of the nest hidden by vegetation from a distance of 4 m and a height of 1 m, similar to techniques described by Chase (2001) and Saunders et al. (2003). The four values were averaged for a mean value of nest concealment.

Lateral cover (hereafter, visual obstruction) was measured with a range pole from 4 cardinal directions immediately in front of the nest and nest substrate. Vegetation

height was recorded in 4 cardinal directions where 100% visual obstruction was observed (ocular estimate taken from a distance of 4 m and a height of 1 m; Robel et al. 1970). Percent ground cover (bare ground, grass, forbs, clover, and litter) was measured immediately adjacent to the nest in 4 cardinal directions with a 0.25-m² metal frame (Daubenmire 1959). For each of these variables, the 4 values were averaged for a single value representing the sampling point. Clover was estimated separately from forbs because it is of management interest to the reclamation specialists (i.e., due to its patchy, aggressive invasion of reclaimed wildlife areas, it hinders the establishment of desirable planted trees and bunchgrasses; Carl Ivy, Reclamation Manager, TXU Energy, *personal communication*). Live shrub (including all trees < 3 m in height) and bunchgrass densities were estimated using an 8-m circular radius plot with the nest as the center point. In addition, an estimate of the number of perch sites (i.e., tall [> 1.5 m], dead standing forbs, e.g., sunflower, curlycup gumweed) were recorded and categorized (none = 0, low = 1-5, moderate = 6-10, high = 11-14, very high = >15) within the circular plot. In 2003, all of these parameters were measured. However, in 2002, percent ground cover, bunchgrass densities, and visual obstruction were not recorded at nests.

In addition to vegetation at dickcissel nests, vegetation along each 200 m transect was sampled systematically every 25 m (8 sample points/transect, 8 transects/site). All vegetation measurements recorded at each sample point were similar to actual nests, with the exception of nest substrate measurements (substrate type, nest height, vegetation above nest, nest concealment). In 2003, shrub, bunchgrass and perch site densities, along with visual obstruction, and percent ground cover were measured at

general vegetation points. In 2002, however, I did not measure bunchgrass density and percent ground cover.

Data Analysis

Nest-site selection. —Nest-site selection was evaluated by comparing actual nest-site characteristics to transect sample points using binary (i.e., 0 = random, 1 = nest) logistic regression (Hosmer and Lemeshow 2000). Each nest was randomly paired with 1 of 8 vegetation sampling points from the same or nearest nest plot transect as described by Marshall and VanDruff (2002). Prior to model building, all model variables were evaluated using univariate logistic regression. Variables with a $P = 0.25$ were used in model construction (Hosmer and Lemeshow 2000), and the most parsimonious model was created via Akaike's Information Criterion (AIC; Burnham and Anderson 2001). Non-linear relationships were examined by introducing a quadratic term, and if significant, I introduced a cubic term to check for asymmetric relationships (Straw et al. 1986, Chase 2002). Only 2003 nest data were used in this analysis due to a more complete suite of vegetation measurements. Logistic regression analyses were performed with Statistica 6 (StatSoft, Inc., Tulsa, Oklahoma).

Nest success. —Nest success was evaluated by comparing vegetation parameters of successful (i.e., fledge = 1 young) and failed nests using binary logistic regression (Hosmer and Lemeshow 2000). An identical modeling approach used with nest-site selection evaluation was used for evaluating nest success (i.e., 0 = failed, 1 = successful). Although more variables were measured in 2003, preliminary univariate analysis revealed that only measurements common between both years were important

predictor variables. Thus, nests for both years were included in the analysis using variables common between years (i.e., nest height, height of vegetation above nest, shrub density, perch sites, nest concealment, and substrate height). Furthermore, nest survival was compared at different shrub densities (stems/8m circular radius plot): low = 2-16, medium = 18-30, and high = 32-44. Categories were determined by dividing the stem density range into 3 equal parts. Overall nest survivorship was calculated for each category of shrub density using Mayfield's estimate (Mayfield 1975, Krebs 2002) and then compared with the program CONTRAST (Hines and Sauer 1989). Nest data from both years were used in this analysis.

Nest substrate use. —Nest substrate selection was examined by comparing actual nest substrates used to available substrates using a Chi-square Goodness of fit test ($\alpha = 0.05$). Data on available substrates were obtained from transect sampling points. Nest data from both years were used in this analysis. Analysis was performed on SPSS 11.5 (SPSS Inc, Chicago, Illinois). I also evaluated the temporal importance of nest substrates by examining the proportions of each substrate used throughout the nesting season. For this comparison, I divided the breeding season into 3 time periods (early = 5–25 May, middle = 26 May–5 June, and late = 16 June– July 5+) based on the estimated incubation initiation and the 20 day nesting cycle for dickcissels (i.e., 12 days incubation, 8 days brooding; Long et al. 1965). Only nest data from 2003 were used in this analysis due to a greater sample size. Lastly, I conducted a cost-benefit analysis described by Schmidt and Whelan (1999) who compared (1) the magnitude of disproportionate use (used – available), and (2) difference between mean daily survival

rates ([all nests]-[nests by substrate being evaluated]). I calculated mean daily survival using Mayfield's survival estimate (Mayfield 1975, Johnson 1979). The product of these 2 variables represent the realized effect (-/+) in survival associated with nest placement (Schmidt and Whelan 1999). Nest data from both years were used in this analysis.

RESULTS

Nest-site Selection

I found and collected data on 118 nests ($n = 25$, 2002; $n = 93$, 2003) in my study. Based on AIC, nest-site selection was best predicted by decreasing values of visual obstruction heights, increasing densities of bunchgrasses around the nest, a cubic term for increasing amounts of perch sites around the nest, and a quadratic term for the increasing amounts of clover at the nest (Figure 2.1). The model correctly predicted 67% of the data with a likelihood ratio $\chi^2 = 36.19$, $P = 0.001$.

Nest Success

Increasing values of nest height and vegetation above the nest were the best predictors of success (Figure 2.2). The model correctly predicted 70% of the data with a likelihood ratio $\chi^2 = 24.26$, $P = 0.001$. Overall survival rates for nests with low, medium, and high density of shrubs around the nest were 0.39, 0.42, and 0.53, respectively, and did not differ ($\chi^2 = 0.801$, $P = 0.67$).

Substrate Use

Dickcissels used 3 kinds of woody plants (oaks, baccharis, and pines) and 3 species of bunchgrasses (Wilman's lovegrass [*Eragrostis superba*], switchgrass, and

bushy bluestem [*Andropogon glomeratus*]) for nesting substrates during both years. No structural or nest concealment differences were found among the 3 kinds of bunchgrasses (nest height, $F_{2, 16} = 0.543$, $P = 0.593$; substrate height, $F_{2, 16} = 3.579$, $P = 0.056$; nest concealment, $F_{2, 16} = 0.180$, $P = 0.837$) and were combined into 1 category. Specifically, various small oaks, willow baccharis, and small pines comprised the woody substrates used, with oaks and pines being preferred and bunchgrass being avoided ($\chi^2 = 33.2$, $P = 0.001$; Figure 2.3). The majority of nests were placed in oaks throughout the entire nesting season (Figure 2.4). Despite being a preferred substrate, oaks incurred a realized cost in terms of nest survival, although minute. Baccharis, being neither preferred nor avoided, offered a slight benefit when used as a substrate. Pine was a preferred species and offered a slight benefit (Table 2.1).

DISCUSSION

Nest-site Selection

The investigation of dickcissel nesting characteristics on reclaimed lands in Central Texas revealed several patterns in nesting characteristics. Study results suggested dickcissels selected nest sites that had low vegetative ground cover (visual obstruction), higher levels of bunchgrass densities and perch sites (tall dead forbs), and higher amounts of clover. These results were consistent with other studies that report dickcissels were often associated with structurally complex habitats (Delisle and Savidge 1997), preferring areas of high forb content (Roth 1980, Bryan and Best 1994) and legumes (e.g., clover; Blankespoor 1970). I hypothesize that use of areas with high bunchgrass and tall dead forb densities provided dickcissels with vegetative structure to

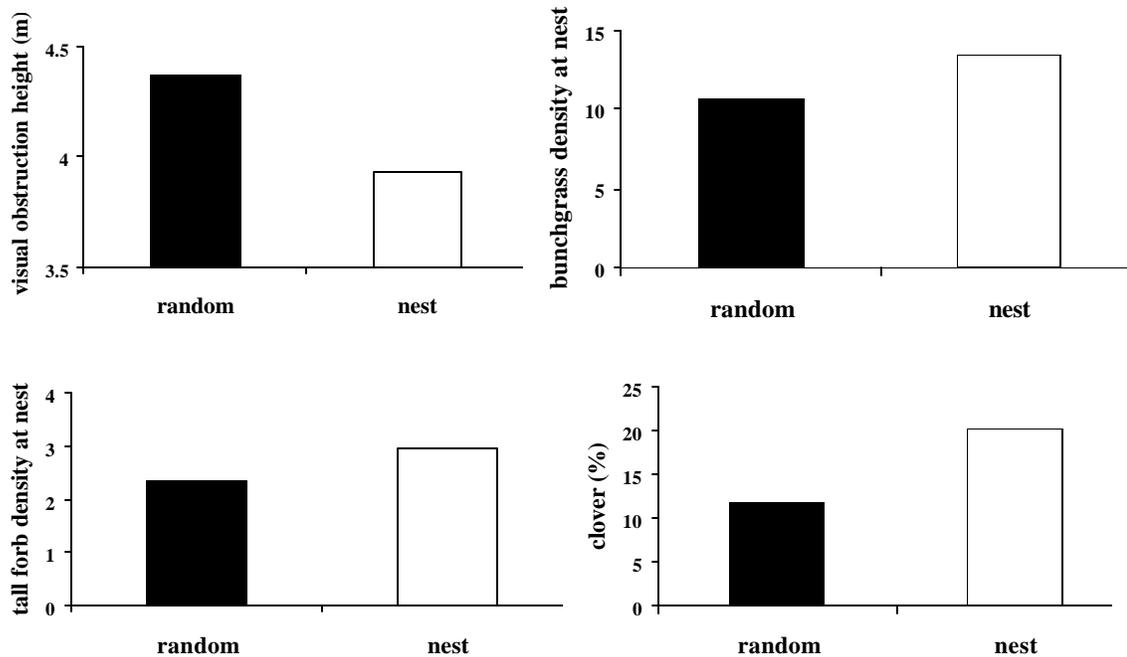


Figure 2.1. Mean values of important variables (lateral visual obstruction [A], bunchgrass density [B], perch site density³ [C], and percent clover² [D]) predicting the probabilities of nest-site selection for dickcissels on reclaimed lands created as wildlife habitat, Big Brown Mine, Fairfield, Texas, 2003. Data for forb density and percent clover are presented in linear terms for ease of interpretation (model contained a cubic and quadratic term for these variables, respectively).

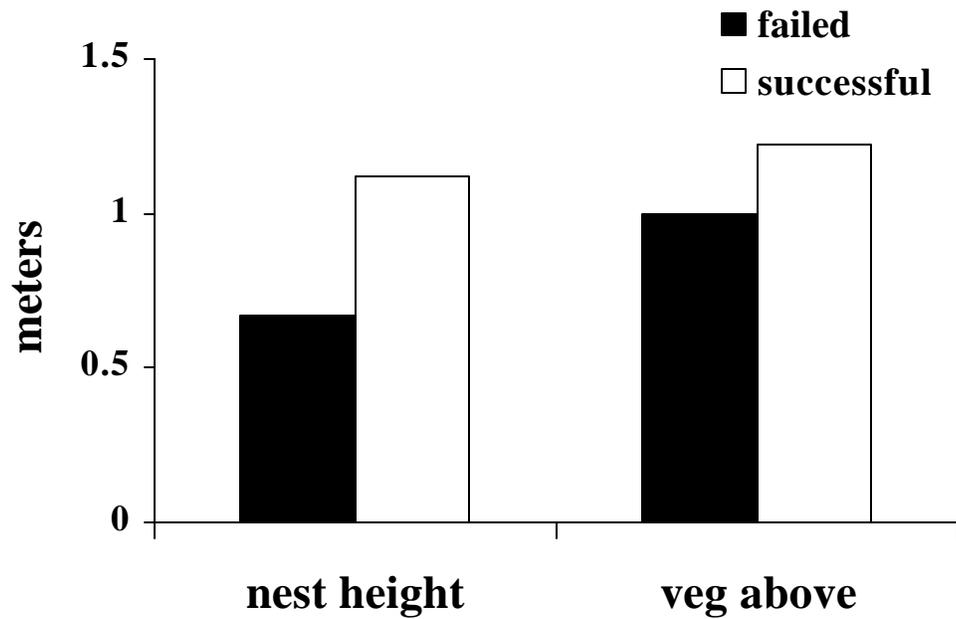


Figure 2.2. Mean values of important variables (nest height and vegetation height above the nest) predicting the probabilities of nest success of dickcissels on reclaimed lands created as wildlife habitat, Big Brown Mine, Fairfield, Texas, 2002–2003.

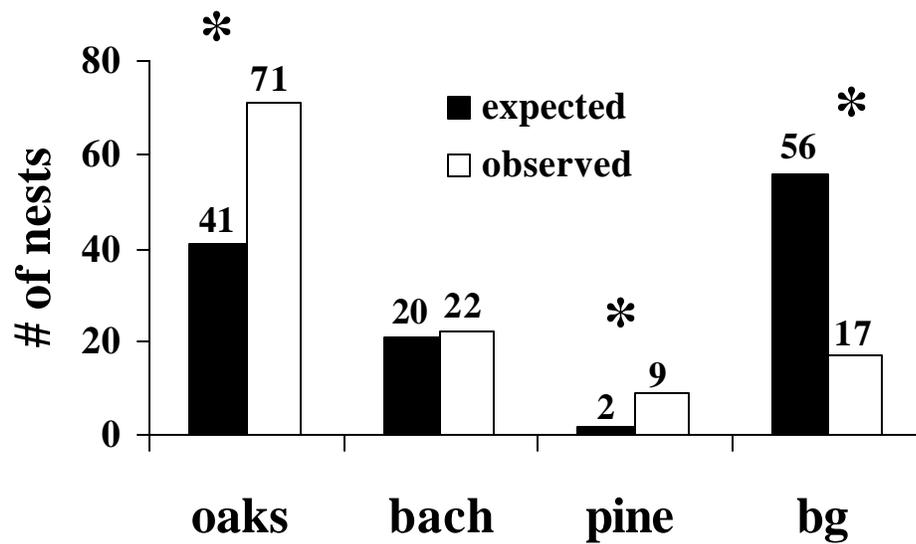


Figure 2.3. Nest substrate use (oak = *Quercus* spp., bach = *Baccharis salicina*, pine = *Pinus* spp., and bg = bunchgrass) by dickcissels on reclaimed lands created as wildlife habitat, Big Brown Mine, Fairfield, Texas, 2002–2003. Asterisks indicate a difference ($\alpha = 0.05$).

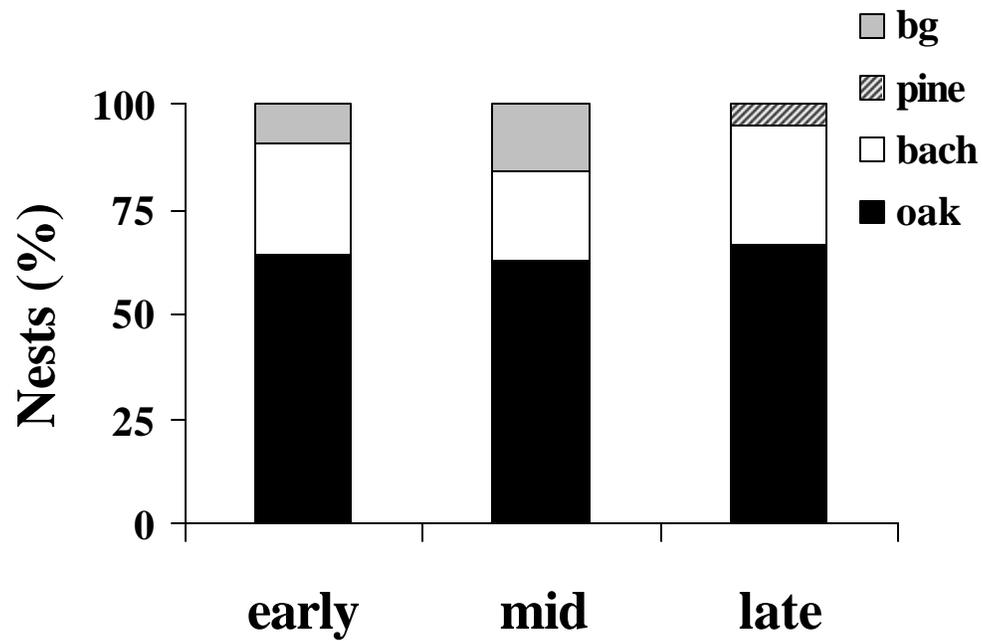


Figure 2.4. Temporal changes (early = 5–25 May, middle = 26 May–15 June, and late = 16 June–July 5+) in nest substrate use (% , oak = *Quercus* spp., bach = *Baccharis salicina*, pine = *Pinus* spp., and bg = bunchgrass) by dickcissels on reclaimed lands created as wildlife habitat, Big Brown Mine, Fairfield, Texas, 2003.

Table 2.1. Realized beneficial (+) or detrimental (-) effects (in terms of survival) associated with nest substrate (oaks, baccharis, pine and bunchgrasses) selection or avoidance by dickcissels on reclaimed lands created as wildlife habitat, Big Brown Mine, Fairfield, Texas, 2002–2003.

Substrate	<i>n</i>	DSR ¹	?DSR ²	Use	Available	Magnitude ³	Realized Effect
oaks	71	0.962	-0.011	0.597	0.345	0.252	-0.003
baccharis	22	0.976	0.003	0.185	0.172	0.131	0.000
pine	9	0.975	0.001	0.756	0.142	0.615	0.001
bunchgrasses	17	0.933	-0.040	0.143	0.469	-0.326	0.013

¹DSR = \bar{x} daily survival rate (Mayfield 1975)

²?DSR = (\bar{x} DSR of all nests; 0.973) – (\bar{x} DSR of nest in substrate)

³Magnitude of disproportionate use (use - available; Schmidt and Whelan 1999)

avoid predation (Martin 1993) and provided important perch sites (Delisle and Savidge 1997). Although the selection for nest sites with low visual obstruction values seems counterintuitive, perhaps the structural heterogeneity provided by high bunchgrass and perch site densities interspersed with lower ground cover was ideal dickcissel habitat. Such habitat would provide dickcissels with enough “openness” of their surroundings for better surveillance and with adequate escape routes (Götmark et al. 1995). In addition, the areas with higher forb content may provide dickcissels with feeding opportunities. Zimmerman (1966) reported that female dickcissels preferred mating with males who defend territories high in forb content, and Denchant et al. (2003) suggested such sites provided birds with higher invertebrate numbers.

Nest Success

Higher nest height and increasing values of vegetation height above the nest were the most important variables predicting nest success. Best and Stauffer (1980) also found that nest success increased with nest height. Perhaps higher nest placement offered some protection from mammalian predators, whereas increasing values of vegetation height above the nest offered protection from predation (avian predators) or nest parasitism (brown-headed cowbirds). The lack of common predictor variables between the nest-site selection and nest success models, however, may indicate a high abundance and diversity of predators. For example, if a relationship exists between nest-site selection and risk of predation (Stauffer and Best 1986, Möller 1988), then one may expect some commonality between the predictor variables of both the success and nest-site selection models. In other words, if natural selection (with selection pressure from

predation) has shaped a bird's search image for a nest site, then one would expect those non-randomly selected nest sites to be more successful. Thus, one would expect vegetation characteristics predicting nest-site selection and nest success to be similar. However, in predator-rich habitats (and associated high levels of predation), nest-site selection preferences may be obscured because many possible sets of vegetative characteristics are likely to be searched by the suite of predators (Filliater et al. 1994). Chase (2001) described similar results for song sparrows nesting in California coastal scrub. In a separate study (Chapter IV), I identified raccoons (*Procyon lotor*) and rodents as nest predators, and coyotes (*Canis latrans*), feral hogs (*Sus scrofa*), snakes, and owls were frequently seen on the sites. Lastly, I failed to demonstrate a relationship between shrubs density and survival, which also may be explained by the probability of a predator-rich habitat.

Substrate Use

Dickcissels used woody species more than bunchgrasses for nest substrates. Overmire (1962) reported more nests (75%) were placed in woody saplings compared to grasses and forbs in Oklahoma on idle, tallgrass pasture. In my study, oaks and pines were a preferred nest substrate for dickcissels, baccharis was not avoided nor selected, and bunchgrasses were avoided (Figure 3). The selection of oaks and pines illustrates the importance of these planted species in the TXU Energy reclamation program. Of these 4 substrates, baccharis is the only substrate not planted by reclamation specialists and is a management concern because it hinders the establishment of the planted woody species substrates (Carl Ivy, Reclamation Manager, TXU Energy, *personal*

communication). My results suggested that baccharis, although it was not avoided nor preferred as a nesting substrate, did offer a benefit in terms of nest survival when used by dickcissels (Table 2.1).

Planted oaks remained the most important substrate throughout the breeding season, though when used a cost was incurred (Table 2.1). It is important to note that oaks were the most frequently-planted substrate on BBM's reclaimed areas, and that nests placed in oaks were relatively lower ($\bar{x} = 0.72$ m) with respect to the other woody substrates, but offered the relatively high vegetation heights above the nest ($\bar{x} = 1.15$ m). Nests in pines and baccharis were relatively higher ($\bar{x} = 1.36$ and 1.67 m, respectively), and offered relatively high values of vegetation height above the nest ($\bar{x} = 1.18$ and 1.04 m, respectively). These differences in structural attributes among pines, oaks, and baccharis may explain the differences in costs and benefits associated with each of these substrates.

MANAGEMENT IMPLICATIONS

I suggest further research evaluating created habitats at BBM and other surface-mined areas with regards to species of conservation importance. Although more replications and years were not possible during this study, the results illustrated the importance of reclaimed areas to breeding dickcissels, particularly those areas designated as wildlife habitat areas (i.e., no mowing or grazing allowed, planting of woody vegetation). I found that reclaimed areas that provided low vegetative ground cover (e.g., clover), and high bunchgrass and tall dead forbs (i.e., perch sites) densities were preferred nesting areas by dickcissels. Based on the results, I recommend

increasing the amount of tall forbs (e.g., sunflower and curlycup gumweed) that may establish on these sites by increasing seeding efforts during reclamation. Similarly, increasing bunchgrass seeding efforts (e.g., more seeds and subsequent planting) could make areas more attractive as nesting sites. Clover, a hindrance to the establishment of planted species, appears to be an important factor in nest-site selection and its eradication should not be management priority in some cases.

Nest height and vegetation height above the nest were the best predictors of dickcissel nest success on reclaimed areas. I propose these nest substrate characteristics are related to the structure offered by woody substrates. Given the preference by dickcissels of woody nest substrates over bunchgrass at BBM, I suggest that oaks and pine continue to be planted on reclaimed areas. *Baccharis* is viewed by reclamation specialists as a species of management concern because it hinders the establishment of desirable woody plants (i.e., pines, oaks); however, study results illustrate their potential benefits to grassland birds and removal should not be management priority in some instances.

Although I have demonstrated that reclaimed lands provide important habitat for breeding dickcissels, these early successional reclaimed habitats provide for many disturbance-dependent organisms. With over 2.3 million ha permitted for surface-mining in the United States (Office of Surface Mining 2002), the opportunities for the management and conservation of the grassland and disturbance-dependent bird assemblage in the near future are enormous. Reclamation specialists are in a unique

position (due to the size and time span involved with reclamation) to create and provide habitat for a fast-declining avian assemblage.

CHAPTER III

FIELD-LEVEL SPATIAL FACTORS, ASSOCIATED EDGES, AND

DICKCISSEL NESTING ECOLOGY

SYNOPSIS

Reclamation involves the restoration of surface-mined lands to early-successional grass and shrub lands that can provide important wildlife habitat for a suite of species. Declines in disturbance-dependent birds have been observed in the last 30 years more than any other bird group; however, the importance of reclaimed lands for many of these bird species have long been recognized. Additionally, many studies have indicated that avian nest predation and parasitism may be highest in highly fragmented habitats and near habitat edges. Variation in predation and parasitism rates are likely due to habitat affinities of nest predators and brood parasites, such as the brown-headed cowbird. Understanding the influence of spatial factors on the nesting ecology of populations of conservation concern is imperative to land managers (e.g., reclamation specialists). I evaluated the influence of spatial factors (roads, water, forested riparian areas, recently reclaimed lands, agricultural edges) on the nest site selection, nest success, and nest parasitism of dickcissels on 2 sites reclaimed as wildlife habitat on the Big Brown Mine owned and operated by TXU Energy, in 2002–2003. I found 119 nests, 14 of which were parasitized. From binary logistic regression, I found that dickcissels were more likely to select nest sites further from riparian areas and closer to roads. Nest success was best predicted by closer distances to permanent water sources. Parasitism by the brown-headed cowbird was more likely to occur near riparian areas

and roads. Based on these results, I offer TXU Energy management recommendations that may increase the success of breeding dickcissels, a species of high conservation concern, on these wildlife areas on the BBM.

INTRODUCTION

The reclamation processes following the surface-mining of lignite coal creates large, contiguous tracts of grasslands (Brothers 1990) that have been recognized as important areas for disturbance-dependant birds (Allaire 1978, Ingold 2002). This is of conservation importance to the grassland avian assemblage, which has declined severely in the last 30 years, more so than any other bird group (Peterjohn and Sauer 1999). Increased nest predation, brood parasitism, habitat loss and fragmentation are attributed to these declines (Johnson and Temple 1990). This loss of habitat is arguably countered by 2 conservation programs (Devault et al. 2002). The first, the Conservation Reserve Program (CRP), converts cropland into suitable grassland habitat (Best et al. 1997), but only on a relatively short timescale. The second conservation effort (Devault et al. 2002) involves the millions of hectares of reclaimed surface-mined land that creates suitable habitat for the declining disturbance-dependant avian assemblage (Wray et al. 1982, Bajema et al. 2001, Ingold 2002). Due to the size and time-span involved with surface-mining and reclamation, the opportunities for grassland bird conservation in these areas are enormous.

The dickcissel, a neotropical migrant of conservation concern (Hunter et al. 2001), is one such grassland bird which has suffered a population decline in the last 30 years due to habitat loss, increased nest predation and parasitism, and over harvest (i.e.,

lethally controlled as an agricultural pest on its wintering range in Central and South America; Basili and Temple 1998, Temple 2002). Indeed, reclaimed surface-mined lands have been documented to provide important breeding habitat for dickcissels in the United States (Cantle 1978, DeVault et al. 2002, Scott et al. 2002), which emphasizes the importance of reclamation efforts.

Since the reclamation process often results in a land use mosaic (Brothers 1990), complete with agricultural and wooded edges, and creates habitat for wildlife at large scales (Brenner 1973), an understanding of how spatial features (of both gradual and abrupt edges) influence avian nesting ecology could provide reclamation biologists with information to provide specific habitat needs of targeted species, such as the dickcissel. Edges, both abrupt and gradual (Jensen and Finck 2004), have been demonstrated to influence the nesting preferences, success and parasitism of birds. For example, evidence suggests grassland birds avoid nesting near wooded edges (Johnson and Temple 1986, Winter et al. 2000). Additionally, many studies have indicated that avian nest predation and parasitism may be highest in highly fragmented habitats and near habitat edges, as reviewed by Paton (1994). Variation in predation and parasitism rates are likely due to habitat affinities of nest predators and brood parasites, such as the brown-headed cowbird. In a grassland habitat, breeding birds may avoid an abrupt edge (i.e., wooded edges) because of the associated effects, but may not avoid more gradual edges (i.e., agricultural edges) because of the lack of effects (Jensen and Finck 2004). Abrupt and gradual edges are common among North American grasslands (Sampson and Knopf 1994) and an understanding the influence of how spatial factors affect the nesting

ecology of populations of conservation concern is imperative to land managers (e.g., reclamation specialists).

Here, I describe a study evaluating the influence of field-level spatial factors, of both gradual and abrupt edges, on the (1) nest-site selection, (2) nest success, and (3) nest parasitism of dickcissels on reclaimed surface-mined lands created as wildlife habitat in Northeastern Central Texas. Such information could prove vital for the conservation of species of concern on similar created lands.

METHODS

My study was conducted on the Big Brown Mine (5,800 ha) owned and operated by TXU Energy in Freestone County, 16 km east of Fairfield, Texas (Chapter I, Figure 1.2). The mine is within the northern Post Oak Savannah vegetation region of Texas wedged between the Pineywoods on the east, Blackland Prairies on the west, and Coastal Prairies and Marshes on the south (Gould 1975). Topography is gently rolling to hilly. Historically, this region was characterized by post oak and blackjack oak in the overstory, and climax grasses (e.g., little bluestem, Indiangrass, switchgrass) in the understory (Gould 1975). Since 1971, TXU Energy has reclaimed surface-mined lands to create a variety of habitats (e.g., wildlife habitat, riparian areas, hayfields, grazed pastures, timber plantations, and wetlands) that all began as early successional grasslands. I evaluated the nesting ecology of dickcissels on 2 study areas designated as wildlife habitat areas (i.e., no mowing or grazing allowed; site 1 = 52 ha; site 2 = 64 ha; Chapter I, Figure 1.2) managed by TXU Energy and reclaimed in 1993.

Vegetation in these areas was characterized by various young oaks, willow baccharis, Chickasaw plum, grasses such as bushy bluestem, Wilmann's lovegrass, switchgrass, Bermudagrass, and clover.

Nest Monitoring

Dickcissel nests were located and monitored from April–July 2002 and 2003 using guidelines suggested by Martin and Geupel (1993). Eight systematically-placed plots (50 x 200 m) for each area were searched once every week. In 2003, less-intensive systematic searches were performed over entire study areas every 2-3 days in addition to the nest search plots. Once a nest was found, its location was marked with a global positioning system (GPS) waypoint, and subsequently revisited every 2-3 days thereafter to monitor success (Martin and Geupel 1993). I determined and categorized nest fate (successful [fledge = 1], failed [depredated or abandoned], parasitized) for each nest monitored.

Spatial Data and Analysis

Two abrupt and 2 gradual-edged field-level spatial features were common to both sites and included: gradual edges - (1) agricultural edges (i.e., fields used for cattle grazing or hay production; primarily a monoculture of Bermudagrass) and (2) recently reclaimed areas (i.e., land reclaimed within the past 2 years and planted with wheat [*Triticum* spp.] as a fast cover); abrupt edges - (1) roads, and (2) forested riparian areas. In addition, I also evaluated the importance of permanent water sources in the analysis because of biological importance (e.g., influence on the establishment of vegetation, predator movements, etc.). These features were digitized from a 1-m resolution Digital

Orthophoto Quadrangle taken in October 2002 with ArcView 3.3 (ESRI Institute, Redlands, California, USA). Proximity of nests from features was also calculated in ArcView using the extension Spatial Analyst.

Nest-site selection, nest success, and nest parasitism were evaluated using binary logistic regression (Hosmer and Lemeshow 2000). Nest-site selection (0 = random point, 1 = nest site) was determined by comparing the distance to features from actual nests and randomly generated points in each site. Although random points were generated throughout each site, I avoided the placement of random points within a 10 m buffer of an actual nest point to increase the model's predictive power (Cohen 1988). This approach of modeling selection is similar to a technique proposed by North and Reynolds (1996). Similarly, nest success (0 = failed, 1 = successful) and nest parasitism (0 = not parasitized, 1 = parasitized) were modeled by comparing distances to spatial features between failed and successful nests, and parasitized and non-parasitized nests, respectively. For the parasitism model, only nests that were observed within the timeframe of known cowbird parasitism activity were used (i.e., 27 May – 25 June for this study; Budnik et al. 2002). In each analysis, predictor variables were based on the proximity of nests from spatial features (i.e., roads, water, agricultural edges, riparian area, and recent reclamation) in which the distances were treated as continuous variables. In addition, site and years were entered as categorical variables to test for temporal and spatial variation. Prior to model building, all model variables were evaluated using univariate logistic regression. Variables with a $P = 0.25$ were used in model construction (Hosmer and Lemeshow 2000), and highly correlated variables were

eliminated before final model building. Models were evaluated using best subsets from Akaike's Information Criterion (AIC; Burnham and Anderson 2001). Logistic regression analyses were performed with Statistica 6 (StatSoft, Inc., Tulsa, Oklahoma).

RESULTS

I found and collected data on 119 nests ($n = 25$, 2002; $n = 94$, 2003) during the study of dickcissels on reclaimed lands in Texas. These 119 nests were compared to 119 randomly generated points. Based on AIC, I found that dickcissels were more likely to select nest-sites further away from riparian areas and closer to recently reclaimed areas (Figure 3.1). The model correctly predicted 70% of the data with a likelihood ratio $\chi^2 = 31.15$, $P = 0.001$.

I modeled nest success using data from 71 failed and 48 successful nests (total $n = 119$). Nest success was best predicted only by distance to water. Nests closer to a permanent water source were more likely to be successful (Figure 3.2). The model correctly predicted 60% (likelihood ratio $\chi^2 = 3.41$, $P = 0.07$).

Brood parasitism was relatively infrequent in this study. A total of 111 nests were monitored during known cowbird parasitism activity, with 14 nests being parasitized (12.6%). Nests closer to forested riparian areas and roads were most likely to be parasitized (Figure 3.3). The model correctly predicted 88 % of the data (likelihood ratio $\chi^2 = 24.84$, $P = 0.001$).

DISCUSSION

Dickcissels were likely to select sites on reclaimed areas that were further from wooded riparian areas and closer to recently reclaimed areas. Although proximity to

wooded riparian areas did not explain nest success, perhaps dickcissels selected sites away from riparian areas because they are inferior habitat (i.e., higher predation and parasitism). Other studies have documented lower nest densities of dickcissels near wooded edges (Hughes et al. 1999, O'Leary and Nyberg 2000, Jensen and Finck 2004), and Winter et al. (2000) showed that generalist mammalian predators were most active near wooded edges of tallgrass prairie remnants in Missouri. I also found that dickcissels were more likely to nest closer to recently reclaimed areas. Results suggest that areas planted with wheat may not represent a conspicuous edge to dickcissels or may not provide the habitat affinities of predators. This supports the findings of Hughes et al. (1999) and Jensen and Finck (2004), who demonstrated that dickcissels did not avoid crop or agricultural edges. Results suggest that the structure associated with crops or hayfields, a gradual edge in relation to grasslands, are not avoided in nest-site selection of dickcissels. However, a forested edge (an abrupt edge in grassland systems), is generally avoided.

The data suggests that nests closer to a permanent water source were more likely to be successful. A lack of statistical power may explain why proximity to certain edges did not predict success, and indeed, the predictive power of the model was low (i.e., 60% concordance). Another rationalization may be explained by the structural diversity associated with the sites' permanent water sources. Small shrubs and oak saplings, as well as bunchgrasses, were well established near the water sources (TPD, unpublished data), perhaps due to higher soil moisture. In a separate study (Chapter II), I found that woody shrubs and oak saplings were a preferred nesting substrate, while bunchgrass

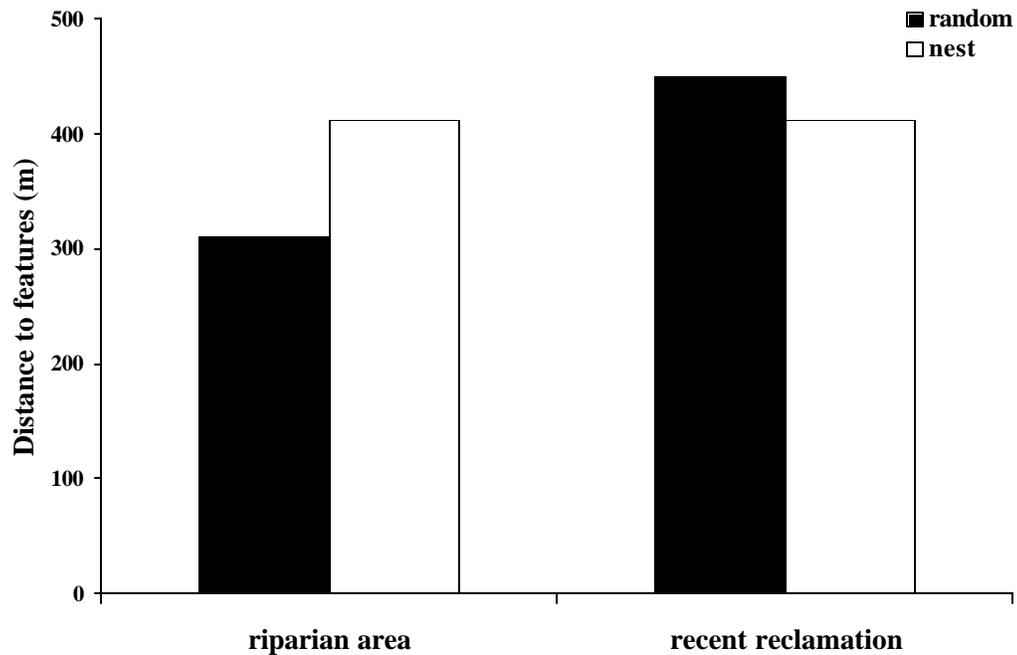


Figure 3.1. Mean values of important variables (distance to wooded riparian edge and recently reclaimed areas) predicting the probability nest-site selection for dickcissels on reclaimed lands created as wildlife habitat, Big Brown Mine, Fairfield, Texas, 2002–2003.

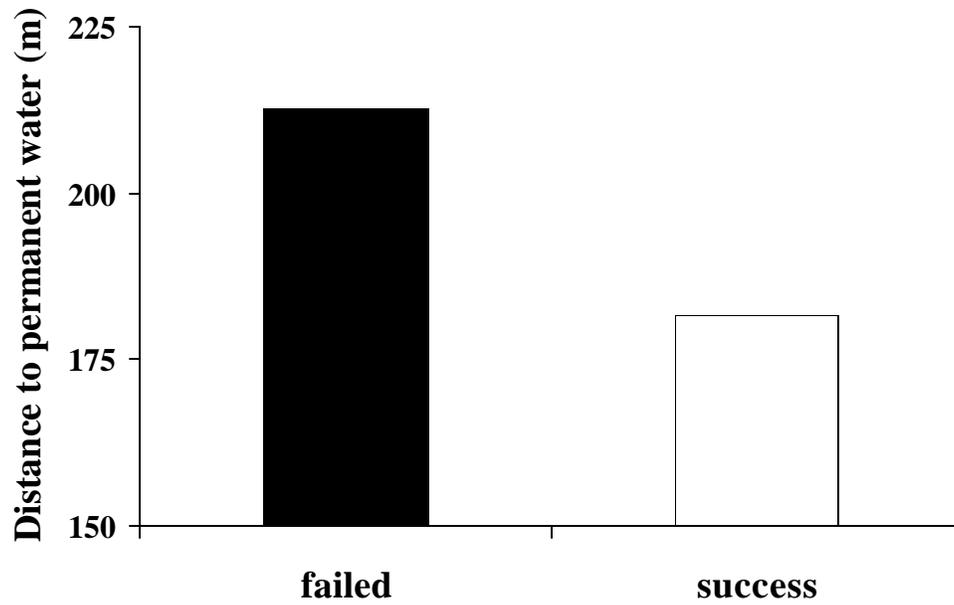


Figure 3.2. Mean values of important variables (distance to permanent water) predicting the probability of nest success for dickcissels on reclaimed lands created as wildlife habitat, Big Brown Mine, Fairfield, Texas, 2002–2003.

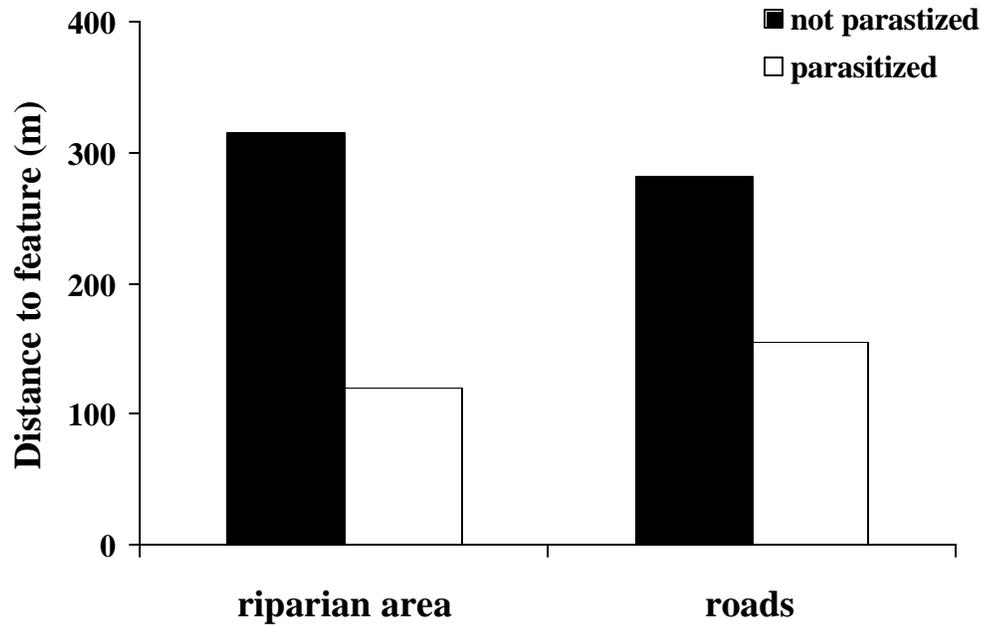


Figure 3.3. Mean values of important variables (distance to wooded riparian edge and roads) predicting the probability of nest parasitism by the brown-headed cowbird on dickcissel nests on reclaimed lands created as wildlife habitat, Big Brown Mine, Fairfield, Texas, 2002–2003.

density surrounding the nest area was an important characteristic predicting nest-site selection of dickcissels on reclaimed lands. Furthermore, nest height, which was the best predictor of nest success, was associated with woody nesting substrates. Therefore, the presence of these nest-site habitat characteristics near permanent water may explain why nests closer to water were more likely to be more successful in the field-level spatial analysis.

Lastly, nest parasitism was most likely to occur at nests closer to wooded riparian areas and roads. This may be explained by the affinity of brown-headed cowbirds to elevated perches, from which they can scan for potential hosts (Gates and Gysel 1978). Other spatial features lack elevated perches and this may also explain why they did not contribute to the nest parasitism model. Roads contained transmission lines and fence posts, while the riparian areas contained tall trees (relative to the study sites), which may explain the higher incidence of parasitism near these spatial features. My results support the findings of several studies that indicate that cowbird parasitism is skewed toward woodland edges in grasslands (Mayfield 1965, Johnson and Temple 1990, Winter et al. 2000, Budnik et al. 2002, Jensen and Finck 2004).

MANAGEMENT IMPLICATIONS

I recommend further research into the effects of edges on species of concern, such as dickcissels, on surrogate habitats, like reclaimed surface-mined lands. Although this study lacked more replicates and sites due to logistical constraints, I offer the following management recommendations based on my results. Upon modeling nest-site selection, I found that forested riparian edges were likely to be avoided and recently

reclaimed areas were not. Additionally, parasitism was most likely to occur near wooded riparian areas and roads. Based on these results, I would suggest the establishment of larger blocks of these areas created for wildlife, which would provide more preferred nesting areas (i.e., more interior-field habitat) for dickcissels breeding on the BBM in Northeastern Central Texas. Also, results suggest that wooded edges, like those associated with riparian areas, perhaps should be a minimal component of the edges of a wildlife area created at BBM, since dickcissels avoided the forested riparian areas, where parasitism was also most likely to occur.

Given the large temporal and spatial scales at which reclamation occurs, the opportunities for providing habitat for the disturbance-dependent assemblages (i.e., grassland birds) are enormous. Reclamation biologists are in a unique position to provide conservation measures and create habitat for longer intervals than what CRP Programs provide. With over 2.3 million ha permitted for surface-mining in the United States (Office of Surface Mining 2002) for now and in the near future, the conservation implications are large scale and long-term. Therefore, I suggest more attention and research should be invested in the surface-mining reclamation process.

CHAPTER IV

A NEW CAMERA TECHNIQUE TO IDENTIFY PREDATORS AT ACTIVE

NESTS

SYNOPSIS

Nest predation is the primary cause of avian nest failure but witnessing a predation event is rare. Although many nest predation studies have been executed with the use of remotely-triggered cameras, most have either involved artificial nests, or if active nests were studied, used miniature video cameras. Infrared-triggered cameras are a useful tool in wildlife management, but are too conspicuous for use on active nests. I replaced the transmitter and receiver portion of a Trailmaster® TM35-1 camera with a unique, animal triggered mechanism; a small (17 × 13 × 5 cm) car alarm shock sensor. To illustrate the use of the shock sensor camera system and to evaluate its field use, I conducted a pilot study and monitored 13 dickcissel nests with cameras and 80 without. Of 9 depredated camera-nests, I photographed predators on 3 occasions. The presence of the apparatus did not appear to bias the behavior of predators or dickcissels as the mean number of days exposed until failure did not differ ($P = 0.719$) between depredated camera and non-camera nests. Camera nests had higher Mayfield success ($P < 0.001$) than non-camera nests, suggesting the presence of equipment did not negatively affect success. The total cost for a camera unit was \$335 (2004 prices), making it less expensive than commercially-available camera systems. I suggest the camera unit can be used in a variety of ways to benefit other wildlife studies.

INTRODUCTION

Nest predation is the primary source of nest failure in birds (Ricklefs 1969, Martin 1988, Martin 1993), however, witnessing a predation event and identifying the nest predator is rare (Major 1991). Speculation on the identity of the depredatee animal based on signs of disturbance (i.e., damage to nests, remnants of egg shells, trampled or broken vegetation) can be misleading. Previous research (Hernandez et al. 1997, Pietz and Granfors 2000, Thompson and Burhans 2003) using cameras on nests reported signs of nest disturbance were variable within and between nest predator species, therefore, physical field evidence at the nest may be an unreliable method for identifying predators (Lariviere 1999).

Camera studies have become an increasingly popular way to monitor wildlife (Cutler and Swann 1999). Infrared-triggered automatic camera systems (passive and active) and miniature video cameras are often used in nest studies to identify nest predators. A number of novel techniques using animal-triggered mechanisms have been employed to remotely photograph nests (artificial and natural, Picman 1987, Major 1991, Major and Gowing 1994), however, many of these units may be too obtrusive or may take too long for deployment onto active nests. Furthermore, remotely-triggered cameras (e.g., Trailmaster, etc.) have been primarily used with artificial nests (Cutler and Swann 1999) which may be a poor surrogate for active nests (Reitsma et al. 1990, Whelan et al. 1994, Major and Kendal 1996, King et al. 1999). Miniature video cameras have numerous advantages, particularly in active nest studies. Video camera systems, however, can be expensive (about \$4,000/unit, Liebezeit and George 2003).

Here I describe a unique animal-triggered mechanism used to monitor predation events at active nests of dickcissels which uses a small (< 20 g) car alarm shock sensor to trigger a camera. The trigger mechanism is used in conjunction with commercially-available 35mm cameras, and can be easily used on active nests due to its small size, easy implementation, and low cost (\$335/unit).

METHODS

Camera System Construction

The camera system consisted of a (1) car alarm shock sensor, (2) a commercially-available 35mm camera, and (3) control box to join the camera and sensor.

Camera and shock sensor.—I used the commercially-available Trailmaster® TM35-1 camera kit (Goodson and Associates, Inc., Lenexa, Kansas) commonly used in conjunction with Trailmaster's active and passive infrared-triggered units (e.g., Trailmaster® TM 550, TM 1500) in my system. The camera kit consisted of a modified 35-mm weather-proof camera (Yashica® T4 Super D). Normally, a camera cable would connect the TM35-1 to either an active (e.g., TM 1500) or passive (TM 550) camera system; in the both cases, I felt the infrared-triggered system (i.e., transmitter and receiver) was too conspicuous to place on active nests so I replaced the system with a miniature car alarm shock sensor (700B Dual Stage Car Alarm Shock Sensor, Bulldog Security, Steubenville, Ohio.). The shock sensor was weather-proofed with silicone sealant (around seam of housing) and camouflaged by gluing vegetation (i.e., nesting material) to the sensor. The shock sensor retails for \$6–15 from a variety of internet

retailers, and is inconspicuous due to its small dimensions (17 × 13 × 5 cm) (Figures 4.1–4.2).

Control box.—Collectively, the switchbox and battery comprised the control box for the camera system. The control box served to link the camera and provide power to the car alarm shock sensor. A switchbox (30 × 20 × 10 cm plastic box) consisted of a 12 VDC reed relay switch, power switch (i.e., mini toggle switch), a 5 mm LED light (to indicate whether the unit was on or off), a size M coaxial power jack (to accept the 12V battery), and a mini phone jack (to accept the Trailmaster camera cable) (Figure 4.2). A 4-strand telephone wire (length – 5 m) was used to connect the shock sensor to the switchbox, as well as to connect the battery to the switchbox. The switchbox and battery were placed in a 3.8L-sized plastic storage bag; an alternative might include a plastic box (e.g. plastic ammunition box).

All wires (except Trailmaster cable) were camouflaged with dark brown and green spray paint to aid in concealing the camera system. The camera system was weathered for about 2 weeks before use on active nests. I constructed 5 shock sensor camera units for use during a nesting study. The bulk of construction cost was the Trailmaster cable and camera (\$290), plus the cost to build the shock sensor (\$45), bringing the total cost to \$335.

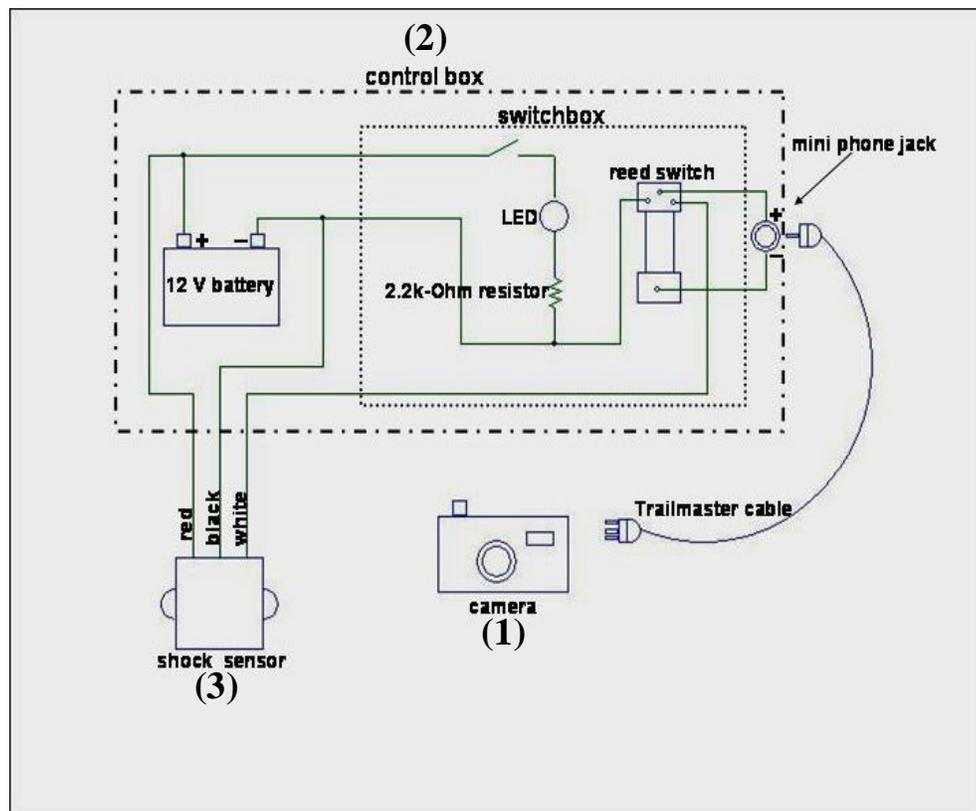


Figure 4.1. Wiring diagram of shock sensor camera unit depicting the camera (1), the control box (2) and the shock sensor (3).

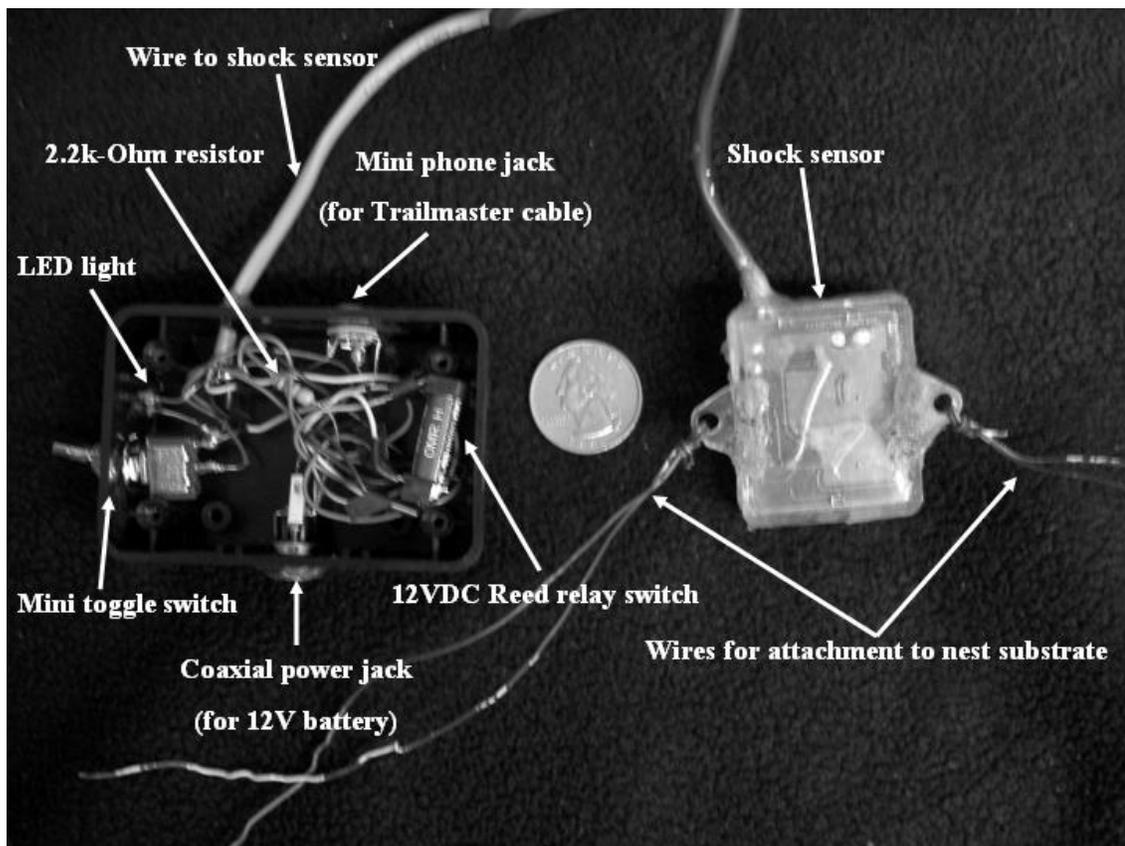


Figure 4.2. Photo of switchbox with labeled parts.

Field Operation

Nest searches and monitoring.—To illustrate the use of the shock sensor camera system and to evaluate its field use, I conducted a pilot study on dickcissel nesting ecology. Field sites were located on Big Brown Mine, owned and operated by TXU Energy, in Freestone County, 16 km east of Fairfield, Texas. The mine site is located within the Post Oak Savannah vegetation region of Texas with an average rainfall of 98 cm (Gould 1975). Our study focused on areas designated as “wildlife habitat” that were reclaimed within the past 10 years. Vegetation in these areas was characterized by various young oaks, willow baccharis, Chickasaw Plum, grasses such as bushy bluestem, Wilman lovegrass, switchgrass, Bermudagrass, and clover. Nests were located and monitored from late April–late July 2003 following guidelines by Martin and Geupel (1993). Once a nest was found, its location was marked with a global positioning system (GPS) waypoint, and subsequently visited every 2–3 days thereafter to monitor success.

Camera deployment.—Selected nests were monitored using my shock sensor camera system by (1) placing shock sensor under the bowl of an active nest, (2) concealing the control box near the nest site (about 1 m away), and (3) attaching TM35-1 camera on a 0.6–1.2 m tall “all-thread” rod (0.6-cm diameter, camera attached to top of rod using the tripod mount insert) (Figure 4.3). First, the shock sensor was placed beneath the nest bowl and secured to nest bowl with plastic-coated wires. Next, the camera rod was inserted into the ground near the nest. Finally, the control box was concealed near the camera unit. The wire leading from the control box to the shock sensor was carefully hidden in vegetation between the nest and ground. Once set, the car

alarm shock sensor would trigger the TM35-1 camera to take a picture when the nest bowl was agitated or jostled.

Data analysis.—I examined potential equipment biases by comparing the proportion of camera and non-camera nests that were depredated, successful, or deserted. For depredated nests (both camera and non-camera), I also compared the mean number of days from estimated nest initiation to depredation event. Lastly, mean nest survival (Mayfield 1975, Johnson 1979) was compared between camera and non-camera nests using the program CONTRAST (Hines and Sauer 1989). Mean exposure days and nest survival were compared with a *t*-test (Ott and Longnecker 2001).

RESULTS AND DISCUSSION

Camera Operation

A total of 93 dickcissel nests were located and monitored between April–July 2003. Of the 93 active nests, 13 were outfitted with the shock sensor camera unit. All camera units were deployed on active nests during the incubation stage. Set up of the entire shock sensor camera unit on an active nest took <2 minutes, which minimized the probabilities of nest desertion. I recorded 9 of 13 (69%; Figure 4.4) depredation events with the camera unit, however, in only 3 of 9 (33%) depredated nests was the predator photographed and identified (2 raccoons, 1 unidentifiable rodent, Figure 4.3).

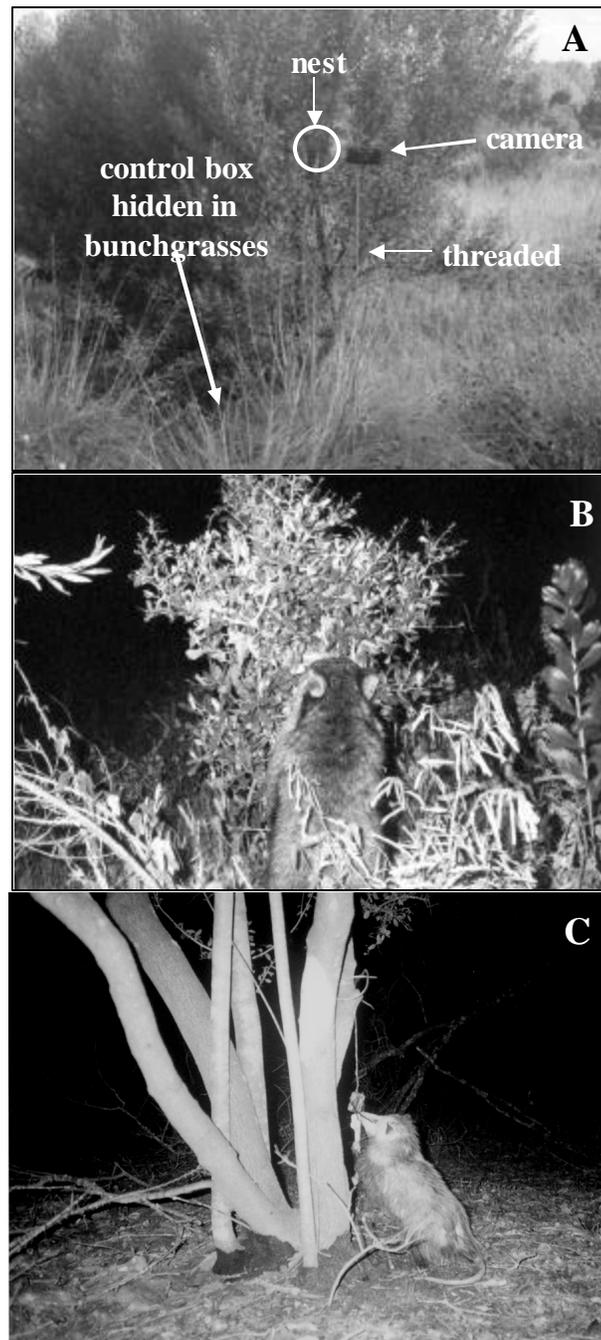


Figure 4.3. Photo showing the field deployment of a camera unit on a dickcissel nest. Note that the control box (i.e., switchbox and 12V battery) is hidden between bunchgrasses and a longer threaded rod is used for a higher nest (A). Raccoon depredate a dickcissel nest (B). Opossum (*Didelphis virginiana*) visiting a scent station (C).

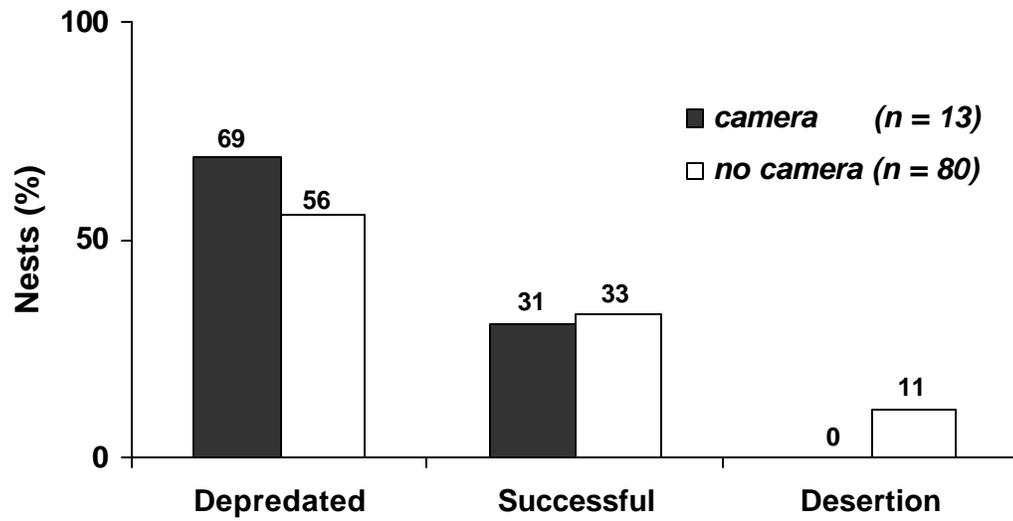


Figure 4.4. Camera and non-camera nests (%) that were either depredated, successful (i.e., fledging =1 young), or deserted.

I experienced 3 initial problems with the camera system. First, of the 6 depredated camera nests that did not reveal the predator, 4 triggered but failed to photograph the culprit due to camera angle, distance, or obstructive vegetation.

A better camera angle could be obtained by using taller rods bent to the desired angle to achieve a clearer, aerial view of the nest and its contents. Removing obstructive vegetation was an option, but I chose not to alter nest-site vegetation. Another alternative might include moving the camera gradually closer over the first few days (Thompson and Burhans 2003).

Second, the use of shock sensor was at times triggered by the nesting bird (e.g., leaving or arriving at nest). For example, the mean number of pictures taken/camera unit was 81 (SE = 24). These “misfires” (i.e., picture of nesting bird rather than predator) could be corrected by adjusting the sensitivity of the shock sensor or adding a time delay to the circuitry to reduce the number of “misfires”. However, in this study, these additional pictures were useful in documenting nest attendance behaviors (e.g., time for parent to return to nest after being flushed by researcher, time spent on and off nests, identification of food items).

Third, on 5 separate occasions units were rendered inoperable by rodents that gnawed through wires. Previous research (Hernandez et al. 1997, York et al. 2001, Thompson and Burhans 2003) described this problem as well and suggested burying the cable or housing in plastic pipe (i.e., PVC). I suggest housing the wires in flexible, metal tubing (e.g., Greenfield conduit). The camera cable provided by Trailmaster

cannot be repaired (i.e., soldered) and I suggest researchers have replacement cables available.

Equipment Biases

The presence and maintenance of camera equipment may attract or deter potential nest predators and is often a concern for researchers (Cutler and Swann 1999). Although the sample size of camera nests was small ($n = 13$), the differences in proportions of successful nests between camera and non-camera nests were similar (33% and 31%, respectively; Figure 4.4). No difference ($P = 0.719$) was found between the mean number of days that depredated camera and non-camera nests were exposed from initiation until failure ($\bar{x} = 11.6$ and 12.2 days, $n = 9$ and $n = 44$, camera and non-camera nests, respectively). Overall nest survival was greater ($\chi^2 = 12.2$, $df = 1$, $P < 0.01$) for camera nests ($\bar{x} = 0.451$ and 0.365 , $n = 13$ and $n = 80$, camera and non-camera nests, respectively). No camera nests were abandoned. This suggests the additional equipment did not adversely affect nest outcome. Major and Gowing (1994) also reported no differences in reproductive success or nest abandonment between camera and non-camera nests during a similar study of New Holland honeyeaters (*Phylidonyris novaehollandiae*).

MANAGEMENT IMPLICATIONS

Although the camera unit was designed for use on active bird nests, the shock sensor camera system has many applications in monitoring wildlife or in law enforcement applications. My system overcomes many of the problems of traditional systems including (1) the conspicuousness associated with traditional infrared-triggered

units, (2) high cost, and (3) misfires due to vegetation, direct sunlight, or misalignment (Rice 1995, Hernandez et al. 1997). The unique triggering mechanism can be easily used with scent stations (Figure 4.3), artificial or active subterranean nests (i.e. turtles or alligators [*Alligator mississippiensis*]; Maier et al. 2002), law enforcement applications (e.g., monitoring traps or gates), or in monitoring wildlife movement corridors (e.g., “crawls”, den openings, tree cavities).

CHAPTER V

CONCLUSIONS AND IMPLICATIONS

The purpose of this chapter is to provide research highlights and management implications. Based on the results of my study, the following is offered to TXU Energy to increase the numbers and success of dickcissels and similar bird species breeding on reclaimed areas created as wildlife habitat on the BBM.

RESEARCH HIGHLIGHTS

Effects of Nest-site Vegetation

Results suggest that dickcissels are not selecting nest-sites at random on the BBM. I found that reclaimed areas that provided low vegetative ground cover (e.g., clover), and high bunchgrass and tall dead forbs (i.e., perch sites) densities were preferred nesting areas by dickcissels. Based on the results, I recommend increasing the amount of tall forbs (e.g., sunflower and curlycup gumweed) that may establish on these sites by increasing seeding efforts during reclamation. Similarly, increasing bunchgrass seeding efforts (e.g., more seeds and subsequent planting) could make areas more attractive as nesting sites. Clover, a hindrance to the establishment of planted species, appears to be an important factor in nest-site selection and its eradication should not be management priority in some cases.

Nest height and vegetation height above the nest were the best predictors of dickcissel nest success on reclaimed areas. I propose these nest substrate characteristics are related to the structure offered by woody substrates. Given the preference by dickcissels of woody nest substrates over bunchgrass at BBM, I suggest that oaks and

pine continue to be planted on reclaimed areas. *Baccharis* is viewed by reclamation specialists as a species of management concern because it hinders the establishment of desirable woody plants (i.e., pines, oaks); however, study results illustrate their potential benefits to grassland birds and removal should not be management priority in some instances.

Influence of Spatial Factors

Upon modeling nest-site selection, I found that forested riparian edges were likely to be avoided and recently reclaimed areas were not. Additionally, parasitism was most likely to occur near wooded riparian areas and roads. Based on these results, I would suggest the establishment of larger blocks of these areas created for wildlife, which would provide more preferred nesting areas (i.e., more interior-field habitat) for dickcissels breeding on the BBM in Northeastern Central Texas. Also, results suggest that wooded edges, like those associated with riparian areas, perhaps should be a minimal component of the edges of a wildlife area created at BBM, since dickcissels avoided the forested riparian areas, where parasitism was also most likely to occur.

MANAGEMENT IMPLICATIONS

Although I have demonstrated that reclaimed lands provide important habitat for breeding dickcissels, these early successional reclaimed habitats provide for many disturbance-dependent organisms. Given the large temporal and spatial scales at which reclamation occurs, the opportunities for providing habitat for disturbance-dependent assemblages (e.g., grassland birds) are enormous. With over 2.3 million ha permitted for surface-mining in the United States (Office of Surface Mining 2002), the opportunities

for the management and conservation of the grassland and disturbance-dependent bird assemblage in the near future are enormous. Due to the size and time span involved with reclamation, reclamation specialists are in a unique position to create and provide habitat for a fast-declining avian assemblage. Therefore, I suggest more attention and research should be invested in the surface-mining reclamation process.

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VITA

Thomas Pingul Dixon

BACKGROUND

Parents: Celia P. and Thomas L. Dixon

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EDUCATION

Master of Science, Wildlife and Fisheries Sciences, Texas A&M University, 2004.

Bachelor of Science, Wildlife and Fisheries Sciences, Texas A&M University, 2001.

WORK EXPERIENCE

Research Assistant, Department of Wildlife and Fisheries Sciences, Texas A&M University and the U.S. Department of Navy, Boca Chica, Florida, Present.

Research Fellow, TXU Environmental Research Program, 2002-2004.

Volunteer Research Technician (numerous projects), Department of Wildlife and Fisheries Sciences, Texas A&M University, 2001-Present.

Teaching Assistant, Department of Wildlife and Fisheries Sciences, Texas A&M University, 2002.