

Nest-defense behavior of Mississippi kites in urban and exurban areas

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Abstract: Mississippi kites (*Ictinia mississippiensis*) have become an abundant raptor in many urban and exurban areas throughout the Southern Great Plains of the United States. Unfortunately, human–wildlife conflicts have resulted from this juxtaposition of suitable breeding areas for kites and areas that humans frequent, with some kites responding aggressively to humans near nests. To date, there are no data describing the prevalence of aggressive nest defense in the species, making informed management of human and kite conflicts difficult. We assessed and compared the prevalence of aggressive nest-defense by Mississippi kites in an urban area and an exurban area by simulating nest disturbance with a trial pedestrian. Additionally, we examine the relationships between physical features of the nest tree where aggressive behaviors were and were not recorded. Individual kites breeding in the exurban area responded to the trial pedestrian by taking flight from the nesting area, circling overhead, swooping at the pedestrian, or remaining on the nest. In the urban area, kites displayed a more limited suit of responses and either remained on the nest or swooped at the pedestrian. Additionally, kites breeding in the exurban area appeared to respond to experimental disturbance at a greater distance than did urban breeding kites, but not with more attacks on pedestrians. Physical characteristics of the nest tree did not explain aggressive behaviors, thereby suggesting that aggression in Mississippi kites is caused by factors other than nesting location features.

Key words: disturbance, flight initiation distance, FID, *Ictinia mississippiensis*, Mississippi kite, nest defense, Texas, urban

RICHARDSON AND MILLER (1997) proposed 3 pathways to describe how human activities might affect birds: (1) direct persecution, (2) loss or alteration of habitat, and (3) disruptions to normal behavior stemming from disturbance. Although the outcomes arising from direct persecution and loss of habitat are generally predictable, outcomes from disruptions due to disturbance are less predictable, as a variety of factors may affect an individual bird's response to a given disturbance. For example, human proximity (Steidl and Anthony 2000), habitat characteristics (Curio 1987), species identity (Holmes et al. 1993), and degree of human development (Evans et al. 2010, McGiffin et al. 2013) have all been shown to influence the response exhibited by birds to human disturbance. If nest defense represents a specific response by birds to disturbance, then it is expected that the intensity, frequency, or both intensity and frequency of nest defense would also vary.

Birds that have adapted to nest in human-altered environments (e.g., urban and agricultural areas) often show pronounced changes in their behavioral responses (i.e., decreased wariness) to human disturbance (e.g., Knight et al. 1987, Evans et al. 2010). This tolerance of humans may arise through the habituation of individuals to human disturbances (Anderson et al. 1999, Metcalf et al. 2002) or by individuals with particular traits being more tolerant and accepting of the urban environment (e.g., boldness; Atwell et al. 2012). Tolerance of human activity in cities, therefore, is thought to be adaptive, as repeated disturbance might affect stress levels (Strasser and Heath 2013), foraging (e.g., Burger 1994, Ward and Low 1997), breeding activities (e.g., Steidl and Anthony 2000), and other behaviors and consequently be detrimental to fitness.

Since the mid-1900s, the Mississippi kite (*Ictinia mississippiensis*; hereafter, kite) has become an abundant breeding raptor in many

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urban areas of the Southern Great Plains (Parker 1999). More recently, kites appear to be colonizing urban areas in the southeastern and midwestern regions of the United States. Although the presence of kites can generally be viewed as a positive wildlife experience for many urbanites, some kites vigorously defend their nesting area against humans who venture close to nests that contain eggs or young. Such defensive actions are typified by repeated low swoops at the intruding human that cease when the intruder leaves the vicinity. Often, such encounters represent a nuisance for recreationists in urban parks and golf courses, however, aggressive kites near facilities providing childcare or care for the elderly represent a more pressing public safety concern (Washburn 2018). Mitigating such human–wildlife conflict requires an understanding of the factors that influence these problematic behaviors. However, no quantitative data are available with which to assess frequency of aggression or situations that lead to aggression by Mississippi kites. Our objectives in the current study were to: (1) determine the prevalence of aggressive nest defense between an urban population and an exurban population of Mississippi kites breeding in the Southern Great Plains of Texas, USA, (2) document differences in kite response to disturbance by humans between the 2 areas, and (3) explore correlates between features of the nest tree and nest placement.

Methods

Study area

This study was conducted in 2 areas: Lubbock, Texas and Palo Duro Canyon State Park, Texas. Lubbock (33°35' N, 101°51' W) is a medium-sized city (population approximately 230,000; U.S. Census Bureau) in northwest Texas. The city is located atop the Llano Estacado, a large, flat mesa that encompasses much of the Texas Panhandle and eastern New Mexico (Leatherwood 2013). Historically, the area was characterized by shortgrass prairie. Today, however, much of the area surrounding Lubbock has been converted to row-crop agriculture, with cotton as the primary cash crop. Within the city, many species of non-native trees have been established to provide shade and aesthetic value for residents. Two of the most common

tree species are Siberian elm (*Ulmus parvifolia*) and honey locust (*Gleditsia triacanthos*). Together, these 2 species comprise the majority of trees in residential neighborhoods, city parks, university campuses, and public and private golf courses. For the purposes of this study, all kite nests we searched and assessed for aggression were within publicly available greenspaces listed above. All greenspaces were structurally similar and contained sparse shade trees interspersed with lawns. Walkways and paths were common elements of greenspaces, and pedestrians and other recreationists frequented them.

Palo Duro Canyon (34°56' N 101°38') is a large (190 km long, 250 m deep) canyon southeast of Amarillo, Texas partially located in Palo Duro Canyon State Park. The canyon has been carved by flows of the Prairie Dog Town Fork of the Red River. Within 75 m of the Prairie Dog Town Fork of the Red River, a narrow band of eastern cottonwoods (*Populus deltoides*) forms a small riparian gallery forest. Within this narrow band, few other species of trees are present other than cottonwood. Our study of Mississippi kites was limited to this narrow riparian gallery. Recreational visitation to the state park peaks in the summer months, with visitors generally remaining near parking lots, campgrounds, and on the developed trail system. Within the park, approximately 50 km of recreational trails exist; however, only 2.5 km fall within the riparian gallery where kites nest. Further, kite nests over the study period (2011–2012) were, on average, 160 m from the nearest recreational trail. Therefore, despite visitation to the park, we believe that kites and their reproductive efforts were sufficiently insulated from human activity to constitute a population inexperienced with human disturbance near the nest site.

The climate of the region is semi-arid; Lubbock receives an average of 485 mm of precipitation annually (30-year average, 1981–2010; National Weather Service 2013a) whereas Palo Duro, based on the closest weather station 28 km away, receives approximately 517 mm of precipitation annually (30-year average, 1981–2010; National Weather Service 2013b). Based on 30-year averages (National Weather Service 2013a, b), mean (\pm SD) daily temperatures during the months of the study

(May to August) were 24.8 °C (\pm 2.6) in Lubbock and 23.2 °C (\pm 3.1) in Palo Duro, whereas mean (\pm SD) monthly precipitation was 58.0 (\pm 13.5) mm and 71.1 (\pm 9.3) mm.

Behavioral measures

We made behavioral observations of nesting Mississippi kites from 0600 to 1200 hours and again from 1600 to 1900 hours on days without inclement weather. We assessed the behavioral response of adults that had young appearing >1 week old. Mississippi kite nestlings remain in the nest 4–5 weeks after hatching, and we noted the age of nestlings at the time of assessment. Independent from nest defense assessments, we checked the status of nests every 7–10 days. Prior to each assessment, we used binoculars and spotting scopes to determine if at least 1 adult was present on the nest or perched within the nest tree or a neighboring tree. We did not make assessments when adults were absent. To assess nest defense among urban nesting kites in Lubbock, a pedestrian approached each nest from a distance of \geq 60 m, while an observer watched from a clear vantage point located at least 100 m from the focal nest and bird(s). On approach to the nest, the pedestrian maintained a level head posture and avoided directly looking at the nest except when checking to see if their path was still on course. Once under a nest, the pedestrian paused for 10 seconds, then continued walking in the same direction for a further 60 m. At Palo Duro Canyon, the distance of the observer to the focal bird(s) was variable due to vegetation and topography; however, observers were always \geq 60 m from nests and focal bird(s). If the focal bird(s) flushed from the nest or left its perch while the pedestrian was on approach, the pedestrian would mark their position with a handheld Global Positioning System unit while the observer would estimate the distance from the pedestrian to the flushing bird. This distance was recorded as the flight initiation distance (FID; Ydenberg and Dill [1986]). If the focal bird(s) flushed and initiated swoops at the pedestrian, the remote observer counted the number of swoops made. We defined swooping as any deviation from level flight directed at the pedestrian.

We scored the response of each focal bird (0–3) based on a modification of the nest defense categories in Morrison et al. (2006). Birds that did

not respond to the pedestrian were considered passive and given a score of 0. Individuals that fled the nesting area (i.e., flew away without vocalization or initiating aggressive behaviors at the pedestrian) were scored as 1, representing a flight response. Individuals that left their perch or ceased brooding activities but remained in flight above the nest or the pedestrian with or without vocalization were assigned a score of 2, representing a passive response. Birds that responded to the pedestrian by swooping, with or without making contact, were assigned a score of 3, representing an aggressive response. We did not attempt to distinguish between male and female kites during nest defense trials due to their similar plumage and overlapping morphological measurements. During some nest-defense trials, we were unable to record FID due to individuals (mates not observed prior to beginning trials) flushing from undiscovered locations. In such instances ($n = 3$), we were still able to assess the response of birds to the pedestrian (i.e., aggressive, passive, and flight responses).

Vegetation measures

To determine the degree to which characteristics of the nest tree influence aggressive responses of kites, we measured features of the nest tree that may influence a bird's responses to disturbance. We made all measurements immediately after confirming nests had failed or fledged young. Features measured included height of the nest tree, diameter at breast height (dbh) of the nest tree, height of nests, and distance of the nest from the nest tree bole. We compare means of kites undisturbed by our trial pedestrian (score 0) to means of kites disturbed by our trial pedestrian (scores 1, 2, and 3).

Analytical procedures

We used a *t*-test (Zar 2010) to determine possible differences in FID between Lubbock and Palo Duro Canyon. We used a Wilcoxon rank sum test (Zar 2010) to test for differences in the number of swoops directed at the pedestrian by aggressive kites and a Fisher's exact test (Zar 2010) to compare the proportions of categorical responses between Lubbock and Palo Duro Canyon. To assess the effect of nestling age on parental nest defense behaviors, we classified nestlings as belonging to 1 of 5 age classes,

Table 1. Responses of Mississippi kites (*Ictinia mississippiensis*) to simulated human disturbance at urban (Lubbock, Texas, USA) and exurban (Palo Duro Canyon State Park, Texas, USA) nesting areas, 2010–2012. Categorical scores modified from Morrison et al. (2006).

Location	Response score <i>n</i> (%) ⁱ			
	0	1	2	3
Lubbock	41 (84)	0 (0)	0 (0)	8 (16)
Palo Duro Canyon State Park	20 (59)	5 (15)	2 (6)	7 (20)

ⁱResponse scores of Mississippi kites as follows: 0 = No response, focal bird did not respond to pedestrian; 1 = Flight response, focal bird left the nesting area without any aggressive behavior directed at the pedestrian; 2 = Passive response, focal bird left nesting area and circled overhead without swooping at pedestrian; 3 = Aggressive response, focal bird responded by swooping at the pedestrian.

Table 2. Flight initiation distance (FID; mean ± SD, *n*) in meters and the number of swoops directed at model pedestrians by Mississippi kites (*Ictinia mississippiensis*) during nest-defense trials at Lubbock, Texas, USA and Palo Duro Canyon State Park, Texas, USA, 2010–2012.

Location	Response		
	FID	Swoops	<i>n</i>
Lubbock	10.8 (17.2)	1.6 (0.7)	8
Palo Duro Canyon State Park	16.2 (21.0)	2.7 (2.0)	11

each of which corresponded to the nestlings age in weeks. Classifying nestlings into age classes was necessary due to some ambiguity in nestling age resulting from our infrequent (7–10 days) nest checks. We then compared the nest defense scores from attendant parents for each of the 5 age classes using Kruskal-Wallis ANOVAs (Zar 2010). Finally, we used *t*-tests (Zar 2010) to compare vegetative characteristic from nest trees where kites did and did not exhibit disturbance behaviors.

Results

We attempted to assess Mississippi kite nest defense behaviors at 49 nests in Lubbock (12, 22, and 15 nest sites in 2010, 2011, and 2012, respectively), and at 34 nests in Palo Duro Canyon (22 and 12 nest sites in 2011 and 2012, respectively). During test trials, an adult kite was present at the nest (i.e., brooding or standing on nest rim) of 46 (94%) nests in Lubbock and 28 (82%) nests in Palo Duro Canyon, or perched elsewhere in the nest tree or in an adjacent tree at 3 (6%) Lubbock nests and 6 (18%) Palo Duro Canyon nests.

In Lubbock, 41 (84%) of nest-defense trials were scored as 0, with adults not flushing from nests or nearby perches. Additionally, none of the nest-defense trials in Lubbock were scored as 1 or 2 (flight response and passive response, respectively). However, kites responded aggressively in 8 (16%) of nest-defense trials in Lubbock. In Palo Duro Canyon, 20 (59%) nest-defense trials were scored as 0, 5 (15%) were scored as 1, and 2 (6%) were scored as 2. Kites responded aggressively (score = 3) in 7 (20%) of trials in Palo Duro Canyon (Table 1). We found no evidence that kites increased aggressive nest defense as nestlings aged in either Lubbock ($H = 4.35$, $df = 4$, $P = 0.36$) or Palo Duro Canyon ($H = 1.87$, $df = 4$, $P = 0.76$).

Kites in Palo Duro Canyon displayed a more varied response to nest-defense trials than did those in Lubbock (Fisher’s exact test, $P = 0.004$). Specifically, no kites in Lubbock displayed a flight (score = 1) or passive response (score = 2) during trials, whereas these responses were observed on 5 and 2 trials in Palo Duro Canyon.

Flight initiation distances did not differ ($t = -0.62$, $df = 17$, $P = 0.54$) between Lubbock (10.8 ± 17.2 m, $n = 8$) and Palo Duro Canyon (16.2 ± 21.0 m, $n = 11$). Qualitatively, aggressive kites made fewer swoops at pedestrians in Lubbock than in Palo Duro Canyon (mean 1.6 ± 0.7 , $n = 8$ vs. 2.7 ± 2.0 , $n = 11$), but there was no statistical difference between the 2 study areas ($W = 20.5$, $P = 0.40$; Table 2). Characteristics of nest trees were similar between undisturbed and disturbed nest-sites in both Lubbock (Table 3) and Palo Duro Canyon (Table 4).

Discussion

Mississippi kites displayed low rates of nest-defense against trial pedestrians, with the majority of nest-defense trials in both the urban and exurban study area failing to elicit aggressive responses. Previous authors (see

Table 3. Features surrounding urban Mississippi kite (*Ictinia mississippiensis*) nest where nest-defense behaviors were assessed in Lubbock, Texas, USA 2010–2012. Units are meters for nest tree height (m), nest height and bole distance (the distance of the nest from the tree bole), and centimeters (cm) for nest tree diameter at breast height (DBH). *P*-values are from *t*-tests.

	Undisturbed			Disturbed			<i>P</i>
	Mean	SD	<i>n</i>	Mean	SD	<i>n</i>	
Nest tree height	16.0	2.7	17	15.2	2.4	12	0.42
Nest tree DBH	48.2	19.3	17	47.0	11.3	12	0.85
Nest height	12.3	5.2	17	10.5	1.3	11*	0.27
Bole distance	1.9	2.4	17	1.1	1.7	11*	0.35

* One nest and the limb supporting nest were lost to high winds.

Table 4. Features surrounding exurban Mississippi kite (*Ictinia mississippiensis*) nest where nest-defense behaviors were assessed in Palo Duro Canyon State Park, Texas, USA, 2011–2012. Units are meters for nest tree height (m), nest height and bole distance (the distance of the nest from the tree bole), and centimeters (cm) for nest tree diameter at breast height (DBH). *P*-values are from *t*-tests.

	Undisturbed			Disturbed			<i>P</i>
	Mean	SD	<i>n</i>	Mean	SD	<i>n</i>	
Nest tree height	24.0	15.7	32	20.9	12.8	8	0.61
Nest tree DBH	82.0	103.6	32	52.8	18.3	8	0.79
Nest height	9.6	2.7	32	8.3	1.6	8	0.20
Bole distance	2.2	1.5	32	1.6	1.0	8	0.32

Parker [1999] for details) have noted aggressive responses to humans near nests, though the pervasiveness of aggression in populations has been assumed low. Incidences of nest-defense by other raptors have been much greater. For example, both Andersen (1990) and Keeley and Bechard (2011) found a high prevalence of aggressive responses to humans near nest trees by red-tailed (*Buteo jamaicensis*) and ferruginous (*B. regalis*) hawks, respectively. We suspect that the differences in response rate in our study and theirs is, in part, attributable to the length of time trial pedestrians paused under the nests, 10 seconds in the current study and 5 and 10 minutes in Andersen’s (1990) and Keeley and Bechard’s (2011), respectively. Our anecdotal observations suggest that kites that rarely swoop at pedestrians will become aggressive if pedestrians linger beneath nest trees for long periods. However, we have also observed numerous situations in which long periods of human activity (e.g., picnics, construction activities) may take place under nests without any detectable response from kites. Although extending the under nest

period during our trials may have resulted in response rates similar to Andersen (1990) and Keeley and Bechard (2011), our intent was to experimentally expose kites to a disturbance level similar to what would typically be encountered in the study areas (i.e., walks with only brief stops). There was a differential pattern of responses of kites between the urban and exurban study areas. Kites in Lubbock either did not respond to nest-defense trials or responded aggressively by swooping at pedestrians, whereas kite responses in Palo Duro Canyon were distributed across all response categories, though not equitably. These patterns may reflect the familiarity of individual kites or kite pairs with a human near the nest. Such a pattern would be explainable by most urban kites recognizing humans as nonthreatening and adjusting their behavioral responses to the presence of a human near nests. In contrast, kites infrequently encountering humans, such as those in Palo Duro Canyon, may have insufficient experience with humans and thus display a variety of responses. Cases of aggression in urban kites

might stem from unfamiliarity with humans near the nest if pedestrian traffic was very low. However, we do not think this is the case in our study, as aggressive responding kites were located in high traffic areas. It is more likely that aggressive urban kites have experienced or perceived threats from humans and associate close proximity of any humans with such a threat.

Mississippi kites did not appear to increase the intensity of nest-defense behaviors in relation to nestling age increase as expected by the parental investment theory (Trivers 1972, Montgomerie and Weatherhead 1988). In both Lubbock and Palo Duro Canyon, many kites remained at the nest and appeared undisturbed by trial pedestrians when nestlings were at all age classes. Moreover, some kites in both areas displayed aggressive nest defense when nestling were young and when nestlings were older. Many studies have found support for increasing nest defense with increasing nestling age (e.g., Redondo and Carranza 1989, Redmond et al. 2009), and its ubiquity is generally accepted (but see Knight and Temple 1986 for an alternative explanation). However, most supporting evidence is from passerines, which differ in many traits from raptors, including but not limited to nestlings' ability to defend themselves (Newton 1979) and potential re-nesting opportunities in subsequent years (Andersen 1990). For example, Andersen (1990) found that nestling age did not influence the number of swoops by adult red-tailed hawks, though emitted calls were more numerous with older nestlings. Similarly, Keeley and Bechard (2011) found that ferruginous hawks decreased nest defense intensity as nestlings aged. Clearly, the issue of nestling age relationships to adult nest-defense behaviors is in need of further study among raptors.

Although we did not find a statistical difference in FID between the urban and rural study areas, we suspect that a biologically relevant difference in FID between the 2 populations might exist. The effect size of mean FID between the 2 populations was 0.28 (Cohen's *d*; Cohen 1988), which suggests a small to moderate difference in this response between the 2 populations. Knight et al. (1987, 1988) and Keeley and Bechard (2011) found that response distances of birds varied along a development

gradient. In the current study, 63% of all flushes by urban breeding kites occurred when the pedestrian had paused under nests, whereas in Palo Duro Canyon, 73% of flushes occurred when the pedestrian was approaching the nest. This difference in response is likely a function of wariness on the part of rural breeding kites.

We detected no difference in the number of swoops directed at pedestrians between Palo Duro Canyon and Lubbock, but there was high variability in the number of swoops given by individual birds both within and between the study areas. Similar to the scoring of nest defense, the limited duration of nest-defense trials used in this study may have precluded more variability in the number of swoops directed at pedestrians. Additionally, after flushing from the nest and making initial swoop(s) at pedestrians, many kites may conclude that the pedestrian posed no real threat and then cease aggressive behaviors.

Features of the nest tree did not appear to be associated with a flushing response or aggressive behaviors in either Lubbock or Palo Duro Canyon, suggesting these behaviors are independent of the habitat features we measured. Nest height has previously been suggested as a way for nesting birds to minimize disturbance from humans (Brown 1957), and Swarthout and Steidl (2001) found that perch height was important in determining whether Mexican spotted owls (*Strix occidentalis lucida*) flushed in response to hikers. We found no evidence that nests where kites displayed aggressive behaviors were substantially lower than nests where aggressive behaviors were not recorded.

The lack of association between aggressive behaviors and characteristics of nest trees may result from our inability to either conceptualize or measure features of habitat that make birds feel more or less secure. We examined habitat features univariately because of limited *a priori* knowledge of factors that may be predictive of aggression. However, multivariate analyses have the added advantage of exploring responses or response rates to novel combinations of variables. Additionally, aggression in Mississippi kites may actually be independent of nest tree features and instead may result from limited behavioral plasticity (Sih et al. 2004) of a few individuals. These behavioral

syndromes (Sih et al. 2004) may explain the haphazard occurrence of aggression exhibited by individual Mississippi kites. Lastly, aggression may result from previous experience (i.e., negative experience with some humans) or genetic factors (i.e., elevated testosterone production), for which we had no *a priori* knowledge or means to assess.

Much remains to be studied in regard to nest-defense and disturbance behaviors of Mississippi kites. We demonstrate that kites breeding in areas with different levels of human disturbance exhibit varying patterns of response to human disturbance. Urban breeding birds seem limited to either complete passivity or aggressive responses, whereas the responses of exurban birds were more varied. Additionally, FID appears to differ (practically if not statistically) based on location and thus disturbance levels. Birds breeding in exurban areas flushed at greater distances and may receive fitness benefits for doing so (i.e., ability to identify and deter would-be predators sooner). In contrast, urban breeding birds exhibited very limited response distances, which makes intuitive sense in a landscape with high human traffic that poses little risk. We found no difference in the number of swoops directed at pedestrians between urban and exurban breeding birds. Quite possibly, our assessment (both the distances walked and the time stopped under nests) greatly influenced the time, and therefore number of responses, that kite could devote to nest defense. Lastly, aggression in kites appears to occur independently of features of the surrounding habitat, suggesting some other factor is responsible for these behavioral responses to humans.

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