

IMPACTS OF RECREATIONAL TRAILS ON BREEDING BIRDS
IN FORESTED URBAN PARKS

A Thesis

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By

Jennifer R. Smith-Castro

The Ohio State University
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Master's Examination Committee:

Amanda D. Rodewald, Ph.D., Advisor

Stanley D. Gehrt, Ph.D.

Virginie Bouchard, Ph.D.

Approved By

Advisor
Natural Resources Graduate Program

ABSTRACT

Most public lands, particularly those in urban areas, are designed to meet both social and ecological needs. Although recreation has traditionally been viewed as relatively harmless to animal communities, trails within urban parks may influence the behavior of wildlife through human disturbance and through changes in the distribution of vegetation. Because park managers must balance the competing interests of conservation and recreational uses of parks in urban areas, consideration must be given to the potential consequences of human disturbance to breeding birds. The central purpose of this study was to determine the extent to which trails affect nest predation and evaluate possible causes of those effects. Specifically, I tested the following three hypotheses about the impacts of human use of trails on breeding birds: 1) Human use of trails in urban forests reduces nest survival by reducing parental attendance rates, thereby leaving nests more vulnerable to predation; 2) Relationships between nest survival and trails derive from modified vegetation surrounding a nest, and these changes in habitat drive trail-related impacts on breeding birds; 3) Human use of trails in urban forests influences the sensitivity of breeding birds to disturbance and induces changes in nest placement through habituation and self-sorting behavior. From April – August 2006 and 2007, I monitored the fate of 263 Northern Cardinal nests and quantified vegetation structure and composition around nests and at random plots within riparian forests in central Ohio.

Sites were located in urbanizing landscapes and contained paved and unpaved recreational trails. Trail cameras were utilized at 6 sites to estimate the amount of human recreational activity. One hour parental attendance observations were conducted at 125 nests to estimate variation in nest attendance. Two experimental trials were conducted on 63 nests such that Flight Initiation Distance (FID), as an index of sensitivity, was recorded as each nest was approached either directly or along a trail. In addition, FID was collected during routine nest checks where the nest was approached directly ($n = 160$). Results showed that birds were 6x more likely to flush when the nest was approached directly than when an observer passed along a trail. Nest height mediated the tendency to flush somewhat, as higher nests were less likely to flush, but flush tendency was not related to distance to trail. Interestingly, the distance at which a bird flushed (FID) was not significantly related to either distance to trail or nest height. I used an information-theoretic approach, incorporating a set of models into a logistic-exposure method to model daily nest survival. Estimated daily survival rates for Northern Cardinals were similar across sites, and variation in daily survival rate of Northern Cardinal nests was not well explained by FID, parental attendance, trail usage, or site. Rather the best explanatory model contained only the variable of nest height, though several alternate models, including one containing distance to trail as well as a null model, were similarly ranked. I used canonical correlation analysis to examine the extent to which vegetation variables were related to distance to trail separately for nest and randomly-located plots.

Results suggest that birds selected nest locations surrounded by greater amounts of native vegetation than expected when farther from trails. In addition, birds selected nest sites that were lower to the ground and more interior in the nest plant when farther from trails. Thus, recreational trails appeared to indirectly influence reproductive behavior by altering nest site selection. Relatively few studies have measured the impact of recreational disturbance to nesting passerines, and this study illustrates that recreational use has the potential to impact, even those species thought to be urban-adapted. Nevertheless, because nest attendance was not related to daily nest survival rates, this study fails to provide evidence of negative reproductive and, hence, potential population-level consequences of behavioral responses to human disturbance. Thus, my work suggests that, at least for certain synanthropic species, recreation may indeed be compatible with conservation.

Dedicated to the memory of my grandparents who were the first to introduce me the joys
of the natural world.

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VITA

April 23, 1976.....Born – Twenty-nine Palms, California, USA

1998.....B.A. Environmental Science, Boston University

August 2005 – present.....Graduate Fellow and Research Associate, The
Ohio State University

October 2003 – July 2005.....Bird Monitoring Project Coordinator,
SalvaNATURA, El Salvador

August 2004 – December 2004.....Avifauna Consultant, CATIE/FIAES, El Salvador

March 2003 – July 2003.....Biological Technician, The Nature Conservancy,
Fort Hood, Texas

June 2002 – August 2002.....Research Assistant, Ria Lagartos Biosphere
Reserve, Mexico

January 2000 – May 2002.....Foreign Language Fellow, Department of State,
US Embassy, El Salvador

April 1999 – July 1999.....Research Assistant, Institute for Bird Populations,
Carrizo Plains, California

June 1998 – August 1998.....Field Assistant, Lambir Hills National Park,
Malaysian Borneo

PUBLICATIONS

Komar, O., J. P. Arce, J. R. Smith, and I. Varley. 2006. Evaluación de Biodiversidad del Parque Nacional Los Volcanes, El Salvador. (Evaluation of Biodiversity at Los Volcanes National Park, El Salvador) Consulting Report for the InterAmerican Development Bank. SalvaNATURA, Conservation Science Program, San Salvador, El Salvador and Natureserve, Washington D.C.

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CHAPTER 1

INTRODUCTION

In many parts of the world, land managers are increasingly asked to provide both social and ecological values on protected lands. Although the highest priority for land acquisition and protection efforts may be the conservation of declining or sensitive species, management decisions within protected areas frequently must still reflect a diverse suite of needs. Particularly in urbanizing landscapes, protected habitats may be valued by nearby residents for their recreational uses and, as such, be subject to intense recreational pressures (Hammitt and Cole 1998, Leung et al. 2001). Recreation, particularly in the form of hiking, running and biking, has traditionally been viewed as relatively benign to animal communities (Hammitt and Cole 1998), in contrast to the thoroughly documented impacts associated with soil compaction and habitat modification (Ream 1980, Hammitt and Cole 1998, Sutherland et al. 2001, Thurston and Reader 2001). Disturbance to wildlife associated with recreationists is often thought to represent, at most, a brief interruption with few lasting negative effects (Shelby and Heberlein 1986, Hammitt and Cole 1998). However, ecologists are learning that disturbance from recreationists can have longer-lasting negative impacts on wildlife populations and communities and, in some cases, may ultimately compromise the value of protected areas (Hammitt and Cole 1998, Miller et al. 1998, Miller and Hobbs 2000, Müllner et al. 2004).

There is a need to more closely examine recreational impacts within urbanizing landscapes. Urban populations have grown tremendously in the last thirty years, and nearly half of the earth's inhabitants live in cities (United Nations 2000). While urban land cover accounts for less than one percent of the Earth's land area (Schneider 2003), and less than 3% of US land area (Imhoff et al. 2004), this proportion is rapidly increasing as cities expand into natural and agricultural areas (Miller 1988, Douglas 1994). This means that urban parks and preserves will have an increasingly important role in global and regional conservation efforts. Nevertheless, most early research on the impacts of recreationists focused on disturbance within national parks, especially to ungulates, bears and raptors (e.g., Ames and Merserau 1964, Reese 1970, Stalmaster and Newman 1978, Ream 1980). Because wildlife within urbanizing landscapes presumably face higher levels of human disturbance, they may respond differently to recreation than animals in wildlands. Ultimately, effective management of urban parks requires an understanding of how recreation can mediate the value of managed land to wildlife.

Breeding birds are thought to be especially sensitive to recreation-related disturbance. Even so, few studies have focused on the consequences of recreation to passerines, and those that have typically focused on indirect effects of habitat modification (Garton et al. 1977, Hammitt and Cole 1998). Ecologists need to better understand how human trails and their users directly and indirectly impact nesting passerines, particularly given that there is some evidence that rates of nest predation may be higher near trails than farther from trails (Miller et al. 1998). Because nest predation is the primary cause of avian nest mortality (Rickelfs 1969, Skutch 1985, Martin 1993 a,b) and may be responsible for population declines in some songbird species (Wilcove

1985, Recher and Serventy 1991), understanding the extent to which recreation may affect nest predation is critical.

OBJECTIVES

The central purpose of this study was to a) determine the extent to which trails affect nest predation, and b) evaluate possible causes of those effects in an urban environment. I tested the following hypotheses about the impacts of human use of trails on breeding birds:

1) Human use of trails in urban forests reduces nest survival by reducing parental attendance rates, which are negatively related to predation.

My testable predictions were that:

- a) Nest attendance rates would be positively correlated with distance from trail (i.e., greater attendance farther from trails).
- b) Nest attendance rates would be positively associated with nest survival.
- c) Nest survival would be negatively correlated with trail usage (i.e., traffic along trails).

2) Relationships between nest survival and trails derive from modified vegetation surrounding a nest, and these changes in habitat drive trail-related impacts on breeding birds.

My testable predictions were that:

- a) Cover by exotic plants would be negatively associated with distance from trails at local scales (i.e., more exotic vegetation along the trail).
- b) Understory vegetation density would be associated with distance from trail.
- c) Nest survival would be a function of vegetation characteristics in the nest patch.

3) *Human use of trails in urban forests influences breeding birds' sensitivity to disturbance and nest placement through habituation and self-sorting behavior.*

- a) Birds nesting closer to trails tend to flush at shorter distances (i.e., are less sensitive) than those nesting at farther distances from trails.
- b) Birds will be more likely to flush on direct approaches than on trail approaches.
- c) Nest success will be associated with tendency to flush and flight initiation distance.

THESIS FORMAT

In this first chapter, I review the effects of landscape and urbanization on predator abundance, community composition, and behavior, vegetation-mediated effects on predation, the influence of urbanization on parental behavior of songbirds, the relationship between human disturbance and nest predation, as well as methods used to study nest predation. In Chapter 2 I evaluate how trail users influence short-term behavioral responses to human recreationists and whether those responses are related to longer-term impacts to nesting passerines such as nest predation. In Chapter 3 I investigate the extent to which human activity affects nest attendance rates and survival. In addition, this chapter examines how vegetation characteristics relate to both trails and nest success in order to address how habitat modification influences nest predation.

BACKGROUND

As human populations continue to grow and become more concentrated in urban areas, natural habitats face increasing pressure from recreational demands (Marzluff

2001). Not only is this pressure from recreationists growing in wildlands (e.g., wilderness areas, national parks, national forests), but also in natural areas within urban landscapes where human populations are actively seeking out recreation areas (Feinerman et al. 2004, Lindsey and Nguyen 2004, Gobster 2005). This combined pressure from urbanization and from recreationists has the potential to affect nest predation by altering 1) predator abundance (Wilcove 1985, Donovan et al. 1997, Haskell, et al. 2001), 2) predator community composition (Miller and Hobbs 2000, Haskell et al. 2001), 3) predator behavior (Prange and Gehrt 2004, Prange et al. 2004, Sinclair et al. 2005), 4) vegetation structure, nest site selection, and possibly nest visibility (Rottenborn 1999, Reichard et al. 2001), 5) parental behavior of songbirds (Pietz and Granfors 2005), and 6) human presence and direct disturbance to nests (Miller et al. 1998, Miller and Hobbs 2000).

Urbanization and predator communities

Several studies have demonstrated that urbanization can profoundly affect composition and abundance of the nest predator community (e.g., Sasvari et al. 1995, Sorace 2002, Patten and Bolger 2003). Nevertheless, there is conflicting evidence about whether nest predation increases or decreases with the degree of urbanization. Some studies (e.g., Wilcove 1985, Jokimaki and Huhta 2000, Jokimaki et al. 2005, Phillips et al. 2005) show higher or similar nest predation rates in more urban areas, whereas others (e.g., Danielson et al. 1997, Gering and Blair 1999, Blair 2004) show decreasing rates with increasing urbanization. These contradictory findings may be partly explained by the landscape context of the study (i.e., the range of urban levels in the landscapes that were studied) and the focal habitat chosen for the study (i.e., some are located directly in

urban land uses and others are within natural habitats). Also, many nest predation studies use artificial nests which are not truly representative of nest predation and differing methods may lead to conflicting results. These differences make it difficult to compare across studies. In addition, abundance and community composition of nest predators may be affected by a variety of landscape characteristics including patch size (Donnelly and Marzluff 2004), landscape composition (Rodewald and Yahner 2001, Rodewald 2003), patterns of urbanization (Thorington and Bowman 2003, Jokimaki et al. 2005), and specific human activities within the landscape (Major et al. 1996). Consequently, the influence of urbanization on predator communities and avian nest predation may be governed by landscape context as well as the specific land uses associated with urban development.

One challenge facing most urban studies of nest predation is that the habitat loss and fragmentation that often accompany urban development can influence nest predation (Marzluff and Ewing 2001), making it difficult to distinguish between effects of urban land uses and habitat loss/fragmentation. As forest patches become dominated by edge habitat, they are increasingly exploited by edge-adapted mammalian and avian predators (Estrada et al. 2002). It is not clear whether edge-adapted predators are attracted to edges due to increases in prey abundance or whether other factors affect this relationship. For example, Wetherland and Blouin-Demers (2004) suggest that snakes may be drawn to edges in forest habitats for their thermal environments, though high use of edges by certain prey also may contribute to the apparent attraction. Even so, Morrison and Bolger (2002), who worked in coastal sage scrub habitats in urban landscapes, found no increase in snake encounter rates by field observers between edges and interiors of study sites.

Though the authors themselves questioned whether the study was truly representative of snake abundance across the sites, their results indicate that, at least in some habitats, snakes may not be attracted to edges.

The dynamic nature of predator prey interactions is particularly apparent in urban areas where predators and prey often exhibit differing responses to disturbance resulting from urbanization. Absence of top predators (raptors, weasels, native cats and canids) from urban areas could potentially lead to an increase in corvids, domestic dogs and cats, rats, and mice (Marzluff and Ewing 2001). Crooks and Soulé (1999) were the first to provide evidence that loss of coyotes in a fragmented urban landscape promoted increased abundance of small-sized predators of bird nests, which they proposed ultimately led to reduced avian diversity. Similarly Sinclair et al. (2005) suggested that the negative relationship between abundance of mammalian nest predators and forest corridor width might result from lower abundances of large-sized mammals (i.e., foxes) in narrow forests, thereby prompting higher densities of small-sized mammalian predators. Likewise, some predator removal studies have shown that the behavior of low-level predators may change when top-level predators are removed (e.g., Dion et al. 2000). Other predator removal studies have shown decreased nest predation or increased nest success after removal (eg. Beauchamp et al. 1996, Garrettson and Rohwer 2001, Schmidt et al. 2001, Ellis et al. 2007, Millus et al. 2007). However, when examining impacts of the removal of mammalian predators on waterfowl nest predation in an urban environment, Meckstroth and Miles (2005) actually found higher predation rates at removal sites. They suggest that this was due to mammals immigrating from surrounding

areas and repopulating removal sites because of increased nesting density at removal sites.

Avian nest predators also may respond to degree and/or pattern of urbanization (Jobin and Picman 1997, Thorington and Bowman 2003). Nilon et al. (1995) showed increased abundance of blue jays in cluster development types as compared to wildlands or single-house development types, where crow abundance was greatest. In addition, many studies demonstrate increased presence of avian nest predators along edges (Wilcove 1985, Nilon et al. 1995, Danielson et al. 1997, Morrison and Bolger 2002, Estrada et al. 2002) and some have shown increased avian predation on artificial nests along edges (Estrada et al. 2002). Although artificial nest studies have many drawbacks, which will be discussed later, these studies do provide insight into the differing responses of predators to urbanization as well as illustrate the need to use caution when trying to generalize about the effects of urbanization on nest predators.

Urbanization and predator behavior

Because urban areas may change the availability and distribution of food resources as well as the population density of predators, individual predator species may undergo pronounced changes in behavior. Certain nest predators in urban areas may rely more on human refuse than on hunting for their food supply, whereas in a more natural setting, those predators would hunt (Shochat 2004). For example, Prange et al. (2004) found that increased densities and reduced home-range size of raccoons in urban areas were primarily due to abundant artificial food resources. Interestingly, artificial food supplies presumably may result in decreased nest predation despite higher densities of

predators, a possibility that might partly explain why some studies have reported decreased nest predation in more urbanized areas.

Although the research linking nest predation and urbanization is equivocal, increased nest predation is sometimes positively associated with urbanization, possibly as a consequence of high prey densities attracting large numbers of predators (e.g., Marzluff 2001, Sorace 2002,). Because some nest predators appear to “specialize” on certain prey species, or at least in ground-nesting or shrub-nesting species (Martin 1993b), the effect of predation may differ widely among species, which could result in conflicting information among studies that focus on particular species or on species that share similar nesting characteristics. In general, an increase in prey (i.e., bird) density is likely to attract certain predators (Meckstroth and Miles 2005). Donnelly and Marzluff (2004) indicated that in smaller patch sizes, suburban areas actually have the highest overall bird density, and a study by Thorington and Bowman (2003) demonstrated that nest predation was positively correlated with human housing density in suburban areas. These studies suggest the importance of considering differences within smaller-scale urban and suburban areas, rather than a simple increase or decrease along a large-scale urban gradient.

Recreational trails may also create small-scale changes that contribute to differences in nest predation. For example, mammalian movement appears to be facilitated by trails in some areas (Sinclair et al. 2005) and predators may travel or concentrate activity along trails and consequently be more likely to detect nests near trails than farther away. Miller et al. (1998) found higher nest predation associated with recreational trails compared to areas lacking trails. Later, Miller and Hobbs (2000)

showed that predator response varied with distance from trails in riparian recreational areas with birds attacking more artificial nests near trails while mammals appeared to avoid trails.

Vegetation-mediated effects on predation

Urban-associated changes in vegetation characteristics may lead to increases in nest predation (Wilcove 1985). For example, trails may modify habitat structure by facilitating invasion by exotic plants (Baret and Strasberg 2005, Dickens et al. 2005, Hendrickson et al. 2005, Hill et al. 2005). Donnelly and Marzluff (2004) indicated that exotic ground and shrub vegetation was positively associated with urbanization which could lead to differences in nesting substrates, particularly in the case of invasive plant species. These differences in nesting substrates could, in turn, lead to differences in nesting height, and nest concealment or visibility (Borgmann and Rodewald 2004). Indeed, previous work shows that nests in exotic shrubs are more vulnerable to predation (Schmidt and Whelan 1999, Borgmann and Rodewald 2004, Leston 2005).

Reduced vegetative cover also may result from trail-associated disturbance, and this may reduce nest success by increasing nest visibility. On the other hand, trails may promote growth of dense vegetation (Patel and Rapport 2000), which could improve nest concealment for some species. Less concealed artificial nests often have higher rates of predation (Jokimaki and Huhta 2000), suggesting that primary predators often use visual nest cues to locate nests. Some studies have measured the visibility of nests and shown correlations between nest visibility and nest predation (Martin 1993b). Others, however, have found no correlation between nest concealment and predation (Filliater et al. 1994, Patten and Bolger 2003).

Although relationships between nest survival and other nest patch characteristics have been examined by other researchers (e.g., Martin 1998, Naiwanga et al. 2004, Hazler et al. 2006), patterns have not been consistent across studies. For example, a positive correlation between nest success and nest height was suggested by Best and Stauffer (1980), however, Filliater et al. (1994) suggested that in areas with diverse nest predator communities, there simply are no predictably “safe” nest sites. In addition, Phillips et al. (2005) found that development had very little effect on vegetation in the forest fragments they studied, although Wood Thrush nests in more developed areas were more heavily predated. Lack of concordance among studies may result from regional or landscape differences, which might contribute to distinct predator communities or differences in prey responses to predation pressures (Jokimaki et al. 2005).

Urbanization and parental behavior of songbirds

While it remains unclear whether behavioral defense of nests by parents reduces the likelihood of nest predation (Andersson et al. 1980, Moller 1984, Nealen and Brietswich 1997, Reyer et al. 2002), Pietz and Granfors (2005) provided evidence from video monitoring of nests that five species of grassland birds actively defended their nests against avian, mammalian and reptilian predators. Although the majority of these events captured on video were not successful (i.e., the eggs or nestlings were taken), some nests did fledge young which may not have happened had the adults not actively defended the nest. Thus, adults who spend more time away from the nest or range further from their nests may have reduced reproductive success because of their inability to actively defend their nests (Safina and Burger 1983, Shochat 2004, Shochat et al. 2004).

One way that urbanization may alter nest defense behavior is by changing the availability of food resources. In some regions, urban areas may not provide adequate food resources while other urban areas may supplement natural food resources (Shochat et al. 2004, Chace and Walsh 2006). Given that territory size is negatively correlated with food resources (Smith and Shugart 1987, Dunk and Cooper 1994), individuals may respond to changing food resources by altering their home range sizes, and thus their ability to actively defend their nests. In addition, some species may trade-off their feeding opportunities and forage at higher rates when human disturbance levels are comparatively low (Fernández-Juricic and Tellería 2000), which ultimately could result in higher nest predation in urban areas. Another possibility is that the lower quality habitat of urban areas relative to more rural landscapes may reduce condition and therefore ability to actively defend nests (Shochat et al. 2004).

Human disturbance and nest predation

Human disturbance may impact nest site selection, parental behavior, density and distribution of songbird territories, and density and distribution of predators. Each of these factors could, in turn, impact nest predation. Some studies examining the effects of direct human disturbance through recreational activities on nest survival or fecundity have found reduced survival or fecundity with increased disturbance (Miller et al. 1998, Langston et al. 2007) while others have found either a positive association (Miller and Hobbs 2000, Baudains and Lloyd 2007) or no association (Verboven et al. 2001, Baines and Richardson 2007). Gutzwiller et al. (1998) and Gutzwiller and Anderson (1999) failed to demonstrate that human disturbance influenced the vertical distribution of birds, and therefore concluded that many species are tolerant to human intrusion. Nevertheless,

human disturbance may have more subtle effects than altering distribution. For example, Müllner et al. (2004) found that the presence of humans increased stress responses in the juveniles of their study species and reduced chick survival. Using a simulation model, Blumstein et al. (2005) suggested that foraging behavior, specifically the amount of food consumed, might be negatively correlated with frequency of disturbance by humans. Other studies indicate that increased human disturbance results in reduced fitness through decreased parental attendance (Safina and Burger, 1983) and decreased ability to feed young (Leseberg et al. 2000). Ultimately, individuals face a variety of trade-offs related to avoiding human disturbance and engaging in other activities that increase fitness, such as foraging, mating and parental care (Frid and Dill 2002).

Additionally, in some situations, birds may habituate to disturbance (Riffell et.al. 1996, Burger and Gochfeld 1998). In particular, many shorebirds have been shown to habituate and demonstrate reduced avoidance and fear responses to human disturbance over time (Fitzpatrick and Bouchez 1998, Fowler 1999, Lord et al. 2001). Birds inhabiting urban areas with high levels of human activities, particularly along trails, may exhibit similar tendencies toward habituation. However, behavioral changes associated with human disturbance may only be short-term and temporary and some authors suggest that these changes are unlikely to have consequences at the population level (Gill et al., 2001).

Methods used to study nest predation

Most studies investigating edge effects and the effects of fragmentation and urbanization on nest predation rely on artificial nest experiments (e.g., Groom 1993, Major et al. 1996, Jobin and Picman 1997, Estrada et al. 2002, Keyser 2002, see also

Paton 1994 for review). Many authors suggest that artificial nest experiments can approximate relative predation pressures (Paton 1994, Keyser et al. 1998, Gering and Blair 1999, Thorington and Bowman 2003), while others suggest that they can provide hypotheses for nest failure and can detect changes in predator community composition (Miller and Hobbs 2000). Even so, numerous disadvantages of artificial nest studies have been suggested including problems with predator attraction to human scent, the scent of the plasticine eggs or other artificial nest materials (Whelan et al. 1994), the size of quail or other eggs used to bait nests when compared to actual passerine eggs, the lack of parental defense of the nests or other parental activity at the nest which may allow visual predators to locate nests (Paton 1994, Haskell 1995), and whether artificial nests are visually accurate replications of real nests (Major et al. 1996). In addition, Thompson and Burhans (2004) used video to document predation on both artificial nests and natural nests and found significant differences between the primary predators of each. Therefore, they strongly caution against the interpretation of artificial nest data as representative of actual predator patterns.

Biases toward larger mouthed mammalian predators may exist when using quail or chicken eggs to bait artificial nests (Haskell 1995). In addition, the lack of parental nest defense in artificial nest experiments is likely to overestimate the importance of some predators and does not account for snake predation (Keyser et al. 1998, Thorington and Bowman 2003, Weatherhead and Blouin-Demers 2004). Many studies have attempted to control for or investigate these problems (e.g., Major et al. 1996, Skagen et al. 1999). Nevertheless, problems with interpretation of the data may be more important than problems with methodology. Some studies using video monitoring have clearly

shown that artificial nests attract different predators than natural nests (Thompson and Burhans 2004, Robinson et al. 2005).

Because actual nest predation events are such a difficult phenomenon to study, most previous evidence of nest predators has resulted from chance observations (Weatherhead and Blouin-Demers 2004). However, several recent studies using video monitoring (e.g., Keedwell and Sanders 2002, Morrison and Bolger 2002, Stake and Cimprich 2003, Schaffer 2004, Stake et al. 2004, Nack and Ribic 2005) and motion triggered still cameras (Meckstroth and Miles 2005) have allowed for a more exact identification of actual nest predators. These studies have resulted in some unexpected findings. For example, one study (Nack and Ribic 2005) showed cattle predating grassland bird nests. Other studies (e.g., Morrison and Bolger 2002, Thompson and Burhans 2003, Stake et al. 2004, Stake et al. 2005) demonstrate the high incidence of snake predation on bird nests in various habitat types (see also review by Weatherhead and Blouin-Demers 2004). These studies indicate that presumptions about predator communities based on anecdotal evidence are likely to be flawed (Weatherhead and Blouin-Demers 2004). Although Major et al. (1996) used artificial nests and did not employ the use of cameras, their novel study design involving 2000 members of the public allowed for a large number (134) of direct observations of artificial nest predation. These observations also resulted in some unexpected predators (e.g., parrots, wattlebirds and sparrows), though some of these may be due to the use of artificial nests. Although fewer studies have been conducted to identify actual nest predators (vs. those involving artificial nest experiments), this is an important missing link in many study systems.

SIGNIFICANCE OF RESEARCH

Decisions about land use and habitat management in many regions of the world seek to accommodate the needs of both wildlife and recreationists (Hammitt 1990, Selman 2000, Leung et al. 2001). Even so, disturbance from recreationists can have negative impacts on wildlife populations and communities and may ultimately compromise the value of protected areas (Anderson 1995, Hammitt and Cole 1998, Leung et al. 2001). This is especially worrisome given that the numbers of recreationists using parklands in the US and in other parts of the world have increased substantially throughout the 80s and 90s (Cordell 2004, Cushman et al. 2005) and those trends are expected to continue (Hammitt and Cole 1998, Leung et al. 2001). The seemingly benign activities of recreationists may exert increasing ecological pressures on limited parklands (Hammit and Cole 1998, Müllner et al. 2004). This potential pressure is particularly likely given that urbanization will soon become a force more powerful than agriculture in driving fragmentation in the coming years (Marzluff and Ewing 2001, Imhoff et al. 2004). Considering the role of nest mortality as a major contributor to population declines in many species (Keyser et al. 1998), we should attempt to alleviate intensifying nest predation pressures from fragmentation and landscape composition.

With nearly half the world's population living in urban areas (United Nations 2000), there is a tremendous demand for outdoor recreational areas in urban landscapes throughout the world (Jim and Chen 2003, Gelso and Peterson 2005). Most urban residents show a preference for parks and preserves near their homes (Jim and Chen 2003, Feinerman et al. 2004) and actively use these greenspaces for recreational activities (Lindsey and Nguyen 2004, Gobster 2005). Understanding how recreational activities

may be impacting wildlife populations and communities and understanding the mechanisms associated with these changes in order to prevent continued species declines is essential. Although most species in these urban areas are not species of conservation concern, identifying the predators and their relative importance to nesting success may provide insights into why urban landscapes are such hostile environments for some species and why others thrive in them.

This research informs this natural resource management issue by first evaluating relationships between nest location relative to trails and probability of nest survival and then examining several potential mechanisms responsible for observed patterns. If human use of trails is correlated with increased predation risk, managers may need to carefully consider the ecological consequences of trail placement in park design to ensure sufficient distance from trails for nesting species that are sensitive to recreationists. Successful future planning of recreational areas in riparian forests will require managers to make thoughtful decisions and balance the needs of recreationists while seeking to maintain the ecological integrity of the area.

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CHAPTER 2

BEHAVIORAL RESPONSES OF NESTING BIRDS TO HUMAN DISTURBANCE ALONG RECREATIONAL TRAILS

Abstract. Recreational trails in urban parks have the potential to impact breeding birds both by modifying habitat and altering movement patterns of people and predators. In particular, reactions of nesting birds to disturbances along trails can have important consequences for parental behavior and nest survival. Behavioral responses of nesting female Northern Cardinals (*Cardinalis cardinalis*) to human disturbance were studied using both experimental and observational approaches that applied Flight Initiation Distance (FID) as a measure of sensitivity. From April – August of 2006 and 2007, I monitored the fate of 189 nests of Northern Cardinal in 11 forested riparian sites in Ohio. Sites were located within urbanizing landscapes and contained paved and unpaved recreational trails. Two experimental trials were conducted for each nest ($n = 63$), such that FID was recorded as each nest was approached either directly or along a trail. In addition, FID was collected during routine nest checks ($n = 160$) where the nest was approached directly. I hypothesized that human use of trails in urban forests influenced sensitivity of breeding birds to disturbance and altered their nest placement through habituation and self-sorting behavior. Results showed that birds were 6x more likely to flush when the nest was approached directly than when an observer passed along a trail.

Nest height mediated the tendency to flush somewhat, as higher nests were less likely to flush, but flush tendency was not related to distance to trail contrary to predictions.

Interestingly, the distance at which a bird flushed (FID) was not significantly related to either distance to trail or nest height. I found no evidence of reproductive consequences of differences in tolerance to human disturbance nor trails themselves given that variation in daily nest survival was not explained by the immediate behavioral responses to human disturbance (FID) or by trail distance. Rather, nest success was best explained by nest height alone. Collectively, these findings suggest that behavioral responses of birds to recreational use of trails represent short-term effects and, as such, are unlikely to have important consequences at the population level. Because birds showed a much stronger tendency to flush when approached directly than when passed along a trail, this study also suggests that previous studies that used FID in response to direct approaches as an indicator of sensitivity to human disturbance may have overestimated the potential impacts of trails on nests.

INTRODUCTION

As our planet becomes more urbanized, urban parks have the potential to play a critical role in preserving wildlife and natural systems and to simultaneously provide recreational opportunity for people living in cities. Although recreation is typically viewed as having relatively minor ecological consequences (Hammitt and Cole 1998), recreational trails can cause subtle or indirect impacts on breeding birds within natural areas, such as by compacting soil or otherwise modifying habitat (Ream 1980, Campbell and Gibson 2001, Thurston and Reader 2001, Roovers et al. 2004, Dickens et al. 2005) and influencing movement patterns of predators and people in parks (Bety and Gauthier 2001, Gutzwiller et al. 2002, Whittington et al. 2004, Whittington et al. 2005, George and Crooks 2006, Marzluff and Neatherlin 2006, Weckel et al. 2006). The behavioral responses of nesting birds to disturbance events along recreational trails, whether caused by predators or humans, can have important consequences for fitness, parental behavior, time allocation, chick or egg survival and productivity (Burger et al. 1995, Rodgers and Smith 1995, Palmer et al. 2001, Müllner et al. 2004, Bouton et al. 2005, Müller et al. 2006, Kight and Swaddle 2007).

Behavioral responses to human disturbance have primarily been studied using Flight Initiation Distance (FID) in a variety of taxonomic groups including lizards (Cooper and Perez-Mellado 2004, Cooper 2007), mammals (Dill and Houtman 1989, Andersen et al. 1996, Bonenfant and Kramer 1996, Stankowich and Coss 2007), raptors (Steidl and Anthony 1996, Wood 1999), shorebirds (Beale and Monaghan 2004a,b, Webb

and Blumstein 2005, Lord et al. 2001), and passerines (Blumstein et al. 2005, Adams et al. 2006, Blumstein 2006). FID, which is sometimes referred to as flush distance (Holmes et al. 1993, Richardson and Miller 1997) or escape flight distance (Madsen and Fox 1995), is the distance at which an animal flees an approaching predator and can be considered a measure of disturbance tolerance (Ydenberg and Dill 1986, Bonenfant and Kramer 1996). This measure can be used as an index of an animal's sensitivity to disturbance and has been used to aid wildlife managers in setting guidelines for buffer zones (Holmes et al. 1993, Rodgers and Smith 1995, Giese 1998, Blumstein 2003).

Both species-specific responses and environmental factors appear to influence FID with some species exhibiting higher tolerance than others (Blumstein 2003, Blumstein et al. 2005, Blumstein 2006). Larger-bodied animals tend to flush at greater distances than smaller-bodied animals (Blumstein 2006), and there is some evidence that levels of urbanization and human visitation to a site may influence FID (Blumstein et al. 2005). Other factors also may influence FID, such as the animal's orientation, vertical location and distance (Blumstein et al. 2004, Fernandez-Juricic et al. 2004) and energetic condition (Beale and Monaghan 2004a).

Interestingly, some studies using FID measures in response to direct human approaches treat results from experiments as approximations of responses to predators (e.g., Cardenas et al. 2005, Boyer et al. 2006) or human recreational activity (e.g., Ikuta and Blumstein 2003, Fernandez-Juricic et al. 2004). However, most recreational uses of forested parklands are restricted almost entirely to trails and frequently do not involve direct approaches towards animals. Because birds nesting near trails may become habituated (Keller et al. 1989, Fowler 1999, Lord et al. 2001) to humans walking trails,

recreational impacts might be more appropriately examined by explicitly considering the type of approach given that it is likely to provoke different responses.

Using FID in response to a direct approach as a measure of sensitivity to human disturbance fails to recognize that individuals may respond very differently to other forms of disturbance and may show spatial variation in sensitivity to disturbance. For example, individuals may become habituated to recreational users walking along trails that generally pass rather than directly approach the nest. In addition to habituation, it is possible that individuals select nest sites based on their inherent sensitivity to human disturbance. In other words, females who are initially more tolerant of human disturbance may choose to nest closer to trails than those that are less tolerant. Therefore, this experiment was designed to examine if bird responses differ when observers directly approach nests vs. walking along trails for birds nesting at different distances from trails. Examining whether individuals flush off the nest and the FID while an observer walks along a trail may provide more accurate assessments of potential recreational impacts at sites.

Specifically, I hypothesized that human use of trails in urban forests influenced the sensitivity of breeding birds to disturbance and nest placement through habituation and self-sorting behavior. I tested the following three predictions derived from this hypothesis:

- a) Birds nesting closer to trails will flush at shorter distances (i.e., are less sensitive) than those nesting at farther distances from trails.
- b) Birds will be more likely to flush when the nest is approached directly than when passed along a trail.

- c) Nest success will be negatively associated with tendency to flush and FID.

METHODS

Study Area

This study was conducted in the urbanizing Scioto River Watershed in central Ohio, USA (ca. 40N 00' 83W 00'). Eleven study sites were located in mature riparian forest on public and private lands in Franklin and Delaware counties, primarily within parks owned by Columbus Recreation and Parks and Franklin County Metro Parks. Levels of visitation by recreational users varied among sites, but all received visitors during the breeding season and had either paved, unpaved or both types of trails. Trail densities varied from approximately 30 – 300 m/ha. The total forested area of sites ranged from approximately 3.5 ha to 8 ha. Nest searching took place throughout the forested area, although the most intensive nest searching was conducted on a 2 ha grid at each site.

These deciduous bottomland forest sites consisted of flat moist terrain which, in many places, was dominated by Amur honeysuckle (*Lonicera maackii*). Particularly dense patches of shrubs in some sites consist of *Lonicera* sp. and multiflora rose (*Rosa multiflora*). These dense patches of shrubs along with thick tangles of grapevine (*Vitis* spp.) provide the most common nesting substrates. Common tree species include boxelder (*Acer negundo*), Ohio buckeye (*Aesculus glabra*), American elm (*Ulmus americana*), sugar maple (*Acer saccharum*), and ash (*Fraxinus* spp.). The avian community at these riparian forest sites was dominated by the Northern Cardinal (*Cardinalis cardinalis*), Red-eyed Vireo (*Vireo olivaceus*), Carolina Chickadee (*Poecile*

carolinensis), American Robin (*Turdus migratorius*), Eastern Wood-Pewee (*Contopus virens*), and Gray Catbird (*Dumetella carolinensis*). A variety of avian and mammalian nest predators were present, including the Blue Jay (*Cyanocitta cristata*), Red Bellied Woodpecker (*Melanerpes carolinus*), common raccoon (*Procyon lotor*), Virginia opossum (*Didelphis virginiana*), Eastern chipmunk (*Tamias striatus*), and Eastern gray squirrel (*Sciurus carolinensis*).

Experiment

From April to August of 2006 and 2007, field teams located and monitored nests of Northern Cardinals at a subset of the 11 study sites. Experimental trials were conducted at 5 sites in 2006 (Kenney, Rush Run, Three Creeks, Casto, and Woodside Green). In 2007, Three Creeks was replaced by Cherrybottom and trials were conducted at Lou Berliner as well, while the other sites remained the same. Two experimental flushing trials were conducted once per nest using only females that were sitting on nests and incubating eggs ($n = 63$). Focal nests were located at varying distances from trails (range = 0 - 70 m) but averaged 15 m (± 1.38 SE), and the majority (83%) were ≤ 25 m from a trail. The order in which the two trials were conducted was randomly assigned for each nest. The same observer conducted all experimental trials in order to reduce variation in speed of approach, production of noise, clothing color, height and overall size of the observer, etc. However, in cases where the distance from a nest to a trail was > 25 m ($n = 12$), a second observer was positioned close enough to the nest to observe the female's response for both trials.

Trail Approach

One trial consisted of an observer walking past the nest along the nearest trail. In this trial, the observer started walking along the trail approximately 10 m before the nest, (i.e., before the perpendicular angle of the shortest distance from the trail to the nest) at a steady pace of approximately 0.5 - 1.0 m/s. If the bird flushed off the nest, the observer stopped walking and noted the distance at which the female flushed. If the bird did not flush off the nest, the observer continued to walk until reaching a point along the trail approximately 10 m past the nest or at the first available dense cover that shielded view of the nest, whichever was further.

Direct Approach

The other trial consisted of an observer approaching the nest directly from the nearest trail. The observer would initially approach the along the trail and would stop at the point nearest the nest. The observer would then turn and face the nest and begin to approach the nest at a steady pace of approximately 0.5 - 1.0 m/s as above. If the bird flushed off the nest, the observer stopped and recorded the distance at which the female flushed. Cases where the female did not flush until the observer was directly below the nest were recorded as flush distances of 0 m. If the female did not flush until an attempt was made to check the contents of the nest, i.e., the observer was reaching with a mirror toward the nest, this was not considered flushing for the experimental trial. Nest checks were only conducted in this manner when the direct approach was the second of the two trials and the trial was considered completed, i.e., the female had not flushed off the nest though the observer was directly below the nest.

In each experimental trial, time, temperature, cloud cover, and wind speed (using the Beaufort wind scale) were recorded. In the event that the bird flushed from the nest during the first randomly assigned trial, the following trial was not conducted until the bird had returned to the nest and remained on the nest for a minimum of 5 minutes. The trials were conducted when the ambient temperature was greater than 60 degrees Fahrenheit and there was no precipitation. Each trial was conducted only once for each given nest. Many Northern Cardinals have been banded at these sites and known females were not used more than once in the analysis. In addition, unbanded females nesting in the same territories were not repeated within or between years. Although females were not intentionally used more than once, there remains the possibility that an unbanded bird may have relocated and therefore been used more than once. However, given the high levels of territory fidelity at these sites, particularly within a season, this possibility seems unlikely.

FID during nest checks

In addition to the experimental trials, flush distances were collected during visits to nests. Nests were monitored for Northern Cardinals from April to August 2007 at all 18 sites. As observers approached nests to check contents and determine if nests were still active, the orientation of females sitting on nests and the distance at which they flushed were recorded. Although the approach to the nest was not initiated from the same direction during each nest check and not necessarily from the direction of a trail, a direct approach of the nest was always used. As in the experiment, only one flush distance was included in the analysis for each nest and for each female. Therefore, only the first visit to a nest on which a flush distance was obtained was used in the analysis.

Data Analysis

Experiment

Because the experimental data were collected over 2 years, I tested for annual differences in the tendency to flush using a two-way contingency table examining the association between treatment type (direct and trail) and flush response (yes or no) while controlling for year (2006 or 2007). The chi-square value was calculated for each year and then for the combined data set. Then a test for heterogeneity (Zar 1999) was used to determine whether the combined data differed in the separate years.

I examined the extent to which tendency to flush was related to the distance to the nearest trail and nest height using a logistic regression model with direct and interaction effects for treatment (direct versus trail approach), distance to nearest trail, and nest height.

Flight Initiation Distance

To test the relationship between FID and distance to trail and nest height, I used a General Linear Model with Flushing Distance (FID) as the response variable. Distance to trail, nest height and their interaction were used as predictors. In this analysis, data from both nest checks and direct approaches from the experiment were combined.

In order to determine how a bird's sensitivity to human disturbance influenced nest success, I used FID as a sensitivity index (i.e., more sensitive individuals should have higher FID) in the logistic-exposure method (Shaffer 2004) to model daily nest survival rates. This approach models the success or failure of nests during each interval between nest checks. I fit the model using PROC GENMOD (SAS Version 9.1, SAS Institute 2002) by using a binomial response distribution (interval nest fate = 1 if success,

and 0 if fail) and provided the user-defined logit link function ($g(\theta)=\log_e(\theta 1/t/[1-\theta 1/t])$) where t = the length of the interval (Shaffer 2004).

Orientation

In order to examine whether orientation of the bird in relation to the observer influenced the tendency to flush, several analyses were conducted. A chi-square analysis compared the tendency to flush and orientation. For this analysis, only those individuals that could be clearly defined as facing toward (225° to 135°) or away (315° to 45°) from the observer were used ($n=99$), i.e., orientation values which were perpendicular to the observer were not included. In addition I fit a model using PROC GENMOD (SAS Version 9.1, SAS Institute 2002) with trail distance as the response and orientation (defined as toward or away) as the predictor.

Because orientation values are directional and cannot be treated as linear variables, circular statistics were used to directly examine if there was a tendency for individuals to have a particular orientation relative to the observer. Using the actual orientation values ($n=114$), I used a Rayleigh test (Fisher 1993) to assess their distribution. In this analysis, a permutation test is used to determine if the distribution of data differed from a uniform distribution, hence concentration of the data in a certain direction. In addition, I used a two-sample Watson-Williams test (Fisher 1993) to examine whether the mean directions of the two treatment types differed significantly and whether the order of the treatments was associated with orientation. With this test, the p-value is also approximated using a randomization procedure.

Finally, I evaluated if the distance from trail was associated with the orientation of a nesting bird (i.e., do birds nesting close to trails tend to face trails perhaps in

directional anticipation of disturbance?). I used a circular-linear correlation test, which calculates the correlation between the circular variable, orientation, and the linear variable, distance to trail (Fisher 1993, Zar 1999, Mardia and Jupp 2000). Significance of the circular-linear correlation was determined using the F distribution approximation as in Mardia & Jupp (2000). Circular-linear correlation tests were performed for the entire data set as well as separately for each treatment type and separately for first and second trial data.

All circular statistics were calculated using Oriana (Kovach Computing Services) while all other statistical analyses were performed using Statistical Analysis Systems Software (SAS Institute 2002).

RESULTS

Tendency to Flush

Because tendency to flush did not differ between years ($\chi^2 = 0.05$, $p = 0.82$), data from both years were pooled. The tendency to flush was influenced both by approach type and nest height and the full model which included the all three explanatory variables (treatment, distance to nearest trail and nest height) and their interactions produced significant results for the global test (Wald $\chi^2 = 29.6$, $n = 126$, $p < 0.001$). Specifically, 67% of female Northern Cardinals directly approached flushed from nests versus only 11% of those passed along a trail (approach type parameter estimate = 3.04 ± 1.23 SE, $\chi^2 = 6.09$, $p = 0.0032$) (Figure 2.1). Birds nesting closer to the ground had an increased tendency to flush (nest height = -1.23 ± 0.429 SE, $n=126$, $\chi^2 = 8.20$, $p = 0.014$). Contrary to the pattern expected for habituation, birds with nests closer to trails showed a slightly

increased tendency to flush, but this relationship was not statistically significant (distance to trail = -0.20 ± 0.107 SE, $n=126$, $\chi^2 = 3.25$, $p = 0.072$).

FID

Using a dataset that included only those nests from which a bird flushed ($n=160$), there was a slight tendency for birds nesting at lower heights and those farther from trails to flush sooner, i.e., to have a larger FID (Full model $F_{3,156} = 3.42$, $p = 0.019$). However, the relationship was not statistically significant for nest height ($F_{1,158} = 3.26$, estimate = -0.25 ± 0.140 SE, $p = 0.073$), trail distance ($F_{1,158} = 1.95$, estimate = 0.026 ± 0.019 SE, $p = 0.16$), or their interaction ($F_{1,158} = 0.73$, estimate = -0.003 ± 0.0041 SE, $p = 0.39$) (Figure 2.2).

Variation in daily survival rate of Northern Cardinal nests was not well explained by FID or distance to trail. Rather, the best explanatory model included only nest height ($\omega_i = 0.85$), and nest survival was positively related to nest height (estimate = 0.26 ± 0.090 SE). No other explanatory models had $\Delta_i < 2$ (Table 2.1). Nevertheless a larger data set suggests a possible relationship between distance to trail and daily survival rate (see Chapter 3).

Orientation

Orientation was not significantly related to either the tendency to flush ($X^2 = 1.8709$, $n = 99$, $p=0.17$) nor flight initiation distance ($X^2 = 2.08$, $n = 99$, $p = 0.15$). However, bird orientation relative to observer was not uniformly distributed (mean direction = $21.2^\circ \pm 108.6^\circ$, Rayleigh $Z = 3.35$, $p = 0.035$) indicating an overall tendency for birds to be facing away (315° to 45°) from the observer (see Figure 2.3). However, the mean direction of the orientation of the birds did not differ between approach types

(mean = 21.2, $F_{1,120} = 0.007$, $p = 0.93$), or depending on trial order (mean = 16.2, $F_{1,112} = 1.96$, $p = 0.16$).

Orientation and trail distance were marginally correlated in the full data set ($n=114$) and for the trail approach trials alone ($n=57$) (Full: $r = 0.159$, $p = 0.061$; Trail approach: $r = 0.234$, $p = 0.052$) (Figure 2.4). However, orientation and trail distance were not correlated in the direct approach trials or within the first or second trials (see Table 2.2).

DISCUSSION

Because birds showed a much stronger tendency to flush when approached directly than when passed along a trail, this study suggests that previous studies, most of which used FID in response to a direct approach as an index of sensitivity to disturbance, may have overestimated the potential impacts of trails on nests. Thus, extending results of studies of flight initiation distance to understand potential impacts of trails may not be appropriate in cases where investigators directly approach birds. Not surprisingly, I also found that nest height mediated the response of birds to human disturbance, and likelihood of flushing tended to decline as nest height increased. Although there was a stronger tendency to flush from lower nests, flight initiation distance was not related to nest height. This contrasts with results of other studies (e.g., Blumstein et al. 2004, Fernández-Juricic et al 2004) in which the perching height influenced FID. The negative association between flight initiation distance and nest height may be a consequence of individuals with high nests perceiving less threat from an approaching human compared to birds with nests closer to the ground. However, if birds distinguish differing levels of

risk depending on the type of predator, as suggested by Adams et al. (2006), then birds that experience high levels of recreational activity might not react strongly to the presence of humans.

Because daily nest mortality rates were not related to distance from trail, this study fails to provide evidence of reproductive and, hence, potential population-level consequences of behavioral responses to human disturbance (Sutherland 1996, Sutherland 1998, Gill et al. 2001). The flushing behavior of nesting birds at my Midwestern forest parkland sites appeared to be limited to short-term responses. Even so, human disturbance may impact nest site selection for subsequent nests within the season or in following seasons, as others have shown that some birds nest higher in seasons following human disturbance (Knight and Fitzner 1985). Interestingly, because nest height was positively related to nest success, one might imagine a scenario where disturbed birds ultimately achieve greater nest success if disturbance causes them to increase the height of their renesting attempts.

Although bird orientation was apparently independent of both tendency to flush, and FID, there was an overall tendency for birds to be facing away from the observer. This suggests the possibility that birds that were oriented toward the observer initially may have been able to flee undetected before the experimental trials were conducted, thus introducing a possible bias. However, because this non-uniformity was only present in the direct approach sample, this may indicate an increased “flightiness” in direct approaches, also suggesting that previous studies may have overestimated the potential impacts of trails on nests. Although trail distance was marginally correlated with

orientation for the trail approach trials, there was no clear tendency for orientation in a particular direction as trail distance increased.

Some studies have shown a positive correlation between flight initiation distance and the nearest trail (Fernández-Juricic et al 2004) though there appears to be no such relationship here. Because Northern Cardinals are quite clearly adapted to urban areas (Leston and Rodewald 2006, Burhans and Thompson 2006), their reactions likely differ from species that are more sensitive to disturbance. In addition, given the urban environment, the relatively small size of the sites, and because not all human use of these parks is entirely restricted to trails, birds may have been habituated to human use throughout the sites. Likewise, many resident birds are observed regularly at feeders near these sites throughout the winter and levels of habituation to human presence may not differ significantly between individuals. Indeed, habituation might be occurring at a larger spatial scale (i.e., all individuals may be habituated to human disturbance).

Because park managers must balance the competing interests of wildlife and recreational use of parks in urban areas, consideration must be given to the mechanisms through which human disturbance may be impacting breeding birds. Relatively few studies have measured the impact of recreational disturbance to nesting passerines (e.g., Kight and Swaddle 2007, Müller et al. 2006), and this study suggests that some previous work may have overestimated the potential behavioral and reproductive impacts of trails on nests. Future research should evaluate the impact of human trail usage on species that are less adapted to human disturbance.

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Model	K	AIC _c	Δ_i	ω_i
Nest height	2	532.8397	0.0000	0.8461
FID, Nest height, FID*Nest height	4	536.7974	3.9577	0.1170
Constant survival	1	540.6704	7.8307	0.0169
FID	2	541.9220	9.0822	0.0090
Trail distance	2	542.4096	9.5699	0.0071
Trial distance, FID	3	543.5672	10.7274	0.0040

Table 2.1. Model selection results from the logistic-exposure models of daily survival rate for Northern Cardinal nests (n=153) revealed that nest height best explained nest survival in 2006 and 2007 in urban riparian sites in central Ohio.

	n	r	p
Full Data Set	114	0.159	0.061
Trail Approach	57	0.234	0.052
Direct Approach	57	0.124	0.435
First Trial	57	0.169	0.212
Second Trial	57	0.161	0.248

Table 2.2. Circular-linear correlation coefficients between the orientation of Northern Cardinal females on nests and trail distance to nests in 2006 and 2007 at urban riparian parks in central Ohio.

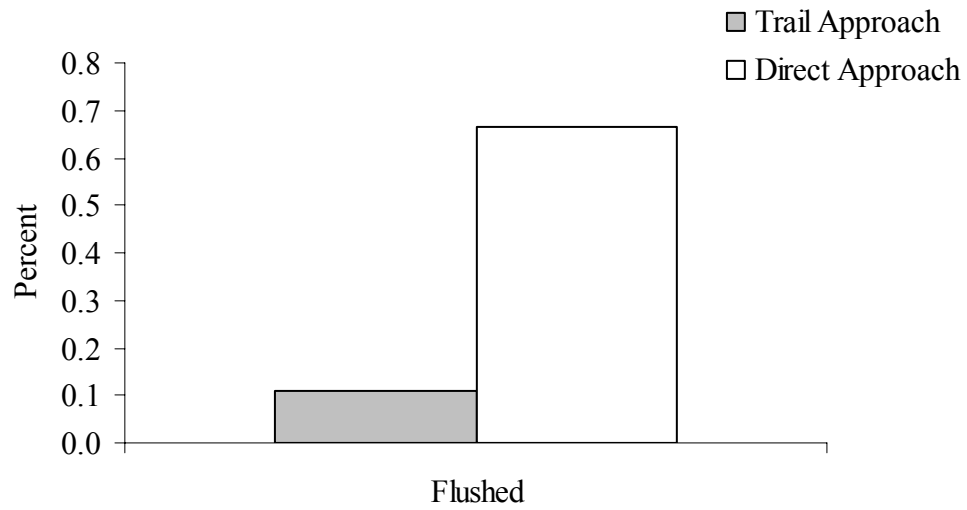
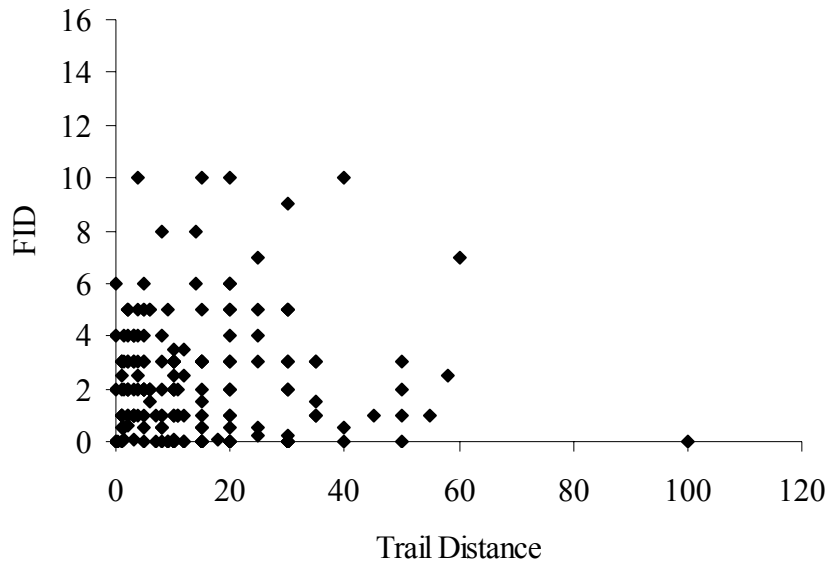


Figure 2.1. Percent of female Northern Cardinals that flushed from nests ($n = 63$) during experimental trials (direct vs. trail approaches) conducted from April to August in 2006 and 2007 at 8 urban parks in central Ohio.

a)



b)

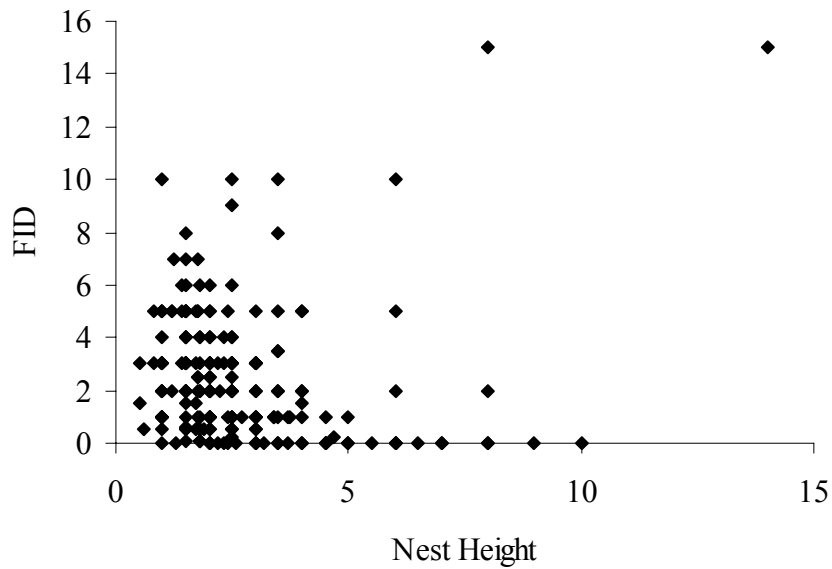


Figure 2.2. Flight initiation distance of female Northern Cardinals flushing from nests compared to (a) distance to trail ($n = 181$), and (b) nest height ($n=209$) for birds that flushed during experimental trials during direct approaches and during nest checks from April to August in 2006 and 2007 at urban riparian sites in central Ohio.

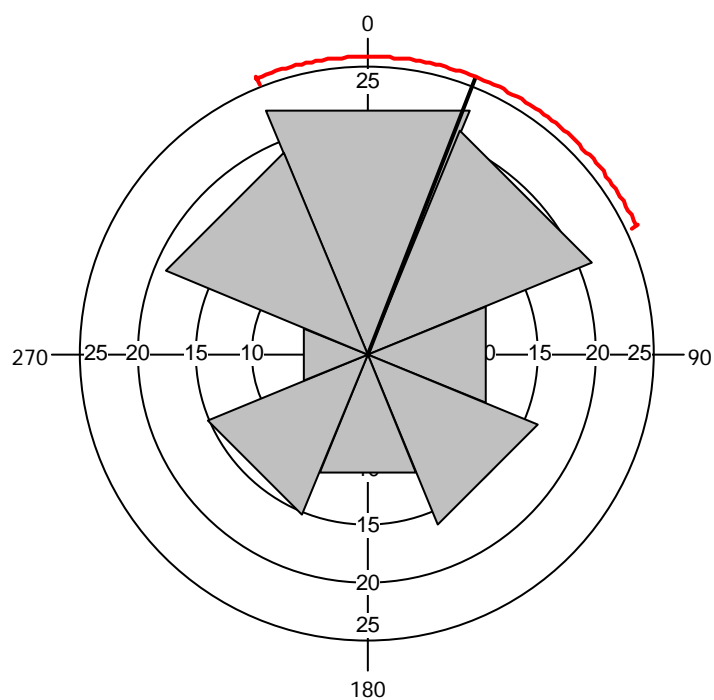
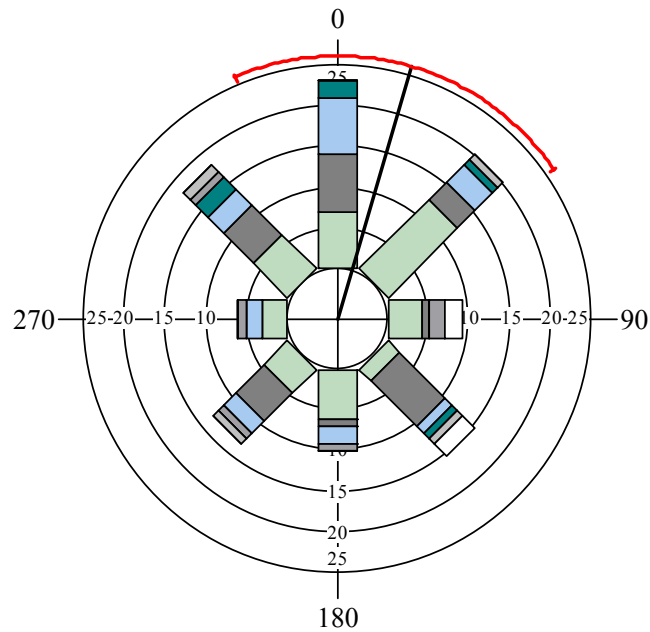
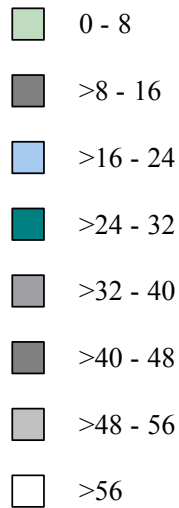


Figure 2.3. Rose diagram of the distribution of the orientation of female Northern Cardinals on nests in relation to the observer (where the observer is always approaching from 180° facing toward 0°) showing the lack of uniform distribution in combined direct and trail approach data from 61 nests monitored from April to August in 2006 and 2007 at urban riparian sites in central Ohio.

(a)

Trail Distance



(b)

Trail Distance

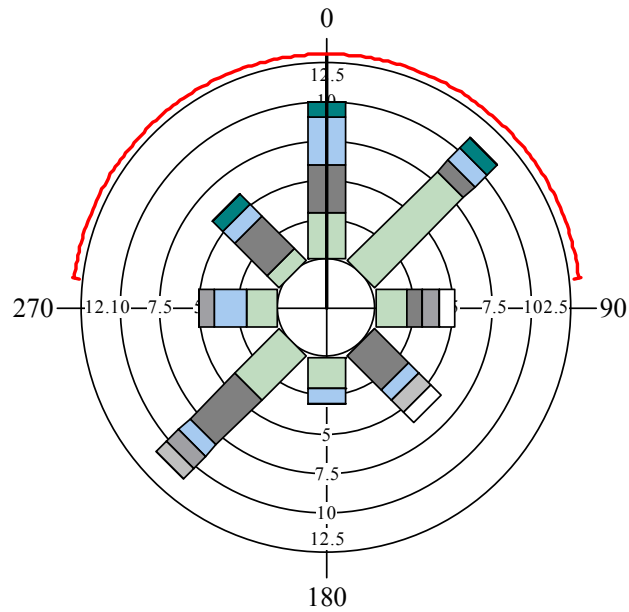
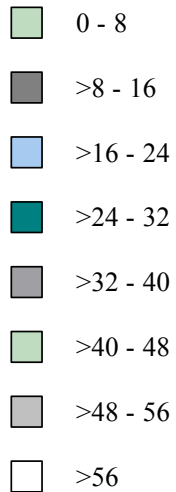


Figure 2.4. Stacked circular histogram of the relationship between trail distance and orientation of female Northern Cardinals on nests monitored from April to August in 2006 and 2007 at urban riparian sites in central Ohio for (a) both experimental trials (n=114), and (b) the trail approach trial alone (n=57).

CHAPTER 3

EFFECTS OF RECREATIONAL TRAILS ON BREEDING BIRDS IN FORESTED URBAN PARKS

Abstract. Most public lands, particularly those in urban areas, serve dual purposes and are designed to meet both social and recreational needs as well as to provide ecological and conservation functions. However, recreational activities, particularly trails, can alter both vegetation characteristics and exposure to human disturbance in ways that may influence parental nest attendance rates and other behaviors that ultimately can affect reproductive success. I hypothesized that recreational trails would negatively impact avian reproductive success either by (1) reducing nest attendance due to direct human disturbance or (2) modifying vegetation characteristics surrounding nests. From April – August of 2006 and 2007, the fate of 263 nests of Northern Cardinals were monitored in 14 forested riparian sites in central Ohio. Sites were located along a rural-urban landscape gradient and contained paved and unpaved recreational trails. Vegetation characteristics were measured around 161 nests and at 114 random locations, and amount of trail usage was estimated using cameras at 7 of the 14 sites. Nest attendance was not significantly related to distance to trail, nest height, or trail usage. Similarly, variation in daily survival rate of Northern Cardinal nests was not well explained by nest attendance, trail usage or site. Instead, the best explanatory models of nest survival included nest height and distance to trail, though the null model also was included in this top model set.

Vegetation characteristics were not significantly related to trail distance for randomly-located plots. However, for nest vegetation plots, trail distance was negatively related to nest height and abundance of very small stems ($\text{dbh} < 8 \text{ cm}$) and positively related to distance of the nest to foliage edge and abundance of native vegetation. Such vegetation differences between random and nest locations suggest that birds modify nest-site selection in relation to recreational trails. Interestingly, none of these vegetation variables were significantly related to daily nest survival rates; rather, nest survival was best explained by and positively related to nest height. Collectively, this work suggests that, at least for certain synanthropic species, recreational trails are not strongly associated with either habitat modification or alteration of reproductive behavior in ways that affect nest success.

INTRODUCTION

Urbanization has tremendous impacts on natural environments and parks within urban areas are expected to play an increasingly important role in preserving at least some biodiversity (Brawn and Stotz 2001, Miller and Hobbs 2002, Daniels and Kirkpatrick 2006, Waite et al. 2007). Most public lands, particularly those in urban areas, serve dual purposes and are designed to meet both social and recreational needs as well as to provide ecological and conservation functions (Searns 1995). There are extensive networks of trails maintained by state, city and local governments and according to federal government websites, over 200,000 miles of trails are maintained on US public lands by the US Forest Service, the National Park Service and the Bureau of Land Management. There is a tendency to assume that trails have little influence on wildlife because recreation has traditionally been viewed as relatively benign to animal communities (Hammitt and Cole 1998). However, recreational trails within urban parks may influence the behavior of wildlife both directly through human and other disturbance (Gutzwiller et al. 2002, Whittington et al. 2005, George and Crooks 2006, Marzluff and Neatherlin 2006) and indirectly through changes in the distribution of vegetation (Ream 1980, Campbell and Gibson 2001, Thurston and Reader 2001, Roovers et al. 2004, Dickens et al. 2005). For example, some mammals exhibit both spatial and temporal displacement in response to human recreation (George and Crooks 2006) and trails alter the distribution of some amphibian species (Davis 2007). In particular, breeding birds

are thought to be especially sensitive to recreation-related disturbance (Langston et al. 2007, McGowan and Simons 2006), and the behavioral responses of nesting birds to disturbance events along recreational trails, whether caused by predators or humans, can have important consequences for fitness, parental behavior, and chick or egg survival (Burger et al. 1995, Müllner et al. 2004, Bouton et al. 2005, Müller et al. 2006, Kight and Swaddle 2007). Even so, few studies have explicitly examined the consequences of recreation to passerines, and those that have typically focused on indirect effects of habitat modification (Garton et al. 1977, Hammitt and Cole 1998).

One way that human disturbance may influence breeding success of birds is by affecting reproductive behaviors (Steidl and Anthony 2000, McGowan and Simons 2006). In particular, nest attendance may be linked to reproductive success in a variety of species (Sandvik and Barrett 2001, Schmidt and Whelan 2005, Fernandez et al. 2007,). Because birds actively defend nests against some predators (Nealen and Breitwisch 1997, Olendorf and Robinson 2000, Pietz and Granfors 2005), spending more time off nests may leave nests vulnerable to predation or parasitism (Safina and Burger 1983, Shochat 2004, Shochat et al. 2004). In this way, the factors that influence nest attendance are likely to indirectly affect nest success. Even in cases where a species reduces self-maintenance behaviors in response to human disturbance in lieu of reducing time at the nest (Kight and Swaddle 2007), future breeding attempts and/or lifetime productivity can still be compromised by behavioral changes.

Another way that trails may affect breeding birds is through habitat modification. Both recreational trails and urbanization are often associated with exotic and invasive vegetation (Donnelly and Marzluff 2004, Baret and Strasberg 2005, Dickens et al. 2005,

Hendrickson et al. 2005, Hill et al. 2005). This change in vegetation structure along trails in urban parks may influence nest site selection in some species by altering the available habitat near trails (Penteriani et al. 2001). Use of exotic nest substrates can prompt certain changes in nest-site characteristics (e.g., reduced vegetative cover or lower nest height) that may make nests more vulnerable to predation (Schmidt and Whelan 1999, Borgmann and Rodewald 2004, Leston 2005). Furthermore, because exotic invasive species tend to exhibit early leaf expansion (Gould and Gorchov 2000), the first available nesting sites each season may be in exotic vegetation closer to trails. Such changes in the temporal and spatial availability of suitable nesting substrate, in and of itself, can result in altered patterns of nest predation (Thompson 2007).

The central purpose of this study was to determine the extent to which trails affected nest predation and evaluate possible causes of those effects. I tested the following hypotheses about the impacts of trails on breeding birds:

1) Human use of trails in urban forests reduces nest survival by reducing parental attendance rates, which are negatively related to predation.

My testable predictions were that (a) Nest attendance rates would be positively correlated with distance from trail (i.e., greater attendance farther from trails), (b) Nest attendance rates would be positively associated with nest survival, (c) Nest survival would be negatively correlated with trail usage (i.e., traffic along trails).

2) Relationships between nest survival and trails derive from modified vegetation surrounding a nest, and these changes in habitat drive trail-related impacts on breeding birds.

My testable predictions were that (a) Cover by exotic plants would be negatively associated with distance from trails (i.e., more exotic vegetation along the trail), (b) Understory vegetation density would be associated with distance from trail, (c) Nest survival would be a function of vegetation characteristics in the nest patch.

METHODS

Study Area

This study was conducted in the urbanizing Scioto River Watershed in central Ohio, USA (ca. 40N 00' 83W 00'). Fourteen field sites were located in mature riparian forests in Franklin and Delaware counties on publicly-owned land. Levels of visitation varied among sites, but all received visitors during the breeding season and had either paved, unpaved or both types of trails. Trail densities varied from approximately 30 – 300 m/ha. The total forested area of sites ranged from approximately 3.5 ha to 8 ha. Nest searching took place throughout the forested area, although the most intensive nest searching was conducted on a 2 ha grid at each site.

These deciduous bottomland forest sites consisted of flat moist terrain which, in many places, was dominated by Amur honeysuckle (*Lonicera maackii*). Particularly dense patches of shrubs in some sites consisted of *Lonicera* sp. and multiflora rose (*Rosa multiflora*). These dense patches of shrubs along with thick tangles of grapevine (*Vitis* spp.) provided the most common nesting substrates. Other exotic shrubs present on the sites included autumn olive (*Eleagnus umbellata*), burning bush (*Euonymus alatus*) and privet (*Ligustrum vulgare.*), while native shrubs included spicebush (*Lindera bezoin*), elderberry (*Sambucus* spp), and blackberry (*Rubus* spp.). Common tree species included boxelder (*Acer negundo*), Ohio buckeye (*Aesculus glabra*), American elm (*Ulmus*

americana), sugar maple (*Acer saccharum*), ash (*Fraxinus* spp.), common hackberry (*Celtis occidentalis*), red mulberry (*Morus rubra*), black maple (*Acer nigrum*), silver maple (*Acer saccharinum*), black walnut (*Juglans nigra*), pawpaw (*Asimina triloba*), American sycamore (*Platanus occidentalis*), eastern cottonwood (*Populus deltoides*), and Osage Orange (*Maclura pomifera*). The avian community found at these riparian forest sites was dominated by the following common species: Northern Cardinal (*Cardinalis cardinalis*), Red-eyed Vireo (*Vireo olivaceus*), Carolina Chickadee (*Parus carolinensis*), American Robin (*Turdus migratorius*), Blue-gray Gnatcatcher (*Polioptila caerulea*), Downy Woodpecker (*Picoides pubescens*), Wood Thrush (*Hylocichla mustelina*), Indigo Bunting (*Passerina cyanea*), Eastern Wood-Pewee (*Contopus virens*), Gray Catbird (*Dumetella carolinensis*), House Wren (*Troglodytes aedon*), American Goldfinch (*Carduelis tristis*), Tufted Titmouse (*Baeolophus bicolor*), and Acadian Flycatcher (*Empidonax virens*). Both avian and mammalian nest predators were present as well. Some potential nest predators frequently detected in these riparian forest sites included Blue Jay (*Cyanocitta cristata*), American Crow (*Corvus brachyrhynchos*), Red Bellied Woodpecker (*Melanerpes carolinus*), common raccoon (*Procyon lotor*), Virginia opossum (*Didelphis virginiana*), eastern chipmunk (*Tamias striatus*), and eastern gray squirrel (*Sciurus carolinensis*).

Nest Attendance Observations

From April to August of 2006 and 2007, field teams located and monitored nests of Northern Cardinals at 14 study sites, and nest attendance observations were conducted at eight sites. In 2006, observations were made at Casto, Elk Run, Kenny, Lou, Rush Run, Three Creeks, and Woodside. In 2007, Three Creeks was replaced by

Cherrybottom while all other sites remained the same. Nest attendance observations were conducted for one hour on each nest ($n = 125$) to determine the amount of time the female spent incubating versus the amount of time away from the nest. Each observation period was conducted at a minimum distance of 10 m from the nest, during the incubation stage when there was no precipitation and ambient temperature was greater than 10° C. For each observation, time, temperature, cloud cover, and wind speed (using the Beaufort wind scale) were recorded. Observations were conducted only once for each given nest. Many Northern Cardinals have been banded at these sites and known females were not used more than once in the analysis. In addition, unbanded females nesting in the same territories were not repeated within or between years. Although females were not intentionally used more than once, there remains the possibility that an unbanded bird may have relocated and therefore been used more than once. However, given the high levels of territory fidelity at these sites, particularly within a season, this possibility seems unlikely.

Trail Cameras

Levels of trail usage were measured using motion detector Wildview Xtreme II Trail Cameras (Model STC-TGL2M Digital Scouting Cameras). These cameras detect motion and heat and produce an image each time the path of the passive infrared sensor is crossed. Cameras were placed between 0.1 and 0.5 meters off the ground and attached with a cable and lock to a tree located approximately 0.5 to 2 meters from trails. In 2006, cameras were placed at six sites (Casto, Kenny, Lou, Rush Run, Three Creeks, and Woodside). At each site, three trail locations were randomly selected and three cameras were placed at two sites at each of those locations for a period of one to sixteen days and

then moved to a different site. This produced a total of approximately 7667 camera-hours from May 13 through September 16 in 2006. A total of six cameras were available, thus camera use was limited to two sites at any given time. In 2007, cameras were placed at four sites (Casto, Kenny, Rush Run, and Woodside). At each site, one camera was placed at a randomly chosen trail location for a period of four to twelve days and then moved to a new trail location at the same site. Cameras were deployed from April 19 through September 25 for a total of approximately 9178 camera-hours in 2007. The total number of images at each site divided by the total number of camera-hours produced an index of activity for each of the sites. There was no visible activity in nearly 88% of the first 8000 images captured. Nevertheless, human activity accounted for nearly 90% of the visible images. Therefore, although images were produced, the activity captured was not considered (i.e., whether the presence that triggered the camera was unknown, a person, or other animal, any image was considered an equal part of the activity index). Although these cameras were not equipped with infrared image technology and the flash was not used, the photos produced after dark were considered to represent trail use as well, likely at least partially due to deer, raccoons, and other nocturnal mammals.

Vegetation Sampling

Habitat and vegetation characteristics were measured surrounding 161 nests and at 114 randomly-located plots from June-August in 2006 and 2007 after nest outcomes had been determined. Vegetation characteristics were measured within an 11.3 m-radius plot centered on each Northern Cardinal nest using a modified Breeding Bird Survey Protocol (BBIRD protocol, Martin et al. 1997). Within all plots, the numbers and sizes (dbh) of trees by species, and the number of small (dbh = 12-23 cm), medium (dbh = 23-

38 cm) and large (dbh > 38 cm) logs, stumps, and snags were recorded. Average canopy height (m), and distance from the plot's center point to the river and to the nearest nonriparian edge (m) were estimated. Two 20-m perpendicular transects, running North-South and East-West, were established in the center of each plot. Percent canopy cover (> 5 m) and ground cover type (litter, log, vegetation, moss, rock, water, concrete) (< 0.5 m) were measured using an ocular tube at 2-m intervals along these transects.

Understory vegetation density was assessed by recording the number of contacts made by forbs, exotic shrubs, native shrubs, and trees within 0.5 m height intervals on a 3.0 m vegetation pole at the same points along the transects (James and Shugart 1970, Martin et al. 1997). To describe nest placement, the following characteristics were recorded: nest height (m), nest-plant species, nest-plant dbh for nests in trees (cm), nest-plant height (m), the number and average diameter of branches (cm) supporting the nest, the distance of the nest to the central axis (m), nearest foliage edge (m) at nest-height, and the percent coverage of the nest by foliage at 1 m from the nest in 4 cardinal directions, above and below the nest (BBIRD protocol, Martin et al. 1997).

Each nest plot was paired with a randomly-located plot. Random plots were located by walking a randomly selected distance (> 23 m so that the random plot and nest plot did not intersect, and < 50 m so that the random plot would remain in the same general area) and direction (0°-359°) from nest plots. If the randomly selected direction and distance produced a plot in an unsuitable location (e.g., a parking lot, the middle of the river, etc.), a new direction and distance were randomly chosen. Randomly-located plots included the same variables with the exception of nest placement features.

Data Analysis

To test the relationship between nest attendance rates, distance from trail, nest height, and trail usage, I fit a General Linear Model using PROC GLM (SAS Version 9.1, SAS Institute 2002) with nest attendance (% time on nest) as the response variable and distance to trail, nest height, trail usage and their interactions as predictors. The dataset for this analysis included only nests with attendance observations at sites where trail usage was measured (i.e., although 125 attendance observations were conducted; only 92 nests were included for this analysis).

Using a set of 10 models, I examined the extent to which nest attendance, distance to nearest trail, nest height and activity levels were related to nest success using the logistic-exposure method (Shaffer 2004) to model daily nest survival rates. This approach models the success or failure of nests during each interval between nest checks. I fit the model using PROC GENMOD (SAS Version 9.1, SAS Institute 2002) by using a binomial response distribution (interval nest fate = 1 if success, and 0 if fail) and provided the user-defined logit link function ($g(\theta) = \log_e(\theta / (1 - \theta))$) where t = the length of the interval (Shaffer 2004). The dataset for this analysis was the same as the previous analysis and included only nests with attendance observations at sites where trail usage was measured.

In order to examine vegetation characteristics, a correlation analysis was first conducted to determine whether highly correlated variables ($r > 0.7$) should be excluded from further analyses. Because the 14 vegetation characteristics chosen for the analyses were not highly correlated ($r < 0.45$), all variables were included in subsequent analyses.

Very small stems (3 – 8 cm dbh) and exotic vegetation showed the strongest correlation ($r = 0.43$) among all variables.

To assess whether vegetation variables varied with distance to trail, canonical correlation analysis were performed for all random vegetation plots ($n = 114$). In addition, canonical correlation analysis for the nest plots ($n = 161$) was used to assess whether nest placement varied near trails. Using variables identified as important in the canonical correlation analysis, a set of models were created to examine the extent to which vegetation was related to nest success. These models were tested using the logistic-exposure method (Shaffer 2004) to model daily nest survival rates as above. The dataset for this analysis included all nests on which vegetation data was collected ($n = 263$).

RESULTS

Average trail usage at all sites was estimated as 1.02 events per hour and estimates of trail usage varied from 0.7 – 4.1 images per hour across sites (Table 3.1). However, the site with the greatest estimated activity (Creeks) had a very small sample of only 49 camera-hours in one year (compared to more than 1000 camera hours for each of the other five sites). Low activity levels were recorded between 22:00 and 06:00 hours and there were two peaks of activity during the day, approximately 13:00 – 15:00 hours and 18:00 – 20:00 hours (Figure 3.1). This pattern was observed at all sites with the exception of Woodside where there was an earlier peak between 07:00 – 09:00 and there was relatively low usage at midday.

During the 60-min observation periods conducted at 125 nests, females were on nests incubating eggs for an average of 31 min (± 1.73 min SE, range 0-60 min). Attendance rates were similar among sites (Figure 3.2). Nest attendance was not significantly related to distance to trail ($F_{1,86} = 0.69$, estimate = 0.009 ± 0.0102 SE, $p = 0.41$) (Figure 3.4), nest height ($F_{1,86} = 0.71$, estimate = 0.06 ± 0.077 SE, $p = 0.40$) (Figure 3.4), or trail usage ($F_{1,86} = 0.60$, estimate = 0.14 ± 0.180 SE, $p = 0.44$), nor was the relationship significant for any of the interactions or the full model (Full model $F_{6,81} = 0.43$, $p = 0.86$).

Estimated daily survival rates for Northern Cardinals were similar across sites and averaged 0.94 ± 0.003 (range = 0.92 – 0.96). Variation in daily survival rate of Northern Cardinal nests was not well explained by nest attendance, trail usage or site. Three explanatory models had $\Delta_i < 2$ (Table 3.2), including nest height and trail distance. Nest survival was positively related to nest height (estimate = 0.12 ± 0.083 SE) (Figure 3.3). Although the model including only trail distance had $\Delta_i < 2$, the direction of the relationship between nest survival and trail distance is not clear (estimate = -0.007 ± 0.0084) (Figure 3.3). In addition, the null model was included among the top three models with $\Delta_i < 2$.

Vegetation characteristics were not significantly related to trail distance for random vegetation plots (Wilks' Lambda $F_{11,102} = 1.01$, $n = 114$, $p = 0.44$). However, abundance of very small stems (3 - 8 cm dbh) was negatively related to trail distance ($F_{1,112} = 3.95$, $p = 0.049$) (Table 3.4). In contrast, vegetation characteristics were significantly related to trail distance for nest vegetation plots (Wilks' Lambda $F_{14,146} = 2.47$, $n = 161$, $p = 0.0037$). Trail distance was negatively related to nest height ($F_{1,159} =$

4.68, $p = 0.032$) and abundance of very small stems (3 – 8 cm dbh) ($F_{1,159} = 5.62$, $p = 0.019$), while there was a positive relationship with distance to foliage edge ($F_{1,159} = 5.35$, $p = 0.022$) and abundance of native vegetation ($F_{1,159} = 7.72$, $p = 0.0061$) (Table 3.5).

Variation in daily survival rate of Northern Cardinal nests was not well explained by native vegetation, distance to foliage edge or very small stems (3 - 8 cm dbh). Rather, the best explanatory model ($\omega_i = 0.49$) indicated that nest survival was positively related to nest height (estimate = 0.08 ± 0.047 SE). However, the null model also had $\Delta_i < 2$ (Table 3.3).

DISCUSSION

Recreational trails were not associated with negative consequences to breeding birds in forested parks within my urbanizing Midwestern study system. Neither the presence nor usage of trails was significantly related to nest attendance during incubation or nest survival. Thus, my study does not support the idea that recreation is incompatible with avian conservation in urban parks. Levels and patterns of trail usage at these sites were within the range of those reported in other studies (George and Crooks 2001, Lindsey and Nguyen 2004). Even so, contrary to studies of other species (Verboven et al. 2001, Baudains and Lloyd 2007), there does not appear to be any relationship between levels of trail usage or disturbance intensity and nest attendance for cardinals in this system. However, my results are consistent with some studies that found no association between nest success and direct human disturbance through recreational activities (e.g., Verboven et al. 2001, Baines and Richardson 2007). Nevertheless, other researchers have observed both negative (Miller et al. 1998, Langston et al. 2007) and positive (Miller and Hobbs 2000, Baudains and Lloyd 2007) associations between nest success

and human recreational disturbance. Lack of concordance among studies may result from differing predator communities or possible landscape effects. In order to identify patterns in the impacts of recreational trails, future research may need to more closely examine predator communities and the influence of the surrounding landscape.

Interestingly, my data suggest that trails may affect nest-site selection, a reproductive behavior that can have important consequences to breeding productivity. Although vegetation characteristics within randomly-located plots were apparently unrelated to distance to trail, nests placed near trails were placed higher in nesting substrates, surrounded by less native vegetation and more small trees, and were located closer to foliage edges than nests located farther from trails. Native vegetation and nest height are known to have important consequences to reproductive success in some species (Best and Stauffer 1980, DeLong et al. 1995, Howard et al. 2001, Marzluff and Ewing 2001), suggesting that trails may have a more subtle indirect influence on nest success.

Contrary to my original predictions, I found no evidence of a relationship between nest survival and either human use of trails or nest attendance. There is some support, however, that daily nest survival rates were related to both distance from trail and nest height, though this relationship is somewhat tenuous given that the null model was also included in top model set. Because nest attendance was not related to daily nest survival rates, this study fails to provide evidence of reproductive and, hence, potential population-level consequences of behavioral responses to human disturbance (Sutherland 1996, Sutherland 1998, Gill et al. 2001). One important caveat is that the one-hour observation periods that I used may have been insufficient to detect attendance patterns.

Other methods such as thermistors (Flint and MacCluskie 1995, Engstrand and Bryant 2002), longer observation periods or multiple observations at individual nests (Komeda 1983, Norment 1995) have been successfully used by other researchers and may be necessary to adequately assess nest attendance for passerines. In addition, recreational use of these parks is not entirely restricted to trails and measured activity levels may not be truly representative of site differences. Also, because observations were restricted to the incubation stage in order to avoid confounding with feeding trips, human disturbance could be affecting provisioning rates, or self-maintenance behaviors of adults leading to negative consequences in the future (i.e., future nesting attempts within or between seasons).

Contrary to my original predictions, exotic cover was not associated with distance to trail although other studies have reported negative associations (Patel and Rapport 2000, Larson 2003, Potito and Beatty 2005). However, significantly higher counts of very small stems (3 – 8 cm dbh) were recorded closer to trails indicating a higher understory density closer to trails as predicted. Furthermore, the vast majority of very small stems represented Amur honeysuckle stems, indicating variation in the age distribution of at least one exotic species. Although stems smaller than 3 cm dbh were not measured, the measure of exotic cover included contacts with a vegetation pole by leaves from all plants, including smaller, younger honeysuckle plants. Amur honeysuckle stems smaller than 3 cm dbh may have increased the number of contacts from exotic vegetation further from trails, indicating a possible dispersal or movement of Amur honeysuckle from trails.

Because my vegetation data from randomly-located plots indicated no overall association between habitat structure and distance from trail, one presumes that

availability of nest-sites was similar near and far from trails. Even so, birds appeared to select sites with higher abundance of native vegetation than expected when farther from trails. One exception was that the negative association between very small trees and distance to trails for nest plots paralleled the negative association between the same variables in random plots, suggesting that birds simply used what was available. One of the most interesting patterns was that birds selected nest sites that were lower to the ground and more interior or centrally-placed in the nest plant when farther from trails. Given that certain predators have been shown to avoid trails (Miller and Hobbs 2000, Whittington et al. 2005), a nest more centrally located in a plant may have been relatively more advantageous farther from trails if predators were more abundant there compared to near trails. However, because nest height and distance to foliage edge could obviously not be measured at random plots that lacked nests, it is unclear whether the observed pattern reflects availability or active selection by nesting birds. In any case, the only vegetation variable that appeared to have any reproductive consequence was nest height (Best and Stauffer 1980, Newell and Kostalos 2007, Smith et al. 2007). Other vegetation variables that were identified as varying with trails and important in nest site selection did not predict nest success, lending support to the idea that there are no predictably safe nest sites (Filiater et al. 1994), perhaps with the exception of higher nests in this case.

Overall, this study failed to find evidence of negative consequences of recreational trails to birds nesting in forested parks. However, because this study focused on one relatively synanthropic species, my results may not be generalized to other species which are more sensitive. Still, my study does provide important information about the potential conservation value of urban parks that are heavily used by recreationists. The

reality of urban-based conservation is that the value of urban parks to wildlife may rely, to a large extent, on synanthropes given that most sensitive species have dropped out of the urban bird communities (Chapman and Reich 2007, Palomino and Carrascal 2007). The lack of a direct response to human disturbance is consistent with other behaviors of urban-adapted species whose reactions likely differ from species that are more sensitive to disturbance (Mortberg 2001, Burhans and Thompson 2004). Because Northern Cardinals are clearly adapted to urban areas (Leston and Rodewald 2006, Burhans and Thompson 2006), extending this work to species that are more sensitive to disturbance could provide valuable insights for urban park managers. Urbanization and recreation are expected to continue to grow in the near future (United Nations 1996, Cordell 2004), and, therefore, there will be a growing need to meet diverse social and ecological needs on public open spaces. This work suggests that, at least for certain synanthropic species, recreation may indeed be compatible with conservation.

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Site	Images per hour	Hours on trail (paved)	Images per hour (paved)	Hours on trail (unpaved)	Images per hour (unpaved)
Casto	1.50	1097.60	2.30	3134.25	1.22
Kenney	0.70	*	*	5046.83	0.70
Rush Run	0.85	*	*	2596.88	0.86
Woodside	1.03	2337.33	1.53	1433.18	0.21
Creeks	4.18 ^a	33.83	6.44	15.20	1.12
Lou	0.87	320.58	1.73	829.77	0.52
TOTAL	1.02	3789.35	1.81	13056.12	0.79

* No paved trails exist at these sites

^a The small sample size at this site likely accounts for the discrepancy between this and other sites.

Table 3.1 Measures of trail usage calculated from motion detecting trail cameras placed along paved and unpaved trails at 6 urban riparian sites in central Ohio in 2006 and 2007. Cameras were operated for 24 hours a day during 1 to 16-day sampling periods.

Model	K	AICc	Δ_i	ω_i
Nest height	2	331.9396	0.0000	0.2652
Null (constant survival)	1	332.0908	0.1512	0.2459
Trail Distance	2	333.4497	1.5101	0.1246
Nest attendance	2	333.9757	2.0361	0.0958
Trail usage	2	334.0826	2.1431	0.0908
Attendance, Nest height	4	334.4913	2.5517	0.0740
Trail distance, attendance	3	335.3510	3.4114	0.0482
Trail usage, Nest height	4	335.8211	3.8815	0.0381
Trail usage, attendance	4	337.9531	6.0135	0.0131
Site	6	340.2455	8.3060	0.0042

Table 3.2. Model selection results from the logistic-exposure models of daily survival rate for Northern Cardinal nests ($n = 92$) at 6 urban riparian parks in central Ohio, 2006–2007.

Model	K	AICc	Δi	ωi
Nest height	2	883.8416	0.0000	0.4946
Null (constant survival)	1	885.4220	1.5803	0.2244
Native Vegetation	2	886.9702	3.1286	0.1035
Distance to Foliage Edge	2	887.2524	3.4108	0.0899
Very small stems (3-8cm dbh)	2	887.3038	3.4622	0.0876

Table 3.3. Model selection results from the logistic-exposure models of daily survival rate for Northern Cardinal nests ($n = 263$) at 14 urban riparian parks in central Ohio, 2006–2007. Models are based on vegetation variables identified in canonical correlation analysis.

Variable	r	F	p
Canopy height	0.0233	0.06	0.8054
Canopy cover	0.0459	0.24	0.6280
Ground cover by vegetation	0.0011	0.00	0.9910
Forb	0.1747	3.53	0.0630
Exotic	0.0185	0.04	0.8451
Native	0.0395	0.17	0.6768
Tree	-0.0414	0.19	0.6616
Very small stems (3-8 cm dbh)	-0.1847	3.95	0.0492
Small trees (8-23 cm dbh)	-0.0324	0.12	0.7326
Medium trees (23-38 cm dbh)	0.0546	0.34	0.5639
Large trees (>38 cm dbh)	-0.0671	0.51	0.4779

Table 3.4. Pearson's correlation coefficients (r) between vegetation variables and distance to trail for 114 randomly-located vegetation plots in 8 riparian forests in Ohio, 2006-2007. F and P test statistics indicate statistical significance of relationship with distance to trail as determined by a canonical correlation analysis.

Variable	r	F	p
Canopy height	0.0064	0.01	0.9358
Nest height	-0.1691	4.68	0.0320
Distance to foliage edge	0.1805	5.35	0.0220
Nest cover	-0.0359	0.2	0.6513
% canopy	-0.0939	1.42	0.2359
Ground cover	0.0569	0.52	0.4737
Forb	0.0806	1.04	0.3096
Exotic	-0.0408	0.27	0.6072
Native	0.2152	7.72	0.0061
Tree	-0.0898	1.29	0.2572
Very small stems (dbh <8 cm)	-0.1847	5.62	0.0190
Small trees (8-23 cm dbh)	-0.0180	0.05	0.8210
Medium trees (23-38 cm dbh)	0.0278	0.12	0.7264
Large trees (>38 cm dbh)	0.1291	2.69	0.1027

Table 3.5. Pearson's correlation coefficients (r) between vegetation variables and distance to trail for vegetation plots around 161 nests in 12 riparian forests in Ohio, 2006-2007. F and P test statistics indicate statistical significance of relationship with distance to trail as determined by a canonical correlation analysis.

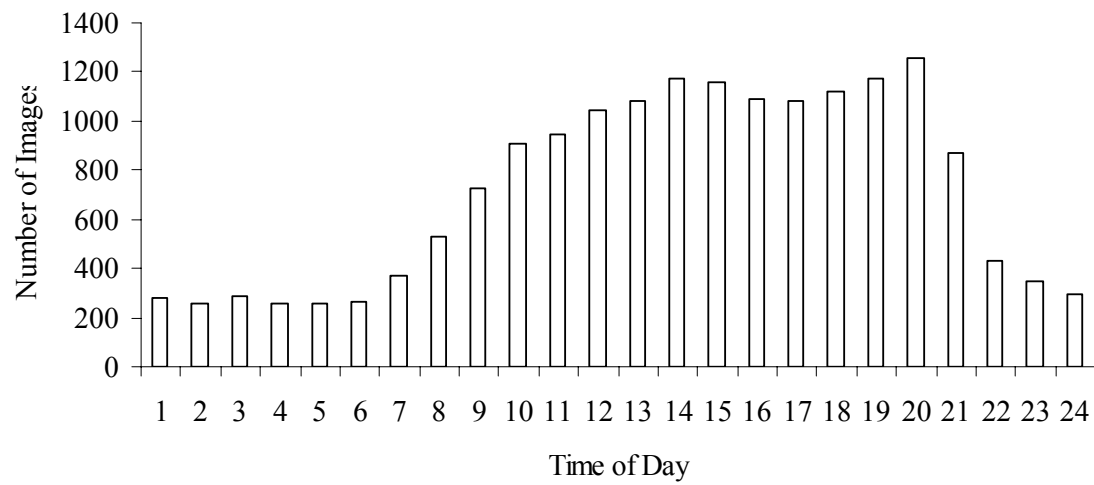


Figure 3.1. Daily temporal variation in the number of images produced from 6 motion detecting cameras (16,824 camera-hours) placed along paved and unpaved recreational trails at 6 urban riparian forest sites in central Ohio in 2006 and 2007.

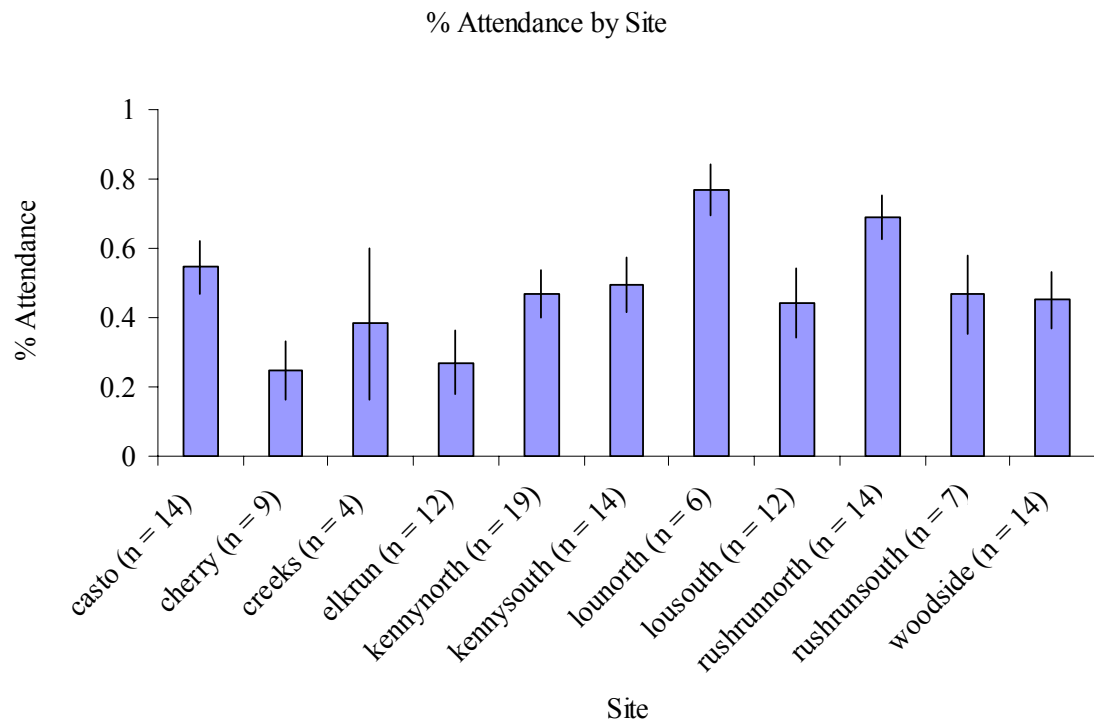


Figure 3.2. Mean time on nest (\pm SE) of female Northern Cardinals measured during one hour observation periods at individual nests ($n = 125$) at urban riparian forest sites in central Ohio in 2006 and 2007.

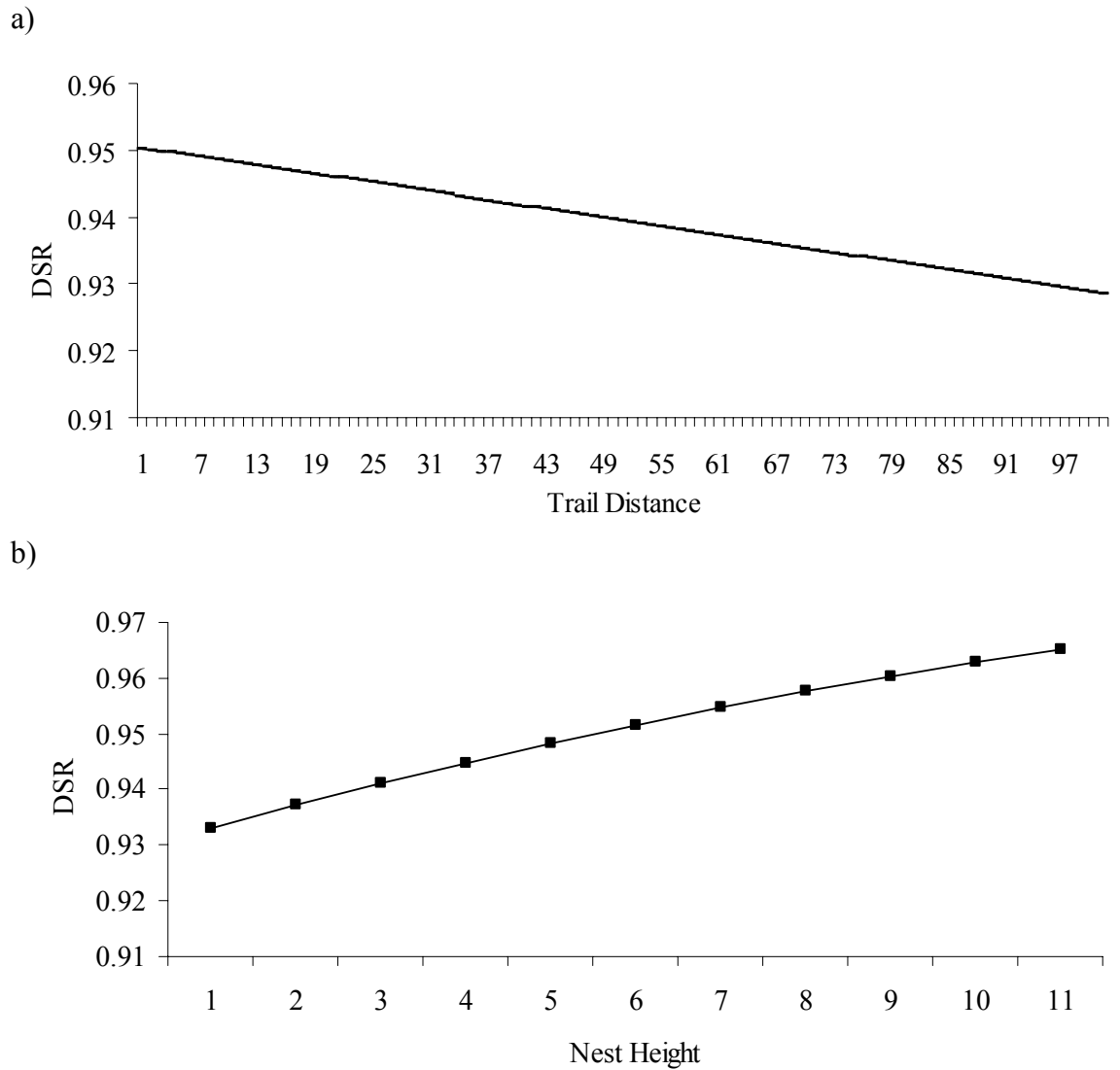
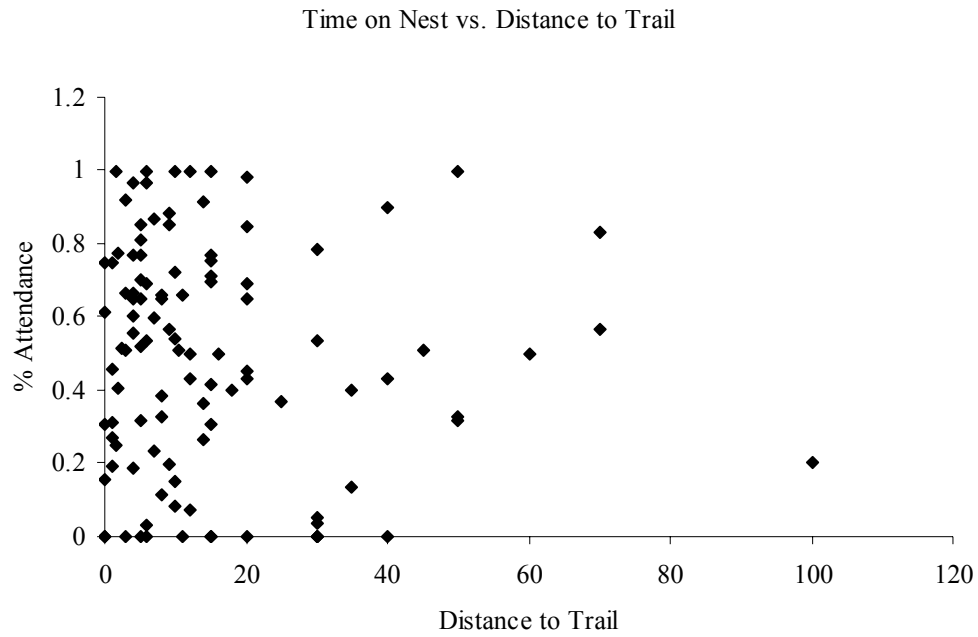


Figure 3.3: Estimated daily survival rate (DSR) of Northern Cardinal nests compared to trail distance ($n = 313$) (a) and nest height ($n=637$) (b) at 14 urban riparian forest sites in central Ohio in 2006 and 2007.

a)



b)

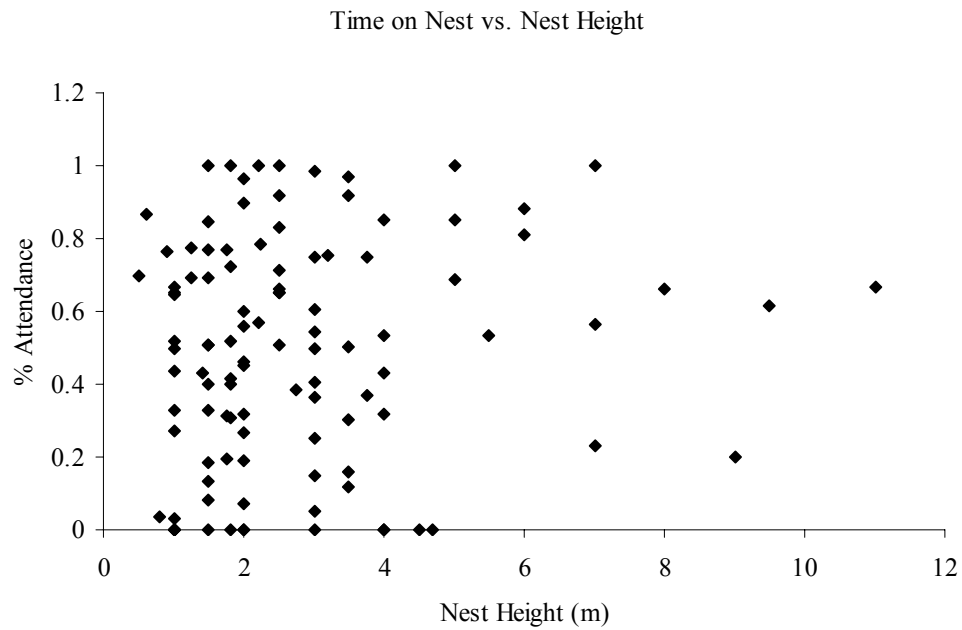
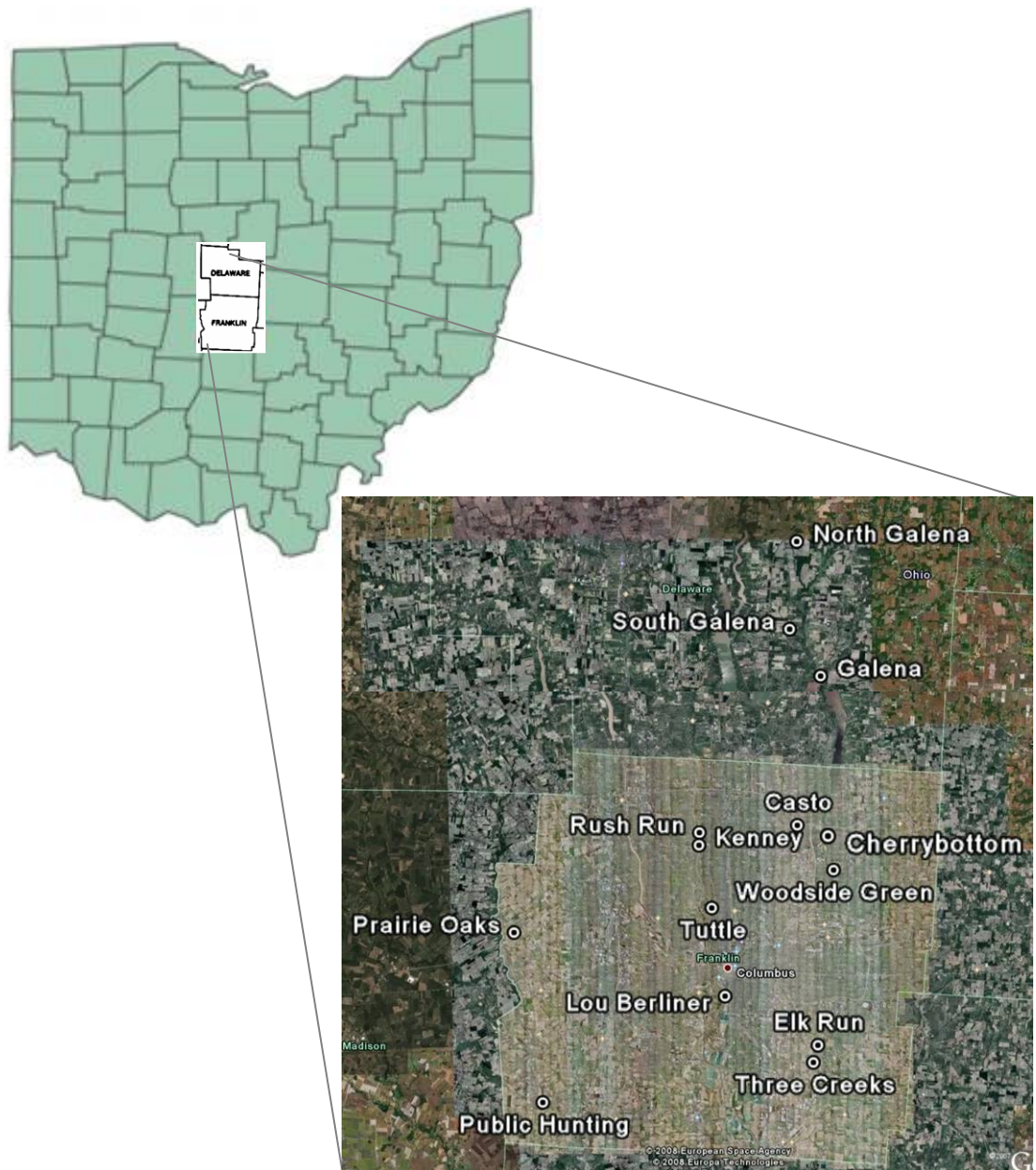


Figure 3.4. Time spent on nest by female Northern Cardinals measured during one hour observation periods at individual nests ($n = 125$) compared to trail distance (a) and nest height (b) at 8 urban riparian forest sites in central Ohio in 2006 and 2007.

APPENDIX A

LOCATION OF RIPARIAN FOREST STUDY SITES IN DELAWARE AND FRANKLIN COUNTIES, OHIO, USA.



APPENDIX B

LOCATIONS FOR 14 RIPARIAN FOREST SITES MONITORED IN CENTRAL OHIO, 2006-2007.

Site	County	Latitude	Longitude
Casto Park	Franklin	40N 05' 00"	82W 55' 26"
Cherrybottom Park	Franklin	40N 03' 44"	82W 54' 16"
Elk Run Park	Franklin	39N 53' 48"	82W 53' 59"
Galena	Delaware	40N 12' 51"	82W 52' 50"
Kenney Park	Franklin	40N 03' 55"	83W 01' 48"
Lou Berliner Park	Franklin	39N 56' 03"	83W 00' 14"
North Galena	Delaware	40N 21' 14"	82W 55' 36"
Prairie Oaks Metro Park	Franklin	39N 59' 03"	83W 14' 56"
Public Hunting	Franklin	39N 50' 53"	83W 12' 06"
Rush Run Park	Franklin	40N 04' 28"	83W 01' 53"
South Galena	Delaware	40N 14' 08"	82W 53' 43"
Three Creeks Metro Park	Franklin	39N 52' 55"	82W 54' 32"
Tuttle Park	Franklin	40N 00' 39"	83W 00' 00"
Woodside Green Park	Franklin	40N 02' 41"	82W 52' 49"

APPENDIX C

ESTIMATED TRAIL USAGE, MEAN ATTENDANCE, DAILY SURVIVAL RATES, AND NEST SURVIVAL AT 14 RIPARIAN FOREST SITES MONITORED IN CENTRAL OHIO IN 2006 AND 2007.

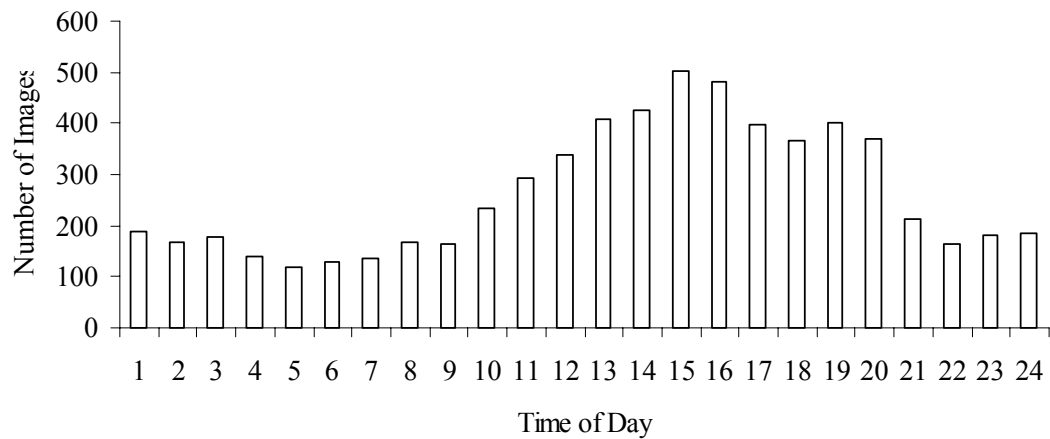
Site	Estimated trail usage (images/hour)	Mean % Attendance (n)	DSR (n)	Nest Survival
casto	1.50	0.55 (14)	0.95 (36)	0.26
cherry	.	0.31 (9)	0.93 (28)	0.19
creeks	4.18	0.41 (4)	0.93 (31)	0.19
elkrun	.	0.32 (12)	0.95 (26)	0.28
galena	.	.	0.95 (31)	0.31
kenny	0.70	0.52 (33)	0.95 (103)	0.27
lou	0.87	0.61 (18)	0.95 (78)	0.26
ngalena	.	.	0.93 (17)	0.18
prairie	.	.	0.94 (34)	0.20
pubhunt	.	.	0.96 (24)	0.38
rushrun	0.85	0.55 (21)	0.95 (66)	0.28
sgalena	.	.	0.92 (56)	0.14
tuttle	.	.	0.96 (77)	0.34
woodside	1.03	0.52 (14)	0.94 (40)	0.23

APPENDIX D

DAILY TEMPORAL VARIATION IN RECREATIONAL TRAIL USAGE AT 6 RIPARIAN FOREST SITES IN CENTRAL OHIO MEASURED FROM APRIL TO AUGUST IN 2006 AND 2007.

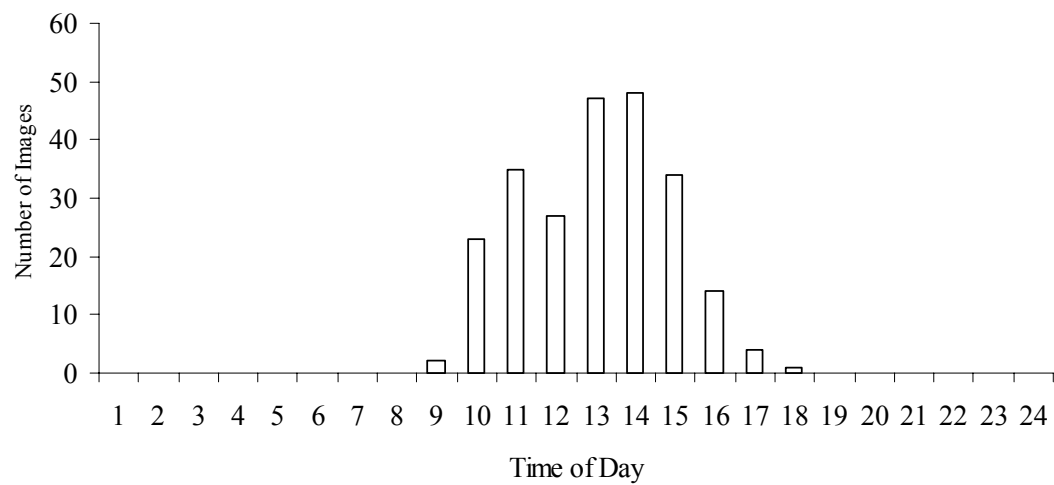
a)

CASTO



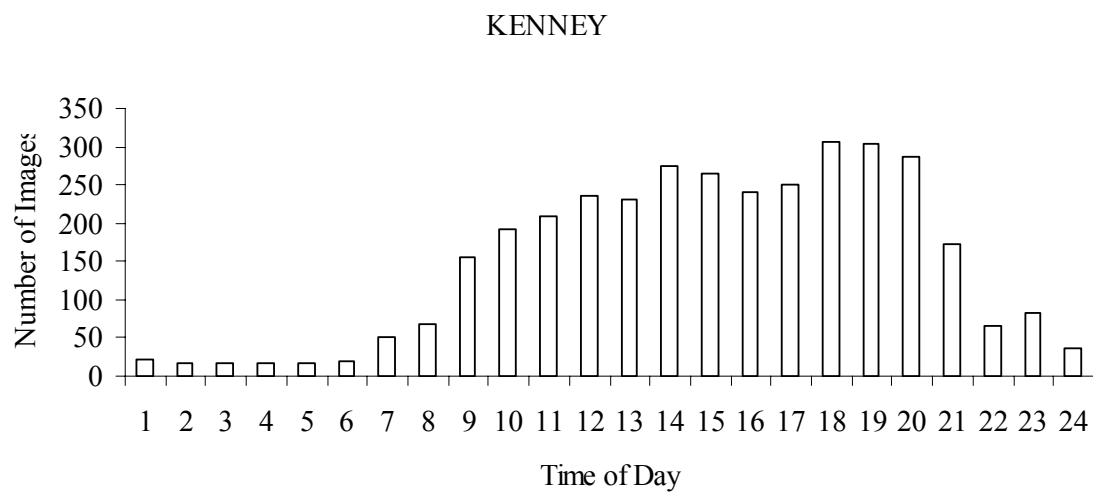
b)

CREEKS

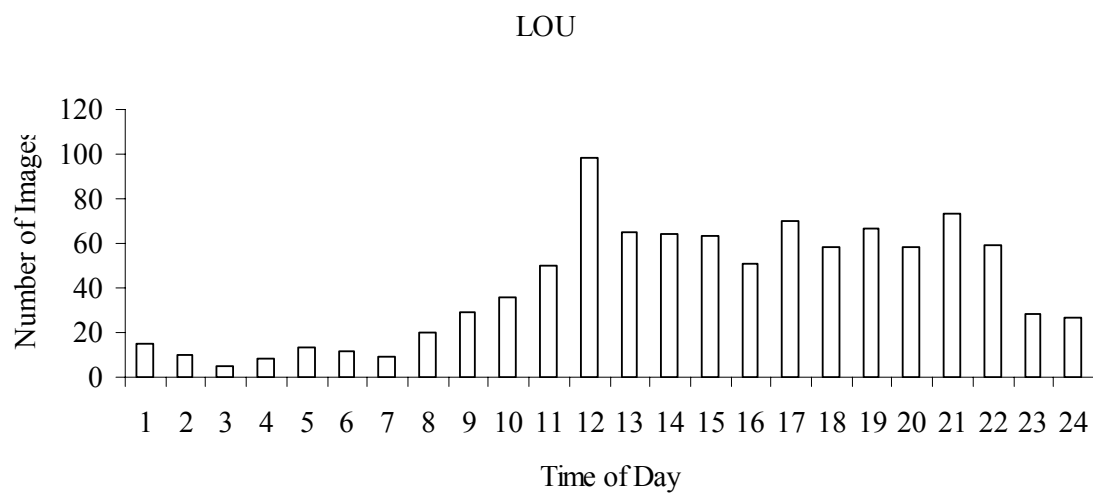


APPENDIX D continued

c)

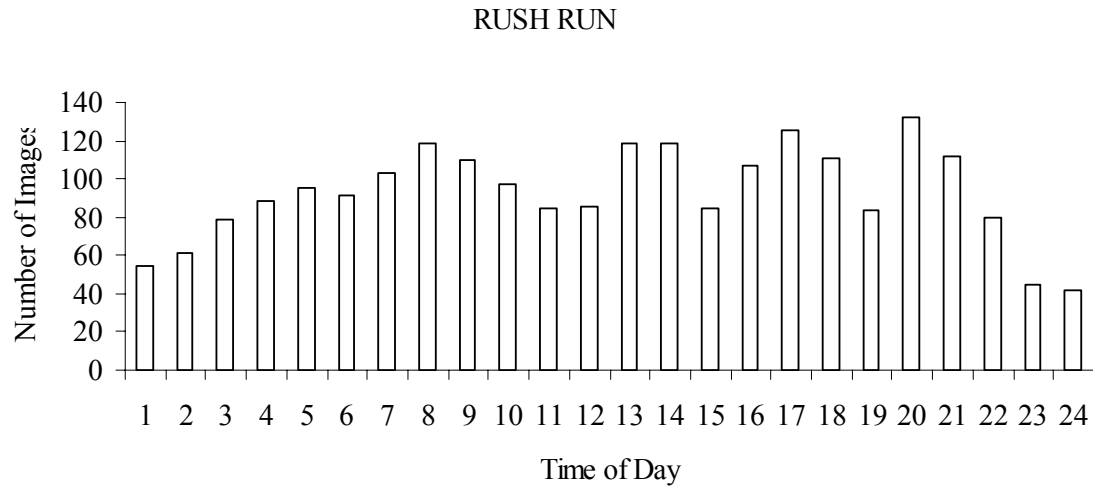


d)

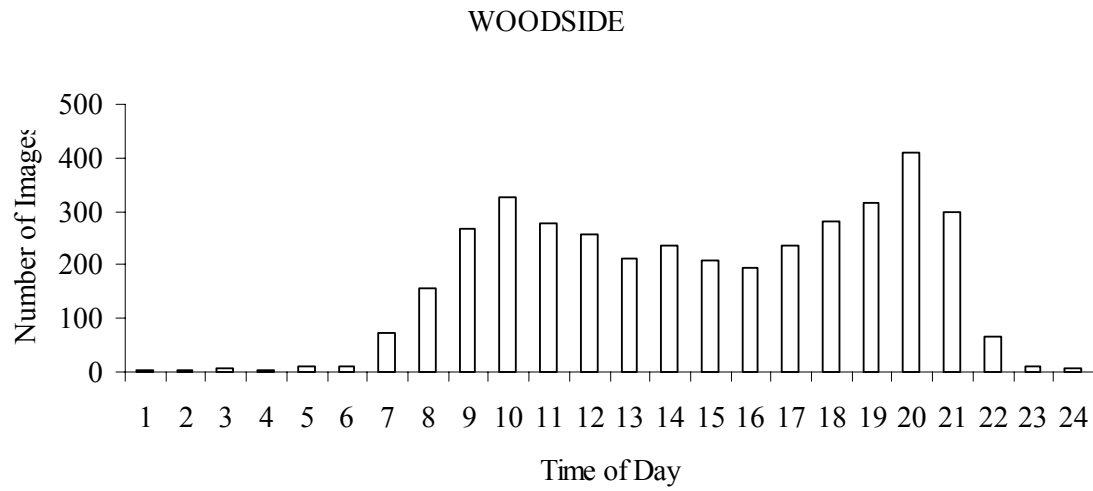


APPENDIX D continued

e)



f)



APPENDIX E

TRAIL CAMERA DATA FROM PAVED AND UNPAVED RECREATIONAL
TRAILS AT 6 RIPARIAN FOREST SITES IN CENTRAL OHIO MEASURED FROM
APRIL TO AUGUST IN 2006 AND 2007.

2006

Site	# of Images	% of Total	# of Images (paved)	% of total per site (paved)	# of Images (unpaved)	% of total per site (unpaved)	Total hours per site	Mean images per hour	Hours on paved trail	Paved images per hour	Hours on unpaved trail	Unpaved images per hour
Casto	4817	0.49	2490	0.52	2327	0.48	1696.40	2.84	710.13	3.50	976.18	2.38
Kenney	1889	0.19	0	0	1889	1.00	2122.65	0.89	0	N/A	2122.58	0.89
Rush Run	143	0.01	0	0	143	1.00	380.77	0.38	0	N/A	363.78	0.39
Woodside	1814	0.18	1634	0.90	181	0.10	2280.30	0.80	1423.83	1.15	871.62	0.21
Creeks	235	0.02	218	0.93	17	0.07	56.18	4.18	33.83	6.44	15.20	1.12
Lou	988	0.10	553	0.56	435	0.44	1135.93	0.87	320.58	1.72	829.77	0.52
Total	9886	1.00	4895	0.50	4992	0.50	7666.53	1.29	2488.38	1.97	5179.13	0.96

2007

Site	# of Images	% of Total	# of Images (paved)	% of total per site (paved)	# of Images (unpaved)	% of total per site (unpaved)	Total hours per site	Mean images per hour	Hours on paved trail	Paved images per hour	Hours on unpaved trail	Unpaved images per hour
Casto	1534	0.21	32	0.02	1502	0.98	2545.53	0.60	387.47	0.08	2158.07	0.70
Kenney	1650	0.23	0	0	1650	1	2924.25	0.56	0	N/A	2924.25	0.56
Rush Run	2086	0.28	0	0	2086	1	2233.10	0.93	0	N/A	2233.10	0.93
Woodside	2057	0.28	1933	0.94	124	0.06	1475.07	1.39	913.50	2.12	561.57	0.22
Total	7327	1.00	1965	0.268186	5362	0.73	9177.95	0.80	1300.97	1.51	7876.98	0.68

APPENDIX F

TYPE OF RECREATIONAL USAGE OF TRAILS CALCULATED FROM THE FIRST 8,000 IMAGES COLLECTED FROM TRAIL CAMERAS AT 6 RIPARIAN FOREST SITES IN CENTRAL OHIO IN 2006.

Activity Type	% of total images	% of images with something visible
Nothing Visible	87.71	--
Adult Walking	6.61	54.27
Child Walking	0.55	4.55
Adult/Child Walking	0.55	4.55
Adult Biking	1.18	9.68
Child Biking	0.21	1.71
Adult/Child Biking	0.07	0.57
Adult Walking/Child Biking	0.12	0.95
Adult Walking/Adult Biking	0.02	0.19
Child on scooter	0.02	0.19
American Robin	0.02	0.19
Squirrel	0.05	0.38
Rabbit	0.02	0.19
Dog	0.79	6.45
Deer	0.18	1.52
People/Dog	1.45	11.95
People/Golf Cart	0.14	1.14
Other	0.18	1.52
TOTAL	99.88	100.00

APPENDIX G

APPROXIMATE LOCATIONS OF TRAIL CAMERAS (LABELED A, B, AND C)
USED TO ASSESS RECREATIONAL TRAIL USAGE AT 6 RIPARIAN FOREST
SITES IN CENTRAL OHIO IN 2006.



APPENDIX G continued

100



APPENDIX G continued

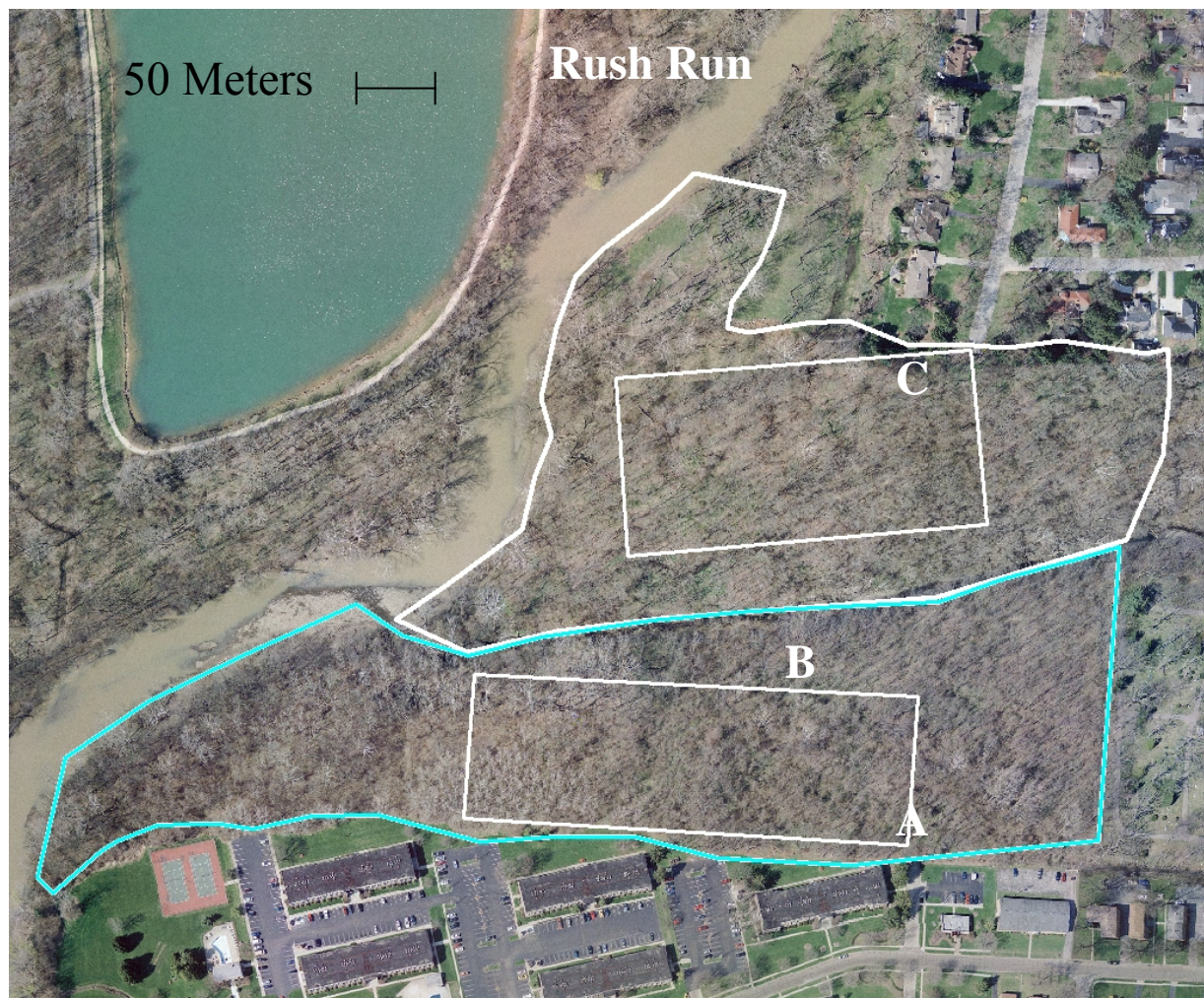
101



APPENDIX G continued



APPENDIX G continued



APPENDIX G continued



APPENDIX H

TRAIL CAMERA DATA FROM THREE LOCATIONS (A, B, AND C) ON
RECREATIONAL TRAILS COLLECTED AT 6 RIPARIAN FOREST SITES IN
CENTRAL OHIO MEASURED FROM APRIL TO AUGUST IN 2006.

Site	Hours at Location A	Hours at Location B	Hours at Location C	Images at Location A	Images at Location B	Images at Location C	Images per hour A	Images per hour B	Images per hour C
Casto	710.13	654.73	321.45	2484	1212	1121	3.50	1.85	3.49
Kenney	872.72	879.10	370.77	754	536	599	0.87	0.61	1.62
Rush Run	98.37	97.72	167.70	35	35	77	0.36	0.36	0.46
Woodside	438.60	985.23	871.62	446	1188	180	1.02	1.21	0.21
Creeks	15.20	16.60	17.23	17	122	96	1.12	7.35	5.57
Lou	320.58	345.50	484.27	553	60	375	1.73	0.17	0.77
Total	2455.60	2978.88	2233.03	4289	3153	2448	1.75	1.06	1.10

APPENDIX I

NEST ATTENDANCE DATA FROM 125 NORTHERN CARDINAL NESTS
MONITORED AT 8 RIPARIAN FOREST SITES IN CENTRAL OHIO IN 2006 AND
2007.

(clouds = estimated % cloud cover, wind = wind speed using beaufort wind scale, % attendance = total time on nest/total time observed)

	Date	Site	Nest	Temperature (°C)	Clouds	Wind	Precipitation	Start Time	Female on at start?	Total time obs (minutes)	% attendance	Succeed/Fail	Distance to paved trail (m)	Distance to unpaved trail (m)	Distance to nearest trail (m)	Nest Height (m)
801	7/8/2006	Casto	06DS133	23.9	50	0	0	13:08	Y	26	0.385	F	120	8	8	2.75
	5/13/2006	Casto	06JF045	12.2	100	0.5	0	10:27	Y	61	0.844	S	120	20	20	1.5
	6/3/2006	Casto	06JF065	23.3	10	0	0	11:50	N	61	0.459	S	35	1	1	2
	5/3/2006	Casto	06JS027	18.3	50	1	0	17:24	Y	61	1	S	60	6	6	2.5
	5/17/2006	Casto	06JS049	16.9	60	1.5	0	15:05	Y	61	0.664	F	150	45	45	1.5
	5/20/2006	Casto	06JS049	13.6	0	1	0	11:02	N	61	0.508	F	150	45	45	1.5
	5/14/2007	Casto	07-02-035	23.3	5	1	0	14:30	N	52	0.327	S	40	8	8	1.5
	6/13/2007	Casto	07-04-046	27.8	5	1	0	14:01	N	60	0	S	100	30	30	4.7
	8/9/2007	Casto	07-04-107	29.4	25	2	0	12:25	N	61	0.508	S	35	3	3	2.5
	8/23/2007	Casto	07-04-109	29.4	40	0	0	11:08	N	60	0.25	S	20	1.5	1.5	3
	5/14/2007	Casto	07-07-021	18.3	0	1	0	11:35	Y	60	0.417	S	100	15	15	1.8
	5/9/2007	Casto	07-07-031	22.2	20	0	0	12:08	Y	60	0.867	S	7	50	7	0.6
	5/7/2007	Casto	07-10-031	20.0	0	1	0	12:05	Y	60	0.767	S	4	18	4	1.75
	5/11/2007	Casto	07-10-070	23.9	70	0	0	13:20	N	60	0.767	S	50	15	15	0.9
	6/11/2007	Cherry	07-01-069	21.1	0	2	0	12:28	N	60	0	S	.	0	0	1
	5/16/2007	Cherry	07-07-025	16.7	65	1	0	13:04	N	60	0	S	.	5	5	1
	5/21/2007	Cherry	07-07-037	20.0	85	1	0	12:25	Y	60	0.433	F	.	40	40	1

APPENDIX I Continued

	Date	Site	Nest	Temperature (°C)	Clouds	Wind	Precipitation	Start Time	Female on at start?	Total time obs (minutes)	% attendance	Succeed/Fail	Distance to paved trail (m)	Distance to unpaved trail (m)	Distance to nearest trail (m)	Nest Height (m)
601	5/23/2007	Cherry	07-07-039	30.0	0	1	0	13:45	N	60	0.433	S	.	20	20	1.4
	4/27/2007	Cherry	07-10-022	11.7	100	1	light	11:07	Y	62	0.839	S	.	30	30	4.5
	5/9/2007	Cherry	07-10-076	23.9	0	2	0	11:58	Y	53	0.038	S	.	30	30	0.8
	5/16/2007	Cherry	07-10-077	16.7	100	0	light	11:23	Y	60	0.7	S	.	5	5	0.5
	6/27/2007	Cherry	07-10-153	25.3	40	1	0	11:02	N	63	0.19	S	.	1	1	2
	6/22/2007	Cherry	07-10-167	18.3	100	0	0	11:10	Y	60	0.2	S	.	100	100	10
	5/2/2006	Creeks	06JF014	18.3	70	0.5	0	15:30	Y	81	0.691	S	100	6	6	1.5
	5/15/2006	Creeks	06JF043	13.3	100	1	0	12:35	N	61	0.074	S	40	12	12	2
	5/23/2006	Creeks	06JF053	18.9	0	0.5	0	12:25	Y	61	0.344	F	65	40	40	1.5
	5/19/2006	Creeks	06JS052	16.7	90	3	0	15:20	Y	62	0.532	F	12	5	5	2.5
	4/25/2006	Elk Run	06JF029	12.8	70	3	0	10:00	N	61	0.328	S	80	50	50	1
	4/21/2007	Elk Run	07-01-014	18.3	0	1	0	11:30	N	60	0	F	50	15	15	1
	6/21/2007	Elk Run	07-02-049	28.3	10	1	0	12:50	Y	60	0.817	F	9	25	9	4
	7/17/2007	Elk Run	07-07-063	28.3	98	0.5	0	12:45	Y	60	0.65	S	110	20	20	2.5
	4/21/2007	Elk Run	07-10-011	21.1	0	0.5	0	12:45	N	60	0	F	80	30	30	1.8
	5/12/2007	Elk Run	07-10-040	23.9	0	0	0	12:10	Y	60	1	F	100	50	50	2.2
	5/10/2007	Elk Run	07-10-080	21.1	0	1	0	11:00	N	70	0.186	S	23	4	4	1.5
	5/5/2007	Elk Run	07-10-081	18.3	100	0.5	0	11:05	Y	60	0.133	F	90	35	35	1.5
	5/19/2007	Elk Run	07-10-088	10.0	100	0	0	11:12	N	60	0	S	60	15	15	1.5
	5/15/2007	Elk Run	07-10-090	23.9	60	2	0	12:55	N	60	0	F	80	30	30	2
	5/31/2007	Elk Run	07-10-128	29.4	90	1	0	12:36	N	62	0.306	S	60	40	40	1.8
	7/13/2007	Elk Run	07-10-180	23.9	100	2	0	14:30	N	60	0.367	S	80	25	25	3.75

APPENDIX I Continued

	Date	Site	Nest	Temperature (°C)	Clouds	Wind	Precipitation	Start Time	Female on at start?	Total time obs (minutes)	% attendance	Succeed/Fail	Distance to paved trail (m)	Distance to unpaved trail (m)	Distance to nearest trail (m)	Nest Height (m)
011	5/5/2006	Kenney_N	06DS035	19.4	30	1.5	0	15:06	N	40	0	F	.	11	11	4.5
	5/7/2006	Kenney_N	06DS036	21.1	80	0	0	12:12	Y	59	0.542	F	.	10	10	3
	5/7/2006	Kenney_N	06DS049	21.1	80	0	0	13:13	Y	61	0.967	F	.	4	4	3.5
	6/1/2006	Kenney_N	06JF059	23.9	50	1.5	0	12:00	Y	61	0.918	S	.	3	3	2.5
	5/15/2006	Kenney_N	06JS032	8.6	30	2.5	0	7:50	N	40	0.763	S	.	10	10	3
	5/21/2006	Kenney_N	06JS032	21.1	20	1.5	0	15:00	Y	40	0.15	S	.	10	10	3
	6/19/2006	Kenney_N	06JS062	23.3	45	1.5	0	13:15	Y	61	0.59	F	.	4	4	4
	7/17/2006	Kenney_N	06JS092	35.0	20	0	0	12:30	Y	91	0.604	S	.	4	4	3
	5/21/2006	Kenney_N	06MH002	21.1	20	1.5	0	16:15	N	51	0.196	F	.	9	9	1.75
	5/12/2007	Kenney_N	07-01-030	23.9	0	2	0	12:53	Y	58	0.724	S	.	10	10	1.8
	7/6/2007	Kenney_N	07-04-062	21.1	15	1	0	11:30	Y	62	0.613	S	.	0	0	4.5
	8/15/2007	Kenney_N	07-04-106	23.9	70	1.5	0	11:00	Y	59	0.407	S	.	2	2	3
	5/15/2007	Kenney_N	07-05-001	23.9	0	3	0	13:20	Y	57	0.158	F	.	0	0	3.5
	4/24/2007	Kenney_N	07-10-029	18.3	70	1.5	0	12:40	N	60	0.65	F	.	5	5	1
	6/9/2007	Kenney_N	07-10-149	23.9	0	2	0	11:42	Y	60	0.317	F	.	50	50	5
	7/7/2007	Kenney_N	07-10-172	28.9	10	2	0	12:00	Y	60	0.117	S	.	8	8	3.5
	7/13/2007	Kenney_N	07-10-186	21.1	100	0	0	11:50	N	60	0.233	F	.	7	7	7
	7/24/2007	Kenney_N	07-10-195	18.3	100	0	0	11:42	N	60	0.883	S	.	9	9	6
	7/24/2007	Kenney_N	07-10-196	23.9	60	2.5	0	12:10	N	60	0.433	F	.	12	12	4
	4/27/2006	Kenney_S	06JS021	10.0	50	2	0	7:33	Y	66	0.939	F	.	4	4	2
	5/5/2006	Kenney_S	06JS021	20.0	25	2	0	13:45	Y	61	0.557	F	.	4	4	2
	5/15/2006	Kenney_S	06JS034	17.8	100	0	0	12:40	N	76	0.776	S	.	2	2	1.25

APPENDIX I Continued

	Date	Site	Nest	Temperature (°C)	Clouds	Wind	Precipitation	Start Time	Female on at start?	Total time obs (minutes)	% attendance	Succeed/Fail	Distance to paved trail (m)	Distance to unpaved trail (m)	Distance to nearest trail (m)	Nest Height (m)
111	6/15/2006	Kenney_S	06JS067	21.1	0	1	0	12:18	Y	61	0.311	S	.	1	1	1.75
	7/5/2006	Kenney_S	06JS073	18.3	30	1	0	16:10	N	78	0.365	S	.	14	14	3
	7/3/2006	Kenney_S	06MH006	29.4	100	1	0	16:07	N	61	0.787	F	.	30	30	4
	4/17/2007	Kenney_S	07-02-010	15.6	0	2	0	12:55	Y	60	0.083	F	.	10	10	1.5
	5/24/2007	Kenney_S	07-02-036	29.4	70	2.5	0	13:35	Y	60	0.967	F	.	6	6	6
	6/16/2007	Kenney_S	07-02-042	25.6	10	2	0	11:30	Y	60	0.833	F	.	70	70	2.5
	6/5/2007	Kenney_S	07-04-044	21.1	30	2.5	0	14:26	N	60	0.5	S	.	12	12	3.5
	7/18/2007	Kenney_S	07-04-086	21.1	100	1	0	11:02	Y	61	0.689	S	.	20	20	5
	5/22/2007	Kenney_S	07-10-102	23.9	0	0	0	12:34	Y	59	0.305	F	.	15	15	3.5
	7/24/2007	Kenney_S	07-10-191	21.1	10	1	0	12:08	Y	51	0.667	S	.	4	4	11
	7/25/2007	Kenney_S	07-10-199	23.9	70	1	0	11:22	N	56	0.054	F	.	30	30	3
	6/22/2006	Lou_N	06BN117	32.2	75	1	Y	14:35	Y	51	1	F	10	.	10	1.5
	6/29/2006	Lou_N	06BN126	26.7	5	2	0	14:26	Y	61	0.508	F	10.5	.	10.5	1.5
	7/20/2006	Lou_N	06DM094	31.1	95	1	0	14:40	Y	61	0.467	S	15	.	15	2.5
	7/24/2006	Lou_N	06DM094	25.6	0	1	0	11:22	Y	61	0.713	S	15	.	15	2.5
	6/6/2007	Lou_N	07-06-010	20.0	70	1.5	0	13:25	Y	107	0.85	F	5	15	5	4
	6/15/2007	Lou_N	07-08-035	26.7	40	2.5	0	12:43	Y	60	0.567	F	70	.	70	7
	6/5/2006	Lou_S	06BN074	23.9	0	2	0	14:00	Y	61	0.648	S	14	4	4	1
	6/22/2006	Lou_S	06BN114	32.2	100	1	Y	13:48	Y	46	0.402	F	.	.	.	1
	7/10/2006	Lou_S	06BN135	29.4	40	2	0	13:04	Y	60	0.667	F	.	.	.	4
	7/13/2006	Lou_S	06BN135	25.6	100	0	Y	7:47	Y	61	0.393	F	.	.	.	4
	7/10/2006	Lou_S	06DS119	29.4	25		0	14:08	N	61	0.598	S	7	.	7	2

APPENDIX I Continued

	Date	Site	Nest	Temperature (°C)	Clouds	Wind	Precipitation	Start Time	Female on at start?	Total time obs (minutes)	% attendance	Succeed/Fail	Distance to paved trail (m)	Distance to unpaved trail (m)	Distance to nearest trail (m)	Nest Height (m)
112	7/3/2006	Lou_S	06DS121	29.4	100	1	0	9:09	N	62	0.661	F	11	.	11	2.5
	7/7/2007	Lou_S	07-01-094	26.7	0	0	0	11:05	N	60	0	S	60	20	20	4
	6/20/2007	Lou_S	07-02-046	23.9	0	3	0	11:41	Y	60	0.9	F	40	.	40	1.8
	5/16/2007	Lou_S	07-06-007	15.6	90	3.5	0	13:55	Y	60	0.75	F	0	.	0	3
	5/28/2007	Lou_S	07-07-028	26.7	100	0.5	0	11:00	Y	70	0.5	F	15	.	15	2.5
	7/20/2007	Lou_S	07-08-066	21.7	50	1.5	0	12:20	Y	60	0.85	S	9	.	9	3.5
	7/20/2007	Lou_S	07-08-067	23.9	5	2.5	0	12:16	N	60	0	F	40	.	40	4
	5/8/2006	RushRun_N	06BN039	19.7	0	2	0	13:40	Y	75	0.453	S	.	20	20	2
	5/18/2006	RushRun_N	06JF048	13.9	100	1.5	0	13:55	N	61	0.77	S	.	5	5	1.5
	5/25/2006	RushRun_N	06JS057	18.3	35	0.5	0	12:25	Y	61	0.811	F	.	5	5	6
	7/3/2006	RushRun_N	06JS070	31.1	100	0	0	14:32	Y	68	0.662	S	.	8	8	8
	4/19/2007	RushRun_N	07-02-012	10.0	100	2.5	0	12:00	Y	60	0.917	F	.	14	14	3.5
	5/11/2007	RushRun_N	07-02-028	26.7	30	1	0	12:20	Y	60	0.567	F	.	9	9	2.2
	6/21/2007	RushRun_N	07-02-048	21.1	0	1	0	11:11	Y	60	1	F	.	1.5	1.5	1.8
	5/3/2007	RushRun_N	07-04-022	21.1	30	0.5	0	13:05	Y	60	0.65	F	.	2	2	1.8
	5/22/2007	RushRun_N	07-04-033	22.8	0	1	0	11:50	Y	60	0.267	F	.	14	14	2
	4/28/2007	RushRun_N	07-07-018	15.6	70	0	0	11:56	Y	64	0.984	S	.	20	20	3
	5/19/2007	RushRun_N	07-07-038	12.8	95	0	0	11:45	Y	60	1	F	.	15	15	7
	6/9/2007	RushRun_N	07-07-046	23.9	10	1	0	11:35	Y	61	0.754	F	.	15	15	3.2
	5/12/2007	RushRun_N	07-10-035	22.2	60	1	0	12:10	Y	60	0.317	S	.	5	5	2
	6/7/2007	RushRun_N	07-10-146	21.1	0	1	0	11:07	Y	60	0.533	S	.	6	6	4
	5/4/2006	RushRun_S	06DS999	16.7	100	0	0	13:00	N	61	0.623	F	.	.	0	2.5

APPENDIX I Continued

	Date	Site	Nest	Temperature (°C)	Clouds	Wind	Precipitation	Start Time	Female on at start?	Total time obs (minutes)	% attendance	Succeed/Fail	Distance to paved trail (m)	Distance to unpaved trail (m)	Distance to nearest trail (m)	Nest Height (m)
111	5/11/2006	RushRun_S	06JS040	17.2	100	1	0	11:11	N	65	0	F	.	6	6	3
	5/15/2006	RushRun_S	06JS044	12.8	100	4	0	15:30	Y	62	0.694	F	.	15	15	1.25
	6/8/2006	RushRun_S	06MH06	22.2	15	1	0	13:00	N	61	0.221	S	.	3	3	2.25
	5/17/2007	RushRun_S	07-01-054	11.1	100	2	light	13:45	Y	60	0.65	F	.	8	8	2.5
	5/8/2007	RushRun_S	07-02-020	21.1	2.5	0	0	11:45	N	60	0.4	S	.	35	35	1.5
	5/1/2007	RushRun_S	07-04-008	23.9	0	1.5	0	11:05	Y	59	0.271	F	.	1	1	4
	5/24/2006	Woodside	06JF046	13.9	25	0.5	0	9:10	Y	71	0.5	F	75	16	16	1
	4/29/2006	Woodside	06JS012	15.6	90	3	0	13:30	N	61	0	F	30	3	3	2
	5/20/2006	Woodside	06JS037	18.3	0	1	0	16:05	N	61	0.033	F	8	6	6	1
	5/11/2007	Woodside	07-02-017	23.9	100	1	0	12:29	Y	58	0.517	S	5	50	5	1
	5/25/2007	Woodside	07-04-032	29.4	40	1	0	14:00	Y	60	0.533	S	30	70	30	5.5
	5/23/2007	Woodside	07-07-036	23.9	50	0	0	12:23	Y	62	0.516	F	2.5	100	2.5	1.8
	4/23/2007	Woodside	07-10-027	15.6	70	4.5	0	12:40	Y	60	0.75	S	1	20	1	3.75
	5/9/2007	Woodside	07-10-045	21.1	5	0	0	12:10	Y	60	0.4	F	20	18	18	1.5
	5/9/2007	Woodside	07-10-046	23.9	40	0	0	14:15	Y	60	0.5	F	100	60	60	2.4
	5/9/2007	Woodside	07-10-048	26.7	2	2	0	14:30	N	60	0	F		0	0	1
	5/18/2007	Woodside	07-10-082	15.6	20	1	0	11:00	Y	60	0.667	F	4	3	3	1
	5/30/2007	Woodside	07-10-105	30.6	20	0	0	13:07	Y	59	0.797	S	60	60	60	6
	7/23/2007	Woodside	07-10-192	18.3	100	0	0	12:01	Y	60	1	F	12	12	12	5
	7/23/2007	Woodside	07-10-286	18.3	60	0	0	11:25	Y	60	1	S	60	20	20	9

APPENDIX J

FLUSH INITIATION DISTANCES FROM 126 EXPERIMENTAL TRIALS
CONDUCTED AT 63 NORTHERN CARDINAL NESTS MONITORED AT 8
RIPARIAN FOREST SITES IN CENTRAL OHIO IN 2006 AND 2007.

Nest height and all distances are given in meters. Orientation refers to female orientation (°) on the nest in relation to the observer.

Site	Nest	Date	Nest Height	Distance to paved trail	Distance to unpaved trail	Distance to nearest Trail	Temperature (°C)	Clouds	Wind	Precipitation	Direct /Trail Approach	Trial #	Start Time	End Time	Orientation	Female Flush?	Distance when flushed	Nest Successful
Casto	06BN009	4/26/2006	1	30	60	30	15.6	30	1	0	T	1	12:20	12:20	.	N	.	N
Casto	06BN009	4/26/2006	1	30	60	30	15.6	30	1	0	D	2	12:23	12:23	.	Y	5	N
Casto	06JF045	5/17/2006	1.5	75	14	14	15.6	60	2	0	T	1	16:57	16:57	.	N	.	Y
Casto	06JF045	5/17/2006	1.5	75	14	14	15.6	60	2	0	D	2	17:00	17:00	.	Y	8	Y
Casto	06JF065	6/14/2006	2	20	2	2	15.6	0	1	0	D	1	7:30	7:30	.	Y	0.3	Y
Casto	06JF065	6/14/2006	2	20	2	2	15.6	0	1	0	T	2	8:30	8:30	.	N	.	Y
Casto	06JS027	5/3/2006	2.5	175	12	12	15.6	50	2	0	D	1	17:05	17:05	.	Y	1	Y
Casto	06JS027	5/3/2006	2.5	175	12	12	15.6	50	2	0	T	2	18:24	18:24	.	N	.	Y
Casto	06JS049	5/17/2006	1.5	120	20	20	15.6	60	2	0	D	1	16:05	16:05	.	N	.	N
Casto	06JS049	5/17/2006	1.5	120	20	20	15.6	60	2	0	T	2	16:10	16:10	.	N	.	N
Casto	07-04-100	7/28/2007	2	15	40	15	23.9	100	0	0	D	1	14:28	14:28	135	Y	0	N
Casto	07-04-100	7/28/2007	2	15	40	15	23.9	100	0	0	T	2	14:40	14:40	225	N	.	N
Casto	07-07-021	5/11/2007	1.7	100	15	15	21.1	60	0	0	D	2	9:53	9:53	225	Y	1.5	N
Casto	07-07-021	5/11/2007	1.7	100	15	15	21.1	60	0	0	T	1	9:47	9:47	315	N	.	N
Casto	07-07-031	5/11/2007	0.6	8	55	8	15.6	20	0	0	T	1	7:42	7:42	45	N	.	N
Casto	07-07-031	5/11/2007	0.6	8	55	8	15.6	20	0	0	D	2	7:47	7:47	45	Y	0.5	N
Casto	07-10-070	5/4/2007	1	50	15	15	23.9	30	1	0	T	1	12:30	12:30	0	N	.	Y
Casto	07-10-070	5/4/2007	1	50	15	15	23.9	30	1	0	D	2	12:35	12:35	0	Y	3	Y
Cherry	07-07-025	5/14/2007	1	N/A	5	5	23.9	20	0	0	D	1	13:30	13:30	.	Y	4	N

APPENDIX J Continued

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Site	Nest	Date	Nest Height	Distance to paved trail	Distance to unpaved trail	Distance to nearest Trail	Temperature (°C)	Clouds	Wind	Precipitation	Direct /Trail Approach	Trial #	Start Time	End Time	Orientation	Female Flush?	Distance when flushed	Nest Successful
Cherry	07-07-025	5/14/2007	1	N/A	5	5	23.9	20	0	0	T	2	14:00	14:00	.	Y	5	N
Cherry	07-10-009	5/14/2007	0.8	N/A	30	30	23.9	20	0	0	T	1	12:05	12:05	0	N	.	Y
Cherry	07-10-009	5/14/2007	0.8	N/A	30	30	23.9	20	0	0	D	2	12:10	12:10	0	Y	5	Y
Cherry	07-10-076	5/14/2007	0.8	N/A	30	30	23.9	20	0	0	D	2	14:05	14:05	45	Y	2	N
Cherry	07-10-076	5/14/2007	0.8	N/A	30	30	23.9	20	0	0	T	1	14:00	14:00	90	N	.	N
Cherry	07-10-077	5/14/2007	0.5	N/A	5	5	23.9	20	0	0	D	2	14:55	14:55	90	Y	3	N
Cherry	07-10-077	5/14/2007	0.5	N/A	5	5	23.9	20	0	0	T	1	14:50	14:50	180	N	.	N
Cherry	07-10-153	6/22/2007	2	N/A	2	2	18.3	50	0	0	D	1	7:12	7:12	45	Y	1	Y
Cherry	07-10-153	6/22/2007	2	N/A	2	2	18.3	50	0	0	T	2	7:20	7:20	45	N	.	Y
Cherry	07-10-167	6/22/2007	9	N/A	10	10	18.3	100	0	0	D	1	11:05	11:05	135	N	.	N
Cherry	07-10-167	6/22/2007	9	N/A	10	10	18.3	100	0	0	T	2	11:10	11:10	225	N	.	N
Cherry	07-10-168	6/22/2007	8	N/A	20	20	23.9	0	1	0	T	1	14:00	14:00	225	N	.	Y
Cherry	07-10-168	6/22/2007	8	N/A	20	20	23.9	0	1	0	D	2	14:05	14:05	225	N	.	Y
Creeks	06JF014	5/5/2006	1.5	120	11	11	21.1	10	2	0	T	1	11:00	11:00	.	N	.	Y
Creeks	06JF014	5/5/2006	1.5	120	11	11	21.1	10	2	0	D	2	11:18	11:18	.	N	.	Y
Creeks	06JS052	5/19/2006	2.5	3	.	3	16.7	50	2	0	T	1	9:00	9:00	.	N	.	N
Creeks	06JS052	5/19/2006	2.5	3	.	3	16.7	50	2	0	D	2	9:07	9:07	.	N	.	N
Elk Run	07-02-032	5/5/2007	1.2	6	25	6	18.3	100	1	0	T	2	10:56	10:56	45	N	.	N
Elk Run	07-02-032	5/5/2007	1.2	6	25	6	18.3	100	1	0	D	1	10:46	10:46	180	Y	2	N
Elk Run	07-10-040	5/12/2007	2.2	100	50	50	23.9	0	0	0	D	1	12:05	12:05	45	Y	3	N
Elk Run	07-10-040	5/12/2007	2.2	100	50	50	23.9	0	0	0	T	2	13:25	13:25	135	N	.	N
Elk Run	07-10-080	5/5/2007	1.5	23	4	4	18.3	100	1	0	D	1	12:31	12:31	0	Y	5	Y
Elk Run	07-10-080	5/5/2007	1.5	23	4	4	18.3	100	1	0	T	2	12:40	12:40	225	N	.	Y
Elk Run	07-10-081	5/5/2007	1.5	90	35	35	18.3	100	1	0	D	2	11:10	11:10	90	Y	3	N

APPENDIX J Continued

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Site	Nest	Date	Nest Height	Distance to paved trail	Distance to unpaved trail	Distance to nearest Trail	Temperature (°C)	Clouds	Wind	Precipitation	Direct /Trail Approach	Trial #	Start Time	End Time	Orientation	Female Flush?	Distance when flushed	Nest Successful
Elk Run	07-10-081	5/5/2007	1.5	90	35	35	18.3	100	1	0	T	1	11:05	11:05	270	N	.	N
Elk Run	07-10-091	5/12/2007	2.4	50	20	20	23.9	0	0	0	D	1	13:20	13:20	0	Y	5	N
Elk Run	07-10-091	5/12/2007	2.4	50	20	20	23.9	0	0	0	T	2	13:45	13:45	0	N	.	N
Elk Run	07-10-127	6/8/2007	3.5	110	30	30	29.4	100	0	0	D	1	15:30	15:30	180	N	.	Y
Elk Run	07-10-127	6/8/2007	3.5	110	30	30	29.4	100	0	0	T	2	15:35	15:35	315	N	.	Y
Elk Run	07-10-180	7/12/2007	3.75	80	50	50	21.1	20	0	0	T	1	10:13	10:13	225	N	.	N
Elk Run	07-10-180	7/12/2007	3.75	80	50	50	21.1	20	0	0	D	2	10:18	10:18	315	Y	1	N
Elk Run	07-10-181	7/12/2007	2.4	11	80	11	15.6	0	0	0	D	1	7:35	7:35	315	Y	1	Y
Elk Run	07-10-181	7/12/2007	2.4	11	80	11	15.6	0	0	0	T	2	7:45	7:45	315	N	.	Y
Elk Run	07-10-183	7/12/2007	1.8	80	25	25	21.1	20	0	0	T	2	9:55	9:55	225	N	.	Y
Elk Run	07-10-183	7/12/2007	1.8	80	25	25	21.1	20	0	0	D	1	9:10	9:10	315	Y	5	Y
Kenney_N	06DS036	5/4/2006	3	N/A	10	10	15.6	100	3	0	D	1	11:02	11:02	.	Y	3	N
Kenney_N	06DS036	5/4/2006	3	N/A	10	10	15.6	100	3	0	T	2	12:30	12:30	.	N	.	N
Kenney_N	06DS049	5/4/2006	3.5	N/A	2	2	15.6	100	3	0	T	1	11:30	11:30	.	N	.	N
Kenney_N	06DS049	5/4/2006	3.5	N/A	2	2	15.6	100	3	0	D	2	11:34	11:34	.	Y	2	N
Kenney_N	06JS092	7/14/2006	3	N/A	2	2	23.9	80	0	0	T	1	12:08	12:08	.	N	.	Y
Kenney_N	06JS092	7/14/2006	3	N/A	2	2	23.9	80	0	0	D	2	12:11	12:11	.	N	.	Y
Kenney_N	07-01-030	5/22/2007	1.8	N/A	10	10	21.1	0	0	0	T	1	10:35	10:35	135	N	.	Y
Kenney_N	07-01-030	5/22/2007	1.8	N/A	10	10	21.1	0	0	0	D	2	10:40	10:40	315	Y	0	Y
Kenney_N	07-02-056	7/3/2007	4.5	N/A	0	0	21.1	30	0	0	D	1	9:50	9:50	180	N	.	Y
Kenney_N	07-02-056	7/3/2007	4.5	N/A	0	0	21.1	30	0	0	T	2	9:55	9:55	270	N	.	Y
Kenney_N	07-05-001	5/22/2007	2.5	N/A	0	0	21.1	0	0	0	T	1	11:56	11:56	0	N	.	N
Kenney_N	07-05-001	5/22/2007	2.5	N/A	0	0	21.1	0	0	0	D	2	12:01	12:01	270	Y	6	N
Kenney_N	07-05-002	5/19/2007	1.5	N/A	15	15	21.1	100	1	0	T	1	15:10	15:10	225	N	.	N

APPENDIX J Continued

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Site	Nest	Date	Nest Height	Distance to paved trail	Distance to unpaved trail	Distance to nearest Trail	Temperature (°C)	Clouds	Wind	Precipitation	Direct /Trail Approach	Trial #	Start Time	End Time	Orientation	Female Flush?	Distance when flushed	Nest Successful
Kenney_N	07-05-002	5/19/2007	1.5	N/A	15	15	21.1	100	1	0	D	2	15:15	15:15	225	Y	0.3	N
Kenney_N	07-10-029	4/27/2007	1	N/A	4	4	15.6	100	3	0	D	2	13:27	13:27	0	Y	10	N
Kenney_N	07-10-029	4/27/2007	1	N/A	4	4	15.6	100	3	0	T	1	13:11	13:11	270	Y	7	N
Kenney_N	07-10-097	5/22/2007	1.5	N/A	1.5	1.5	21.1	0	0	0	D	2	12:04	12:04	45	Y	4	N
Kenney_N	07-10-097	5/22/2007	1.5	N/A	1.5	1.5	21.1	0	0	0	T	1	11:53	11:53	315	Y	8	N
Kenney_N	07-10-157	6/24/2007	2.3	N/A	4	4	26.7	100	0	0	D	2	15:05	15:05	0	Y	0	N
Kenney_N	07-10-157	6/24/2007	2.3	N/A	4	4	26.7	100	0	0	T	1	15:00	15:00	270	N	.	N
Kenney_N	07-10-170	6/23/2007	4.5	N/A	2	2	23.9	100	0	0	D	2	11:35	11:35	45	Y	0	N
Kenney_N	07-10-170	6/23/2007	4.5	N/A	2	2	23.9	100	0	0	T	1	11:30	11:30	135	N	.	N
Kenney_N	07-10-186	7/13/2007	7	N/A	11	11	23.9	60	1	0	T	2	11:45	11:45	45	N	.	N
Kenney_N	07-10-186	7/13/2007	7	N/A	11	11	23.9	60	1	0	D	1	11:40	11:40	135	N	.	N
Kenney_N	07-10-191	6/23/2007	4.5	N/A	3	3	23.9	100	0	0	T	1	10:52	10:52	135	N	.	Y
Kenney_N	07-10-191	6/23/2007	4.5	N/A	3	3	23.9	100	0	0	D	2	10:58	10:58	135	Y	1	Y
Kenney_N	07-10-191	7/24/2007	11	N/A	15	15	15.6	100	0	0	T	2	7:20	7:20	45	N	.	Y
Kenney_N	07-10-191	7/24/2007	11	N/A	15	15	15.6	100	0	0	D	1	7:15	7:15	315	N	.	Y
Kenney_N	07-10-195	7/24/2007	6	N/A	9	9	15.6	100	0	0	D	1	7:26	7:26	135	N	.	Y
Kenney_N	07-10-195	7/24/2007	6	N/A	9	9	15.6	100	0	0	T	2	7:31	7:31	225	N	.	Y
Kenney_N	07-10-196	7/24/2007	4	N/A	12	12	15.6	80	0	0	D	1	8:30	8:30	45	N	.	N
Kenney_N	07-10-196	7/24/2007	4	N/A	12	12	15.6	80	0	0	T	2	8:35	8:35	45	N	.	N
Kenney_N	07-10-197	7/24/2007	3	N/A	5	70	37.8	70	0	0	T	1	12:58	12:58	135	N	.	Y
Kenney_N	07-10-197	7/24/2007	3	N/A	5	70	37.8	70	0	0	D	2	13:03	13:03	135	N	.	Y
Kenney_S	06JS073	7/3/2006	3	N/A	20	20	29.4	100	1	0	D	1	17:17	17:17	.	N	.	Y
Kenney_S	06JS073	7/3/2006	3	N/A	20	20	29.4	100	1	0	T	2	17:32	17:32	.	N	.	Y
Kenney_S	06MH008	7/3/2006	4	N/A	35	35	29.4	100	1	0	D	1	17:10	17:10	.	N	.	N

APPENDIX J Continued

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Site	Nest	Date	Nest Height	Distance to paved trail	Distance to unpaved trail	Distance to nearest Trail	Temperature (°C)	Clouds	Wind	Precipitation	Direct /Trail Approach	Trial #	Start Time	End Time	Orientation	Female Flush?	Distance when flushed	Nest Successful
Kenney_S	06MH008	7/3/2006	4	N/A	35	35	29.4	100	1	0	T	2	17:15	17:15	.	N	.	N
Kenney_S	07-01-044	5/22/2007	1.4	N/A	5	5	21.1	0	1	0	T	1	11:35	11:35	90	N	.	Y
Kenney_S	07-01-044	5/22/2007	1.4	N/A	5	5	21.1	0	1	0	D	2	11:40	11:40	180	Y	6	Y
Kenney_S	07-02-010	4/24/2007	1.5	N/A	10	10	18.3	70	2	0	D	1	11:07	11:08	45	Y	3	N
Kenney_S	07-02-010	4/24/2007	1.5	N/A	10	10	18.3	70	2	0	T	2	14:26	14:28	135	N	.	N
Kenney_S	07-02-036	5/22/2007	2	N/A	6	6	15.6	0	0	0	D	1	8:30	8:30	315	N	.	N
Kenney_S	07-02-036	5/22/2007	2	N/A	6	6	15.6	0	0	0	T	2	8:35	8:35	315	N	.	N
Kenney_S	07-02-042	6/23/2007	2.5	N/A	70	70	23.9	80	0	0	T	1	8:52	8:52	90	N	.	N
Kenney_S	07-02-042	6/23/2007	2.5	N/A	70	70	23.9	80	0	0	D	2	8:57	8:57	90	N	.	N
Kenney_S	07-04-044	6/9/2007	3.5	N/A	15	15	21.1	0	0	0	D	1	9:00	9:00	0	N	.	Y
Kenney_S	07-04-044	6/9/2007	3.5	N/A	15	15	21.1	0	0	0	T	2	9:05	9:05	90	N	.	Y
Kenney_S	07-04-064	6/23/2007	9.5	N/A	17	17	23.9	80	0	0	T	2	8:51	8:51	270	N	.	N
Kenney_S	07-04-064	6/23/2007	9.5	N/A	17	17	23.9	80	0	0	D	1	8:45	8:45	315	N	.	N
Kenney_S	07-04-086	7/25/2007	5	N/A	20	20	21.1	50	0	0	D	1	9:40	9:40	225	N	.	Y
Kenney_S	07-04-086	7/25/2007	5	N/A	20	20	21.1	50	0	0	T	2	9:45	9:45	225	N	.	Y
Kenney_S	07-10-102	5/19/2007	3.5	N/A	15	15	21.1	100	1	0	T	1	14:20	14:20	135	N	.	N
Kenney_S	07-10-102	5/19/2007	3.5	N/A	15	15	21.1	100	1	0	D	2	14:25	14:25	135	Y	0	N
Kenney_S	07-10-199	7/25/2007	3	N/A	30	30	18.3	50	0	0	D	1	9:30	9:30	315	N	.	N
Kenney_S	07-10-199	7/25/2007	3	N/A	30	30	18.3	50	0	0	T	2	9:35	9:35	315	N	.	N
Lou_N	07-01-085	6/20/2007	3	5	.	5	23.9	0	1	0	T	2	14:35	14:35	225	N	.	Y
Lou_N	07-01-085	6/20/2007	3	5	.	5	23.9	0	1	0	D	1	14:28	14:28	315	Y	3	Y
Lou_N	07-01-088	6/20/2007	6	11	.	11	23.9	0	1	0	D	2	14:20	14:20	135	N	.	N
Lou_N	07-01-088	6/20/2007	6	11	.	11	23.9	0	1	0	T	1	14:15	14:15	225	N	.	N
Lou_N	07-02-050	6/20/2007	4.5	3	.	3	23.9	0	1	0	T	1	13:56	13:56	225	Y	6	N

APPENDIX J Continued

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Site	Nest	Date	Nest Height	Distance to paved trail	Distance to unpaved trail	Distance to nearest Trail	Temperature (°C)	Clouds	Wind	Precipitation	Direct /Trail Approach	Trial #	Start Time	End Time	Orientation	Female Flush?	Distance when flushed	Nest Successful
Lou_N	07-02-050	6/20/2007	4.5	3	.	3	23.9	0	1	0	D	2	14:24	14:24	315	N	.	N
Lou_S	07-01-094	7/7/2007	4	60	20	20	26.7	0	0	0	D	1	12:05	12:05	0	Y	5	Y
Lou_S	07-01-094	7/7/2007	4	60	20	20	26.7	0	0	0	T	2	12:10	12:10	0	N	.	Y
Lou_S	07-02-046	6/20/2007	1.8	30	.	30	23.9	0	2	0	T	2	13:00	13:00	45	N	.	N
Lou_S	07-02-046	6/20/2007	1.8	30	.	30	23.9	0	2	0	D	1	12:42	12:42	135	Y	2	N
RushRun_N	06BN020	5/8/2006	3	N/A	20	20	23.9	0	2	0	D	1	16:00	16:00	.	Y	3	N
RushRun_N	06BN020	5/8/2006	3	N/A	20	20	23.9	0	2	0	T	2	16:20	16:20	.	N	.	N
RushRun_N	06BN039	5/8/2006	2	N/A	12	12	23.9	0	1	0	T	1	14:55	14:55	.	N	.	Y
RushRun_N	06BN039	5/8/2006	2	N/A	12	12	23.9	0	1	0	D	2	15:00	15:00	.	Y	2.5	Y
RushRun_N	06JF048	5/22/2006	1.5	N/A	8	8	18.3	0	1	0	D	1	9:15	9:15	.	Y	4	Y
RushRun_N	06JF048	5/22/2006	1.5	N/A	8	8	18.3	0	1	0	T	2	9:35	9:35	.	Y	4	Y
RushRun_N	06JS057	5/29/2006	6	N/A	6	6	29.4	30	0	0	D	1	13:15	13:15	.	N	.	N
RushRun_N	06JS057	5/29/2006	6	N/A	6	6	29.4	30	0	0	T	2	13:20	13:20	.	N	.	N
RushRun_N	06JS070	7/3/2006	8	N/A	10	10	29.4	100	0	0	T	1	14:25	14:25	.	N	.	Y
RushRun_N	06JS070	7/3/2006	8	N/A	10	10	29.4	100	0	0	D	2	14:30	14:30	.	N	.	Y
RushRun_N	07-02-012	4/26/2007	4	N/A	14	14	15.6	100	1	0	T	2	11:05	11:05	225	N	.	N
RushRun_N	07-02-012	4/26/2007	4	N/A	14	14	15.6	100	1	0	D	1	10:56	10:56	315	N	.	N
RushRun_N	07-02-028	5/10/2007	2.2	N/A	9	9	23.9	50	0	0	T	1	11:12	11:12	0	N	.	N
RushRun_N	07-02-028	5/10/2007	2.2	N/A	9	9	23.9	50	0	0	D	2	11:17	11:17	0	Y	0	N
RushRun_N	07-02-029	5/10/2007	3	N/A	8	8	23.9	50	0	0	T	1	11:05	11:05	0	Y	8	N
RushRun_N	07-02-029	5/10/2007	3	N/A	8	8	23.9	50	0	0	D	2	11:33	11:33	315	Y	3	N
RushRun_N	07-02-048	6/14/2007	1.8	N/A	2	2	26.7	0	1	0	T	1	11:40	11:40	225	N	.	N
RushRun_N	07-02-048	6/14/2007	1.8	N/A	2	2	26.7	0	1	0	D	2	11:45	11:45	225	Y	2	N
RushRun_N	07-04-022	5/3/2007	1.8	N/A	2	2	21.1	30	1	0	T	1	13:05	13:05	45	N	.	N

APPENDIX J Continued

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Site	Nest	Date	Nest Height	Distance to paved trail	Distance to unpaved trail	Distance to nearest Trail	Temperature (°C)	Clouds	Wind	Precipitation	Direct /Trail Approach	Trial #	Start Time	End Time	Orientation	Female Flush?	Distance when flushed	Nest Successful
RushRun_N	07-04-022	5/3/2007	1.8	N/A	2	2	21.1	30	1	0	D	2	14:05	14:05	45	Y	3	N
RushRun_N	07-07-046	6/14/2007	3.2	N/A	15	15	26.7	0	0	0	T	2	11:25	11:25	0	N	.	N
RushRun_N	07-07-046	6/14/2007	3.2	N/A	15	15	26.7	0	0	0	D	1	11:20	11:20	45	N	.	N
RushRun_S	06JS040	5/8/2006	3	N/A	5	5	23.9	0	2	0	D	1	17:40	17:40	.	Y	2	N
RushRun_S	06JS040	5/8/2006	3	N/A	5	5	23.9	0	2	0	T	2	18:00	18:00	.	N	.	N
RushRun_S	06JS042	5/10/2006	1.5	N/A	8	8	18.3	90	1	0	D	1	9:00	9:00	.	Y	2	N
RushRun_S	06JS042	5/10/2006	1.5	N/A	8	8	18.3	90	1	0	T	2	9:25	9:25	.	N	.	N
RushRun_S	06JS090	7/20/2006	2.5	N/A	25	25	26.7	100	1	0	D	1	10:33	10:33	.	Y	0.2	N
RushRun_S	06JS090	7/20/2006	2.5	N/A	25	25	26.7	100	1	0	T	2	12:20	12:20	.	N	.	N
RushRun_S	06JS100	5/8/2006	1.2	N/A	2	2	23.9	0	2	0	T	1	15:35	15:35	.	Y	5	N
RushRun_S	06JS100	5/8/2006	1.2	N/A	2	2	23.9	0	2	0	D	2	16:10	16:10	.	Y	5	N
Woodside	06JF040	5/20/2006	10	30	30	30	18.3	0	1	0	T	1	15:30	15:30	.	N	.	Y
Woodside	06JF040	5/20/2006	10	30	30	30	18.3	0	1	0	D	2	15:35	15:35	.	N	.	Y
Woodside	06JF046	5/20/2006	1	30	30	30	18.3	0	1	0	T	1	15:50	15:50	.	N	.	N
Woodside	06JF046	5/20/2006	1	30	30	30	18.3	0	1	0	D	2	15:55	15:55	.	Y	1	N
Woodside	06JF079	6/17/2006	1.5	45	2	2	26.7	0	2	0	T	1	12:25	12:25	.	N	.	N
Woodside	06JF079	6/17/2006	1.5	45	2	2	26.7	0	2	0	D	2	12:32	12:32	.	Y	0.6	N
Woodside	06JF080	6/17/2006	0.5	12	120	12	26.7	0	2	0	T	1	12:16	12:16	.	N	.	Y
Woodside	06JF080	6/17/2006	0.5	12	120	12	26.7	0	2	0	D	2	12:22	12:22	.	Y	0.5	Y
Woodside	06JS012	4/29/2006	2	27	3.5	3.5	15.6	100	3	0	D	1	13:17	13:17	.	Y	3	N
Woodside	06JS012	4/29/2006	2	27	3.5	3.5	15.6	100	3	0	T	2	14:30	14:30	.	Y	4	N
Woodside	06JS037	5/6/2006	1	6	120	6	12.8	85	2	0	D	1	9:00	9:00	.	Y	0.3	N
Woodside	06JS037	5/6/2006	1	6	120	6	12.8	85	2	0	T	2	10:55	10:55	.	N	.	N
Woodside	07-02-017	5/2/2007	1	5	50	5	21.1	60	1	0	T	1	12:18	12:18	45	N	.	Y

APPENDIX J Continued

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Site	Nest	Date	Nest Height	Distance to paved trail	Distance to unpaved trail	Distance to nearest Trail	Temperature (°C)	Clouds	Wind	Precipitation	Direct /Trail Approach	Trial #	Start Time	End Time	Orientation	Female Flush?	Distance when flushed	Nest Successful
Woodside	07-02-017	5/2/2007	1	5	50	5	21.1	60	1	0	D	2	12:25	12:26	135	Y	2	Y
Woodside	07-02-057	7/23/2007	8	8	12	8	18.3	60	0	0	D	1	8:52	8:52	135	N	.	N
Woodside	07-02-057	7/23/2007	8	8	12	8	18.3	60	0	0	T	2	8:57	8:57	135	N	.	N
Woodside	07-07-036	5/18/2007	1.8	100	3	3	15.6	30	1	0	D	2	12:45	12:45	180	Y	0.1	N
Woodside	07-07-036	5/18/2007	1.8	100	3	3	15.6	30	1	0	T	1	12:40	12:40	225	N	.	N
Woodside	07-10-027	5/2/2007	3.75	1	20	1	21.1	30	1	0	T	1	12:57	12:58	180	N	.	Y
Woodside	07-10-027	5/2/2007	3.75	1	20	1	21.1	30	1	0	D	2	13:03	13:04	180	N	.	Y
Woodside	07-10-045	5/9/2007	1.5	20	18	18	21.1	10	1	0	T	1	13:10	13:10	225	N	.	N
Woodside	07-10-045	5/9/2007	1.5	20	18	18	21.1	10	1	0	D	2	13:12	13:12	225	Y	0.1	N
Woodside	07-10-046	5/2/2007	2.4	100	40	40	21.1	70	1	0	T	2	15:00	15:02	225	N	.	N
Woodside	07-10-046	5/2/2007	2.4	100	40	40	21.1	70	1	0	D	1	14:25	14:30	315	N	.	N
Woodside	07-10-048	5/9/2007	1	5	75	5	15.6	20	0	0	D	1	9:20	9:20	0	Y	1	N
Woodside	07-10-048	5/9/2007	1	5	75	5	15.6	20	0	0	T	2	11:20	11:20	0	N	.	N
Woodside	07-10-082	5/9/2007	1	4	3	3	12.8	20	0	0	T	1	8:30	8:30	90	N	.	N
Woodside	07-10-082	5/9/2007	1	4	3	3	12.8	20	0	0	D	2	8:32	8:32	90	Y	1	N
Woodside	07-10-186	7/23/2007	9	60	20	20	18.3	60	0	0	D	1	11:20	11:20	315	N	.	N
Woodside	07-10-186	7/23/2007	9	60	20	20	18.3	60	0	0	T	2	11:25	11:25	315	N	.	N
Woodside	07-10-192	7/23/2007	5	12	12	12	18.3	60	0	0	D	1	7:50	7:50	45	N	.	N
Woodside	07-10-192	7/23/2007	5	12	12	12	18.3	60	0	0	T	2	7:55	7:55	45	N	.	N
Woodside	07-10-193	7/23/2007	5	40	40	40	18.3	60	0	0	T	1	9:25	9:25	90	N	.	N
Woodside	07-10-193	7/23/2007	5	40	40	40	18.3	60	0	0	D	2	9:30	9:30	180	N	.	N

APPENDIX K

VEGETATION CHARACTERISTICS MEASURED AT 161 NORTHERN CARDINAL
NESTS MONITORED AT 12 RIPARIAN FOREST SITES IN CENTRAL OHIO IN
2006 AND 2007

Stem categories (very small stems, small stems, medium stems, large stems) represent counts of stems in each size class in each plot. Forb, tree, exotic and native represent the total number of contacts made by forbs, trees, native shrubs and exotic shrubs on a vegetation pole.

124	Nest	Site	Date	Distance to trail (m)	Nest height (m)	Distance to foliage edge (cm)	Very small stems (3 – 8 cm dbh)	Small stems (8-23 cm dbh)	Medium stems (23 – 38 cm dbh)	Large stems (> 38 cm dbh)	% Nest cover	% canopy (> 5m)	% Groundcover (< 0.5 m)	Forb	Tree	Exotic	Native
	06BN009	casto	09/08/06	60	1	20	33	19	6	1	38.3	85	95	12	11	25	3
	06DS133	casto	08/02/06	6	2.75	20	24	13	1	1	42.5	75	90	9	26	62	6
	06JF045	casto	08/30/06	14	1.5	30	28	24	7	2	38.3	75	95	9	22	18	16
	06JF065	casto	07/08/06	2	2	50	32	11	8	3	43.3	75	90	6	29	5	0
	06JS027	casto	06/28/06	12	2.75	20	13	18	2	3	35.0	90	95	2	13	3	3
	06JS049	casto	09/08/06	20	1.5	40	39	31	5	4	40.0	55	80	6	10	59	6
	06JS086	casto	08/25/06	60	2	30	18	10	2	5	40.0	65	80	9	12	33	0
	06JS087	casto	08/16/06	12	2	30	64	14	0	2	56.7	80	95	12	12	72	6
	07-04-040	casto	07/05/07	15	6	200	2	1	0	0	42.5	5	5	0	1	0	0
	07-04-052	casto	07/30/07	10	15	100	13	4	3	3	10.0	90	70	1	19	8	2
	07-07-021	casto	07/30/07	10	2	100	13	11	1	0	38.0	95	70	3	14	0	17
	07-07-031	casto	06/18/07	50	0.8	5	12	5	2	4	69.7	75	75	20	16	0	0
	07-10-070	casto	06/18/07	150	1	1100	9	32	2	1	51.7	75	100	0	15	46	6
	07-10-084	casto	07/23/07	20	2.5	5	8	13	2	2	26.67	85	50	21	14	0	0
	06JF061	cherry	08/22/06	90	1.5	40	24	6	3	4	46.67	60	100	8	12	18	14

APPENDIX K Continued

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Nest	Site	Date	Distance to trail (m)	Nest height (m)	Distance to foliage edge (cm)	Very small stems (3 – 8 cm dbh)	Small stems (8-23 cm dbh)	Medium stems (23 – 38 cm dbh)	Large stems (> 38 cm dbh)	% Nest cover	% canopy (> 5m)	% Groundcover (< 0.5 m)	Forb	Tree	Exotic	Native
06JS025	cherry	08/22/06	70	1.5	10	20	6	0	2	15.83	65	100	13	8	10	9
06JS084	cherry	08/22/06	90	1.8	10	76	12	7	7	20.83	75	95	9	13	2	16
07-07-039	cherry	08/02/07	20	1.5	5	36	6	3	2	7.8	75	50	19	30	0	10
07-10-009	cherry	08/16/07	40	0.8	30	28	0	0	0	58.3	5	100	14	45	16	3
07-10-022	cherry	06/27/07	30	4	50	7	5	0	1	57.5	60	55	5	27	20	18
07-10-076	cherry	06/27/07	25	0.8	30	17	3	2	0	24.2	60	70	25	17	34	0
07-10-077	cherry	08/02/07	100	0.5	10	14	14	5	3	16.7	75	50	47	13	0	0
07-10-153	cherry	08/06/07	2	2	2	44	2	0	1	29.2	20	75	5	24	10	3
07-10-168	cherry	08/16/07	20	7.5	5	16	14	0	1	42.5	100	45	0	0	0	0
06BN144	creeks	08/04/06	100	2	10	31	5	2	3	39.2	90	75	4	27	80	12
06JF007	creeks	07/07/06	40	1.5	50	13	11	5	0	38.3	75	60	9	3	81	0
06JF014	creeks	06/16/06	11	1.5	30	1	3	1	0	55.0	65	95	59	6	0	5
06JF043	creeks	07/14/06	12	2.25	120	2	9	3	1	51.7	40	95	31	17	0	0
06JF052	creeks	07/07/06	20	3	40	7	11	3	3	33.3	75	45	14	3	52	1
06JF053	creeks	08/04/06	30	1.5	60	36	18	3	0	30.0	80	55	35	21	32	3
06JS066	creeks	08/04/06	18	0.75	50	38	6	1	2	53.3	55	90	2	8	61	16
07-01-055	creeks	08/16/07	40	8	50	34	6	5	4	57.5	95	85	3	20	14	0
07-01-096	creeks	08/27/07	100	5.5	15	14	20	9	3	25.8	95	55	9	11	0	0
07-03-033	creeks	07/04/07	15	1.7	40	15	19	7	0	26.8	80	45	30	16	30	0
07-09-016	creeks	07/09/07	70	1	200	29	5	0	0	78.3	30	75	23	1	68	46

APPENDIX K Continued

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Nest	Site	Date	Distance to trail (m)	Nest height (m)	Distance to foliage edge (cm)	Very small stems (3 – 8 cm dbh)	Small stems (8-23 cm dbh)	Medium stems (23 – 38 cm dbh)	Large stems (> 38 cm dbh)	% Nest cover	% canopy (> 5m)	% Groundcover (< 0.5 m)	Forb	Tree	Exotic	Native
07-09-022	creeks	07/09/07	10	1	100	15	11	3	4	69.2	90	90	0	10	56	0
07-11-010	creeks	07/30/07	130	1.6	20	19	6	0	2	55.8	75	85	9	26	142	13
07-11-013	creeks	07/09/07	50	1	75	22	18	2	0	88.3	70	55	8	4	45	4
06DS069	elkrun	08/21/06	2	9	20	28	12	2	4	68.3	85	75	11	9	1	3
06DS071	elkrun	08/21/06	20	1.7	20	74	12	2	3	23.3	80	95	13	12	11	7
06JF029	elkrun	08/21/06	40	1.25	0	34	5	4	7	5.0	75	95	5	8	34	15
06JS002	elkrun	06/27/06	27	1.25	60	25	8	1	2	28.3	40	70	0	6	38	8
06JS018	elkrun	08/21/06	12	1	15	13	12	1	2	35.0	65	90	0	6	25	26
06JS074	elkrun	08/21/06	10	1.75	10	29	12	5	0	36.7	70	95	20	19	44	7
07-01-014	elkrun	08/15/07	15	1	5	17	10	5	3	6.3	95	25	0	2	47	13
07-02-032	elkrun	06/23/07	28	1.2	200	25	9	2	2	27.5	35	45	0	1	75	7
07-10-040	elkrun	08/08/07	45	1.9	10	14	21	6	3	10.0	70	65	1	11	47	1
07-10-071	elkrun	08/15/07	35	1.5	12	33	13	7	0	23.0	100	60	0	3	57	18
07-10-080	elkrun	08/15/07	4	1.2	10	13	7	2	3	6.7	55	55	9	3	11	19
07-09-099	galena	08/28/07	12	4	500	23	16	6	3	46.7	75	50	8	23	0	0
06DS035	kennynorth	08/03/06	12	4.5	90	73	12	2	2	66.7	85	75	19	5	107	2
06DS036	kennynorth	08/21/06	10	3	80	84	19	5	3	48.3	95	75	0	5	81	3
06DS048	kennynorth	08/12/06	30	2.5	20	77	11	8	5	23.3	80	60	0	1	78	2
06DS050	kennynorth	08/29/06	18	1.25	10	10	10	0	3	28.3	90	85	11	12	62	0
06MH002	kennynorth	08/25/06	6	1.75	30	44	12	2	3	39.2	80	65	4	10	69	0

APPENDIX K Continued

Nest	Site	Date	Distance to trail (m)	Nest height (m)	Distance to foliage edge (cm)	Very small stems (3 – 8 cm dbh)	Small stems (8-23 cm dbh)	Medium stems (23 – 38 cm dbh)	Large stems (> 38 cm dbh)	% Nest cover	% canopy (> 5m)	% Groundcover (< 0.5 m)	Forb	Tree	Exotic	Native
07-01-030	kennynorth	07/04/07	20	2	30	33	6	2	1	28.3	60	25	0	5	25	0
07-05-001	kennynorth	07/11/07	0.5	2.4	30	41	11	2	0	47.7	75	65	0	6	35	0
07-05-002	kennynorth	07/11/07	20	1.8	10	36	14	3	2	17.8	85	65	0	5	57	0
07-10-029	kennynorth	07/21/07	5	1.25	0	39	17	4	1	14.3	85	65	0	21	51	0
07-10-149	kennynorth	08/10/07	35	3.5	30	66	15	3	1	33.3	90	75	0	1	31	0
07-10-157	kennynorth	07/24/07	5	2.8	1	45	31	12	0	17.8	85	80	2	27	58	0
07-10-171	kennynorth	08/03/07	4	4.5	0	70	19	6	2	28.7	100	70	3	4	21	1
06BN021	kennysouth	08/08/06	2.5	2.5	35	35	3	2	0	40.0	55	85	85	20	44	11
06JF010	kennysouth	08/10/06	17	2	110	87	11	0	1	52.0	85	95	0	27	94	17
06JF084	kennysouth	08/04/06	1	7	50	34	9	3	3	60.0	85	65	20	6	26	0
06JS021	Kennysouth	07/10/06	3	1.5	0	8	4	1	2	42.5	70	95	5	19	40	15
06JS034	kennysouth	07/17/06	1.5	1.5	90	85	5	0	1	33.3	90	80	7	11	61	6
06JS061	kennysouth	07/09/06	20	1.5	100	6	23	3	0	36.0	30	100	15	3	37	0
07-01-044	kennysouth	06/28/07	15	1.4	30	27	5	3	4	16.7	100	15	0	3	7	0
07-01-045	kennysouth	07/14/07	20	1.5	40	17	5	0	3	47.5	25	95	4	13	32	8
07-02-001	kennysouth	06/19/07	50	1.5	40	45	7	0	2	38.3	50	65	0	1	30	5
07-02-010	kennysouth	06/14/07	50	1.5	0	21	6	1	3	39.2	80	100	8	14	29	38
07-02-036	kennysouth	06/21/07	0	3.7	50	10	17	5	3	62.5	55	0	0	26	0	0
07-02-042	kennysouth	07/25/07	60	2.5	7	50	12	4	1	54.2	100	50	0	4	48	0
07-02-044	kennysouth	07/14/07	20	1.9	40	10	5	0	3	87.2	55	100	6	8	11	1

APPENDIX K Continued

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Nest	Site	Date	Distance to trail (m)	Nest height (m)	Distance to foliage edge (cm)	Very small stems (3 – 8 cm dbh)	Small stems (8-23 cm dbh)	Medium stems (23 – 38 cm dbh)	Large stems (> 38 cm dbh)	% Nest cover	% canopy (> 5m)	% Groundcover (< 0.5 m)	Forb	Tree	Exotic	Native
07-04-006	kennysouth	07/07/07	25	1.5	40	26	4	5	5	51.2	65	95	0	12	95	0
07-04-044	Kennysouth	08/03/07	20	3.5	0	45	3	2	3	30.0	75	100	12	1	36	2
07-04-064	kennysouth	07/25/07	14	9	15	10	9	2	1	62.5	90	90	7	8	6	0
07-10-063	kennysouth	06/28/07	20	0.7	30	5	4	3	2	36.7	95	95	0	17	2	5
07-10-097	kennysouth	07/07/07	2.5	1.5	10	13	16	4	1	30.2	80	75	3	4	55	0
07-10-102	kennysouth	06/14/07	20	3	2.75	42	0	4	5	37.5	95	75	0	0	108	0
06BN007	lounorth	06/22/06	8	2	6	17	7	4	6	23.3	75	50	4	3	62	0
06DM040	lounorth	07/03/06	100	2.5	7	30	10	8	5	36.7	85	50	14	9	123	0
06BN001	lousouth	08/12/06	6	1.5	0	13	14	4	0	23.7	75	15	0	9	24	5
06BN074	lousouth	08/21/06	4	1.75	17	17	15	7	1	45.8	100	55	3	0	197	3
07-01-089	lousouth	07/25/07	5	10	100	9	11	3	2	86.7	100	20	0	12	0	0
07-08-001	lousouth	07/20/07	5	1.75	0	29	26	5	5	41.7	100	15	0	6	127	0
06BN025	prairie	06/20/06	30	2	0	5	11	4	3	38.3	95	60	92	15	0	0
06BN044	prairie	08/09/06	70	1	75	1	0	0	0	100.0	0	100	24	0	53	28
06BN054	prairie	07/14/06	7	2.5	30	6	8	5	3	61.7	60	50	4	23	15	2
06DM023	prairie	06/30/06	8	1.75	80	28	31	3	0	28.3	85	45	2	8	159	0
06DS023	prairie	06/27/06	7	1.5	5	33	22	0	2	54.2	85	35	4	15	36	0
06DS138	prairie	08/04/06	2.25	1.25	80	28	17	2	2	76.7	65	85	4	33	66	0
07-01-020	prairie	07/14/07	70	1.5	0	28	14	4	1	45.0	100	75	9	38	57	2
07-01-034	prairie	07/21/07	15	1	5	35	23	2	3	52.5	100	60	2	17	71	0

APPENDIX K Continued

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Nest	Site	Date	Distance to trail (m)	Nest height (m)	Distance to foliage edge (cm)	Very small stems (3 – 8 cm dbh)	Small stems (8-23 cm dbh)	Medium stems (23 – 38 cm dbh)	Large stems (> 38 cm dbh)	% Nest cover	% canopy (> 5m)	% Groundcover (< 0.5 m)	Forb	Tree	Exotic	Native
07-01-058	prairie	07/11/07	8	3.5	0	3	20	6	0	35.0	75	80	33	12	2	0
07-01-059	prairie	07/07/07	50	2.25	0	6	10	9	4	50.0	85	35	10	28	0	0
07-01-063	prairie	07/17/07	2	3.5	9	23	18	2	1	63.3	90	35	0	13	6	1
07-08-012	prairie	07/11/07	1	1.5	75	16	5	0	1	95.8	50	95	15	69	38	2
07-08-054	prairie	07/17/07	50	2.5	10	13	5	4	1	52.5	80	80	33	12	0	13
06DM091	pubhunt	08/04/06	7	2.5	25	33	5	0	0	68.3	55	60	7	19	116	3
06BN038	rushrunnorth	08/17/06	13	1	35	25	25	5	2	32.2	100	85	0	12	22	1
06DS006	rushrunnorth	07/13/06	3	2.7	30	16	4	0	1	46.7	25	80	4	41	0	6
06DS012	rushrunnorth	08/21/06	9	1.5	0	57	13	2	3	38.3	90	90	0	18	109	3
06JF048	rushrunnorth	08/03/06	8	1.5	50	35	19	5	0	30.0	85	70	3	14	45	3
06JF049	rushrunnorth	07/13/06	5	2.75	30	16	4	0	1	45.0	25	80	5	28	0	2
06JF064	rushrunnorth	09/05/06	3	2.5	0	108	27	6	7	45.8	75	55	0	10	66	1
06JF072	rushrunnorth	07/13/06	6	2.75	60	2	2	0	1	60.8	50	65	6	16	0	0
06JS007	rushrunnorth	07/13/06	20	2	30	29	16	4	3	34.2	85	95	3	15	20	0
06JS057	rushrunnorth	08/17/06	6	6	50	36	21	0	0	86.7	100	90	0	15	0	4
07-02-028	rushrunnorth	07/27/07	10	2	0	47	15	5	0	43.3	90	75	0	8	27	8
07-02-048	rushrunnorth	08/01/07	5	2	0	18	7	1	4	25.2	50	75	6	45	15	0
07-04-022	rushrunnorth	07/13/07	0.5	2	100	55	11	3	2	10.3	75	75	0	6	46	0
07-04-033	rushrunnorth	07/13/07	15	2	30	24	8	3	3	8.7	65	95	0	9	50	1
07-07-018	rushrunnorth	08/01/07	20	3	8	44	7	1	2	30.8	85	40	0	16	80	0

APPENDIX K Continued

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Nest	Site	Date	Distance to trail (m)	Nest height (m)	Distance to foliage edge (cm)	Very small stems (3 – 8 cm dbh)	Small stems (8-23 cm dbh)	Medium stems (23 – 38 cm dbh)	Large stems (> 38 cm dbh)	% Nest cover	% canopy (> 5m)	% Groundcover (< 0.5 m)	Forb	Tree	Exotic	Native
07-07-038	rushrunnorth	07/17/07	30	5	75	27	19	2	1	83.3	90	25	0	30	26	0
07-07-046	rushrunnorth	07/18/07	17	3	20	22	7	3	2	63.3	90	100	0	7	18	0
07-10-035	rushrunnorth	07/28/07	4	2	50	28	17	1	1	24.2	90	80	0	24	36	0
07-10-146	rushrunnorth	08/01/07	6	4	0	55	12	4	0	20.2	80	85	0	14	28	0
06JS044	rushrunsouth	09/06/06	25	1.7	10	63	25	7	2	23.3	65	100	7	16	14	0
06JS100	rushrunsouth	09/06/06	1.75	1	110	47	16	3	1	45.8	90	90	0	8	172	11
06MH006	rushrunsouth	09/06/06	5	2.5	15	133	33	9	0	50.0	85	95	0	2	72	4
07-01-054	rushrunsouth	07/06/07	8	2.5	50	38	16	0	2	33.8	90	45	2	2	61	0
07-02-020	rushrunsouth	07/06/07	35	1.5	0	40	8	5	4	8.7	95	75	0	1	50	0
07-04-008	rushrunsouth	08/07/07	5	1.2	150	42	19	3	1	53.3	70	50	0	30	54	1
07-10-075	rushrunsouth	08/14/07	3	2.3	10	28	16	3	0	21.0	95	85	0	7	55	0
06DM020	tuttlenorth	08/09/06	0.5	2	60	63	2	1	4	56.7	75	50	0	27	77	0
06DM022	tuttlenorth	06/26/06	9	2.5	5	65	14	10	3	59.2	85	70	4	12	37	0
06DS005	tuttlenorth	06/22/06	1	2	15	48	21	1	1	78.3	85	65	23	25	84	0
06DS013	tuttlenorth	07/10/06	13	2.5	80	60	2	1	4	60.8	65	55	6	49	116	43
06DS014	tuttlenorth	06/08/06	45	1	60	32	4	5	2	75.0	70	90	6	12	31	0
06DS051	tuttlenorth	07/10/06	20	2.5	70	49	4	5	0	26.7	90	75	21	67	50	1
06DS056	tuttlenorth	06/22/06	19	2.5	60	25	19	0	1	61.7	55	70	0	11	56	0
07-01-051	tuttlenorth	06/22/07	10	2.5	40	23	5	4	1	17.5	85	65	3	18	0	5
07-03-030	tuttlenorth	06/27/07	10	3	0	27	8	3	2	48.3	70	65	24	47	0	0

APPENDIX K Continued

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Nest	Site	Date	Distance to trail (m)	Nest height (m)	Distance to foliage edge (cm)	Very small stems (3 – 8 cm dbh)	Small stems (8-23 cm dbh)	Medium stems (23 – 38 cm dbh)	Large stems (> 38 cm dbh)	% Nest cover	% canopy (> 5m)	% Groundcover (< 0.5 m)	Forb	Tree	Exotic	Native
07-04-001	tuttlenorth	06/25/07	0	3	150	17	9	0	2	33.3	80	85	15	20	1	0
07-09-003	tuttlenorth	07/27/07	10	1.75	300	21	6	2	1	65.8	60	45	0	16	19	20
07-09-056	tuttlenorth	06/29/07	20	2.5	172	20	8	3	1	57.5	65	55	36	33	1	3
07-09-093	tuttlenorth	08/03/07	5	1.75	20	18	3	0	2	50.0	90	60	1	7	62	3
07-11-022	tuttlenorth	06/20/07	15	2.5	80	52	6	2	4	64.7	85	85	0	18	62	0
06DM005	tuttlesouth	06/15/06	4	1.5	0	65	7	9	3	12.5	90	45	0	8	29	0
06DS122	tuttlesouth	08/22/06	2	2.75	90	28	9	1	2	63.3	80	65	4	22	79	0
06DS129	tuttlesouth	08/31/06	4.5	1.75	20	45	10	4	5	45.0	95	80	0	38	20	1
06DS143	tuttlesouth	08/26/06	25	3.25	110	76	6	3	1	44.2	95	85	0	7	65	6
07-01-005	tuttlesouth	07/13/07	25	1.5	105	85	7	1	1	62.5	95	25	0	3	39	5
07-01-006	tuttlesouth	07/02/07	1	2.5	100	81	15	0	4	29.5	40	40	0	15	76	0
07-01-039	tuttlesouth	07/13/07	20	2.5	630	93	1	2	2	28.5	100	25	0	4	54	0
07-09-005	tuttlesouth	06/18/07	2	2	35	73	9	7	3	49.2	95	60	0	4	115	3
07-09-032	tuttlesouth	07/02/07	32	1.4	530	44	9	0	1	37.5	90	85	0	23	14	0
06DS011	woodside	08/19/06	5	1	20	21	8	4	3	15.0	60	60	0	7	10	19
06JF040	woodside	08/12/06	30	5	50	13	7	4	3	55.0	40	30	0	2	6	0
06JF046	woodside	08/30/06	3	1	30	17	12	1	3	23.3	50	60	0	7	5	19
06JF080	woodside	09/07/06	120	0.5	20	18	14	0	3	6.7	20	25	0	4	6	4
06JS012	woodside	06/24/06	3.5	2	125	17	2	2	2	36.7	85	85	9	16	10	4
06JS037	woodside	09/07/06	120	1	40	22	18	0	2	28.3	65	65	0	10	8	27

APPENDIX K Continued

Nest	Site	Date	Distance to trail (m)	Nest height (m)	Distance to foliage edge (cm)	Very small stems (3 – 8 cm dbh)	Small stems (8-23 cm dbh)	Medium stems (23 – 38 cm dbh)	Large stems (> 38 cm dbh)	% Nest cover	% canopy (> 5m)	% Groundcover (< 0.5 m)	Forb	Tree	Exotic	Native
07-02-017	woodside	06/25/07	60	1	4	0	2	1	6	37.5	75	55	0	10	31	2
07-04-032	woodside	06/20/07	55	3.5	0	9	15	4	4	36.3	95	5	4	24	0	0
07-07-036	woodside	07/23/07	100	1.8	0	9	8	3	0	60.0	60	70	11	14	0	0
07-10-027	woodside	06/20/07	25	4	0	22	15	0	0	44.2	85	5	12	16	4	3
07-10-045	woodside	.	22	1.5	100	9	4	4	3	56.7	40	45	1	2	1	1
07-10-048	woodside	06/25/07	70	1.5	4	12	6	6	3	26.3	90	80	1	2	79	0

APPENDIX L

VEGETATION CHARACTERISTICS MEASURED AT 114 RANDOMLY LOCATED
11.3 M RADIUS PLOTS AT 12 RIPARIAN FOREST SITES IN CENTRAL OHIO IN
2006 AND 2007.

Stem categories (very small stems, small stems, medium stems, large stems) represent counts of stems in each size class in each plot. Forb, tree, exotic and native represent the number of contacts made by forbs, trees, native shrubs and exotic shrubs on a vegetation pole. All heights and distances are given in meters.

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nest	site	date	Distance to trail	Distance to road	Very small stems (3 – 8 cm dbh)	Small stems (8 – 23 cm dbh)	Medium stems (23 – 38 cm dbh)	Large stems (> 38 cm dbh)	Canopy height	% canopy (> 5 m)	% groundcover (≤ 0.5 m)	Forb	Tree	Exotic	Native
06BN007	lounorth	07/10/06	27	250	10	3	0	5	16.3	75	70	1	24	6	0
06BN009	casto	09/08/06	40	100	18	6	3	2	18.8	50	85	13	14	38	12
06BN021	kennysouth	08/13/06	16		47	7	3	3	9.8	95	65	20	10	98	0
06BN038	rushrunnorth	08/17/06	23	125	29	18	3	3	14.5	100	75	0	2	0	2
06BN074	lousouth	08/18/06	1		23	11	10	1	8.5	90	70	0	1	122	4
06BN092	lounorth	06/29/06	40	300	16	4	3	4	27.5	100	60	1	54	0	0
06DM005	tuttlesouth	06/15/06	17	65	75	4	4	3	21.3	100	65	3	8	37	0
06DM020	tuttlenorth	08/13/06	8	135	55	8	1	1	13.0	75	75	31	23	17	2
06DM022	tuttlenorth	08/22/06	0	30	23	10	1	3	27.0	80	35	2	5	32	0
06DS002	kennynorth	08/23/06	7	200	57	16	2	0	15.0	95	70	0	7	53	0
06DS004	tuttlesouth	08/24/06	15	65	104	10	2	3	18.8	85	50	0	9	92	2
06DS005	tuttlenorth	06/22/06	10	75	32	25	0	0	12.8	90	90	20	15	22	2
06DS011	woodside	08/19/06	0	200	15	6	5	2	8.0	50	30	3	13	2	9
06DS013	lousouth	08/18/06	3		16	4	8	7	15.0	90	60	5	41	13	0
06DS013	tuttlenorth	07/10/06	19	110	18	6	1	1	13.0	55	85	33	22	0	0
06DS014	tuttlenorth	06/15/06	2	115	65	5	1	3	20.8	90	80	3	15	76	1

APPENDIX L Continued

nest	site	date	Distance to trail	Distance to road	Very small stems (3 – 8 cm dbh)	Small stems (8 – 23 cm dbh)	Medium stems (23 – 38 cm dbh)	Large stems (> 38 cm dbh)	Canopy height	% canopy (> 5 m)	% groundcover (< 0.5 m)	Forb	Tree	Exotic	Native
06DS035	kennynorth	08/03/06	9	200	18	12	1	2	12.5	75	95	49	26	33	0
06DS036	kennynorth	08/21/06	50	85	94	11	2	0	16.0	95	90	3	2	45	3
06DS043	lounorth	06/19/06	50	120	3	7	2	1	15.0	60	95	16	12	0	1
06DS048	kennynorth	08/12/06	30	100	31	14	1	0	13.3	70	90	6	44	67	10
06DS050	kennynorth	08/29/06	17	110	83	9	3	2	9.8	100	55	0	0	58	6
06DS051	tuttlesouth	08/04/06	28	85	25	3	2	5	20.0	80	90	4	9	35	0
06DS056	tuttlenorth	08/04/06	8	110	28	10	3	2	12.0	85	85	5	19	25	0
06DS113	tuttlesouth	08/26/06	2		69	12	1	0	8.0	45	75	3	22	59	0
06DS129	tuttlesouth	09/01/06	16	75	37	4	1	2	17.5	75	75	4	44	13	9
06DS133	casto	08/02/06	25	200	27	10	2	1	11.8	65	95	7	22	75	29
06DS143	tuttlesouth	08/31/06	11		29	4	0	3	23.8	55	75	7	1	38	0
06JF010	kennysouth	08/10/06	10	190	74	22	2	4	18.3	90	100	0	21	77	5
06JF040	woodside	08/12/06	7	85	62	10	2	5	21.0	70	90	6	24	0	1
06JF045	casto	08/30/06	25	60	29	26	6	2	23.0	75	100	3	28	39	1
06JF046	woodside	08/30/06	30	150	16	11	1	3	15.5	55	60	0	4	7	20
06JF048	rushrunnorth	08/03/06	0.7	90	34	21	5	2	25.0	90	70	0	5	30	7
06JF049	rushrunnorth	08/17/06	2.5	30	38	10	3	2	11.5	95	85	5	12	53	0
06JF064	rushrunnorth	09/05/06	6	100	80	38	15	2	15.8	75	85	0	11	12	2
06JF065	casto	07/08/06	12	40	11	5	6	3	26.3	55	95	10	7	0	6
06JF072	rushrunnorth	08/17/06	20	40	48	16	3	2	15.0	85	90	5	6	35	0

APPENDIX L Continued

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nest	site	date	Distance to trail	Distance to road	Very small stems (3 – 8 cm dbh)	Small stems (8 – 23 cm dbh)	Medium stems (23 – 38 cm dbh)	Large stems (> 38 cm dbh)	Canopy height	% canopy (> 5 m)	% groundcover (< 0.5 m)	Forb	Tree	Exotic	Native
06JF080	woodside	09/07/06	20	70	0	1	5	3	12.0	40	85	0	5	0	0
06JF084	kennysouth	08/10/06	16		52	30	5	8	13.0	100	95	0	23	74	0
06JS007	rushrunnorth	08/17/06	30	40	37	15	7	2	19.0	65	100	0	2	71	0
06JS012	woodside	09/07/06	6	50	46	9	3	4	23.5	70	95	1	23	0	1
06JS027	casto	09/05/06	15	45	37	17	4	1	12.8	80	100	9	22	57	14
06JS034	kennysouth	07/17/06	2	120	46	7	1	2	9.3	80	90	7	3	69	10
06JS037	woodside	09/07/06	15	150	6	16	6	0	20.5	50	90	3	11	5	3
06JS040	rushrunsouth	09/06/06	40	70	112	31	4	7	18.8	80	95	2	2	47	1
06JS044	rushrunsouth	09/06/06	30	90	66	19	3	1	12.3	80	95	1	6	64	0
06JS049	casto	09/08/06	30	75	20	17	1	4	25.0	85	95	15	17	17	0
06JS057	rushrunnorth	08/17/06	25	145	31	21	1	4	16.3	100	85	0	11	0	0
06JS061	kennysouth	08/10/06	1.5		74	28	3	0	9.0	100	80	0	6	91	0
06JS063	rushrunsouth	09/06/06	14	190	47	10	8	5	12.5	100	90	0	7	50	0
06JS086	casto	08/25/06	10	100	44	30	3	4	25.0	60	100	8	20	85	11
06JS087	casto	08/16/06	5	100	74	16	2	0	14.3	70	100	9	15	92	9
06JS100	rushrunsouth	09/06/06	10		32	12	0	0	15.3	100	100	1	7	78	0
06MH002	kennynorth	08/25/06	0	100	12	9	5	3	17.5	40	15	8	7	9	0
06MH006	rushrunsouth	09/06/06	5	120	46	19	3	2	14.0	65	70	4	2	19	2
07-01-030	kennynorth	07/04/07	10	120	31	29	6	1	14.3	85	30	0	2	49	0
07-01-044	kennysouth	06/28/07	7	700	0	2	1	3	7.5	85	0	0	6	0	0

APPENDIX L Continued

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nest	site	date	Distance to trail	Distance to road	Very small stems (3 – 8 cm dbh)	Small stems (8 – 23 cm dbh)	Medium stems (23 – 38 cm dbh)	Large stems (> 38 cm dbh)	Canopy height	% canopy (> 5 m)	% groundcover (< 0.5 m)	Forb	Tree	Exotic	Native
07-01-045	kennysouth	07/14/07	40	130	6	7	1	2	9.5	90	55	22	3	2	0
07-01-054	rushrunsouth	07/06/07	35	175	40	22	3	1	12.0	95	55	0	0	78	0
07-02-010	kennysouth	06/19/07	50	130	4	12	0	2	15.5	80	100	0	22	49	0
07-02-012	rushrunnorth	08/01/07	12	15	20	17	6	3	11.5	100	100	2	3	47	0
07-02-020	rushrunsouth	07/06/07	16	200	80	14	0	0	6.0	85	65	4	14	27	0
07-02-028	rushrunnorth	07/27/07	0.3	20	33	16	2	3	23.8	100	80	0	12	26	1
07-02-029	rushrunnorth	07/28/07	10	80	39	6	9	2	12.0	65	100	0	8	34	1
07-02-032	elkrun	06/23/07	0	150	28	16	3	3	8.0	60	40	0	4	0	5
07-02-036	kennysouth	06/21/07	12	100	12	9	4	2	10.8	75	95	7	8	0	1
07-02-042	kennysouth	07/25/07	90	50	56	8	2	4	7.0	90	85	0	4	147	0
07-02-044	kennysouth	07/14/07	10	130	11	10	2	4	9.5	90	90	1	8	4	0
07-02-048	rushrunnorth	08/01/07	5	25	38	25	3	5	11.0	100	95	0	12	11	0
07-02-049	elkrun	08/21/07	3	190	15	31	1	5	15.5	80	75	0	5	2	0
07-04-006	kennysouth	07/07/07	3	180	5	10	5	5	7.5	80	20	0	0	0	0
07-04-008	rushrunsouth	08/07/07	2	115	33	16	2	6	16.8	80	95	1	14	16	0
07-04-022	rushrunnorth	07/13/07	30	70	29	10	1	1	10.8	95	100	0	11	32	0
07-04-032	woodside	06/20/07	75	170	6	16	9	5	15.0	95	0	0	13	4	0
07-04-052	casto	07/30/07	0	60	14	13	6	5	12.8	100	70	1	18	8	0
07-04-064	kennysouth	07/25/07	0	200	7	16	2	4	9.8	75	40	0	22	0	0
07-04-078	casto	08/20/07	7	130	5	11	1	4	10.5	80	55	1	6	0	1

APPENDIX L Continued

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nest	site	date	Distance to trail	Distance to road	Very small stems (3 – 8 cm dbh)	Small stems (8 – 23 cm dbh)	Medium stems (23 – 38 cm dbh)	Large stems (> 38 cm dbh)	Canopy height	% canopy (> 5 m)	% groundcover (< 0.5 m)	Forb	Tree	Exotic	Native
07-05-001	kennynorth	07/24/07	20	100	43	19	2	2	8.5	100	70	0	6	66	0
07-05-002	kennynorth	07/11/07	2	270	73	9	0	1	8.5	90	45	0	3	27	2
07-07-018	rushrunnorth	08/01/07	40	120	20	24	1	1	12.0	95	90	0	13	2	0
07-07-025	cherry	08/16/07	20	100	2	8	3	3	16.8	65	95	0	4	0	8
07-07-031	casto	06/18/07	80	130	13	22	3	2	17.5	90	80	31	15	28	0
07-07-036	woodside	07/23/07	70	100	1	6	6	4	10.5	75	35	23	11	0	0
07-07-037	cherry	08/02/07	50		3	8	6	1	19.5	95	65	1	4	4	2
07-07-038	rushrunnorth	07/17/07	30	275	19	13	2	3	16.0	65	90	0	5	3	0
07-07-039	cherry	08/02/07	50	80	9	11	2	1	11.5	100	55	28	3	0	14
07-07-046	rushrunnorth	07/18/07	5	15	41	12	4	5	15.0	95	70	6	7	38	0
07-07-052	casto	08/20/07	1	45	8	5	3	4	12.8	75	55	0	15	0	0
07-10-009	cherry	08/16/07	11	70	21	9	6	0	6.8	50	100	10	64	6	28
07-10-021	cherry	08/16/07	40	130	13	11	6	4	11.8	95	65	24	0	2	18
07-10-022	cherry	06/27/07	25	120	8	3	3	6	8.0	70	60	34	23	3	35
07-10-027	woodside	06/20/07	8	120	18	25	3	3	13.8	100	80	6	14	96	1
07-10-029	kennynorth	07/21/07	40	170	57	23	11	0	9.5	95	100	0	0	103	0
07-10-035	rushrunnorth	07/28/07	22	130	24	17	4	2	11.0	100	100	1	13	4	0
07-10-040	elkrun	08/15/07	50	160	8	12	5	0	12.5	75	75	10	13	16	3
07-10-045	woodside		20	150	14	12	6	4	15.0	90	55	6	5	0	0
07-10-048	woodside	06/25/07	35	18	9	14	6	1	17.8	90	60	0	4	2	1

APPENDIX L Continued

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nest	site	date	Distance to trail	Distance to road	Very small stems (3 – 8 cm dbh)	Small stems (8 – 23 cm dbh)	Medium stems (23 – 38 cm dbh)	Large stems (> 38 cm dbh)	Canopy height	% canopy (> 5 m)	% groundcover (< 0.5 m)	Forb	Tree	Exotic	Native
07-10-063	kennysouth	06/28/07	2	100	38	2	1	1	17.5	100	100	6	12	57	0
07-10-070	casto	06/18/07	75	150	3	9	3	1	13.5	65	100	2	16	25	2
07-10-071	elkrun	08/15/07	3	100	12	16	4	1	12.0	100	100	0	18	8	4
07-10-077	cherry	08/02/07	45	80	2	5	3	1	12.5	55	90	25	7	0	4
07-10-081	elkrun	08/08/07	8	90	17	12	6	2	12.3	70	90	10	16	35	4
07-10-084	casto	07/23/07	30	50	13	9	6	1	13.3	85	50	4	15	0	0
07-10-090	elkrun	08/08/07	10	60	46	26	1	3	11.3	95	65	0	12	0	0
07-10-097	kennysouth	07/07/07	20	80	1	3	5	2	8.3	70	90	28	0	0	0
07-10-102	kennysouth	06/21/07	25	150	13	2	2	5	9.5	95	100	56	4	40	0
07-10-105	woodside		10	220	26	11	2	2	13.5	100	60	0	12	0	0
07-10-146	rushrunnorth	08/01/07	11	70	32	11	4	3	10.5	100	100	0	5	0	0
07-10-149	kennynorth	08/10/07	1.5	65	33	11	3	2	9.3	95	75	0	15	33	1
07-10-153	cherry	08/16/07	10	30	36	6	0	0	5.5	30	100	7	26	0	0
07-10-157	kennynorth	07/24/07	30	100	41	24	3	2	8.0	95	65	0	19	41	0
07-10-168	cherry	08/16/07	30	180	13	22	4	2	15.0	85	45	0	3	0	0
07-10-170	kennynorth	08/03/07	12	170	44	9	7	1	8.3	100	100	7	3	42	0
07-10-171	kennynorth	08/03/07	6	140	44	12	3	3	10.5	90	90	5	3	27	0
07-10-199	kennysouth	08/03/07	4	170	7	0	2	3	13.5	65	100	32	1	0	0

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