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Behavioral Notes and Nesting of the Black Solitary Eagle (*Buteogallus solitarius*) in Belize

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ABSTRACT

Behavioral observations of the first recorded Black Solitary Eagle (*Buteogallus solitarius*) nest with a two-month-old nestling in the Cayo District, Belize were made from 7 – 30 June 2011. The nest was in a fork of the main trunk of a Nicaraguan Pine (*Pinus oocarpa*) with an eastern slope exposure at ~670 m elevation. The nesting area was ecotonal submontane pine forest overlooking deep valleys of broadleaf forest. Observations suggest the species forages for snakes (Genera: *Spilotes*, *Drymobius* and *Dryadophis*) in broadleaf forest habitat at elevations ≤ 400 m. Black Solitary Eagles relied on static soaring to deliver prey to the nest, following an indirect route over mountain contours. Of the observed flights (N=10), soaring averaged 4.65 min, while flapping flight averaged 0.08 min. Soaring duration (N=6) averaged 6.75 min with carried snake prey, but decreased to 2.00 min without prey (N=3). Our notes offer new insights on the habitat use, flight styles and patterns, and other behaviors of this poorly known Nearctic-Neotropical raptor.

Keywords: Belize; Black Solitary Eagle; *Buteogallus solitarius*; habitat use; nest; snake; static soaring

INTRODUCTION

The Black Solitary Eagle (*Buteogallus solitarius*) inhabits subtropical and tropical montane forests between 600 m – 2,100 m from western Mexico to northern Argentina, but has a patchy distribution (Howell and Webb 1995; Clark 2010) and is considered rare in many areas (Thiollay 1985; Ramos 1986; Howell and Webb 1995). The population is estimated between 1,500 – 4,000 individuals (BirdLife International 2015). Despite a wide distribution, documented nests of the Black Solitary Eagle are scarce. The only reported nests were found in 1947 and 1958 in the foothills of the Sierra Madre Occidental of Mexico (Harrison and Kiff 1977). The Tablas Mountain nest was reused in 1959, but the egg was depredated (Harrison and Kiff 1977); thereafter, no active nests have been reported in 52 years.

Sightings of adult pairs or fledged juveniles, however, persist throughout the species' range (Ridgley 1980; Vannini 1989; Clark et al. 2006). Researchers in Peru noted territorial and escorting behavior by a Black Solitary Eagle pair and concluded they were breeding (Valdez and Osborn 2004). In 2005, Black Solitary Eagles were observed carrying nesting material within the Jocotoco Reserve in Ecuador (G. George pers. comm.). Courting pairs were observed in Guatemala in 1986 (Beavers et al. 1991) and Nicaragua in 2013 (Vallely and Chavarría-Duriaux 2014). Additional sightings of pairs involved courtship displays, mutual soaring and calling (Ridgley 1980; Thiollay 1985; Denton 2009; Clark 2010). While these observations suggest breeding, no nests were found.

Belize also has a long history of reports of Black Solitary Eagle breeding activity, primarily from the Mountain Pine Ridge, the Maya Mountains and surrounding areas. Juveniles were reported in 1969 and 1983 (Weyer 1984); and a breeding pair was noted in the Mountain Pine Ridge Forest Reserve in 1985 (Wood and Leberman 1987). Benesh (2006) observed a pair copulating in 2005 and a juvenile in 2006. In 2009, a pair and fledged juvenile were seen near an Orange-breasted Falcon (*Falco deiroleucus*) release site operated by The Peregrine Fund, Inc. (Seminario et al. 2011). In 2011, we observed a Black Solitary Eagle displaying breeding behaviors near the falcon release site and followed it to a nest ~3.5 km away. Although prior evidence of breeding activity existed, ours is the first nest record for Belize. Herein, we report behavioral observations, adding new insights to the Black Solitary Eagle's poorly known natural history.

MATERIALS AND METHODS

Study Area

Our study area was located in the Cayo District, Belize, 6 km from the Mountain Pine Ridge Forest Reserve. The area was submontane pine-oak forest, dominated by stands of Honduran Pine (*Pinus caribaea*), Black Oak (*Quercus oleoides*), Red Oak (*Quercus perseifolia*) and Craboo (*Byrsonima crassifolia*) (Means 1997). Pine-oak forest transitioned into semi-evergreen seasonal forest and evergreen broadleaf forest at lower elevations and riparian areas (Stanford and Meyer 2000). We described semi-evergreen seasonal forest and evergreen broadleaf forest as "broadleaf forest". Plant community ecotones were sharp or gradual, depending upon terrain steepness. June temperatures averaged 84°F (28°C) with prevailing easterly winds; temperature and winds > 25 knots peaked from 0800 hours – 1600 hours (14th Weather Squadron 2014).

Behavioral Observations

From 7 – 26 and 29 June 2011, we made observations at an Orange-breasted Falcon (OBF) release site operated by The Peregrine Fund, Inc. The release site was monitored daily from dawn to dusk (~0530 hours – 1830 hours) by 2 – 6 attendants in a wooden blind. The OBF release site was placed on a steep, peninsular ridge at 720 m, overlooking tributaries of Roaring Creek. On 27, 28 and 30 June 2011, we conducted observations at selected surveillance points (SPs) within 8 km of the OBF release site. We observed the eagles using a 15X – 45X/20X – 60X spotting scope and 10 X

50 WB binoculars. Whenever we sighted a Black Solitary Eagle, we observed it with optics until it flew out of sight or alighted. We noted dates/times (Central Standard Time, CST) and duration of sightings, flight behavior, prey, vocalizations and interactions with other bird species (Table 1). We rounded the duration of each behavior to the nearest one-fourth of a minute (i.e., 15 seconds). We determined the sexes of adults by differences in size and coloration (Ferguson-Lees and Christie 2001); however, the eagles were not marked.

Table 1. Black Solitary Eagle sightings, behavioral observations and prey, Belize, June 2011.

Date	Time (CST)	Duration (min)	Sex	Prey	Behavior
07-Jun-11	1337 - 1341	4	M	Snake (unidentified)	Thermal soaring ascent followed by descent into river gorge.
08-Jun-11	1318 - 1319	1	M		Thermal soaring with whistled flight calls, followed by descent into broadleaf forest.
10-Jun-11	1307 - 1315	8	M	Snake (unidentified)	Thermal soaring ascent with whistled flight calls, followed by final descent to nest.
14-Jun-11	1519 - 1527	8	M	Snake (unidentified)	Thermal soaring ascent from broadleaf forest with whistled flight calls, followed by final descent to nest.
17-Jun-11	1331 - 1338	7	M	Tiger Ratsnake (*Spilotes pullatus*)	Thermal soaring ascent followed by final descent to nest.
24-Jun-11	1430 - 1433	3	F		Thermal soaring ascent from broadleaf forest with whistled flight calls, followed by descent near Baldy Beacon Road.
27-Jun-11	1400 - 1402	2	M		Thermal soaring, followed by final descent to nest.
28-Jun-11	1250 - 1256	6	M	Speckled Racer (*Drymobius margaritiferus*)	Flapping flight to exit broadleaf forest canopy (0.5 min) followed by thermal soaring ascent (5.5 min) with whistled flight calls. Defense posturing toward Red-tailed Hawks, followed by final descent to nest.
29-Jun-11	1339 - 1347	8	M	Dryad Snake (*Dryadophis melanolomus*)	Thermal soaring ascent from broadleaf forest with whistled flight calls. Defense posturing toward Orange-breasted Falcons, followed by final descent to nest.
30-Jun-11	1026	0.25	M	Snake (unidentified)	Flapping flight to alight at nest.
30-Jun-11	1155 - 1332	97	F		Adult perched on nest rim with continuous vigilance of humans (Fig. 1). Single nestling crouched in nest.

Nest Finding Methods

Most diurnal raptors are known to carry prey items directly (i.e., in a straight line) to the nest to feed young; thus, nests can be located by following prey-carrying adults (Beebe and Webster 1985; Sullivan et al. 2011). In contrast, Black Solitary Eagles transporting food to the nest moved in undulating patterns typical of thermal soaring. Therefore, we needed to differentiate between final descents to the nest and successive thermal descents. A final descent could be identified by body conformation, and then waiting one minute to confirm that the eagle did not reappear in a thermal.

Black Solitary Eagles approached the nest at a glide angle of ~45°, parallel with the downward slant of the ridge above the nesting area. During the steep, gliding approach to the nest, the eagle held its legs and feet against the body and tail with the wings partially folded. On the final approach, the eagle thrust its legs and feet forward, opened or flapped its wings, and then alighted on the nest. When soaring with prey, Black Solitary Eagles held their wings fully spread and horizontal to the body with the legs approximately perpendicular. The eagles held their wings in this position when working thermals too.

Once the route to the nest was surmised from the flight trajectory of adults, we chose SPs on elevated terrain (700 m – 800 m) to intercept the eagles closer to the potential nest location. SPs allowed unobstructed views of the landscape, movements of the eagles and triangulation of local landmarks in relation to the potential nest site. Each sighting of the prey-carrying eagle led to closer approximations of the nest's location. Observations made from 27 – 28 June 2011 indicated that the nest was on a forested slope directly across a river gorge. On 30 June 2011, from a SP 2 km away, we observed an adult Black Solitary Eagle descending to and alighting on the nest to deliver a snake.

We estimated the nestling's age with a photographic key (Driscoll 2010). Elevations and terrestrial locations were identified using satellite imagery (Google Earth™) and topographic maps. All elevations are above sea level measurements.

RESULTS

Sightings of the eagles totaled 144.25 minutes and occurred at 1026 hours – 1527 hours from 7 – 30 June 2011 (Table 1). Nine observations were of the male eagle and two of the female. From 18 – 23 June 2011, no Black Solitary Eagles were observed.

The Black Solitary Eagle nest was constructed of branches in a fork of the main trunk of a Nicaraguan Pine (*Pinus oocarpa*) with an eastern slope exposure (Fig. 1). On 30 June 2011, it contained a single, two-month-old nestling that was attended by the adult female. The female perched on the nest rim while the nestling crouched down low in the adult's shadow. The nesting area was a steep, ecotonal slope of submontane pine forest overlooking riparian valleys of broadleaf forest (17° 01' N, 88° 49' W). The Belize Forest Department reported that the nest was not reused after the 2011 breeding season.

Black Solitary Eagles traveled the same route to the nest by following mountain contours: ascending from the north, soaring over the OBF release site, and descending to the south to intersect another thermal (6 observations, 7 – 24 June 2011). Upon nearing the nest, the eagles approached from the northwest, soaring along a ridge and into prevailing winds, to alight and deliver prey (Fig. 2).

Nest elevation was ~670 m in pine forest, but Black Solitary Eagles were observed hunting in broadleaf forest ≤ 400 m. The

Figure 1. Active Black Solitary Eagle *(Buteogallus solitarius*) nest in the canopy of a Nicaraguan Pine, Cayo District, Belize, 2011. Note the diagnostic field marks of the species: broad yellow facial skin patch and long primary wingtips that extend to, or nearly to, the tip of the short tail.

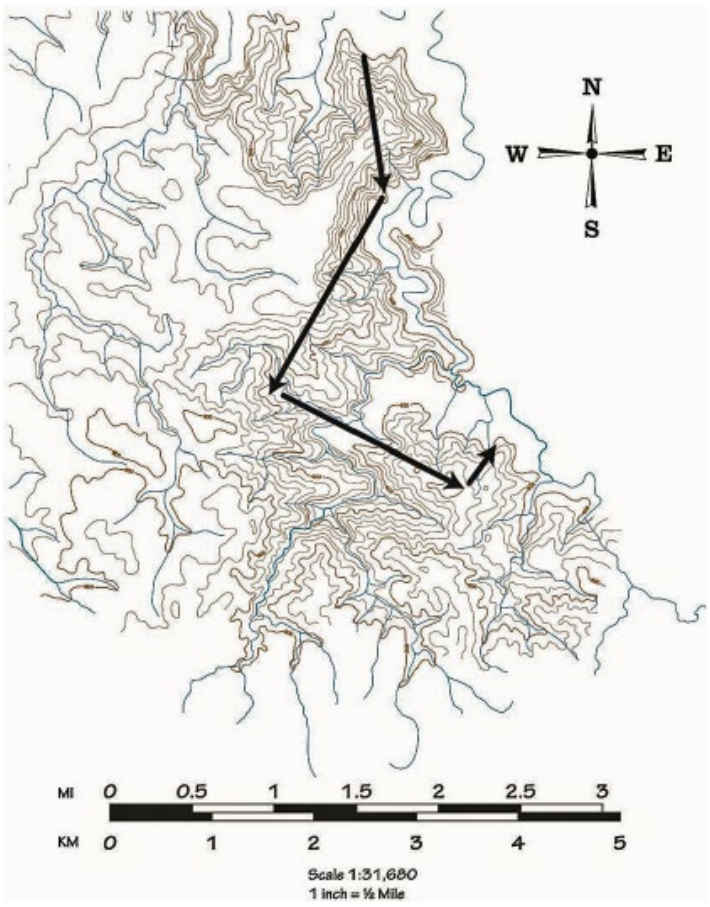

Figure 2. Topographic map (400 m – 800 m elevation) depicting Black Solitary Eagle nest site, Cayo District, Belize, 2011. Arrows indicate the adults' indirect flight path to the nest following mountain contours.

adult male was observed delivering prey to the nest, all snakes, in seven of nine sightings (Table 1). The male was seen exiting the broadleaf forest canopy and delivering a snake to the nest on 28 and 29 June 2011. The eagles' flight trajectories descended into or originated from lower elevation broadleaf forest on three additional occasions. The male gripped snakes with both feet while soaring to the nest site (6 observations, 7 – 29 June 2011).

Of the observed flights (N=10), soaring averaged 4.65 min and flapping averaged 0.08 min. The Black Solitary Eagle used flapping flight only to become airborne, exit the forest canopy with prey and alight at the nest. The eagle flapped its wings until it reached a thermal and then it soared on convective or obstructive currents for the rest of the flight. The route to the nest did not vary, and durations of soaring flight shortened with proximity to the nest. All instances of flapping flight were observed from beginning to end. Soaring flight averaged 6.75 min with carried prey (N=6), but decreased to 2.00 min without prey (N=3). All vocalizations made in flight were rapid whistled notes (Howell and Webb 1995).

Interspecific Interactions

On 28 June 2011 the adult male eagle was attacked by a pair of Red-tailed Hawks (B*uteo jamaicensis*) and the next day by five Orange-breasted Falcons. Both attacks occurred while the Black Solitary Eagle carried a snake. The attacking raptors dived repeatedly with lowered feet in an attempt to strike the eagle in the head or back. The Black Solitary Eagle lowered its head to avoid a direct hit each time, but made no other evasive movements. After the attacking raptors passed, the eagle raised its head, gaped at its attackers and vocalized. The Black Solitary Eagle did not present its talons in defense, as both feet were grasping the prey.

DISCUSSION

Our findings suggest that the Black Solitary Eagle may be a soaring specialist dependent upon thermal and obstructive currents for lift. Static soaring is constrained by geography and environmental factors: terrain, wind, temperature and heated surfaces. Thus, static soaring birds are limited to geographical areas, routes and activity times that reliably produce the meteorological phenomena necessary for sustained flight (Pennycuick 1998). This would explain the indirect route the pair of eagles took over mountains to the nest, their predominant soaring behavior and increased activity during peak wind times. The species displays the high lift, slotted wing shape of soaring birds (Feduccia 1999). Prior records described soaring and gliding (Ferguson-Lees and Christie 2001), but none proposed the species might be dependent

on this form of flight. Clark et al. (2006) suggested that the species needed hills, but did not offer an explanation for the assertion. The soaring data we collected are probably underestimated with respect to overall flight behavior as the route did not vary, and soaring durations shortened with proximity to the nest.

The ecotonal nest placement and ophiophagous diet are in agreement with previous reports (Harrison and Kiff 1977; Valdez and Osborn 2004; Seminario et al. 2011). The prey species we identified are found in broadleaf forest (Table 1, Stanford and Meyer 2000), the habitat in which we observed the Black Solitary Eagle hunting. The Tiger Ratsnake (*Spilotes pullatus*) and Speckled Racer (*Drymobius margaritiferus*) are found from sea level to 600 m (Stanford and Meyer 2000), elevations below that of the nest. Perhaps, foraging success is higher in broadleaf forest at elevations ≤ 400 m where these snakes occur. Black Solitary Eagles may require mountainous terrain and ecotones to optimize flight and foraging habitats.

Our findings of habitat stratification and altitudinal movements between nesting and foraging areas may validate past sighting records. Previous reports of Black Solitary Eagles at lower elevations or in tropical rainforest were dismissed as misidentifications or considered atypical (Clark et al. 2006).

Our observations indicated that the adult male was the primary food provider early in the nesting cycle, while the female remained mostly at the nest. These observations are consistent with other raptor species (Brown 1977; Johnsgard 1990; Gerhardt et al. 2012) and a record by Harrison and Kiff (1977).

Raptors under aerial attack often present talons, which can lead to dropped prey or kleptoparasitism (Johnsgard 1990; Dekker 2012). The fixed prey restraint observed in the Black Solitary Eagle may be a behavioral adaptation to ophiophagy. Snakes can be dangerous, as even nonvenomous species can constrict a potential avian predator (Wenner 2012). Several of the captured snakes were 1.5 – 2 times the length of the eagle and twisted violently in the air currents. It is not known if the snakes were alive, but the extra drag increased flight duration. The Black Solitary Eagle may have developed a fixed grip to subdue such prey or prevent it from being dropped and lost in steep, forested terrain. This explanation was proposed for the large feet of Orange-breasted Falcons which share the same habitat (Cade 1982).

Black Solitary Eagles and their nests may go largely undetected because of low population densities, steep, forested terrain and high altitude flight styles. The species is known to soar at extreme heights (Global Raptor Information Network 2015). Optics with at least 10X magnification and unobstructed views were needed to follow the eagles in flight. In the apex of a thermal, Black Solitary Eagles were invisible to the unaided eye and could travel undetected in home ranges. The alternating pattern of ascents and descents made it difficult to follow individual eagles and confused observers. Closely monitoring and noting changes in flight behavior was critical to maintaining visual contact with an eagle, as it did not fly directly to the nest with prey.

Our findings and interpretations were drawn from one pair during a short observational period. More research is needed to determine if the prey, foraging habitat, flight patterns and behaviors that we reported are representative of the species. Our behavioral insights may assist future researchers in locating nests or Black Solitary Eagles, and in habitat where they were previously unexpected. The population status, reproductive cycle, habitat use and ecological role of this raptor need to be more fully defined.

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EDITOR'S NOTE

For the sake of clarity, the Black Solitary Eagle nest described in this article is the same nest first reported by R. Phillips as "Breaking News in *Solitarius*," in a 2011 issue of the Belize Raptor Research Institute Newsletter, with Phillips providing subsequent newsletter updates (see http://www.belizeraptorresearch.com/science/publications/).