Home Range and Dispersal of Juvenile Florida Burrowing Owls

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Incidence of Nest Material Kleptoparasitism Involving Cerulean Warblers

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ABSTRACT.—We document 21 observations of interspecific stealing of nesting material involving Cerulean Warblers (*Dendroica cerulea*), Red-eyed Vireos (*Vireo olivaceus*), Blue-gray Gnatcatchers (*Polioptila caerulea*), Northern Parulas (*Parula americana*), Black-throated Green Warblers (*D. virens*), American Redstarts (*Setophaga ruticilla*), and Orchard Orioles (*Icterus spurius*) that occurred during studies of Cerulean Warbler breeding biology. These incidents involved a variety of combinations of nest owner and nest material thief suggesting that each of these species is both a perpetrator and recipient of this behavior in our study areas. Kleptoparasitic incidents occurred at all stages of the nesting cycle from nest-building through post-fledging. Two possible motivations for this behavior are related to saving time in finding nest materials and collecting this material for nest construction. *Received 21 November 2005. Accepted 3 September 2006.*

The Cerulean Warbler (*Dendroica cerulea*) is a canopy-nesting bird of eastern deciduous forests. Nests of this species are composed mainly of bark fiber, fine grass stems, weed stalks, hairs, spider webs, grapevine bark, lichen, and moss (e.g., Bent 1953, Ehrlich et al. 1988, Oliarnyk and Robertson 1996, Hamel 2000). Nests are typically on horizontal branches and are concealed from above by nest-tree and/or vine foliage (Bent 1953, Hamel 2000, Roth 2004). Few published studies have documented interspecific nest kleptoparasitism involving Cerulean Warblers. Hamel (2000) noted in the Mississippi Alluvial Valley that Cerulean Warblers and American Redstarts (*Setophaga ruticilla*), and Cerulean Warblers and Blue-gray Gnatcatchers (*Polioptila caerulea*) interacted aggressively over nesting materials. Cerulean Warblers have also been observed gathering nesting materials from vireo nests (species unspecified) in New Jersey (Dater 1951).

Cerulean Warbler breeding biology studies have focused on nest observation beginning in 1992 in Tennessee and Arkansas, and in 2002 in southern Indiana. This paper documents 21 interspecific contests for nesting material involving Cerulean Warblers that were observed during stages of the nesting cycle (Table 1). We present three detailed accounts of nest material kleptoparasitism involving Cerulean Warblers as both victim and perpetrator. Owner defense usually started at the point at which the owner discovered the robber at its nest.

OBSERVATIONS

The following two accounts document nest material kleptoparasitism with the Cerulean Warbler as victim. The first incident occurred on 19 May 2003 between 1230 and 1300 hrs CST when a Red-eyed Vireo (*Vireo olivaceus*) was observed taking material from a Cerulean Warbler nest in a grove of black walnut (*Juglans nigra*) at Big Oaks National Wildlife Refuge (39° 03′ N, 85° 25′ W) near Madison, Indiana. The vireo landed on the nest branch within a meter of the nest, then flew to the nest and removed a piece of the outer cup when the Cerulean Warbler was not present. The nest material was sufficiently large to be seen in the vireo's beak as it flew to a more densely wooded area. No bird visited the nest for a period of several minutes until a vireo again landed on the nest branch. The vireo hopped toward the nest when the male Cerulean Warbler chased it into the heavily wooded area. The female Cerulean Warbler then flew to the nest and sat in it. The female Cerulean Warbler was first observed building the nest on 8 May and incubating on 17 May. She was last observed incubating on 29 May and the nest had failed on 31 May. The walnut

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TABLE 1. Nest material kleptoparasitism involving Cerulean Warblers recorded during Cerulean Warbler breeding biology studies in Tennessee, Arkansas, New York, and Indiana.

Study area	Date	Nest owner	Stage	Kleptoparasite
Meeman Shelby Forest, TN	9 May 93	Cerulean Warbler	Building	American Redstart
Meeman Shelby Forest, TN	15 May 93	Cerulean Warbler	Building	American Redstart
Meeman Shelby Forest, TN	16 May 93	Cerulean Warbler	Abandoned	American Redstart
Meeman Shelby Forest, TN	23 May 97	Cerulean Warbler	Building	American Redstart
Meeman Shelby Forest, TN	24 May 97	Cerulean Warbler	Building	American Redstart
Chickasaw NWR, TN	7 Jun 93	Cerulean Warbler	Building	Blue-gray Gnatcatcher
Chickasaw NWR, TN	22 May 94	Cerulean Warbler	Incubation	Blue-gray Gnatcatcher
Chickasaw NWR, TN	23 May 94	Cerulean Warbler	Immediately after depredation	Blue-gray Gnatcatcher
Chickasaw NWR, TN	5 Jun 94	Cerulean Warbler	Abandoned	Blue-gray Gnatcatcher
Desha, AR	11 May 93	Cerulean Warbler	Abandoned	Blue-gray Gnatcatcher
Desha, AR	13 May 93	Cerulean Warbler	Dismantling and Cerulean Warbler reconstructing	Blue-gray Gnatcatcher
Desha, AR	28 May 93	Cerulean Warbler	Dismantling and Cerulean Warbler reconstructing	Blue-gray Gnatcatcher
Meeman Shelby Forest, TN	10 Jun 93	Cerulean Warbler	Incubation	Blue-gray Gnatcatcher
Yellowwood State Forest, IN	29 May 05	Cerulean Warbler	Building	Black-throated Green Warbler
Meeman Shelby Forest, TN	11 May 94	Cerulean Warbler	Building	Northern Parula
Desha, AR	14 May 93	Cerulean Warbler	Incubation	Orchard Oriole
Desha, AR	27 Jul 93	Cerulean Warbler	Unknown	Orchard Oriole
Big Oaks NWR, IN	19 May 03	Cerulean Warbler	Incubation	Red-eyed Vireo
Ulster County, NY (Smith 2001)	26 May 99	Red-eyed Vireo	Abandoned	Cerulean Warbler
Hoosier National Forest, IN	6 May 05	Red-eyed Vireo	Building	Cerulean Warbler
Meeman Shelby Forest, TN	11 May 93	Blue-gray Gnatcatcher	Immediately after depredation	Cerulean Warbler

grove had an open canopy, permitting detailed observations of the birds' behavior.

The second incident occurred on 29 May 2005 between 1030 and 1130 hrs when a female Black-throated Green Warbler (*Dendroica virens*) was observed taking material from a Cerulean Warbler nest in Yellowwood State Forest (39° 12′ N, 86° 21′ W) near Bloomington, Indiana. It landed on the nest branch within 1 m of the nest, approached it in a quick hopping manner, and stole nest material. The female Black-throated Green Warbler repeated this behavior three times and each time she was chased from the nest by the female Cerulean Warbler. In one of the three incidents, a male Cerulean Warbler was observed chasing with the female Cerulean Warbler. Eventually, both male and female Cerulean Warblers exhibited aggressive behavior (making repeated harsh call notes and chasing) toward the female Black-throated Green Warbler any time she perched within 15 m of the nest. The male Black-throated Green Warbler was not observed participating in chasing or nest robbing. The Cerulean Warbler nest was in a red elm (*Ulmus rubra*) near a planting of shortleaf (*Pinus echinata*) and eastern white pine (*P. strobus*). This may have increased the chances of proximity to a Black-throated Green Warbler territory, as that species is often associated with coniferous forests (Morse 1993).

The following account describes nest material kleptoparasitism with Cerulean Warbler as the perpetrator. On 6 May 2005 between 1430 and 1500 hrs a female Cerulean Warbler was observed taking material from a Red-eyed Vireo nest in the Pleasant Run Unit of the Hoosier National Forest (39° 01′ N, 86° 20′ W) near Bloomington, Indiana. The Cerulean Warbler made three separate trips from its own nest to the vireo nest approximately 30 m to the east, each time successfully acquiring material. On the first trip, the vireo presumably did not detect the Cerulean Warbler, as no interaction occurred; however, the vireo gave chase on the warbler's second and third trips. The stolen material was sufficiently large to be seen in the Cerulean Warbler's beak, and was incorporated into its nest. Both the Cerulean Warbler and the Red-eyed Vireo nests appeared to be mostly completed at the time of the raid. Construction of the Cerulean Warbler nest was first observed on 4 May 2005 at 1230 hrs; on 26 May 2005 the nest was confirmed to have failed.

DISCUSSION

The studies in which these observations occurred were specifically focused on Cerulean Warbler nests and it is not surprising that most incidents (18 of 21 observations, Table 1) involved Cerulean Warblers as victims rather than perpetrators. Most observations of female Cerulean Warblers returning to their nests with nesting material did not include observing them collect the material. Therefore, Cerulean Warblers may be robbing other nests more often than we are aware.

Red-eyed Vireos and Black-throated Green Warblers are not unlikely participants for nest material thievery interactions with Cerulean Warblers. Red-eyed Vireos are one of the most abundant bird species in our study areas (KCJ and KLR, pers. obs.), and both Red-eyed Vireos and Black-throated Green Warblers forage at the same heights where Cerulean Warbler nests occur (Morse 1993, Cimprich et al. 2000). Additionally, and perhaps most importantly, Cerulean Warblers, Red-eyed Vireos, and Black-throated Green Warblers may have similar requirements for nest composition and compete for materials. Red-eyed Vireos have been documented to use all of the same materials as Cerulean Warblers, with the exception of moss, in their nests (Harrison 1975, Ehrlich et al. 1988, Cimprich et al. 2000). Black-throated Green Warblers have been documented to use all materials except grapevine bark and lichen (Ehrlich et al. 1988, Morse 1993).

Prolonged completion of nest building may indicate that nest robbing has taken place, as was likely the case in the second nest robbing account. In this case, the Cerulean Warbler nest was probably not the pair's first attempt of the season based on the late date of nest construction. They began building their second nest on 25 May 2005, four days before nest robbing was observed. Immediately prior to observing nest material kleptoparasitism, the female Cerulean Warbler was seen bringing nesting material to her nest. As replacement nests are typically constructed more quickly than first nests, a 5-day spread of nest building was unexpected (KCJ and KLR, pers. obs.). Despite the interference, the nest successfully fledged at least two offspring.

Why would individuals risk physical conflict with neighboring birds to steal nesting material? It is possible that (1) some materials may take a great amount of time to locate, and (2) some materials may not be difficult to locate, but may be difficult to remove and collect in quantity in an appropriate size or shape to be incorporated into a nest (Yezerinac 1993).

Nest material may be in limited supply, as a result of the large demand for it by a variety of users, or the phenology of the source is limited in time. Nest construction is a time-consuming process, as it requires the adult bird to locate materials, to gather the materials into the nest site, and to form the actual nest. Nest construction appears to be a costly process in terms of energy expenditure. This process involves a multitude of flights to gather material. Bent (1953) indicated a single female American Redstart might make 700 trips in the construction of a single nest. The female pulls material from sources, such as dried cambium of broken tree branches and grapevines, even from inner portions of stems of herbaceous materials. The female must identity the most useful adhesive materials for attaching nests to supports and for holding surfaces together. ''Spider webs'' or silk from cocoons of emerged moths are often listed as the adhesive material. A variety of types of spider silk exist; variation among species may indicate that some may be more useful than others and the possibility of discriminate selection by avian users (Gosline et al. 1999, Žurovec and Sehnal 2002). Early nesting behavior may in part be favored by the ability to find the most effective nest materials. Competition for materials that are limited in time may occur between users of the favored material, irrespective of cost considerations.

Benefits of stealing nest materials are substantial reductions in (1) distance the female must travel from her nest, (2) time spent away from her nest, and/or (3) amount of effort spent while away from the nest. Birds may be more likely to resort to time-saving nest kleptoparasitism because the benefits outweigh the risks. The Red-eyed Vireo and the Black-throated Green Warbler may have robbed Cerulean Warbler nests because of the pressure of time during what was probably (based on the time of season) their second nesting attempt.

Another potential benefit of engaging in nest kleptoparasitism is decreased predation risk. Nest building birds may experience increased predation risk when gathering so much material in such a short period of time, often from relatively few locations which are repeatedly visited. Canopy-nesting species must often resort to gathering nesting material near or on the ground. These sites are not typical for the species; the birds may have less experience with the potential escape routes from predators available in such situations. The large number of sorties to and from a nest site increases the likelihood that a nest parasite may observe the location, follow the progress of the construction, and time their parasitic laying event. It is equally possible that other species, including but not limited to birds, mammals, snakes, and parasitic insects, may also observe locations frequented by nest building birds. Banks and Martin (2001) noted that when visitations by nest owner decreased in frequency, rates of Brown-headed Cowbird (*Molothrus ater*) nest parasitism increased. Therefore, less time spent foraging for nesting materials would allow the female more time for activities such as egg-laying and nest guarding.

All of these factors, acting individually or in concert, indicate that time of nest construction is a critical part of the life cycle of a bird, when the most important reproductive activities, including mate selection and egg production, occur. Study of the process is difficult, particularly for small species that nest in tree canopies in forest habitats. It is difficult to observe canopy-nesting species gathering nesting materials. Consequently, few data exist on predation risks associated with gathering nest material and the propensity to avoid certain locations as sites for gathering material.

It is not clear exactly how advantageous or disadvantageous kleptoparasitism of nest material is to individuals which participate in it. The perpetrators in all three detailed accounts presented, consistently returned to the victimized nests, despite the threat of being chased, indicating the rewards of kleptoparasitism outweighed the risks. One of the two Cerulean Warbler nests that was raided was successful. This indicates that victimization did not necessitate failure. The Cerulean Warbler pair that stole from the vireo nest was unsuccessful in raising young despite any benefits obtained from nest robbing. Further studies on nest robbing behavior, as related to the phenology, availability, and selection of nest materials will contribute to our understanding of when a nest-building female engages in nest material kleptoparasitism.

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Home Range and Dispersal of Juvenile Florida Burrowing Owls

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ABSTRACT.—We present the first use of necklace radio transmitters to document the home range and dispersal of juvenile Burrowing Owls (*Athene cunicularia floridana*) during the breeding and post-breeding period in rural Florida. Juvenile Burrowing Owls (n = 4) were detected close to main and satellite burrows during 65 day-time relocations. Home range estimates (95% kernel) for juvenile owls varied from 98 to 177 m^2. Juvenile Burrowing Owls were not detected near main and satellite burrows during three evening relocations. Dispersal of juvenile owls coincided with flooding of burrows during the rainy season. Juvenile owls upon fledging used an extensive patch of saw palmetto (*Serenoa repens*) before dispersing beyond the range of ground telemetry capabilities. Aerial telemetry assisted in locating one juvenile Burrowing Owl using scrub oak (*Quercus* spp.) habitat approximately 10.1 km southeast of its main and satellite burrows. *Received 16 February 2006. Accepted 7 October 2006.*

Early observations of Florida Burrowing Owls (*Athene cunicularia floridana*) describe their propensity to excavate burrows in short grass habitat (Hoxie 1889, Rhoads 1892, Scott 1892, Palmer 1896). Typically, a breeding pair of owls excavate one breeding burrow and one or more satellite burrows (Scott 1892, Neill 1954, Wesemann 1986, Mealey 1997). Burrows, which can be 1–3 m in length, contain an enlarged nest chamber at their terminus (Rhoads 1892, Scott 1892, Nicholson 1954, Sprunt 1954). Male and female Florida Burrowing Owls can breed at 1 year of age (Haug

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et al. 1993) with most females laying eggs in the spring (Nicholson 1954, Courser 1976, Millsap and Bear 1990). However, nesting can occur between October and July with 2–10 eggs/nest (Rhoads 1892, Scott 1892, Nicholson 1954, Owre 1978, Stevenson and Anderson 1994). Previous ecological research on Florida Burrowing Owls has occurred during the breeding period in urban areas including college campuses (Courser 1976), private residences (Mealey 1997), and vacant lots (Wesemann 1986; Millsap and Bear 1990, 1997, 2000).

The majority of ecological data on Florida Burrowing Owls in rural areas is observational and was collected in the late nineteenth and early twentieth centuries on dry prairie habitat in southcentral Florida (Ridgway 1874, Cahoon 1885, Hoxie 1889, Rhoads 1892, Scott 1892, Palmer 1896, Bent 1938, Nicholson 1954). There are no published studies from rural areas (agricultural lands, grazing land for cattle, and areas managed or maintained as natural habitat) in Florida that document productivity, survival, prey preference, dispersal, or habitat requirements (breeding and post-breeding) of Burrowing Owls.

Identifying habitat requirements for Florida Burrowing Owls in rural areas is particularly important because of the rate of habitat loss due to development. Florida's human population is the third fastest growing in the nation (U.S. Department of Census 2004) and a variety of habitats is being lost such as upland forests (Sprott and Mazzotti 2001), scrub oak (Myers 1990), and prairie habitats (Abrahamson and Hartnett 1990). There are no management strategies for Burrowing Owls in rural environments (Florida Fish and Wildlife Conservation Commission 2004a).

The objectives of our study were to estimate home range size and dispersal of juvenile Burrowing Owls in a rural environment. We also estimated size of home range of juvenile Burrowing Owls during the breeding season, measures of dispersal from breeding habitat, and the location and type of post-breeding habitat occupied by juvenile Burrowing Owls.

METHODS

The study was undertaken from 1 March to 5 August 2004 on Rutland Ranch, Bradenton, Florida (27° 30′ N, 82° 15′ W). Rutland Ranch encompasses 2,372 ha and is managed by the Southwest Florida Water Management District (Barnwell et al. 2003). The ranch contains a mixture of habitats including oak scrub, herbaceous marshes, riparian hardwoods containing laurel (*Quercus laurifolia*) and water oak (*Q. nigra*), pine flatwoods containing slash pine (*Pinus elliottii*) and saw palmetto (*Serenoa repens*), and non-native pastures. Burrowing Owls excavate burrows within a 81-ha rectangular portion of improved pasture that undergoes yearly prescribed burning. The major land uses surrounding Rutland Ranch include cattle ranching and agriculture.

We captured and fitted radio transmitters to seven juvenile Burrowing Owls (one male, one female, five gender unknown) between 6 June and 22 July. Juvenile owls were captured using noose carpet traps (Mealey 1997, Millsap and Bear 1997) placed on the burrow mound and in the entrance of burrows. The average (± SD) weight of captured juvenile owls (n = 7) was 122.9 ± 10.3 g. Juvenile Burrowing Owls were fitted with necklace-style radio transmitters (AVM Instrument Company Ltd., Colfax, CA, USA). Prior to capture, juvenile owls were observed flying between their respective main and satellite burrows, and undertaking short flights within the improved pasture.

The maximum range of the receiver and transmitters during field tests was 1.61 km and the expected battery life was 160 days. Five randomly selected transmitters were tested to examine the precision of directional bearings with a resulting mean and standard deviation of 1.64 ± 4.13 degrees (White and Garrott 1990). The average weight of the transmitters was 4.9 g which was 4% of the average body mass of the seven juvenile Burrowing Owls marked.

We attempted to locate radio-marked Burrowing Owls once each day between 1000 and 2000 hrs (EST) from 7 June to 10 October. Relocations were attempted between 2100 and 0500 hrs on 1–2 August to document activity and location of each owl during the evening and early morning. Radio tracking was conducted along all road and trails within Rutland Ranch when any radio-marked owl was not relocated during the day and evening telemetry sessions in the improved pasture. Once an

TABLE 1. Kernel home range estimates of juvenile Burrowing Owls within improved pasture, Bradenton, Florida, 2004.

Bird #	Relocations	95% Kernel home range (m^2)	75% Kernel home range (m^2)	50% Kernel home range (m^2)
1	8	177	123	79
2	13	186	110	70
3	22	105	64	45
4	22	98	60	38
Mean		141	89	58

TABLE 2. Dispersal distance of juvenile Burrowing Owls from improved pasture, Bradenton, Florida, 2004.

			Distance from main burrow	
Bird #	Dates	Relocations	Min (m)	Max (m)
1	6 Aug−5 Oct	3	407	10,083
2	6 Aug−24 Sep	15	466	679
3	17 Aug	1	366	366
4	6–17 Aug	7	236	337

owl was not located after several attempts, the road network surrounding Rutland Ranch was surveyed at intervals of 0.80 km. Aerial telemetry was used to locate missing owls if an owl was still not located.

Program Animal Movement V.2 Beta (Hooge and Eichenlaub 1997) was used to estimate home ranges for each juvenile owl during the breeding period using the fixed kernel method with least squares cross validation as the smoothing parameter. The home range for each juvenile owl was calculated using relocations taken during daylight hours. Three separate home range estimates for each owl were calculated based on probabilities (95, 75, and 50%) of the estimated distribution of use. The measure tool in ArcMap 8.3 was used to calculate dispersal distance by measuring the distance (m) from each owl's location outside of the improved pasture to its respective main burrow.

RESULTS

Three radio-collared juveniles were killed by unknown predators. The four remaining owls were relocated 41 of 56 days radio tracking was attempted within the improved pasture. Radio tracking was not attempted during 2 days due to lightning and for 13 days because two stream crossings were flooded. The mean home ranges of the four juvenile Burrowing Owls, based on probabilities of 95, 75, and 50% of the estimated distribution of use were 141, 89, and 58 m^2, respectively (Table 1).

Two Burrowing Owls during night tracking sessions were near their main burrows at 2100 hrs, but no Burrowing Owls were located in the pasture after 2200 hrs. One Burrowing Owl was located at 2300 hrs, 264 m from its main burrow within the extensive patch of saw palmetto surrounding the pasture. Telemetry signals outside of the improved pasture were faint and brief making it difficult to triangulate the position of any owl. No signals were located after midnight in the improved pasture or from the trails surrounding it.

Burrowing Owls began dispersing from the improved pasture on 6 August when all burrows, except for a main and satellite burrow in the highest elevated area of the pasture, were flooded due to seasonal rainstorms. No juvenile owls could be located within Rutland Ranch or from the road network surrounding the property by 30 September.

Aerial surveys were conducted on 5 October within a radius of approximately 15 km of the improved pasture to locate the missing owls. One juvenile owl was relocated 10.1 km southeast of Rutland Ranch in habitat composed of predominantly scrub oak (W. D. Gordon, pers. comm.). Dispersal distance for juvenile owls varied (Table 2).

DISCUSSION

The home range estimates of juvenile Burrowing Owls post hatch indicates that juvenile owls are extremely dependent on main and satellite burrows. Dispersal of juvenile Burrowing Owls from habitat used post hatching coincided with flooding of the pasture and burrows beginning on 6 August. Juvenile owls were not relocated in the improved pasture after dispersal even after the pasture had dried. All four juvenile Burrowing Owls used the extensive saw palmetto patch surrounding the pasture during the day before dispersing beyond the range of the receiver. One juvenile owl was relocated near several live oaks (*Quercus virginiana*) growing near the improved pasture.

The large areas of private agricultural and pasture land surrounding Rutland Ranch, coupled with limited access to these properties, made it difficult to locate Burrowing Owls from the surrounding road network. Aerial telemetry, initiated after the owls had dispersed from the pasture, assisted in locating only one of four juvenile Burrowing Owls, possibly because of battery failure of the three remaining transmitters.

Knowledge of breeding and post-hatching habitat requirements of Burrowing Owls in rural environments (especially grazing lands and natural areas) is particularly important because of continued habitat loss due to increased growth and development throughout Florida. We also note that Burrowing Owl populations in urban areas such as vacant lots, college campuses, and private residences are also not immune to the effect of development. Urban areas may provide only temporary Burrowing Owl habitat due to the inverse relationship between the size and persistence of owl populations, and the level of human development (Courser 1976, Wesemann 1986, Millsap and Bear 2000).

The Burrowing Owl has been listed as a Species of Special Concern since 1979 by the Florida Fish and Wildlife Conservation Commission (Millsap 1997). Without conservation and management, Burrowing Owls may become a state listed threatened species because of vulnerability to habitat modification, environmental alteration, human disturbance, or human exploitation (Florida Fish and Wildlife Conservation Commission 2004b). A greater understanding of Burrowing Owl ecology in rural environments is needed to successfully manage and conserve this species throughout Florida.

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American White Pelicans Force Copulations with Nestlings

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ABSTRACT.—We observed 56 forced copulation (FC) events in a breeding colony of American White Pelicans (*Pelecanus erythrorhynchos*) in Saskatchewan, Canada during the 2005 nesting season. All FCs were directed at nestlings >21 days of age that were not continuously attended by an adult. The onset of FCs occurred in close synchrony with an unexpected late-season increase in adult copulation attempts. We suggest that FC directed at nestlings is not simply an aberrant and non-adaptive behavior. Rather, copulations with nestlings result from adult male pelicans being inappropriately stimulated to copulate with nestlings when actually seeking copulations with adult females. *Received 22 December 2005. Accepted 24 July 2006.*

Forced copulation is a behavior used by males of some species as a strategy to fertilize females that would otherwise be unreceptive (McKinney et al. 1983). The proportion of fertilization events gained via forced copulations is likely low (e.g., 2–5%; Dunn et al. 1999), but this behavior is generally considered adaptive and has been reported for several avian orders (e.g., Anseriformes, McKinney et al. 1983; Charadriiformes, Ewins 1993; Passeriformes, Rising and Flood 1998; and Galliformes, Giudice and Ratti 2001). On rare occasions, forced copulation attempts by adults are directed toward conspecific young. We found a small number of reports of adults attempting to copulate with fledged conspecific juveniles (Armstrong 1988, Ewen and Armstrong 2002) and with unfledged chicks (Kinkel and Southern 1978, Besnard et al. 2002). Fledged juveniles may be mistaken for adult females in some species, but there is no obvious adaptive explanation for forced copulations with unfledged chicks. The motivation for forced copulation with unfledged chicks is therefore unclear.

We describe patterns associated with forced copulation attempts on chicks by adult American White Pelicans (*Pelecanus erythrorhynchos*; hereafter pelicans) in a breeding colony

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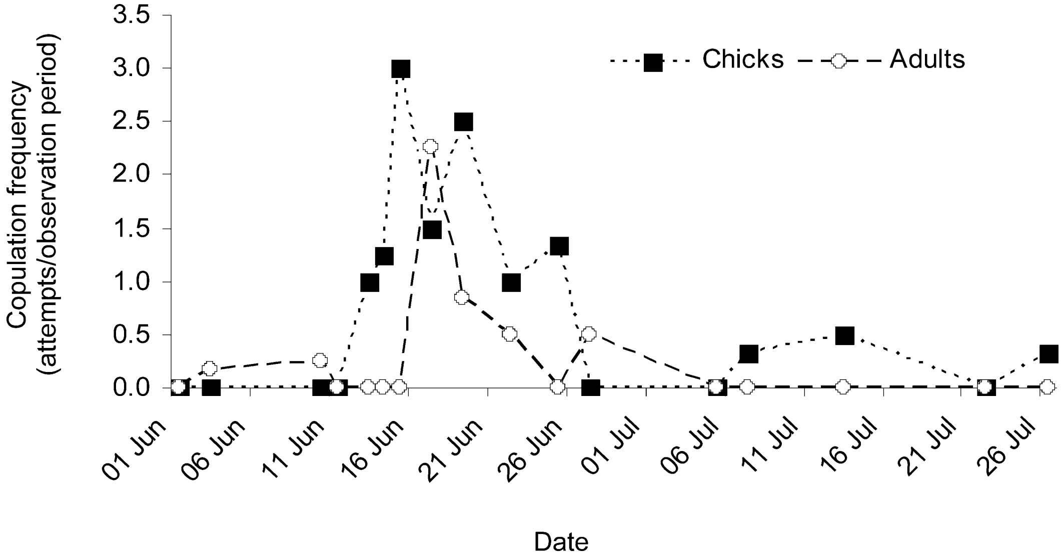

FIG. 1. Mean frequency of copulation attempts by adult American White Pelicans with other adults or with unfledged chicks at Last Mountain Lake National Wildlife Area and Migratory Bird Sanctuary, Saskatchewan in 2005. The data are expressed as the number of attempts per 30-min observation period. Means are based on two to six observation sessions per day; error bars have been omitted for clarity.

in Saskatchewan, Canada. To our knowledge, this behavior in pelicans has been reported anecdotally once previously (Schaller 1964) and remains poorly characterized for birds.

METHODS

We observed interactions between adult pelicans and chicks in breeding colonies on two islands in the Last Mountain Lake National Wildlife Area and Migratory Bird Sanctuary in Saskatchewan, Canada (51.1° N, 107.0° W). The islands were shared with breeding colonies of Double-crested Cormorants (*Phalacrocorax auritus*) and California Gulls (*Larus californicus*). We estimated there were 1,360 pelican nests on Island A (10.1 ha) and 240 nests on Island B (3.5 ha) from aerial photos taken on 6 June 2005. The islands were 680 and 550 m from shore, and were observed from the mainland using 45× and 30× spotting scopes, respectively. Two observers continuously monitored interactions in fields of view containing similar numbers of chicks for 30 min at a time. We performed two to six observation periods per day with the exception of 15 June 2005 when only a single 30-min session was possible due to inclement weather. We observed the islands for a total of 41.5 hrs between 1 June and 26 July 2005 and recorded all copulation attempts. We defined forced copulations (FC) with chicks as any interaction during which an adult attempted to mount, or actually mounted and copulated with, an unfledged nestling. In all FCs, nestlings appeared to resist the actions of adults by struggling not to be pinned and attempting to escape and/or dislodge the adult during copulation motions. Between 15 June and 5 July 2005, we visited the pelican colony on Island B on 5 days (two to four observers/visit; each visit lasted 12–20 min) to collect regurgitations from chicks as part of a diet study. We visited Island A once for 15 min (three observers) on 5 July 2005 to conduct a disease and mortality survey.

RESULTS

We observed a total of 56 FCs that began on 13 June, peaked on 15 June, and declined thereafter (Fig. 1). FCs were first observed when a large proportion of the chicks were approximately 3 weeks of age and formed pods in which they were not continuously attended by a parent, and continued until chicks were near fledging. We were unable to estimate the total number of adults and chicks involved in FCs over the season because individual birds were not uniquely marked.

However, we were able to distinguish between independent FCs during each 30-min observation session because of our continuous monitoring approach. The number of adults involved in FCs in each observation period ranged from one to three, and the number of targeted chicks ranged from one to five. There were 13 30-min sessions in which a single FC was detected involving one adult and one chick. In 11 sessions we detected multiple FC events (up to a maximum of six) involving two to three adults and two to five chicks. In these sessions, 23% (range 0–67%) of the total FCs in each session were repeated events initiated by the same adults. Similarly, 12% (range 0–33%) of FCs in each session were experienced by the same chick that was targeted several times.

We were able to view and record details of adult behavior in 34 FCs. In the remaining 22 events we were unable to clearly see the behavior of the adults preceding the FC. Of the 34 FC interactions characterized, 12 (35%) involved adults seeking out an isolated chick that was not part of a pod, and violently jabbing and biting it. The adult then forced the chick to the ground and pinned it by the neck or back of the head using its bill, followed by attempted mounting and/or copulation movements lasting approximately 15–30 sec. In 11 of 34 (32%) FCs, adults first actively isolated chicks by disrupting pods using violent bill jabbing. Once a chick was accessible, FCs occurred as described above. Before and/or after 9 of 34 (27%) FCs, adult pelicans appeared to be tending chicks. In these nine cases, adults preened the chicks before pinning them and attempting to copulate and, in some cases, adults continued to preen and/or sun-shade chicks afterwards. In 2 of 34 (6%) instances, we observed an FC followed by the adult feeding the chick. In all cases, chicks visibly resisted adults attempting FCs, struggling not to be pinned, and attempting to dislodge the adult during copulation motions. We were unable to ascertain whether cloacal contact occurred between adults and chicks during any of the observed FC events.

Adult pelicans began initiating copulations with other adults on 17 June 2005 (Fig. 1; $n = 20$ instances observed). This behavior was unexpected given the colony was well beyond the stage of nest establishment, with more than 90% of nests into the chick-rearing phase and only several small sub-colonies that were late in egg incubation. When the pattern of copulation events was considered separately by island, FCs were split evenly between islands (28/56, or 50% on each island). In contrast, 16 of 20 (80%) of the adult copulation attempts occurred on Island B, compared to only 4 of 20 (20%) on Island A (Fig. 2A, B). Adult copulations began concurrently with the appearance of a group of adult pelicans standing near some of the later nesting birds incubating eggs on Island B. This group of birds engaged in frequent courtship displays (e.g., head up with pouch flaring, and strut-walking; Knopf 2004). On at least one occasion, a male pelican from this group attempted to copulate with an unreceptive adult sitting on a nearby nest.

DISCUSSION

Based on a small number ($n = 23$) of FC observations, Schaller (1964) proposed that movements of nestling pelicans might resemble those of receptive females, thus stimulating sexual behavior in adult males. However, that study provided no quantitative data on FC timing or frequency, and the observations did not permit establishment of any link between FC events and adult copulation behavior. In our study, the similarity in the date of onset of both FCs and adult copulations suggests a relationship between these two behaviors. We postulate that FCs represent adult male pelicans directing inappropriate sexual attention towards nestlings when actually seeking to copulate with adult females. If this is the case, FCs in pelicans can be interpreted as a non-adaptive by-product of potentially adaptive adult copulation attempts, as opposed to simply aberrant behavior. Thus, we expect FC behavior to be widespread in pelican colonies.

It is not clear why some adult pelicans began courtship and copulation attempts, including FCs, at our study site in mid-June. This is well beyond the nest-establishment period on the observed islands where even the latest sub-colonies to begin nesting were at least 3 weeks into egg incubation. Besnard et al. (2002) suggested the high frequency of FC observed in Black-billed Gulls (*Larus bulleri*) was a direct result of a flooding event that destroyed part of the colony. Nest loss asso-

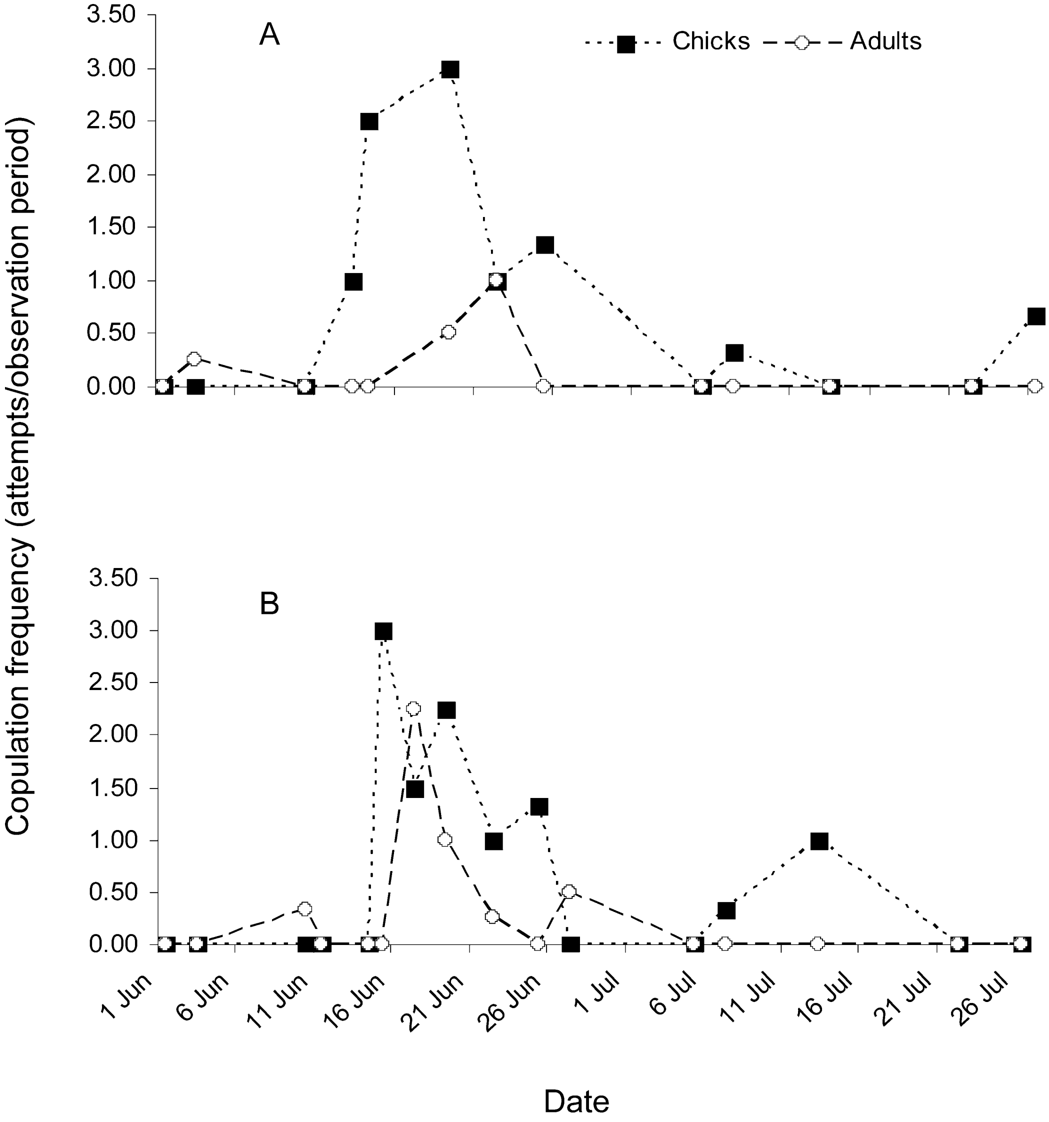

FIG. 2. Mean frequency of observed copulation attempts by adult American White Pelicans with other adults or with unfledged chicks in (A) a primarily undisturbed colony on Island A, and (B) a colony on Island B at Last Mountain Lake National Wildlife Area and Migratory Bird Sanctuary, disturbed five times between 15 June and 5 July 2005 for collection of diet samples. The data are expressed as the number of attempts per 30-min observation period. Means are based on two to six observation sessions per day; error bars have been omitted for clarity.

ciated with the flood stimulated large-scale and intensive re-nesting, placing nestlings in the colony concurrent with courting and copulating adults. Re-nesting male gulls directed inappropriate sexual attention towards chicks begging for food, which resembles female solicitation in that species. It is therefore possible that disturbance and nest loss may be a prelude to FCs.

In our study, the only disturbances of which we are aware were our five visits to Island B between 15 June and 5 July 2005, and the single visit to Island A on 5 July 2005. FC frequency peaked on 15 June, and most adult copulations were observed between 17 and 22 June on the more disturbed Island B. This raises the possibility that our research activities indirectly caused the associated FC behavior. On Island B, we documented the loss of 12 of 240 (5%) pelican nests due to depredation of young chicks by California Gulls during our first two visits. By the time we visited Island A, however, all chicks were too large to be at risk of gull depredation. It seems unlikely this small level of nest loss and potential re-nesting by the associated adult pelicans can explain the number of FC events we observed. In addition, individual pelicans typically abandon colonies following nest loss rather than attempting to re-nest within a season (Schaller 1964), and it is extremely unlikely that a re-nesting response could be induced so quickly following the first disturbance event. Preliminary observations of three FC events in early June 2005, in the absence of any colony disturbance, support the idea that disturbance is likely not the major cause of the behavior.

An alternative explanation for the sudden appearance of courtship behavior, adult copulations, and FCs in mid-June is the possibility that birds were still attempting to join the colony despite its advanced state, or that non-breeding adults entered the colony to 'practice' copulation. A further point worth considering is that while we have assumed FCs to be instigated by adult male pelicans, Kinkel and Southern (1978) reported forced copulation attempts on chicks by adult female Ring-billed Gulls (*Larus delawarensis*), suggesting this assumption could be erroneous. We conclude that FCs occur in pelicans and appear to be non-adaptive, and associated with adult copulation activity. The circumstances surrounding the stimulation of FC behavior and the extent to which it occurs in other colonies and other species requires further investigation.

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