Nesting ecology and habitat use of Swallow-tailed and Mississippi Kites in the White River National Wildlife Refuge, Arkansas

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Abstract

The northern Swallow-tailed Kite (*Elanoides forficatus forficatus*) was extirpated from Arkansas during the 1940s. Since 1998, Swallow-tailed Kites, including a pair on several occasions, have been reported within the White River National Wildlife Refuge (WRNWR). This report summarizes the monitoring of Swallow-tailed Kites and our ongoing study of the breeding ecology of Mississippi Kites (*Ictinia mississippiensis*) in the WRNWR, 2006 – 2008. Our objectives were to locate any and all Swallow-tailed Kite nests to better understand their breeding ecology and habitat needs. In addition, we continued studying the reproductive success, causes of nesting failures, and habitat use of the Mississippi Kite. We located two Swallow-tailed Kite nests and 52 Mississippi Kite nests from 2006 to 2008. The 2006 Swallow-tailed Kite nest failed shortly after it was discovered. The 2008 Swallow-tailed Kite nest was monitored through incubation and one week of brooding until the adults abandoned following our deployment of a camera near the nest. Fifteen (28.8%) of the 52 Mississippi Kite nests fledged one young successfully. We deployed video recording systems at 18 Mississippi Kite nests. We documented five predation events that led to nesting failures; four depredations by Barred Owls (*Strix varia*) and one depredation by a black rat snake (*Elaphe obsolete*). In addition, in 2007 we documented one chick collapsing in a nest from unknown causes and in 2008 we documented one chick falling out of its nest. In 2008, we began investigating the effectiveness of snake-excluder devices (SNED) at preventing rat snake depredations of Mississippi Kite nests by applying them to half of the active nest trees. Our preliminary results do not suggest SNEDs are particularly effective at increasing nest success, but more data are needed. We captured, banded, and took measurements on 14 adult and seven nestling Mississippi Kites. Of these captured kites, 14 adults and five nestlings were outfitted with radio transmitters. Three of the five nestlings/fledglings died or were killed by predators before we could collect spatial use data. In addition, two adults were excluded from our mean home-range estimates due to their nest failing prior to us collecting locations on them. We documented a mean of 25 locations for each radio-tagged individual. The mean 95% fixed kernel home-range was 3,144 ha (N = 5) for adult males, 3,137 ha for adult females (N = 7), and 2,599 ha for juvenile Mississippi Kites (N = 2). We collected nest site data for all Swallow-tailed and Mississippi kite nests and an equal number of associated random sites. Mean height of Mississippi Kite nest trees (mean = 32.0 m) was significantly greater than the height of randomly-selected trees (mean = 27.4 m). Mean diameter at breast height (DBH) of Mississippi Kite nest trees (mean = 76.97 cm) was significantly greater than DBH of randomly-selected trees (mean = 55.44 cm). Mississippi Kite nests were significantly closer to a forest edge (mean = 37.1 m) than random plots (mean = 73.9 m) and were significantly closer to water (mean = 42.4 m) than random plots (mean = 71.5 m). Based on the data collected to date, we offer a proposed management plan for Swallow-tailed Kite conservation and restoration in Arkansas. We plan to continue our study in 2009 by locating the Swallow-tailed Kite nest and ≥ 20 Mississippi Kite nests. We will also continue our investigation of the nesting ecology of both species, the effectiveness of snake-excluder devices at Mississippi Kite nest trees, and habitat use by Mississippi Kites.

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INTRODUCTION

The northern Swallow-tailed Kite (*Elanoides forficatus forficatus*) formerly bred in areas of at least 17 states from Florida and the Southeast coastal plain west to central Texas and north through the Mississippi and Ohio River drainages to Minnesota (Meyer and Callopy 1995). Around the turn of the century the population experienced the most drastic range reduction of any land bird in eastern North America (Twedt et al. 1999) and now breeds in portions of only seven southeastern states (Sykes et al. 1999, Meyer 2004). Since its range reduction, the Swallow-tailed Kite has failed to return to former areas of its breeding range for unknown reasons. The species had essentially disappeared from Arkansas and was assumed extirpated in the late 1940s (James and Neal 1986).

Reports of Swallow-tailed Kites nesting in Arkansas were not numerous, but they indicated that the species was historically common in the state (James and Neal 1986, Sutton 1962). In 1998, the first recent sightings of STKIs in Arkansas, a pair on at least one occasion, were reported in and around the White River National Wildlife Refuge (WRNWR), eastern Arkansas (St. Pierre 2006). Since those reports, St. Pierre (2006; *N* = 1), Bader (2007; *N* = 2), and Anich et al. (2007; *N* = 1) documented nesting attempts and subsequent nesting failures of one pair of Swallow-tailed Kites in the WRNWR. To better understand what factors may be inhibiting the Swallow-tailed Kites from nesting successfully in the WRNWR, we also studied the nesting ecology and habitat use of Mississippi Kites (*Ictinia mississippiensis*) breeding on the refuge.

The Mississippi Kite, a neotropical migrant that breeds solely in the United States, is an ecologically similar species to the Swallow-tailed Kite with regard to diet, breeding biology, and habitat selection. A comparison of reproductive success rates between the Great Plains and Southeastern populations illustrates a considerable difference. Studies in the Great Plains and Southwest that investigated the Mississippi Kite's reproductive success consistently reported relatively higher rates of nest success (Parker 1974, Glinski and Ohmart 1983, Shaw 1985) than those performed within and around the Mississippi River Valley (MRV; Barber et al. 1998, St. Pierre 2006, Bader and Bednarz 2009). Moreover, St Pierre (2006), Anich et al. (2007), and Bader (2007) have reported relatively high rates of nesting failures in the WRNWR.

Nest predation is considered the principal cause of nesting failures in neotropical migrants (Mullin and Cooper 2002). Numerous studies on Mississippi Kites have suggested nest predators as a likely cause of most nesting failures and both Anich et al. (2007) and Bader (2007) reported the Barred Owl (*Strix varia*) and the rat snake (*Elaphe obsoleta*) as nest predators of Mississippi Kites breeding in the WRNWR. Rat snakes are commonly recognized as nest predators of numerous avian species (e.g., Neal et al. 1998, Weatherhead and Blouin-Demers 2004) and are well known for their tree climbing abilities (Mullin and Copper 2002). Anich et al.'s (2007) and Bader's (2007) results suggest that rat snakes, in addition to Barred Owls, play an important role as nest predators of Mississippi Kites breeding in the WRNWR, but nesting failures caused by these two predators are not the only factors affecting Mississippi Kite reproduction. A better understanding of the factors contributing to the relatively poor reproductive rates of Mississippi Kites within the WRNWR is important if we are to understand possible limiting factors affecting Swallow-tailed Kite reproductive efforts.

OBJECTIVES

Due to the relatively low nest success rates of Mississippi Kite nests and the failure of the Swallow-tailed Kites to produce a successful nest within the WRNWR (St. Pierre 2006, Anich et al. 2007, Bader 2007) we continued investigating the reproductive ecology of Swallow-tailed and Mississippi kites. With the current study, we addressed the objectives listed below and used the data to develop management strategies for the conservation of both kite species.

- Locate all Swallow-tailed Kite nests and as many Mississippi Kite nests as possible within the WRNWR and adjacent lands.
- Monitor the success of all kite nests located.
- Document the causes of Mississippi Kite nesting failures.
- Initiate an assessment of the effectiveness of snake excluder devices at preventing rat snakes from depredating kite nests.
- Capture, measure, band, and radio-tag Mississippi Kite adults and nestlings.
- Quantify nest-site characteristics of both kite species.
- Determine habitat and spatial use patterns of nesting kites.
- Provide management recommendations that will enable agencies to improve habitat, preserve the Mississippi Kite population, and further promote the re-colonization by Swallow-tailed Kites in Arkansas.

Methods

Study Area

The White River National Wildlife Refuge (WRNWR) is located in eastern Arkansas and is one of the largest remaining contiguous bottomland hardwood forests in the Mississippi Alluvial Valley (Fig. 1). The refuge contains approximately 62,800 ha and is divided into a North and South Unit by Arkansas Hwy 1. Searches for the Swallow-tailed Kites were conducted in the area of the South Unit between LaGrue Bayou, the White River, Prairie Bayou, and Brook’s Bayou where the kites have historically been sighted and have nested. Both the North and South Units of the WRNWR were searched for Mississippi Kite nests, with most areas being searched numerous times throughout the study season.

The WRNWR consists primarily of bottomland hardwood forest in addition to upland forest, fallow fields, agricultural fields, moist-soil impoundments, and 356 natural and man-made lakes. The refuge is open to the public for recreational use, hunting, and fishing and is managed for both game and non-game wildlife species. Dominant tree species of the WRNWR include

Nuttall oak (*Quercus nuttallii*), overcup oak (*Quercus lyrata*), bald cypress (*Taxodium distichum*), sweetgum (*Liquidambar styraciflua*), sugarberry (*Celtis laevigata*), hickory species (*Carya* spp.), and green ash (*Fraxinus pennsylvanica*).

Nest Searching

We began searching for Swallow-tailed and Mississippi kite nests on 7 April, 6 April, and 3 April during the 2006, 2007, and 2008 study seasons, respectively. Searches were conducted using a 25 hp outboard motorboat, an all-terrain vehicle, a backwater kayak, and by foot. The primary focus areas were locations where nests of both species have been located in previous years of study (T. Bader and J. Bednarz, unpubl. data), but we did not restrict out searches to these areas. If we could not access an area by boat, then we would search it using either a backwater kayak or an all-terrain vehicle. Searches began approximately 30 min before sunrise and involved travelling waterways in search of perched or low flying kites. Searches for Swallow-tailed Kites continued throughout the day until approximately 2 hr before sunset, as our initial focus was to locate an individual or pair. Searches for Mississippi Kites would last until approximately noon, which is when most kites would typically cease nest building and begin high elevation soaring (St. Pierre 2006). When we discovered a perched kite, we recorded its location with a hand-held GPS receiver and watched its behavior for about 30 min from a distance of approximately 100 – 200 m with the intention of following it to its nest or a super-emergent tree that may support a nest. During observations of kites, we watched for any indication of nesting activities, such as carrying nesting material, copulations, or repeatedly flying to and returning from a specific area. If, during our observations, a kite was heard calling, it was carefully observed to monitor for any breeding or nest building activities. If the kites we were observing began soaring or did not exhibit any breeding behaviors within 30 min, we would revisit the location about 2 – 4 days later to determine the pair's reproductive status and potentially locate a nest. Revisits continued until we determined that the individual or pair had abandoned their nesting attempt. St. Pierre (2006) found that kites, on average, perched within 80 m of their nest, so this association with their nest site helped us to focus our efforts in the area immediately around a perch.

Snake Excluder Devices

During the 2008 study season, we randomly selected half of the active Mississippi Kite nest trees to erect non-lethal snake excluder devices (SNED) to test if this management technique could be employed to prevent rat snakes from depredating kite nests. SNEDs were also used at the 2006 and 2008 Swallow-tailed Kite nests to improve the chances of the pair producing a successful nest. Use of SNEDs at half of the Mississippi Kite nests allowed us to begin to assess the effectiveness of this management practice at potentially reducing snake depredations of nests of both kite species. SNEDs consisted of a thin sheet of aluminum flashing 0.9 m tall wrapped around and stapled or screwed to the trunk of the nest tree with the bottom of the aluminum about 1 m from the ground (Neal et al. 1993). The aluminum was painted in a camouflaged pattern to prevent glare and potential visual disturbance to the nesting pair (Fig. 2). We attached SNEDs in the least amount of time possible (ca. 4 min) to minimize any potential disturbance to nesting birds. All SNEDs were removed from nest trees once the nest failed or the chicks fledged.

Nest Monitoring

Both Swallow-tailed and Mississippi kite nests were monitored at least once every 3 days through ground observations using binoculars and spotting scopes at a distance of 50 – 100 m. We classified a nest as active if we observed an adult on the nest during at least two occasions. We determined the stage of nests by observing the adults behavior on or around the nest (e.g., incubation exchanges or food deliveries to nestlings). If no activity was observed at the nest within an hour of beginning our observation, we revisited the nest again in 3 days to further determine its status. If no activity was observed at the nest after three consecutive visits, we classified it as failed. However, we extended the monitoring when nests were found during the building stage because most building varies in length from a couple of days to greater than 2 weeks (Parker 1999). If we located a nest and during subsequent visits noticed new material was added (e.g., fresh leaves or sticks), but did not see any adults on or near the nest we would continue to monitor for activity for at least another 3 visits or until we believed the nest was abandoned. Our records of kite activities and behaviors at nest sites allowed us to determine nest stages and estimate hatching and fledging dates.

Video Recording of Nests

In addition to our checking nests from the ground, we employed video recording systems at nests to continuously monitor nest activities and causes of nesting failures. We employed two different camera systems at nests. The overhead camera system consisted of a Supercircuits mono-power infrared camera (PC177IR-1color, Liberty Hill, TX) mounted on a limb approximately 45 cm above the nest. The other was a specially-designed infrared video recording system from Fuhrman Diversified, Inc. (Fieldcam: Field Television System: LDTLV/Box/Versacam/IR60, Seabrook TX). The Fuhrman system has an 18× optical zoom and 4× digital zoom, enabling us to place the camera close to the nest, or a maximum distance of 20 m from the nest. Videos were recorded on either Sony VHS time lapse recorders (SVT-LC300, New York, NY) or Supercircuits VHS time lapse recorders (NCL3300, Liberty Hill, TX). The time-lapse recorders allow video data to be viewed in slow motion without reducing picture quality. These systems allowed us to monitor nesting activity at each nest for 24 hr/day throughout the entire nesting cycle. An 8 hr tape recording eight frames per second would record for 72 consecutive hours. To avoid nest abandonment, camera systems were set up after kites were incubating for ≥7 days. Camera systems were set up by climbing the nest tree or an adjacent tree using a climbing harness, tree spikes, and lanyards. Cameras were left up until the nest failed or the young fledged and were moved to another occupied nest upon failure or fledging. Video data were reviewed to determine causes of nesting failures and to quantify prey deliveries and nesting behavior. Systems were continuously powered by three deep-cycle marine batteries placed at the base of the tree. Tapes and batteries were replaced approximately every 3 days and a viewing monitor was used to determine the stage and condition of the nest and to check that the camera was still in its proper position.

Capturing and Radio-tagging Kites

We attempted to capture, measure, band, and radio-tag adult Mississippi Kites and chicks (4-5 weeks old). Trapping attempts began on 27 June 2006, 3 July 2007, and 1 July 2008 during respective field seasons. Adults were caught within 20 – 30 m of their nest using two 2.6 × 6 m mist nets (72 mm mesh) placed one above the other and attached to a pulley system on telescoping metal poles (St. Pierre 2006). The top of the mist net system was 7 m above the ground with the bottom being approximately 1.5 m above the ground. We lured kites in using a live Great Horned Owl (*Bubo virginianus*) tethered to a 2-m tall octagonal platform, and a remote-controlled FoxPro Digital Caller (Lewistown, PA) playing various raptor calls (St. Pierre 2006). The nets and owl were set up approximately 30 min prior to sunrise with the goal of luring in and capturing adults as they returned to their nest with prey to feed to their chicks. We monitored the net from an enclosed, camouflaged ground blind placed approximately 10 m from the net for at least 2 hr. We lengthened the time of trapping attempts depending on the behavior of the adults. Chicks were caught by climbing to their nest and capturing them by hand. Upon capture, we collected blood samples, linear measurements, and masses from captured kites. Blood samples were used to determine the sex of adults and chicks. Both adults and chicks were banded with a United States Geological Survey (USGS) aluminum band and 2 or 3 plastic color bands to identify individuals in the future. In addition, adults and chicks exceeding 240 g in weight were fitted with a 6.0-g radio-transmitter using a modified figure-eight harness (Rappole and Tipton 1991). If we captured a chick late in the breeding season (e.g., beyond the first week in August) we did not attach a radio-transmitter to it due to the limited amount of time the fledgling had to develop fat reserves and flight skills prior to migration in early September. Climbing to nest trees to capture chicks or set up video systems was done in the least amount of time possible to minimize disturbance to adult and nestling kites.

Radio-telemetry of Adults and Nestlings

We employed two techniques to obtain locations on radio-tagged individuals; ground triangulations and aerial telemetry flights. After we radio-tagged at least 3 birds, we began collecting telemetry locations from the air using a fixed-winged aircraft flown by Arkansas Civil Air Patrol pilots. We did not begin tracking birds from the air until we tagged 3 birds due to flight costs of aerial tracking. During flights, we attempted to get ≥2 locations per individual, depending on available time. The Cessna 172 or 182 that was used was equipped with one "side-looking" 4-elemental yagi antenna on each wing strut. We located tagged kites by flying toward their capture location and listening for a difference in signal strength between the right- and left-wing antennas. When we determined which side of the plane that the signal was stronger on we directed the pilot to turn in that direction and again determined which side of the plane the signal was strongest. Once the signal was strongest on the same side of the plane each time it turned, the bird's location was confirmed by flying in a square pattern around it. By continuously reducing the size of the square the plane flew around the bird, we eventually narrowed down its location and were able to determine a relatively accurate location (within about 100 m). Locations were marked using a hand-held GPS receiver. Telemetry flights took place at least once per week. If we failed to detect a bird's signal, we widened the search to try and locate it. If we still could not detect a signal, we assumed the transmitter failed or the bird migrated too far to allow us to receive the signal.

We also determined locations by ground triangulations after one bird was radio-tagged and involved selecting three to four receiver sites, each separated by >500 m, within 1 – 2 km of where a bird was radio-tagged. Receiver sites were established along roadways and all-terrain vehicle trails. We recorded compass azimuths (1 from each receiver site) in the direction of the strongest radio signal within a 5-min period. We collected 3 azimuths for each location within a 5-min period to allow for the estimation of an error ellipse around the tagged bird's location. We then waited 10 min before collecting more locations on the same individual in order to allow it to move between triangulation attempts and to minimize autocorrelation between locations (Swihart and Slade 1985). We attempted to collect at least 10 triangulations per week for each bird, but the number varied based on available time and weather conditions.

Home-range Estimation

The triangulation azimuths were entered into Locate II (Nams 2000), which calculated coordinates for the estimated location of the radio-tagged kite as well as a 95% error ellipse surrounding the estimated location using the Maximum Liklihood Estimate technique (White and Garrott 1990). This technique calculates an error ellipse that has a 95% probability of containing the true location of the bird. We eliminated all estimated locations that had an error ellipse greater than 10 ha to remove less-accurate triangulations. The relatively large error ellipse criteria were chosen to account for the high mobility of kites. However, 10 ha is relatively small (<0.4%) in relation to the mean home range size of a Mississippi Kite (>3000 ha; Bader 2007).

All point locations, triangulation data output, and aerial telemetry locations, were entered into Arcview GIS software to estimate home range sizes for tagged kites. Using the point locations, we generated 95% fixed kernel home range estimates (Worton 1989). The fixed kernel technique incorporates utilization distribution by creating probability contours around point locations with little bias (Worton 1989).

Nest-site Characteristics

Upon success or failure of nests, we collected vegetation data at nest trees and an equal number of random locations to determine if kites were selecting specific habitat characteristics for nesting. Random sites were selected using a random number table comprised of randomly ordered values of 0 – 9. The first random number was multiplied by 25 to determine the distance from the nest tree to the random plot center and the second random digit was multiplied by 36 to determine the azimuth from the nest tree to the random plot center. The distance to the random plot was paced while using a compass to follow the randomized direction. Once the distance and direction to the random plot was travelled, the nearest overstory tree was selected as the plot center. Vegetation data for both nest site and random plots was collected within a 0.04 ha (11.3-m radius) circular plot. Data collection for both nest and randomized 11.3-m radius circular plots followed a modified BBIRD Protocol (Martin et al. 1997) and included species of all overstory trees, height of all overstory trees, diameter at breast height (DBH) of all overstory trees, and canopy cover of the plot center tree using a spherical densiometer at 1 m from the tree's base. We measured the emergence of the nest tree above the surrounding trees in the 0.04 ha plot by calculating the difference between the height of the nest tree and the mean height of the surrounding trees. We also measured nest characteristics, which included nest height, the nest's orientation in the tree (e.g., northeast, northwest, southeast, southwest), and whether the nest was in a primary fork (forking from the main bole of the tree) or secondary fork of the tree.

In addition, we measured distance to nearest forest edge and distance to nearest water (e.g., lake, bayou, river) from each nest site and randomized plot center.

We used Minitab® Statistical Software (Minitab Inc. 2007) to analyze our nest site characteristic data. We used paired *t*-tests to compare nest site characteristics to random site characteristics. We designated a *p*-value <0.05 as statistically significant.

RESULTS AND DISCUSSION

Nest Searching

We documented 11 sightings of Swallow-tailed Kites in 2006 (Appendix A), 9 in 2007 (Appendix B), and 32 in 2008 (Appendix C), not including kites seen during regular nest checks. We considered Swallow-tailed Kite sightings separate if they were ≥30 min apart.

In 2006, we began searching for Swallow-tailed Kites in the area south of Prairie Bayou where the 2002 and 2005 nests were located (Fig. 3). On 17 April 2006, we located a pair of Swallow-tailed Kites soaring over Prairie Bayou and shortly thereafter observed the kites carrying nesting material to a nest. The nest was located approximately 220 m from the 2002 nest, 410 m from the 2005 nest, and 3.70 km from the 2004 nest. The nest was approximately 470 m from Prairie Bayou and was located in a Nuttall oak tree (Fig. 3).

In 2007, we observed Swallow-tailed Kites on nine occasions scattered around the former nesting areas and portions of the South Unit. Due to the failure to observe any breeding behaviors and the variability in the sighting locations, we were unable to locate a nest in 2007. We believe there may have been a nest early in the breeding season that failed relatively early in the nesting cycle. Because we spent a substantial amount of field time throughout the area used by the Swallow-tailed Kites, we were certain that no fledglings were produced in 2007.

In 2008, we began searching for kites in all areas of previous nesting attempts and sightings. We observed a pair of Swallow-tailed Kites soaring above Prairie Bayou on 9 April. We relocated and observed the pair for the following 6 days in the area between Prairie Bayou and the powerline to the south of Prairie Bayou that runs through the middle of the South Unit of the refuge. The nest was located on 15 April during the nest building stage. The nest was approximately 518 m south of the powerline and was placed in an overcup oak (Fig. 3). The nest location was approximately 1.90 km from the 2004 nest and approximately 1.66, 1.42, and 1.80 km from the 2002, 2005, and 2006 nests, respectively. No more than two Swallow-tailed Kites were seen at any time during 2007 and 2008.

Between 11 May and 11 June 2006, we located 17 Mississippi Kite nests (Appendix D); 11 in the South Unit and 6 in the North Unit. Nests in the South Unit were located along Indian Bay, Big Island Chute, LaGrue Bayou, and Brook's Bayou. Nests in the North Unit were located along the White River, Lambert Bayou, and Holly Lake. Twelve (71%) of the nests were along bayous, three (18%) were along the White River, and two (12%) were located off of lakes.

Between 30 April and 29 June 2007, we located 15 Mississippi Kite nests (Appendix D); 12 in the South Unit and 3 in the North Unit. Nests in the South Unit were located along Indian

Bay, Big Island Chute, Prairie Bayou, and LaGrue Bayou. Nests in the North Unit were located along the White River and Holly Lake. Twelve (80%) of the nests were along bayous, two (13%) were along the White River, and one (7%) was off of a lake.

Between 4 May and 28 June 2008, we located 20 Mississippi Kite nests (Appendix D); 12 in the South Unit and 8 in the North Unit. Our search area in 2008 included 20 lakes, over 56 km of the White River, and approximately 145 km of bayous and sloughs throughout the refuge. We also included Maddox Bay and its tributaries, both of which were mostly unsearched areas of the refuge. Nests in the South Unit were located along the White River, Indian Bay, Big Island Chute, Prairie Bayou, and LaGrue Bayou. Nests in the North Unit were located along the White River and Maddox Bay. Fourteen (70%) nests were located along bayous and six (30%) were located along the White River. We found no nests along lake shores.

The time required for Mississippi Kites to finish constructing their nests ranged from a few days to >2 weeks (Parker 1999). In 2008, the mean time between nest location and the first observed day of incubation was 6.1 days. On 15 May 2008, we located a pair of Mississippi Kites constructing a nest in a green ash on the bank of the White River in the South Unit. When the nest was found the nest tree was completely bare, while trees surrounding it had begun to leaf out. We checked the nest every 3 days from 15 May to 31 May and about every 4 – 6 days thereafter, as we had assumed the nest had failed or had been abandoned due to the lack of activity. Although our standard methodology considered a nesting attempt a failure if we observed no activity at or around the nest during three consecutive nest visits, we determined that new nesting material was added to the nest, primarily in the form of green leaves, and therefore extended our monitoring. During a nest check on 14 June, we observed two adults perched in the nest tree. One adult proceeded to acquire and add nesting material to the nest. On 18 June, an adult was on the nest in incubation position. The time period from when we located the nest to when we first saw an adult incubating was 34 days. This was a relatively long period of time compared to the time taken for other 2008 nesting pairs to initiate incubation. The delay in this pair's initiation of incubation may be due to the nest tree lacking foliage until 31 May, relatively later than the majority of trees on the refuge. Typically, nests that are initiated later in the breeding season have a lower chance of being successful (Newton 1979). However, this nest fledged one nestling on 21 August 2008. This nest serves as an example of the variable time allocated to nest building by Mississippi Kites. Therefore, we suggest that nests should be checked for activity beyond three consecutive nest checks. If there are signs of activity at the nest (e.g., presence of adults, new material added to the nest), we recommend 3 additional nest checks before considering the nest to be a failure.

Nesting Success

When we located the Swallow-tailed Kite nest on 17 April 2006, we determined that the pair had not yet begun incubating. On 18 April, we observed an adult sitting on the nest in incubation posture. On 27 April we attached a SNED to the base of the nest tree and covered it in grease as an added protective measure. On the following nest check, 3 May, there was no kite on the nest and we determined that it had failed. On that date, we observed the track of a rat snake going down from the SNED through grease that was added to the SNED. We believe the snake was in the tree when the SNED was attached, as the nest tree was almost totally isolated from other trees.

An important observation of a third Swallow-tailed Kite occurred while checking the nest on 18 April. While watching the adult on the nest, we observed two Swallow-tailed Kites soaring above the nest area. We believe that one of the two individuals soaring above the nest area was a member of the nesting pair. Both soaring kites appeared to have equal tail lengths and overall body sizes, indicating that the third individual was also an adult. During this observation, we recorded that one of the two soaring kites dove at the other multiple times in an apparent attempt to chase it away. Meyer (1995) reported that aggressive behavior toward other kites is common near nest sites, particularly within 50 – 100 m of the nest. During a subsequent nest check on 21 April, we again documented a kite incubating while two others were soaring above the nest area. This was the last day a third kite was seen in the nest area. We believe that this third individual was a transient that may have flown north of its breeding grounds. The interaction of the third Swallow-tailed Kite with the nesting pair further strengthens our belief that if the Swallow-tailed Kites produce a successful nest, there exists the chance that any surviving young returning to the WRNWR have some probability of pairing with a transient individuals. Ultimately, we believe that this would potentially lead to the establishment of a small population of Swallow-tailed Kites that would have the ability to further expand their range throughout Arkansas and into areas of their former breeding range.

In 2008, upon locating the Swallow-tailed Kite nest on 15 April, we determined the pair was still nest building. Thereafter, we performed nest checks approximately every 3 days. On 21 April, we observed a kite in incubation position on the nest and determined the start of incubation as either 19 or 20 April. On 4 May, we attached a predator shield to the trunk of the nest tree. On 19 May, we observed the adult on the nest looking down into the nest, suggesting the chicks may be in the process of hatching. On 22 May, we observed prey deliveries at the nest, indicating that the chicks definitely hatched. On 26 May we attached a camouflaged camera system to a limb on the nest tree approximately 3 m from the nest. The brooding adult remained on the nest until S. Chiavacci was 4 m below it. Both adults were circling low over the nest and calling during camera system deployment. After setting up the camera, we left the nest area immediately to avoid further disturbing the adults. We returned to the nest site early on 28 May and observed one kite soaring low over nest area and calling. Upon checking the video we saw no adult on the nest or the heads of any nestlings near the top of the nest. We observed the nest for approximately 1 hour and did not observe any movement of nestlings in the nest or adults tending to the nestlings. After reviewing the video we determined that the adults did not return to the nest after camera deployment. The following day, 29 May, S. Chiavacci climbed to the nest and recovered two dead nestlings from the nest. During the climb to the nest, two Swallow-tailed Kites soared within 100 m of the nest on two occasions, indicating that they remained in the vicinity of the nest and continued to defend it. The circumstances suggest that climbing the nest tree in combination with deployment of the camera system caused the Swallow-tailed Kites to stop caring for their nestlings.

Fifteen (28.8%) of 52 Mississippi Kite nests successfully fledged one nestling each (Appendix D). Nest success rates were 47% (8/17) in 2006, 21% (3/14) in 2007, and 20% (4/20) in 2008. While we located 15 nests in 2007, one nest’s fate was unknown and was therefore excluded from our nest success estimate. The nest success rate of Mississippi Kites from 2006 to 2008 was similar to the 27.3% nest success reported by St. Pierre (2006) and the 28.2% reported by Bader and Bednarz (2009). From 2006 to 2008, we recorded the construction of seven nests by Mississippi Kites, but never observed a kite in incubation position; six of these were in 2008. Nine nests failed during incubation and 19 failed during the nestling stage. Of the failures during incubation, one was attributed to abandonment, while the remaining failures were due to unknown causes. Of the failures during the nestling stage, four were attributed to Barred Owl depredation, one was due to rat snake depredation, one was due to the nestling falling from the nest, one was due to the chick collapsing, one was due to abandonment, and 11 were due to unknown causes. There was an additional abandoned nest in 2006, but the stage of the nest when it was abandoned was unknown. Details of documented failures are discussed in more detail later in this report. Kites laid eggs in at least 86% of nests located, and chicks hatched in 68% of the nests. Of those nests that hatched chicks, 56% failed during the nestling stage. The number of nests that successfully hatched chicks during the 3 years of this study was relatively higher than the 46.2% hatching success reported by Bader and Bednarz (2009). Kites fledged 1.0 nestling per successful nesting attempt across all years.

Five of 52 nests (9.6%) were determined to have contained a clutch of two eggs. Two of 52 nests (3.8%) hatched two chicks, while two other nests that contained two eggs hatched only one chick. The last 2-egg nest failed before hatching any chicks. Parker (1999) noted that Mississippi Kite nests in the Great Plains region typically contained two egg clutches, while nests in the east often contained one egg. However, this difference may exist due to the loss of a single egg to predators or high winds (Parker 1999). The height of kite nests in the WRNWR and the period of time we wait before deploying camera systems at nests make it difficult to accurately determine the original clutch size of all kite nests located. We determined nest contents (i.e., clutch and brood) in three of the four nests with 2-egg clutches during camera deployment or during the nestling stage when chicks were able to be seen. The fourth nest with a 2-egg clutch was determined when, during a nest check, we found eggshell fragments on the ground below the nest and observed the adult on the nest in incubation position. The nest eventually hatched one chick indicating that the initial clutch size was two. In the fifth case, we found two separate clusters of eggshell fragments about 1.5 m apart below the nest, suggesting that the nest had contained two eggs.

We believe one nesting failure in 2008 was attributed to a thunderstorm that passed through the WRNWR on 1 June. The wind gust speed was estimated to be >90 km/hr (National Oceanic and Atmospheric Association). The nest was located in a relatively small (DBH = 49.2) water oak (*Quercus nigra*) on the edge of Maddox Bay and we had observed an adult on the nest in incubation position on two prior nest checks. During our nest check on 2 June, we discovered the nest was gone except for a few remnant sticks hanging where the nest was. We thoroughly searched the ground below the nest tree, but could not find nesting material or eggshell fragments. Given that this nest tree was within 1 m of the water, it is possible that the nest and its contents fell into the water during the storm. Several studies have reported Mississippi Kite nesting failures associated with high wind events (e.g., Parker 1974, Glinski and Ohmart 1983). We speculate that this nesting failure was caused by the extreme wind gusts associated with the thunderstorm on 1 June.

Extra Pair Copulations (EPCs)

During 2008, while searching for Mississippi Kite nests, we observed an extra-pair copulation (EPC). On 17 May, we observed a male Mississippi Kite soaring approximately 30 m from an active nest we located 3 days earlier. While watching this male soaring, we saw a female Mississippi Kite perched in a bare tree approximately 250 m west of the soaring male kite. We travelled 150 m west along the chute to a location where we could observe both the perched female and the soaring male. While we were observing the perched female another Mississippi Kite flew in and perched next to her. Soon after perching next to the female, the newly arrived bird quickly flew off to the north. At 1025 H, we observed the male seen soaring earlier near a nest 250 m upstream, fly downstream and attempt to copulate with the perched female. The female moved, interfering with the copulation attempt. Within approximately 3 sec of the male's attempt to copulate with the female, another Mississippi Kite flew directly at the male and chased him away from the perch tree until they were both out of view. At 1027 H, one Mississippi Kite returned to perch next to the female. Minutes later (1032 H), a Mississippi Kite came flying toward the perch from the north and rapidly descended on and chased away the kite perched next to the female. At 1033 H, a male Mississippi Kite flew onto the back of the female and copulated with her for approximately 15 s before circling the perch and landing next to her. At 1041 H, the male that copulated with and perched next to the female flew to the north over the timber and out of sight. Within 10 s of the male's departure another male kite flew toward the female from the southeast and immediately copulated with her for approximately 5 s before flying north over the timber. We believe that the second male that copulated with the female at 1041 H was the male seen soaring near a nest 250 m away, given the behavior of that male earlier in the day and the aggressive actions between the two males near the female's perch. Due to the northward departure of one male and the arrival of a male from the southeast in such a short amount of time (ca. 10 s), we believe these were definitely two different individuals.

Our observations are very similar to those reported by Bader et al. (2007) in which they discuss an EPC involving a male and female Mississippi Kite of one pair and a male from another pair. The behaviors of the individuals involved in the EPC observed by us and the EPC reported by Bader et al. (2007) suggests that what we observed was an EPC. Bader et al.'s (2007) and our observation of EPCs involving Mississippi Kites are the only accounts reported for the species. However, there has been no study of marked Mississippi Kites, so EPCs could easily be missed. We can only document EPCs if 2 males are interacting with a female at the same time. Thus, we suggest a study of marked Mississippi Kites is required to document the true frequency of EPCs in Mississippi Kite populations.

Nest Reuse

From 2006 to 2008, we documented six cases of nest reuse. Of these six reused nests, four were successful the year prior to reuse. Only one of the six nests was successful when reused. One reused nest was occupied for four consecutive years and was successful for the first 3 years. However, it was not reused following an unsuccessful year. St. Pierre (2006) reported the reuse of three nests, two of which were successful the year prior to reuse and none of which were successful when reused. Bader (2007) reported the reuse of six nests, four of which were successful prior to their reuse and three of which were successful when reused. Combining all study seasons in which reused nests were documented in the WRNWR (2003 – 2007) results in a reuse rate of 18%. These results indicate that the majority (67%) of reused Mississippi Kite nests were successful the year before their reuse, while only 30% were successful when reused. The fate of two reused nests was unknown and these were therefore excluded from the analysis. Parker (1974) reported a nest reuse rate (16%) similar to ours for Mississippi Kites nesting in the Great Plains and noted that successful nests were more often reused. Barber (1995) reported a reuse rate of 21% for kites in Missouri and Evans (1981) reported a reuse rate of 50% in southern Illinois. Our results clearly indicated that the number of reused nests may be influenced by the fate of the nest the year prior to reuse. Evans (1981) reported a similar trend in nest reuse and noted that the Mississippi Kite's nest site fidelity makes it particularly vulnerable to degradation of nesting habitat by land use practices. Newton (1979) noted that reuse of nesting areas is advantageous because birds may be more successful in territories they are more familiar with. While we were not able to identify if the pair reusing a nest was the same pair from the previous year, the fact that successful nests are being reused more than unsuccessful nests has important conservation implications. Nest sites that are reused may represent higher-quality territories than those that are only used once, thereby making them more valuable with respect to conserving the nesting habitat of Mississippi Kites on the WRNWR.

Snake-excluder Devices

In 2008, we had 11 nests that survived beyond the first week of incubation, thus making them eligible for SNED application. Of the 11 available nests, we placed SNEDs on the trunks of five randomly-selected nest trees. In an attempt to determine what the causes of nesting failures were between flashed and unflashed nest trees we deployed cameras at three flashed and three unflashed nests. Of the five flashed nest trees, two fledged one nestling each (40%), two failed during the nestling stage, and one failed during incubation. The nest failure during incubation was due to unknown causes. One of the nests that made it to the nestling stage was depredated by a Barred Owl. The other nest that reached the nestling stage failed due to unknown causes; although the nestling was found on the ground below the nest we were unable to determine what caused the failure. Of the six nest trees that did not have SNEDs attached, two fledged one nestling each (33.3%), two failed during incubation, and two failed during the nestling stage. Of the failures, one was attributed to the nestling falling out of the nest, and the causes of the remaining failures were unknown. Our preliminary results, although sample-size limited, show no clear difference between the success of nests with and without SNEDs attached.

Rat snakes possess the ability to detect prey via chemosensory and visual stimuli (e.g., Halpern 1992, Mullin and Cooper 1998, Mullin et al. 1998), which both aid in the location and acquisition of prey (Mullin and Gutzke 1999). In addition, rat snakes are well known as skilled tree climbers (e.g., Jackson 1976, Neal et al. 1993, Mullin and Cooper 2002) and have been documented to spend a high proportion of their time in arboreal habitats (Jackson 1976, Mullin et al. 2002). Due to the mean height of Mississippi Kite nests (26.89 m; Bader 2007) in the WRNWR, we believe that rat snakes are not able to visually detect movement in or immediately around the nest from the ground, and therefore, are unlikely to select specific trees in which to climb based on visual cues. Consequently, we suggest that rat snakes may be utilizing chemosensory stimuli (Halpern 1992) to detect Mississippi Kite nests from the ground. Several studies have documented rat snakes visiting nests where nestlings had recently fledged, suggesting that rat snakes likely locate nests by detecting odor (Eichholz and Koenig 1992, Neal et al. 1993, Stake et al. 2005). Rat snakes also have been reported to selectively climb trees to depredate Red-cockaded Woodpecker (*Picoides borealis*; Neal et al. 1993) and Western Bluebird (*Sialia Mexicana*; Eichholz and Koenig 1992) nests. The eggshells of Mississippi Kites, which are left in the nest (Parker 1999) or are thrown from it by the adults (Shaw 1985), in addition to nestlings defecating within or over the side of nests (Parker 1999) are all potential sources of odor that a rat snake could potentially detect. Undoubtedly, traceable amounts of fecal material reach the ground or tree leaves relatively close to the ground to be detected by a rat snake, thereby allowing snakes to more precisely select trees to climb. Although rat snakes may detect and depredate bird nests simply by chance while moving through the forest canopy, such a technique may be energetically inefficient (e.g., Lillywhite and Henderson 1993, Mullin and Cooper 1998) and dangerous as a result of the potential risk of predation to the snake (Fitch 1963). Although our initial results do not indicate that SNEDs were effective at increasing nest success by lowering predation rates, our sample size was extremely limited. Thus, we believe that the effectiveness of SNEDs at preventing snake depredations requires additional investigation as a management tool for both Swallow-tailed and Mississippi kite nests.

Video Recording at Nests

During the 2006, 2007, and 2008 study seasons, we deployed a total of 18 video camera systems at Mississippi Kite nests; six each year. We deployed 11 cameras during the incubation stage and seven during the nestling stage. We recorded >14,000 hr of video footage. We documented 10 events that led to nesting failures. Five were attributed to nest predation, and five were attributed to non-predator related causes.

In 2006, we deployed six camera systems at nests and documented three nesting failures. Two of the documented failures were due to nest abandonment following camera setup near the nest. At 0914 H on 22 June, we deployed an overhead system at a nest with a nestling approximately 1 week old. The adult left the nest during setup and failed to return to brood and feed the nestling for 31 hours. At 1615 H on 23 June, the adult returned to the nest with a prey item, but the nestling died approximately 40 min prior to the arrival of the adult. The adult brooded the dead nestling through the morning of 24 June, realized it was dead, and left. In the other case, at 1208 H on 15 June, we deployed a camera at a nest that was believed to be late in the incubation stage. Following camera setup, we recorded no adults returning to the nest. No egg or nestling was able to be seen in the nest from the video. The third failure occurred at 2059 H on 19 July when a Barred Owl killed a 1-week old nestling.

During the 2007 study season, we deployed six video camera systems at Mississippi Kite nests. We documented five events that led to nesting failures; two were attributed to Barred Owls, one was caused by a rat snake, and two were due to non-predator related causes. At 0449 H on 29 June, a Barred Owl footed a brooding adult off of its nestling and then killed the nestling and flew off with it. At 0441 H on 23 July, a Barred Owl landed on a 4-week-old nestling and killed it. At 2133 H on 29 June, a rat snake climbed into a nest and struck the brooding adult on its side, forcing it to flush from the nest. The snake immediately coiled around and killed the nestling. The snake then attempted to swallow it for >90 min until it dropped the dead nestling over the side of the nest.

One non-predator related nesting failure occurred at 0026 H on 23 July 2007. We documented a nestling collapse and die while sitting in its nest. The necropsy results indicated that the bird died of myocardial thrombosis probably caused by a protozoan parasite infection in several organs. The other failure was attributed to an abandonment following camera setup. The nest was located on 2 June during the building stage. The nest was checked on 7 June and an adult was in incubation position on the nest. On 8 June we deployed an overhead camera system at the nest. The adult flushed from the nest prior to the climber ascending the tree. The video showed no adults returning to incubate the single egg.

During the 2008 study season, we recorded video data at six Mississippi Kite nests. We deployed a camera at a seventh nest, but the camera malfunctioned and the nest failed before we were able to replace the camera, thus yielding no data. We documented two events that led to nesting failures. At 1050 H on 8 July 2008 an approximately 4-week-old nestling stood up in its nest, spread its wings, and fell over the side of the nest. The nestling grabbed onto a stick below the nest and hung upside down for 6 min before falling out of view. The limb the camera was mounted on and the limb the nest was in were both swaying as a result of the wind at the time the nestling fell out of the nest. Therefore, we believe that while the nestling was standing and exercising its wings a gust of wind caused it to lose its balance and fall from the nest. The nestling was found dead on the ground below the nest at 1503 H on 9 July.

At 0022 H on 23 July, a Barred Owl killed a 5-week-old nesting by pulling it off the nest and flying away with it. During nest checks prior to the predation event, we observed ≥ one Barred Owl flying through the timber within 50 m of the nest tree on two occasions. This failure and other predation events that occurred at Mississippi Kite nests during brooding suggest that predators, particularly Barred Owls, are likely cuing in on parental activity at and around the nest. Barred Owls prefer large, contiguous blocks of mature and old-growth forest, which facilitate movement and hunting, especially in bottomland hardwood forests (Mazur and James 2000). The apparent similarity between habitat selected by both Mississippi Kites and Barred Owls suggests that likely frequent interaction between these two species in the WRNWR may be a reason for the observed predation events.

On 11 June 2008, we checked a Mississippi Kite nest's status prior to deploying an overhead camera system and observed an adult on the nest in incubation position. While continuing to observe the adult on the nest, we observed an incubation switch between the adults. We proceeded to climb to the nest and upon reaching it we discovered there were no eggs in it. While near the nest, three Mississippi Kites were circling overhead and calling. Because of this discovery, we decided to abort the camera deployment and we searched the ground thoroughly below the nest for eggshell fragments, but found none. The pair of this nest began incubating on 20 May and had been on the nest in incubation position during each subsequent 3-day nest check, including on 11 June. When we returned on 14 June, there were no adults on the nest or in the nest area. The behaviors of the adults throughout incubation and during the attempted camera deployment suggested that the female likely laid at least one egg. However, we believe that the nest could have been depredated by a rat snake shortly before we climbed to it and the adults simply continued to incubate the nest without eggs.

Capturing and Radio-tagging

In 2006, we captured seven adult and three juvenile Mississippi Kites (Table 1). All adults (5 females and 2 males) and two juveniles were outfitted with radio transmitters. One juvenile was not outfitted with a radio transmitter due to it being trapped late in the nesting season. In 2007, we captured four adult and one juvenile Mississippi Kites (Table 1). All adults (1 female and 3 males) and the single juvenile were outfitted with radio transmitters. In 2008, we captured three adult and three juvenile Mississippi Kites (Table 1). We outfitted all adults (2 females and 1 male) and two juveniles with radio transmitters. We did not outfit one juvenile with a radio transmitter due to it being trapped late in the nesting season. We collected morphometric measurements, mass, and blood samples and placed USGS aluminum bands and two plastic color bands on all individuals.

Three of the five radio-tagged juveniles died or were killed by predators before spatial use data were collected. One kite still wearing a radio transmitter from a previous year was resighted in 2006 and two kites still wearing radio transmitters were resighted in 2007, but we were unable to read their colored leg bands to identify individuals.

Radio-tracking and Home-range Analysis

We radio tracked Mississippi Kites from a fixed-wing aircraft 2 – 3 times per week, from 18 July to 25 August 2006, 19 July to 22 August 2007, and 21 July to 30 August 2008. We collected 404 locations from the air (2006 = 158 locations, 2007 = 82 locations, 2008 = 164 locations, mean per kite = 23 locations). We also collected a mean of 28 triangulations per bird (N = 8 kites). We generated home-range size estimates on eight Mississippi Kites in 2006, four in 2007, and four in 2008. The 2006 and 2008 home-range size estimates were based on locations obtained from aerial telemetry and ground triangulations whereas the 2007 home-range size estimates were based solely on aerial telemetry locations.

We estimated 95% fixed kernel home-ranges for each radio-tagged kite (Table 1). The largest home range was that of a female captured in 2006 and was 7,998 ha. The smallest home range was that of a female also captured in 2006 and was 356 ha. The mean female home-range for all years was 3,137 ha (N = 7). The mean male home-range size for all years was 3,144 ha (N = 5). The mean juvenile home range for all years was 2,599 ha (N = 2). We excluded some locations for two radio-tagged kites before calculating their home-range sizes, as the locations were relatively far outside of their previously-used area and were in mid- to late-August when kites begin migrating. An adult female (745-57342) tracked in 2006 was located 36 km northeast of its nest on 14 August. In addition, a hatch-year kite (745-57352) trapped in 2008 was located 39 km north of its nests on 24 and 30 August. Home-ranges for these individuals were generated after excluding the pre-migratory locations.

The home-ranges of two kites (745-57336, 745-57337) radio-tagged in 2006 were not included in our mean home-range estimates due to their relatively large size. Both adults were of the same breeding pair and were trapped on 12 July and locations were first collected on 18 July. The pair's nest failed on 19 July. Locations on the pair continued to be collected, but ranged widely, likely due to no longer having to care for their nestling. Therefore, we do not believe the home ranges of these two individuals are representative of a nesting kite, as the majority of the points were collected following nesting failure.

Our home-range results are similar to those reported by Bader (2007). Mean male Mississippi Kite home-range size was larger than mean female home-range size. This is likely the result of the female playing a more important role in the nest defense and nestling care while the males play a more important role in providing food for the nestlings, resulting in them travelling farther distances to obtain food (Bader 2007).

Table 1. Mississippi Kites banded and radio-tagged in the White River National Wildlife Refuge, Arkansas in 2006, 2007, and 2008.

Year	USGS_No.	Sex	Age[a]	Number of Triangulations	Number of Aerial Locations	Total Points	95% Kernel Home Range (ha)
2006	745-57334	F	AHY	23	18	41	7998.8
2006	745-57335	F	AHY	0	26	26	356.5
2006	745-57336	M	AHY	0	26	26	93621.3[d]
2006	745-57337	F	AHY	0	18	18	30048.2[d]
2006	745-57338	---[c]	HY	0	2	2	0[bd]
2006	745-57339	F	AHY	5	12	17	620.4
2006	745-57340	M	AHY	5	21	26	780.7
2006	745-57341	---[c]	HY	0	24	24	4086
2006	745-57342	F	AHY	8	13	21	2796.6
2007	745-57345	F	AHY	0	17	19	4746.9
2007	745-57346	M	AHY	0	15	27	3864.5
2007	745-57347	M	AHY	0	16	18	5228.6
2007	745-57348	M	AHY	0	15	18	4010.4
2008	745-57358	F	AHY	44	39	83	3521.9
2008	745-57350	F	AHY	50	40	90	1920.1
2008	745-57351	M	AHY	47	37	84	1839.6
2008	745-57352	---[c]	HY	38	38	76	1111.7
2008	745-57353	---[c]	HY	0	10	10	0[bd]
Mean				**16**	**22**	**38**	**3063.1**

[a] AHY = After hatch year or breeding adult; HY = Hatch year or nestling.

[b] Chick died or was depredated before a sufficient number of locations were collected.

[c] Gender could not be determined by plumage characteristics or measurements.

[d] Excluded from mean home-range estimations.

Nest-site Characteristics

We collected nest site characteristic data for the two Swallow-tailed Kite nests and two paired random plots (Table 2). The mean height of the 2006 and 2008 Swallow-tailed Kite nest trees was 28.4 m and was not significantly taller (P = 0.784) than the mean height of the randomly selected trees (27.2 m). Mean nest tree diameter at breast height (82.8 cm) did not differ significantly (P = 0.242) from mean diameter at breast height (DBH) of random trees (47.8 cm).

Table 2. Characteristics of Swallow-tailed Kite nests (N = 2) and two paired randomly-selected sites in the White River National Wildlife Refuge, AR, 2006 and 2008.

Variable	2006		2008	
	Nest	**Random**	**Nest**	**Random**
Fate	Eggs eaten, Rat snake	---	Abandoned	---
Tree Sepcies	Nuttall Oak	Nuttall Oak	Overcup Oak	Pecan
Tree height (m)	34.10	36.27	22.75	18.22
DBH (cm)	89.00	68.00	76.60	27.60
Nest Height	30.70	---	19.83	---
No. of trees in 0.04 ha plot	---[a]	---[a]	4	5
Mean height of trees (m)[b]	---[a]	---[a]	18.36	14.99
Distance to forest edge (m)	---[a]	---[a]	518.00	618.00
Distance to water, flooded (m)	---[a]	---[a]	11.05	71.40

[a] No data available.

[b] Mean height of overstory trees surrounding plot-center tree in 0.04 ha circular plot.

To more effectively analyze nest site data for the Swallow-tailed Kite nests in the WRNWR, we combined data from all five nests and associated random plots (Table 3). Mean nest tree DBH was significantly greater than mean random DBH. Although Swallow-tailed Kite nest tree height was on average larger than random tree height, the difference was not significant. In addition, while nest tree emergence was greater between the Swallow-tailed Kite nest trees and the surrounding canopy than between random tree emergence above the surrounding canopy, the difference was not significant. There was no significant difference between nest-site distance to forest edge and random site difference to forest edge.

Table 3. Swallow-tailed Kite nest site characteristics in the White River National Wildlife Refuge, AR (2002, 2004, 2005, 2006, 2008).

	Means		
Variable	**Nest**	**Random**	***P*-value** [a]
Tree height (m)	31.27	27.05	0.062
Diameter at breast height (cm)	83.92	49.33	0.003*
Nest Tree Emergence [b]	7.34	-0.41	0.053*
Distance to nearest edge (m)	502.8	496.5	0.927

[a] *P*-value <0.05 is significant.

[b] Emergence of the nest or plot center tree above the surrounding canopy.

* Statistically significant.

We collected nest measurements for the 2008 nest (Table 4). No measurements were collected for the 2006 nest. Sizes of the WRNWR nest are relatively smaller than those reported by Meyer (1995) (Bader 2007), particularly with respect to short and long diameters of the outside dimensions of the nest. In addition, the 2008 nest was relatively smaller than previously measured nests in the WRNWR.

Table 4. Swallow-tailed Kite nest dimensions (cm) in the White River National Wildlife Refuge, AR (2002-2008).

	Bowl Dimensions			Outside Nest Dimensions		
Nest Year	**Depth**	**Short Dia.** [a]	**Long Dia.** [a]	**Height**	**Short Dia.** [a]	**Long Dia.** [a]
2002	11	15	17	26	36	39
2004	6	19	22	20	34	37
2005	5	19	20	34	37	38
2006	--- [b]	--- [b]	--- [b]	--- [b]	--- [b]	--- [b]
2008	7	9	10	32.5	22	30
Meyer (1995), ± SD	4 ± 5	--- [b]	--- [b]	21 ± 9	42 ± 10	52 ± 10

[a] Dia. = diameter.
[b] No data available.

All five documented Swallow-tailed Kite nests in the WRNWR were located within a circular area approximately 3.7 km in diameter (Fig. 3). While we were unable to identify if the individuals returning each year were the same as individuals nesting in previous years, the strong site fidelity indicated by the proximity of the nesting attempts leads us to believe that at least one individual of the breeding pair has returned to the nest area in the WRNWR over the last 6 years. Meyer and Callopy (1995) reported the reuse of 17 of 22 nest sites in Florida, further suggesting the Swallow-tailed Kite's strong site fidelity to nest sites. Bader (2006) reported the site fidelity of Swallow-tailed Kites in the WRNWR, pointing out their consistent use of the area between Prairie Bayou, LaGrue Bayou, Brooks Bayou, and the White River. Our documentation of this high-use area has allowed us to more efficiently locate Swallow-tailed Kite nesting attempts on the WRNWR and will continue to serve as our focal point in future searches for Swallow-tailed Kite nests.

We collected nest site data for 52 Mississippi Kite nests and an equal number of associated random sites (Table 5). Mississippi Kite nest trees were significantly taller than random trees ($P < 0.001$) and nest tree DBH was significantly greater than random tree DBH ($P < 0.001$). Mississippi Kite nests were closer to a forest edge than random plots ($P < 0.02$) and were closer to water than random plots ($P < 0.05$). There was no difference between nest tree canopy density and random tree canopy density. We also found no significant difference between nest tree emergence above the surrounding canopy and random tree emergence above the surrounding canopy, although mean nest tree emergence was greater than random tree emergence (Table 5). Other studies on nesting Mississippi Kites in the MRV have reported nest trees as being significantly taller than the surrounding canopy (Barber et al. 1998, St. Pierre 2006, Bader 2007). Barber et al. (1998) speculated that Mississippi Kites nest in super-emergent trees to afford them easier access to their nests and better views of potential aerial predators. Bader (2006) noted that the significantly larger DBH of nesting trees is correlated with the age and size of a tree. The older age of Mississippi Kite nest trees likely results in there being thicker, sturdier limbs near the tops of tree where these kites build their nests. The sturdy limbs may be less likely to break or sway excessively during storms and high wind events, thus providing a relatively solid platform for kite nests. In addition, Bader (2007) reported that Mississippi Kite nest trees are significantly closer to a forest edge, perhaps related to the prey abundance associated with such habitat. Members of the insect family Odonata, which are often associated with water, make up a significant proportion of the Mississippi Kites' diet (Bader 2007). This may be a reason why Mississippi Kite nests are placed in relatively close proximity to a forest edge and water.

Table 5. Means and standard errors of Mississippi Kite nest site characteristics and random site characteristics in the White River National Wildlife Refuge, AR (2006 – 2008).

	Nest Site		**Random Site**		
Variable	**Mean**	**SE**	**Mean**	**SE**	***P*-Value**[a]
Tree height (m)	31.99	0.91	27.37	0.72	<0.001*
DBH (cm)	76.97	2.46	55.44	2.39	<0.001*
Plot Center Densiometer	6.80	0.39	7.09	0.47	0.540
No. of trees in 0.04 ha plot[b]	3.05	0.37	2.68	0.41	0.497
Mean tree ht. (m)[b,c]	27.23	1.62	24.54	1.71	0.154
Nest tree emergence (m)[b,d]	5.11	1.46	1.46	1.02	0.086
Distance to forest edge (m)[b]	37.10	7.10	73.90	15.00	0.016*
Distance to water (m)[b]	42.40	6.80	71.50	14.50	0.049*

[a]*P*-value <0.05 is significant.
[b]Data collected in 2008 only.
[c]Mean height of surrounding trees in 11.3 m circular plot.
[d]Emergence of nest tree above surrounding overstory trees.
*Statistically significant.

Mississippi Kite nests were located in 10 species of trees. Overcup oak (*N* = 14), Nuttall oak (*N* = 13), and sweetgum (*N* = 12) constituted 75% of nest tree species. American sycamore (*Platanus occidentalis*; *N* = 5), willow oak (*Quercus phellos*; *N* = 3), water oak (*N* = 1), pecan (*Carya illinoensis*; *N* = 1), cedar elm (*Ulmus crassifolia* ; *N* = 1) bald cypress (*N* = 1), and green ash (*N* = 1) were also used. The common use of overcup oaks, Nuttall oaks, and sweetgums as nesting trees may be due to their overall abundance on the refuge in addition to their relatively large size in comparison to other available tree species. The variety of tree species used coupled with the nest site characteristics selected by Mississippi Kites for nesting indicates that the physical characteristics of the trees in addition to their spatial location may be more important than the species of the tree (Bader 2007).

MANAGEMENT RECOMMENDATIONS

This study of a single breeding pair of Swallow-tailed Kites and the population of nesting Mississippi Kites on the WRNWR have yielded an invaluable amount of data and insight into the species' nesting ecology and habitat requirements. Overall, our results suggest that the Mississippi Kite population suffers from an unusually low nest success rate in comparison to other studied populations both in the MRV and the Great Plains and Southwest. Continued monitoring of Swallow-tailed Kite breeding attempts along with timely management actions is likely to be essential to the restoration of this species within the state and much of its former breeding range. With sound conservation and management practices, we suggest that it is possible to both increase Mississippi Kite nesting success within the WRNWR and re-establish a viable breeding population of Swallow-tailed Kites within Arkansas.

The data collected throughout the past three field seasons supplements the data collected since 2002, and we propose a management plan for Swallow-tailed Kites and management suggestions for Mississippi Kites in the White River National Wildlife Refuge:

Proposed Swallow-tailed Kite Management Plan

- The current known Swallow-tailed Kite nesting area (4-km diameter area), specifically, the area between LaGrue Bayou, Prairie Bayou, White River, and Brook's Bayou should be conserved and no significant timber harvest such as a clear-cut or a seed-tree cut should take place in this area. Small patch or group-selection cuts (<5 ha) may be consistent with kite conservation, but all super-emergent trees with a DBH >70 cm within this area should be conserved.

- Minimize disturbances in the Swallow-tailed Kite nesting area from 1 April through 31 July. No timber harvest should take place in this area during this time period.

- Large, super-emergent trees should be conserved throughout the refuge as nesting habitat. Management to promote the development of additional large, mature patches of super-emergent trees will likely be beneficial. Conservation of ≥5 overstory or canopy trees per ha during all future timber harvests would provide sufficient nesting and foraging habitat.

- Conserve large, mature tracts of forest and avoid forest fragmentation.

- Timber harvest should be conducted in such a way that even-height canopy forests are not created. Second growth forest should be allowed to develop for a longer period of time between harvests (>75 yr). Minimize even-aged regeneration of large clear-cuts, seed-tree cuts, and fallow fields.

- All wetlands should be conserved to support habitat diversity and prey abundance.

- Conserve all known Swallow-tailed Kite nest sites. Do not harvest any documented nesting trees.

- We recommend the following with regards to safely locating and monitoring all Swallow-tailed Kite nests.

    1. Begin searching for Swallow-tailed Kites on 1 April each year. Initial searches should focus in areas of prior sightings and nesting attempts. Posting flyers around the refuge asking citizens to report sightings may aid nest searchers in determining areas in which to focus search efforts.

    2. The breeding status of located kites should be determined by observing behaviors such as copulations, food offerings, and nest material acquisition.

    3. Every attempt should be made to locate the nest prior to the start of incubation (ca. April 19).

    4. Once a nest is located, the WRNWR staff should be made aware of its location and should take precautions to avoid disturbing it. This may include a 1-km radius protected area around the nest where all potentially-disturbing activities should be prohibited between when the nest is located and 31 July.

    5. All nest trees should have a camouflaged snake-excluder device attached to them 7 – 14 days after the start of incubation. Snake excluder devices should be setup in the least amount of time possible to minimize disturbances. For conservation and re-establishment of this extremely vulnerable population (i.e., one pair), all reasonable efforts should be made to support successful production of fledgling kites. These young kites will then likely return to WRNWR and potentially establish additional pairs. The establishment of multiple nesting pairs in a "nesting neighborhood" will allow the Swallow-tailed Kites to more effectively deter predation by aerial predators, such as Barred Owls.

    6. In regard to recommendation number 5 above, we further recommend continued research in the effective deployment and use of snake-excluder devices and other innovative approaches to minimize predation on kite nests to best foster successful reproduction by Swallow-tailed Kites in Arkansas.

7. Nest monitoring should take place every 3 – 4 days from a distance of at least 100 m from the nest tree until the nest fails or fledged chicks. There should be no more than two observers present during nest monitoring to minimize potential disturbances.

Mississippi Kite Management Suggestions:

- Large, super-emergent trees should be conserved throughout the refuge as nesting habitat. Management to promote the development of additional large, mature patches of super-emergent trees will likely benefit nesting kites.

- Conserve large, mature tracts of forest and avoid forest fragmentation.

- Timber harvest should be conducted in such a way that even-height canopy forests are not created. Second-growth forest should be allowed to develop for a longer period of time between harvests (>75 yr). Minimize even-aged regeneration of large clear-cuts, seed-tree cuts, and fallow fields.

- Conserve all known Mississippi Kite nest sites. Do not harvest any documented nesting trees (Appendix D; St. Pierre 2006, Appendix III; Bader unpubl. data, Appendix E).

- All wetlands should be conserved for habitat diversity and prey abundance.

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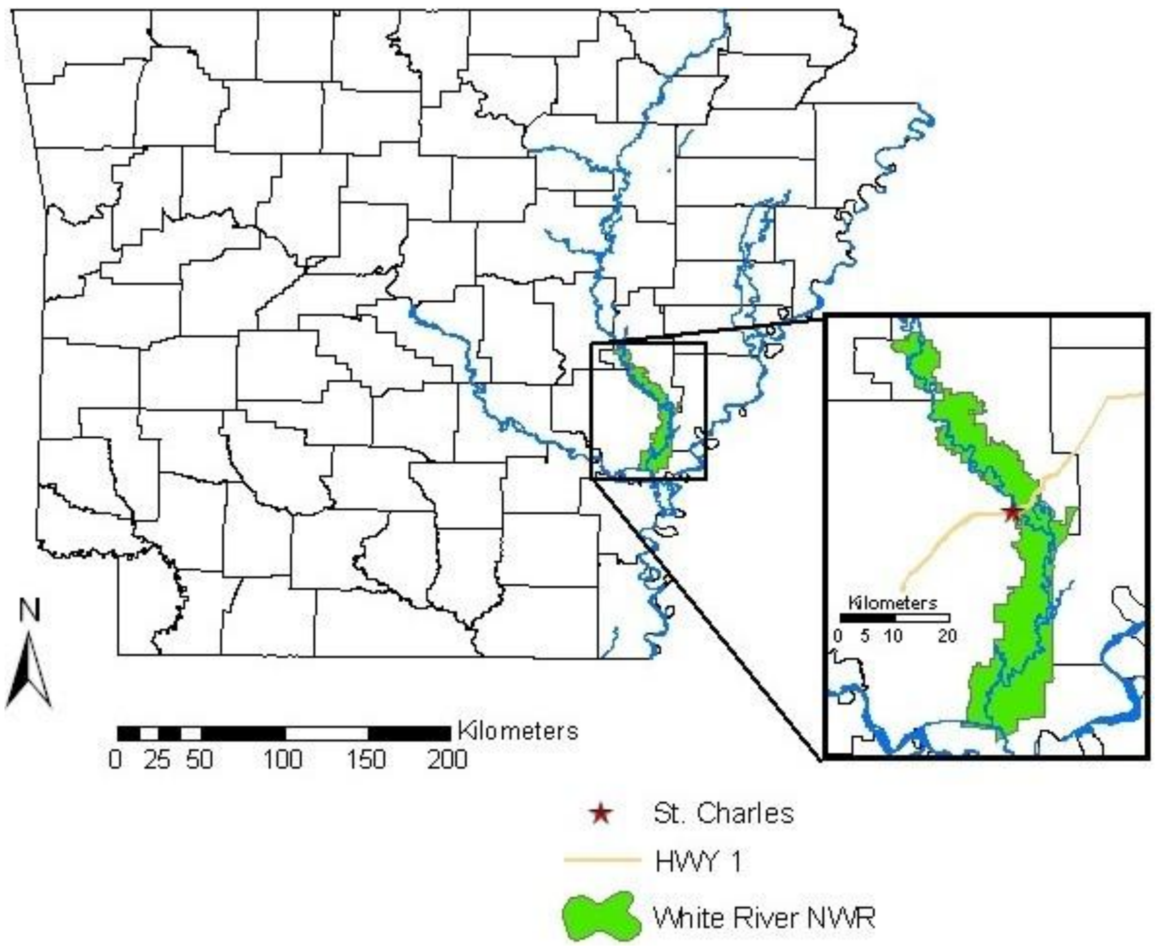

Figure 1. Location of the White River National Wildlife Refuge in Arkansas.

Figure 2. Snake excluder device (SNED) ≥ 0.9 m tall wrapped around and stapled to trunk of a Mississippi Kite nest tree.

Figure 3. The 2002, 2004, 2005, 2006, and 2008 Swallow-tailed Kite nest locations (stars) in the White River National Wildlife Refuge, AR.

Appendix A. 2006 Swallow-tailed Kite (STKI) sightings in the White River National Wildlife Refuge, AR.

04/17/06 – 9:30 – Found STKI nest with 2 adults present between Prairie Bayou and powerline.
UTM 670878 3782199

Observer: Sabine Schaefer

04/18/06 – 13:34 – 1 Red-shouldered Hawk flew by nest and was chased away by 3 STKIs.

13:35 – STKI incubating. 2 STKIs present flying around nest area.

14:02 – 1 STKI on nest. 2 STKI flying near nest area. One of the flying kites seems to be trying to chase off the other kite.

Observer: S. Schaefer

04/27/06 – 8:00 – Protective flashing put up around nest tree, STKI still incubating.

Observer: S. Schaefer

05/03/06 – 9:15 – STKI nest failed, no birds present. Snake tracks found going down grease on flashing.

Observer: S. Schaefer

05/14/06 – 14:00 – 2 STKI foraging at beginning of ATV trail by Prairie Lake.
UTM 673595 3782183

Observer: S. Schaefer and Troy Bader

05/15/06 – 11:54 – 2 STKI flying over main gravel road under powerline.
UTM 673789 3781330

Observer: J.P. Fairhead

13:00 – 1 STKI flying over ATV trail near 2006 nest.
UTM 672710 3782260

Observer: T. Bader

05/19/06 – 12:10 – 1 STKI flying low over canopy near 2006 nest.
UTM 670878 3782199

Observer: S. Schaefer

05/26/06 – 6:45 – 1 STKI flying over Prairie Bayou.
UTM 670560 3782886

Observer: S. Schaefer and T. Bader

06/01/06 – 10:30 – 1 STKI high over Albert's Pond.
UTM 668907 3780691

Observer: T. Bader

Appendix A (continued).

06/03/06 – 14:30 – 1 STKI and 50 MIKI foraging over field north of Highway 44 coming from Weber boat ramp.
UTM 667246 3780122

Observer: S. Schaefer and T. Bader

Appendix B. 2007 Swallow-tailed Kite (STKI) sightings in the White River National Wildlife Refuge, AR.

04/24/07 – 8:35 – 1 STKI appeared from north, circled low over canopy near powerline at height of ATV trail, then flew out of sight back toward north.

8:38 – 1 STKI appeared again and circled directly above powerline then disappeared toward south.
UTM 670905 3781447

Observer: Sabine Schaefer

04/29/07 – 15:50 – 1 STKI flying over Allen Clawson's house (Weber) at height of about 18 m.
UTM 667655 3779157

Observer: Allen Clawson

05/11/07 – 8:00 – 1 STKI circling over Wolf Lake.
UTM 672842 3780049

Observer: Nina Capps

05/21/07 – 12:00 – 1 STKI reportedly came from woods toward ATV trail by Brooks Bayou near Wolf Lake campground.
UTM 672842 3780049

Observer: Campers

05/25/07 – 17:00 – 1 STKI kiting over Farm Unit (east side of Big Island Chute).
UTM 672155 3799715

Observer: Hugo Gee (forestry PhD student at LSU)

05/31/07 – 7:00 – 1 STKI flushed, later dove down under canopy during helicopter search - south of Jack's Bay.
UTM 668177 3772816

Observers: Karen Rowe and Kevin Best

8:00 – 2 STKI circling over canopy moving slowly toward west along powerline.
UTM 671493 3781624

Observers: K. Rowe, K. Best, J. Bednarz, and S. Schaefer

06/02/07 – 13:15 → 13:30 – 2 STKI foraging over main gravel road along power line.
UTM 673562 3781402

Observers: Dan Scheiman, Dennis Braddy, Gail and Carl Northcutt

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06/07/07 – 8:50 – 2 STKI foraging in area of MIKI nest (07MN11).
UTM 671551 3781534

Observers: Joel Tebbenkamp and S. Schaefer

Appendix B (continued).

06/08/07 – 10:10 – 2 STKI circling and calling over MIKI nest together with MIKIs (just attached overhead-camera system at nest (07MN11).
UTM 671551 3781534

Observers: J. Tebbenkamp and S. Schaefer

Appendix C. 2008 Swallow-tailed Kite (STKI) sightings in the White River National Wildlife Refuge, AR.

04/01/08 – 10:30 – One Swallow-tailed Kite observed soaring over a wheat field near the Weber boat launch.
UTM 667246 3780122

Observer: Larry Bruce

04/09/08 – 14:28 – 2 STKIs soaring above Prairie Bayou.
UTMs: 672375, 3782173

15:05 – 2 STKIs soaring above ATV trail south of Prairie Bayou.
UTMs: 672562, 3782144

Observer: Scott Chiavacci

04/10/08 – 10:59 – 1 STKI soaring over timber north of powerline.
UTMs: 672088, 3781505

12:12 – 2 STKI soaring over powerline and timber south of powerline.
UTMs: 672292, 3781536

12:57 – 1 STKI soaring approximately 90 m above canopy northeast from corner of powerline south of Fish Lake.
UTMs: 673130, 3781820

13:26 – 2 STKIs soaring approximately 30 m above canopy north of powerline.
UTMs: 672316, 3781743

13:39 → 14:19 – 2 STKIs soaring above powerline and timber north of powerline.
UTMs: 672442, 3781525

Observer: S. Chiavacci

04/11/08 – 9:17 – 1 STKI soaring above ATV trail south of Prairie Bayou
UTMs: **672593, 3782113**
12:13 – 2 STKIs soaring over timber north of powerline
UTMs: 672446, 3781749

Observer: S. Chiavacci

Appendix C (continued).

04/12/08 – 11:25 – 2 STKIs soaring approximately 15 m above canopy, about 120 m north of powerline.
UTMs: 672295, 3781824

11:30 – 1 STKI flew directly overhead low and fast about 5 m above canopy north of powerline.
UTMs: 672358, 3781749

12:00 – 1 STKI came flying toward powerline low and fast from north while dipping in and out of canopy.
UTMs: 672388, 3781774

13:39 – 1 STKI soaring over timber north of my location along powerline.
UTMs: 672343, 3781810

Observer: S. Chiavacci

04/13/08 – 7:12 – 2 STKIs flying very low over timber near powerline.
UTMs: 672273, 3781820

8:04 – 2 STKIs soaring over timber north of the powerline.
UTMs: 672213, 3782006

13:07 – 2 STKIs soaring low timber north of powerline. One kite promptly flew east of my location. The remaining kite, which soared low for 30 sec, appeared to drop a stick from its feet before flying south.
UTMs: 672312, 3781812

14:57 – 1 STKI soaring approximately 20 m above canopy north of powerline.
UTMs: 672103, 3781620

Observer: S. Chiavacci

04/14/08 – 11:45 – 1 STKI soared from north to south low over powerline and out of view.
UTMs: 672460, 3781517

12:42 – 1 STKI appeared from south of powerline carrying twigs. It flew north across powerline, but quickly turned around and flew back south of powerline.
UTMs: 672362, 3781313

13:15 – 1 STKI came flying low over canopy from timber south of powerline and continued to fly in a northeast direction and out of view.
UTMs: 672533, 3781678

13:24 – 1 STKI came flying from northeast of powerline, flew across powerline, and continued in a southwest direction. The kite was carrying nesting material and its flight was straight and deliberate.
UTMs: 672238, 3781396

Observer: S. Chiavacci

Appendix C (continued).

04/15/08 – 11:22 – 1 STKI appeared from southwest of my location on powerline soaring low over canopy.
UTMs: 672293, 3781445

11:56 – 1 STKI soared over canopy south of powerline carrying a stick. Its flight was straight and low over canopy.
UTMs: 672342, 3781304

13:42 – STKI nest located. No STKIs on nest.
UTMs: 672288, 3781003

13:55 – 2 STKIs flew back into nest area low over canopy. Neither flew to the nest.
UTMs: 672263, 3781010

15:48 – 2 STKIs flew into view from east of my location. One was carrying a live rough green snake (*Opheodrys aestivus*) in its talons.
UTMs: 672230, 3781061

Observer: S. Chiavacci

04/16/08 – 6:54 – 2 STKIs soaring low over canopy in area of nest for ca. 3 min.

7:25 – Female STKI standing on edge of nest

7:34 – The male STKI flew toward the nest with a stick, landed on the female's back while she was on the edge of the nest, copulated with her, and then flew off.

7:36 → 8:27 – Both birds added nest material to the nest on 12 separate occasions. The majority of the time the female was standing on the nest edge while the male searched for and acquired nest materials, which he delivered to the waiting female. When the male gave the female the material she would add it to the nest while he would return to searching for material.

8:29, 8:53, 9:03 – On three separate occasions an immature Broad-winged Hawk flew within 70 m of the STKI nest and was chased out of view of my location by at least 1 adult kite.
UTMs: 672288, 3781003

Observer: S. Chiavacci

04/21/09 – 6:45 – STKI in incubation position on the nest. No other STKIs observed near nest area.

Observers: S. Chiavacci and Dick Baxter

04/28/08 – 8:11 – 1 STKI soared low across Brook's Bayou and then proceeded to fly south over the timber.
UTMs: 671873, 3779638

Observer: S. Chiavacci

Appendix C (continued).

05/01/08 – 7:09 – 1 STKI flew from north to south over powerline carrying a small stick in direction of the STKI nest.
UTMs: **672408, 3781520**

8:56 – 1 STKI soaring low over Brook's Bayou near south end of Wolf Lake.

9:00 – 1 STKI reemerged from south of Brooks Bayou flying low and heading north toward nest area.
UTMs: 672269, 3779667

Observer: S. Chiavacci

05/04/08 – 6:30 – Attached flashing to nest tree. One adult incubating.
UTMs: 672288, 3781003

Observers: S. Chiavacci, Brad Bawden, T. Bader, Erica Bader

05/12/08 – 13:00 – 1 STKI soaring over road leading to Alligator Lake.
UTMs: 677076, 3769689

Observers: Brian Wilson, Nicholas Thompson (Pileated Woodpecker research crew)

05/22//08 – 11:57 – 1 STKI soared from north to south low over powerline heading in direction of nest.
UTMs: 672200, 3781000

Observers: S. Chiavacci, B. Bawden

05/26/08 – 7:00 – Began setting up camera at nest. Brooding adult remained on nest until S. Chiavacci was 4 m below it. Both adults circled low overhead and called during camera setup. Following camera deployment we immediately left nest area to avoid further disturbance to the adults.
UTMs: 672288, 3781003

Observers: S. Chiavacci, J. Bednarz, B. Bawden

05/28/08 – 9:10 – 1 STKI soaring low and calling within 100 m of nest. No adult brooding and no chicks over the top of the nest. Upon checking video camera we did not see a brooding adult or the heads of the nestlings.
UTMs: 672288, 3781003

Observers: S. Chiavacci, B. Bawden

05/29/08 – 7:25 – Began climbing to the nest to remove camera system and check nest for contents. S. Chiavacci recovered two dead nestlings from inside the nest. During S. Chiavacci's climb to the nest and the time spent near it, two adult STKIs soared within 100 m of the nest during camera removal for approximately 20 minutes.
UTMs: 672288, 3781003

Observers: S. Chiavacci, B. Bawden

Appendix C (continued).

08/06/08 – 15:39 – 1 STKI soaring over timber south of Hwy 1 in the middle of the refuge. The kite slowly soared in a northwest direction across Hwy 1 and out of view. I observed the bird for approximately 5 min before losing sight of it.
UTMs: **675736, 3806727**

Observer: S. Chiavacci

Appendix D. Mississippi Kite nest locations, nest tree species, and nest fates in the White River National Wildlife Refuge, Arkansas in 2006, 2007, and 2008.

Nest[a]	Nest Location[b]	UTM[c]		Tree Spp.	Success[d]	Cause of Failure	Camera[e]
06MIKI01	Big Island Chute	674952	3798243	Willow Oak	0	Infertile egg?	
06MIKI02	Big Island Chute	674500	3797461	Nuttall Oak	0		
06MIKI03	Brook's Bayou	670493	3779664	Nuttall Oak	0	Abandoned	Y
06MIKI05	Indian Bay	678101	3802249	Nuttall Oak	1		Y
06MIKI06	Holly Lake	667658	3813406	Sycamore	1		
06MIKI07	Indian Bay	678677	3801607	Nuttall Oak	0		
06MIKI08	LaGrue Bayou	668328	3779637	Overcup Oak	1		Y
06MIKI09	White River, NU	668644	3809975	Nuttall Oak	1		
06MIKI10	Brook's Bayou	670663	3779794	Overcup Oak	0	Abandoned	Y
06MIKI11	Holly Lake	666735	3812741	Sweetgum	0		
06MIKI12	Lambert Bayou	670736	3811517	Sweetgum	1		
06MIKI13	LaGrue Bayou	669671	3779236	Overcup Oak	0	Barred Owl	Y
06MIKI14	White River, NU	669210	3810551	Sweetgum	0		
06MIKI15	White River, NU	665907	3812294	Sweetgum	1		
06MIKI16	Jack's Bay	669125	3774825	Overcup Oak	1		
06MIKI17	LaGrue Bayou	668722	3779008	Overcup Oak	1		Y
06MIKI18	Brook's Bayou	670339	3778011	Overcup Oak	0		
07MN01	Prairie Bayou	673644	3783593	Nuttall Oak	0		
07MN02	LaGrue - Weber	668722	3779008	Overcup Oak	0	Chick collapsed	Y
07MN03	LaGrue - Weber	668779	3780203	Overcup Oak	1		
07MN04	Powerline	670581	3781624	Nuttall Oak	0	Rat snake	Y
07MN05	Powerline	671054	3782025	Nuttall Oak	0		
07MN06	Big Island Chute	675740	3798361	Nuttall Oak	0	Barred Owl	Y
07MN07	Big Island Chute	674952	3798243	Willow Oak	0		
07MN08	White River, NU	669416	3810143	Sycamore	1		
07MN09	Powerline	669796	3781597	Sweetgum	0	Barred owl	Y
07MN10	LaGrue Bayou	669431	3775027	Overcup Oak	1		Y
07MN11	Powerline	671551	3781534	Overcup Oak	0	Abandoned	Y
07MN12	White River, NU	665908	3812294	Sweetgum	0		
07MN13	Holly Lake	667658	3813406	Sycamore	0		
07MN14	Indian Bay	678677	3801607	Nuttall Oak	U[f]		
07MN15	Indian Bay	677941	3803275	Sweetgum	0		
08MKN01	Prairie Bayou	670627	3782878	Overcup Oak	0		
08MKN02	Big Island Chute	673006	3799783	Sweetgum	1		Y
08MKN03	Big Island Chute	675140	3798286	Willow Oak	0	Chick fell from nest	Y
08MKN04	LaGrue Bayou	668479	3780558	Overcup Oak	0	Barred Owl	Y
08MKN05	White River, NU	669195	3811950	Sweetgum	0		
08MKN06	White River, NU	665589	3812638	Sycamore	0		
08MKN07	White River, NU	665752	3812933	Sycamore	0		
08MKN08	Big Island Chute	674404	3793465	Bald Cypress	0		

08MKN09	Big Island Chute	674064	3799630	Nuttall Oak	0	Rat snake?	
08MKN10	White River, SU	679018	3800298	Green Ash	1		Y
08MKN11	Big Island Chute	673130	3799592	Sweetgum	0		
08MKN12	Big Island Chute	674030	3793449	Nuttall Oak	0		
08MKN13	Maddox Bay	666595	3815506	Nuttall Oak	1		Y
08MKN14	Maddox Bay	668026	3817164	Water Oak	0		
08MKN15	Maddox Bay	668190	3817012	Sweetgum	0		
08MKN16	White River, NU	672364	3805447	Sweetgum	0		
08MKN17	White River, NU	672056	3806565	Pecan	0		
08MKN18	LaGrue Bayou	667298	3784978	Cedar Elm	0		
08MKN19	LaGrue Bayou	668388	3779961	Overcup Oak	1		Y
08MKN20	LaGrue Bayou	667196	3781947	Overcup Oak	0		

[a] Prefix: 06 = 2006, 07 = 2007, 08 = 2008.
[b] NU = North Unit.
[c] WGS 84, Zone 15.
[d] 1 = nest successful and 0 = nest failure.
[e] Y = yes, monitored with video camera.
[f] U = nest fate unknown.

Appendix E. Mississippi Kite nest locations, nest tree species, and nest fates in the White River National Wildlife Refuge, Arkansas in 2004 and 2005.

Nest[a]	Nest Location[b]	UTM[c]		Tree Spp.	Success[d]
Mkite 1	NA	NA	NA	NA	0
Mkite 2	LaGrue/Weber	668722	3779008	NA	1
Mkite 3	White River, NU	669203	3810589	NA	0
Mkite 4	Moon Lake	675405	3805518	NA	0
Mkite 5	Indian Bay	677877	3805941	NA	0
Mkite 6	Indian Bay	678627	3802079	NA	1
Mkite 7	LaGrue Bayou	668318	3780005	NA	0
Mkite 8	Brook's Bayou	671596	3779471	NA	0
Mkite 9	Brook's Bayou	671092	3778700	NA	0
Mkite 10	Prairie Bayou	669736	3784164	NA	1
Mkite 11	Indian Bay	677216	3806446	NA	0
Mkite 12	Big Island Chute	674180	3797396	NA	1
Mkite 13	LaGrue Bayou	668124	3779778	NA	0
Mkite 14	Big Island Chute	674244	3799847	NA	0
Mkite 15	LaGrue Bayou	667205	3781668	NA	1
Mkite 16	LaGrue Bayou	668441	3779136	NA	0
Mkite 17	Weber	668849	3780662	NA	U[f]
Mkite 18	Indian Bay	678541	3805260	NA	0
Mkite 19	Brook's Bayou	672009	3779603	NA	0
Mkite 20	Big Island Chute	672539	3799806	NA	0

Mkite 21	Prairie Bayou	670121	3785408	NA	0
Mkite 22	Wolf Lake	672733	3779785	NA	0
Mnest 1	White River, NU	669883	3810275	Sycamore	0
Mnest 2	Brook's Bayou	675141	3779680	Nutall	0
Mnest 3	Big Island Chute	673861	3793061	Sweetgum	0
Mnest 4	Big Island Chute	669283	3793061	Sycamore	0
Mnest 5	LaGrue Bayou	668124	3779778	Willow Oak	1
Mnest 6	White River, NU	668801	3810017	Sweetgum	0
Mnest 7	LaGrue Bayou	666841	3783567	Overcup	0
Mnest 8	Indian Bay	678438	3803520	Willow Oak	0
Mnest 9	Indian Bay	678719	3801795	Willow Oak	0
Mnest 10	Brook's Bayou	671405	3779269	Nutall	0
Mnest 11	Big Island Chute	674147	3798658	Willow Oak	0
Mnest 12	Indian Bay	678627	3802079	Willow Oak	0
Mnest 13	Prairie Bayou	669736	3784164	Willow Oak	0
Mnest 14	LaGrue/Weber	668722	3779008	Overcup	1
Mnest 15	Brook's Bayou	670951	3779553	Nutall	0
Mnest 16	Big Island Chute	672539	3799806	Sweetgum	1
Mnest 17	Columbus Lake	673946	3785210	Overcup	1
Mnest 18	LaGrue Bayou	668515	3779450	Overcup	1

[a] Prefix: 06 = 2006, 07 = 2007, 08 = 2008.

[b] NU = North Unit.

[c] WGS 84, Zone 15.

[d] 1 = nest successful and 0 = nest failure.

[e] Y = yes, monitored with video camera.

[f] U = nest fate unknown.