

SHORT COMMUNICATION

J. Raptor Res. 42(4):000

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OBSERVATIONS OF TWO HAWK-EAGLE SPECIES IN A HUMID LOWLAND TROPICAL FOREST RESERVE IN CENTRAL PANAMA

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KEY WORDS: *Black Hawk-Eagle*; *Spizaetus tyrannus*; *Ornate Hawk-Eagle*; *Spizaetus ornatus*; *behavior*; *density*; *Panama*; *survey*.

The Black Hawk-Eagle (*Spizaetus tyrannus*) ranges from central Mexico to eastern Peru, southern Brazil, and Misiones Province, Argentina. The Ornate Hawk-Eagle (*Spizaetus ornatus*) ranges from central Mexico to northern Argentina and Paraguay, but also occurs in Trinidad and Tobago (Brown and Amadon 1968). In Panama, the former species is fairly common and widespread throughout humid forest areas in the Pacific slope, being frequently noted in the Panama Canal area on both slopes (Ridgely and Gwynne 1989). The Ornate Hawk-Eagle, however, is uncommon in more humid forested areas on Pacific slope; in Panama it is thought to be outnumbered by the Black Hawk-Eagle (Ridgely and Gwynne 1989).

The objectives of my study were to survey for the Black Hawk-Eagle and the Ornate Hawk-Eagle in the Panama Canal Zone area, and to estimate the minimum number of pairs and the species' densities within this area.

STUDY AREA

The Soberania National Park (09°15'N, 79°41'W) is located along the banks of the Panama Canal, adjacent to Gatun Lake, with 22 104 ha of protected land. It is a reserve of structurally mature humid lowland tropical forest (Karr 1971, 1976, 1977) that is seasonally dry, and it is located on the Caribbean slope of the Canal Zone. Annual precipitation averages about 260 cm and falls primarily in the rainy season, late April to mid-December. The forest canopy often exceeds 40 m and stays predominantly green throughout the year (Karr 1971, 1977). Gatun Lake (420 km²) is an artificial lake created by the damming of the Chagres River to form the central part of the Panama

Canal in 1914 (Angehr 1999). The lake and adjacent railroad form the western border of the national park.

The north and the south portions of Soberania National Park, along with the Empire Range forest patch, Howard forest patch, the Camino de Cruces National Park, and several other small forest remnants link the forested zones in the Panama Canal corridor (Robinson et al. 2004).

METHODS

I recorded both species of hawk-eagles while working as a hack-site attendant on a Harpy Eagle (*Harpia harpyja*) project for Fondo Peregrino in Panama. The survey was accomplished coincidentally while making long hikes and monitoring ten radio-tagged Harpy Eagles released at the Soberania National Park. During these hikes, observations of hawk-eagles (individuals and pairs) were made from several different locations within the study area. Most of the work was carried out in the rainy season (May to November). I walked a total of 574 hr during 87 d of sampling (3 wk/mo), averaging 5.3 hr/d. Transects were walked between 0800 H and 1600 H and locations of hawk-eagles were recorded using compass, Global Position System (eTrex Vista, Garmin, Olathe, KS U.S.A) and printed digital maps. Hawk-eagles were seen mainly during the warmer morning hours when both species were heard or seen. I used an all-terrain vehicle for quick travel between areas along Pipeline Road. I spent extra time at specific locations that would permit me to observe birds in flight (clearings, tree fall gaps, edges, along streams, and at hilltops)

I surveyed different types of habitat, including mature and secondary-growth forests on ridges of >300 m in height, in valleys, along streams, and on plains. Habitats along the border of Soberania National Park were also visited, including the Pipeline Road, small villages, and other properties. This methodology was comparable to that used by others (e.g., Thiollay 1991) wherein observations were maximized by using different sampling methods, sampling along all available trails and roads, and throughout the day.

Observation of Breeding Behaviors. Both species of hawk-eagles soared regularly, accompanied by loud calling

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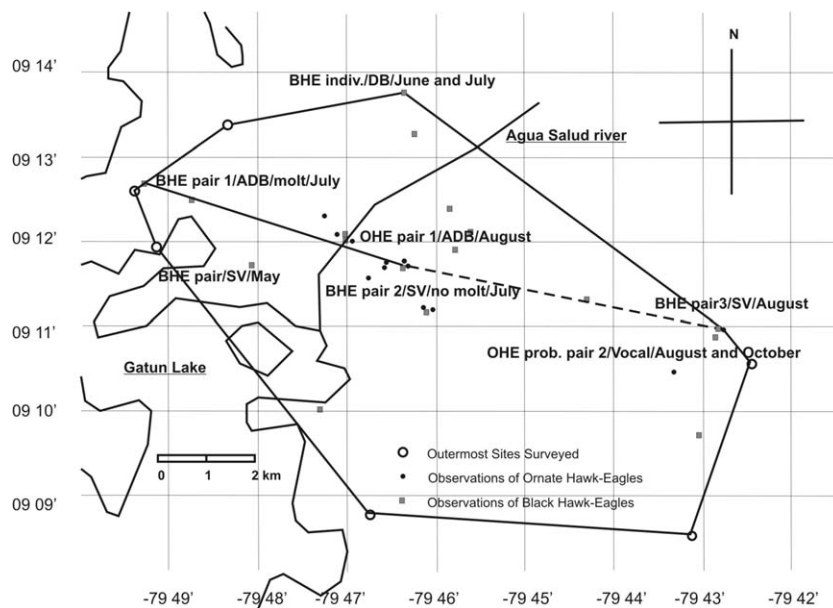


Figure 1. Observations of Ornate Hawk-Eagle and Black Hawk-Eagle pairs in the 88.8-km² study area in Soberania National Park, Panama. The distance between pairs is represented by a solid line (5.7 km) and a dashed line (7.9 km) for Black Hawk-Eagles and Ornate Hawk-Eagles, respectively. The month of the observations and bird behaviors are also shown for records used in the estimate of pair density. Legend: SV = soaring/vocal behavior; ADB = aerial display behavior; DB = dropping behavior; prob. pair = probable pair, individuals not seen together.

and courtship displays; thus, territorial pairs could be relatively easily observed. I classified birds as breeding pairs if I observed courtship display behaviors or two individuals soaring together during the breeding season. I classified birds as potential breeding pairs when individuals were recorded circling and calling or showing breeding behavior on at least two different occasions at the same site. These areas were considered “defended” territories not only because of the presence of a hawk-eagle pair together, but also because of behaviors such as attacking or threatening intruders and other territorial behaviors (see Emlen in Brown 1969). Adult birds, especially when displaying, fly mostly over their own territory (Thiollay 1989b), and displays have been shown to be a fairly reliable indicator of an occupied territory (Thiollay 1989b). Soaring behavior performed by adults on their breeding grounds has mainly a territorial function (surveillance and maintenance of pair bond or territorial limits, Newton 1979), so I consider that records of pairs, or even individuals, presenting courtship behavior during the breeding season represent pairs in use of a limited area.

In general, pair-formation in raptors is associated with establishment of nesting territories (Newton 1979). Thus, I considered only records from the estimated period of courtship and nesting (July–August for Black Hawk-Eagles; August–October for Ornate Hawk-Eagles) to reduce the probability of including wandering movements during the nonbreeding season.

Mapping Pairs. To estimate pair density, I entered locations of pair records in a digital map (GPS TrackMaker software by Odilon Ferreira Júnior, version 13.0, copyright 2003–07). I considered data on behavior, number and distance of records, date of the encounter, and molt.

The plotted map areas including all records for each species were calculated by connecting the outer records of the transects I walked. The outermost sites on these maps were the maximum extent of the area covered by my random transects, even though these areas might contain no records of hawk-eagles (Fig. 1.). Therefore, the estimated home ranges might include potentially unsuitable habitat not used by the birds.

Estimates of relative densities, based on the minimum number of pairs within the surveyed area, are presented as pairs/plotted map area, pairs/km², and pairs/221 km² (the area of the entire Soberania National Park).

RESULTS

The daily frequency of encounters for the Black Hawk-Eagle was 0.19 records per day (17 records in 87 d). Encounters with this species were recorded between 0920 H and 1250 H. Aural only and aural/visual detections made up 47% and 53% of the encounters, respectively. Of the 17 records of Black Hawk-Eagles, 29% were confirmed pairs. Fifty-eight percent of the observations were within the forest; the other 42% were made from borders (forest edges, railroad/Gatun Lake).

The daily frequency of encounters for the Ornate Hawk-Eagle was not determined, because a pair was frequently recorded in area surrounding the base camp. Encounters with this species were recorded between 0900 H and 1300 H. All observations of Ornate Hawk-Eagles were within the forest.

On three different occasions both species were recorded at the same site within minutes of each other. However, I observed no interactions between the two species.

Breeding Behavior and Neighboring Pairs. For the Ornate Hawk-Eagle, the plotted map was based on distances between observations and the proximity of record dates. Two neighboring pairs were identified. One active breeding pair was observed a few times making courtship displays (which consisted of a short dive with half-closed wings, followed by vigorous wing-flapping to recover altitude) and also defending the territory by behaving aggressively toward a Black Vulture (*Coragyps atratus*). A second potential breeding pair (individuals not actually seen together) was recorded 7.9 km away from the first pair (Fig. 1). The two pairs were encountered within a few days of each other with at least two records on each site.

For the Black Hawk-Eagle, the minimum distance between pairs was estimated based on two records of pairs differentiated by molt patterns and observed in courtship behavior. Two neighboring pairs 5.6 km apart (Fig. 1) were distinguished in this manner. However, to determine the relative density of pairs, I used records of pairs or individuals that exhibited breeding behavior, rather than the minimum distance between known pairs. I observed the aerial courtship display of this species in the encounter with pair one (Fig. 1), which consisted of the male and female circling, with the male above calling loudly and rapidly flapping his wings, apparently from the carpal joint outwards. As the wings beat, they produced a series of whistles. This behavior was repeated at least three times for >6 min.

On two different occasions at the same site (records 800 m apart), a Black Hawk-Eagle individual was seen soaring and vocalizing. After ascending to a high altitude, the bird made one quick shallow dive with semi-closed wings, descending a short distance; then after gliding for a few seconds, he dropped at an angle of at least 60°, with the wings entirely closed, toward a forested hill 300 m away from the observer.

Relative Density of Black and Ornate Hawk-Eagles. I recorded 17 observations of Black Hawk-Eagles in the study area, and six observations outside the study area, in another area of the Panama Canal Zone. In the 88.8-km² area of the plotted map, three distinct pairs were identified (Fig. 1), resulting in density estimates (minimum number of pairs within the surveyed area) of one pair per 29.6 km² or 7.4 pairs for the entire 221-km² study area. Each pair of Black Hawk-Eagles was observed at least two times at the same site.

Two pairs of Ornate Hawk-Eagles were identified in the 88.8-km² area of the plotted map, giving density estimates (minimum number of pairs within the surveyed area) of one pair per 44.4 km² or 4.9 pairs for the entire study area. For 635.8 km² of protected areas in central Panama (Ro-

binson et al. 2004), I estimated a minimum population of 14.3 pairs of Ornate Hawk-Eagles and 21.4 pairs of Black Hawk-Eagles.

DISCUSSION

Hawk-Eagle Densities. Raptor density estimates may be influenced by raptor behavior, habitat types, sampling time and effort, and probability of encounter. In this study, raptor densities were estimated using more than one type of data. The density estimate for Black Hawk-Eagles was based on observations of two pairs differentiated by molt patterns; the density estimate for Ornate Hawk-Eagles was based on the distances among observations and observations of courtship behavior. Thus, the estimates represent a minimum number of pairs within the surveyed area.

In this study, I assumed that records in July and August are representative of the breeding season in this area. However, Smith (1970) published a report of one Black Hawk-Eagle nest in the Panama Canal Zone that was used during two distinct seasons. On one occasion, in August 1968, one fledged juvenile was observed near the nest tree; also in February 1965, two downy young were present.

According to Willis (1968, *in* Brown and Amadon 1968), adults of the Ornate Hawk-Eagle were nesting on 29 December in Panama, and a young bird was visible in the nest in April and fledged in May. So my observations of courtship and display behaviors, obtained August–October, likely represent the period prior to egg-laying.

Thiollay (1989a) estimated more than four pairs of Ornate Hawk-Eagles in a 10 000-ha study area in French Guiana. His results are comparable to mine because he also identified pairs on the basis of their breeding behavior and distance between observations. The maximum length of territory size of the Ornate Hawk-Eagle in French Guiana was of 6.9 km (Thiollay 1989a), which was relatively consistent with my results. However, Thiollay (1989a) recorded only one Black Hawk-Eagle pair in the 10 000-ha study area. This difference was probably due to differences in habitat type (contiguous pristine forest vs. mature forest patch) between the study areas, as well as inherent landscape features such as topography and habitat complexity. Densities in different habitats can also be influenced by interspecific competition, predation, availability of nest sites, and food resources (Thiollay 2007). Differences in landscape features may be responsible for the pattern found in the relative density of pairs for both species in my study.

Hawk-eagles in less productive areas should be spaced further apart than those in more productive areas (Hustler and Howells 1988). According to Lyon and Kuhnigk (1985) a region with higher primary productivity should support a higher density of hawk-eagles. Compared to estimates of hawk-eagle home ranges from surveys in Tikal National Park, Guatemala (Flatten 1990, Julio 1991, Montenegro 1992, Sixto 1992), a semi-deciduous forest located in the tropical dry life zone (Holdridge 1957 *in* Burnham 1998), hawk-eagles at Soberania National Park, a humid lowland

Table 1. Observations of Black Hawk-Eagles and Ornate Hawk-Eagles at Soberania National Park, central Panama, May–October 2005.

SPECIES	SITE	DATE	NO. INDIV.	DISPLAY ^b	BEHAVIOR ^a	HABITAT
Black Hawk-Eagle						
	A	25-May	2		sv	forest
	B	24-Jun	1		d	border
	D	1-Jul	1		v	forest
	C	5-Jul	2		sv	Forest
	E	13-Jul	2	x	sv	urban area
	E	16-Jul	1	x	sv	urban area
	A	21-Jul	2	x	sv	border
	B	24-Jul	1		dd	border
	A	19-Aug	1		svg	border
	F	25-Aug	2	x	sv	forest
	F	29-Aug	2		g	forest
	C	7-Sep	1		sg	forest
	B	16-Sep	1		sv	border
	C	11-Oct	1		sv	forest
	C	12-Oct	1		sv	forest
	E	15-Oct	2		sv	urban area
	F	17-Oct	1		v	forest
Ornate Hawk-Eagles						
	A	24-May	1		v	forest
	C	8-Jul	1		v	forest
	A	10-Aug	1		v	forest
	A	2-Aug	2		v	forest
	F	29-Aug	1		v	forest
	C	23-Sep	2		sv	forest
	C	11-Oct	1	x	Sv ^c	forest
	C	12-Oct	1		V	forest
	C	21-Oct	1	x	sv	forest
	C	28-Oct	1		sv	forest
	C	28-Oct	1		p	forest
	F	29-Oct	1		sv	forest

^a Behavior codes: sv = soaring/vocalizing, d = dropping after glide/soaring, v = vocalizing, dd = diving and dropping, svg = soaring, vocalizing, and gliding, g = gliding, sg = soaring and gliding, p = perching.

^b Aerial display behavior: x = recorded display behavior, blank = no display recorded.

^c Aggression toward a Black Vulture (*Coragyps atratus*).

tropical forest, would be expected to have higher density because of their more productive habitat. However, that was not the case, which suggests that my estimate represents a minimum number of pairs only.

Conservation. The fact that hawk-eagles require large areas of forest makes them suitable umbrella species (Newton 1979). Sites capable of supporting viable populations of top predators also sustain populations of smaller species with smaller area requirements (Sergio 2006). I considered Soberania National Park to be an important remnant forest for the conservation of these medium-sized raptors, due to its proximity to other forest fragments and patches in the region (M. Canuto unpubl. data). In addition, there are several nearby patches of forest on both the Caribbean and Pacific slopes (Robinson et al. 2004).

Viable populations of Black Hawk-Eagles and Ornate Hawk-Eagles may exist in central Panama. The ecological functions of linked forest corridors are of great importance for the conservation of these top predators. The small- and medium-sized protected forest patches adjacent to Soberania National Park were used by gliding and soaring Black Hawk-Eagles on several occasions, indicating the patches' potential importance for dispersion and movements, necessary for the population's conservation. It is important that these forest corridors remain, as they include 635.8 km² (Robinson et al. 2004) of protected forested areas. The future conservation plans for the Panama Canal Zone should include management of these patches as a single protected corridor, and incorporation of the remaining unprotected areas within that plan.

The lack of observations of Ornate Hawk-Eagles at forest edges in the studied area suggests that this species is sensitive to habitat fragmentation, edges, and human presence, which may limit the species' ability to disperse along edges or through fragmented environments. However, Black Hawk-Eagles showed some tolerance toward human activities, as Thiollay (2007) also reported. In my study, one individual was observed soaring above the streets of an urban area (Fort Clayton) at the edge of Camino de Cruces National Park, and another individual was observed soaring near the Camino de Cruces National Park, above a busy highway running from Gamboa City to Panama City. My observations suggest that the more isolated the patches become, the greater the threat for the long-term persistence of these sensitive species, particularly the Ornate Hawk-Eagle, in central Panama.

OBSERVACIONES DE DOS ESPECIES DE *SPIZAETUS* EN UNA RESERVA DE BOSQUE HÚMEDO TROPICAL EN EL CENTRO DE PANAMÁ

RESUMEN.—Entre mayo y noviembre de 2005, realicé búsquedas de *Spizaetus ornatus* y *S. tyrannus* en el Parque Nacional Soberanía (221 km²), centro de Panamá. Los censos fueron realizados durante 574 horas en un total de 87 días (promedio 5.2 hr/d), a lo largo de transectos aleatorios ubicados en bosque húmedo tropical estructuralmente maduro y bosque húmedo tropical de crecimiento secundario, incluyendo bordes de bosque, quebradas y ríos, colinas, fincas ubicadas alrededor de la reserva, poblaciones pequeñas, una línea férrea y un lago (Lago Gatún, Canal de Panamá). Realicé 13 y 17 observaciones de parejas o individuos de *S. ornatus* y *S. tyrannus*, respectivamente, y ubiqué la posición geográfica de cada registro en un mapa digital. También registré los comportamientos reproductivos observados durante cada encuentro. De las 17 observaciones de *S. tyrannus*, el 58% fueron dentro de hábitats boscosos y el 42% en bordes de bosque. Las 13 observaciones de *S. ornatus* fueron en interior de bosques, lo que sugiere que esta especie es más sensible a la fragmentación del hábitat o a la deforestación en comparación con *S. tyrannus*. Con base en el tamaño del área censada, el número de parejas observadas, el comportamiento reproductivo y la distancia entre registros, estimé que existen al menos 4.9 parejas (1 pareja/44.4 km²) de *S. ornatus* y 7.4 parejas (1 pareja/29.6 km² en promedio) de *S. tyrannus* en el Parque Nacional Soberanía.

[Traducción del equipo editorial]

ACKNOWLEDGMENTS

I thank the staff of Fondo Peregrino—Panama, in particular Magaly Linares and Angel Muela, who accepted me into the Harpy Eagle Conservation Program, and, along with Marta Curti, helped me with the English language on the first draft. While on site, I was able to use a variety of equipment and survey Soberanía National Park with the help of the "Ecological Police of Panama" and Edwin Campbell-Thompson, my field supervisor for the Harpy

Eagle Project and a friend. I also thank Hernan Vargas for assisting me with data analysis. I appreciate the improvements in English usage made by James Armacost through the Association of Field Ornithologists' program of editorial assistance.

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Received 21 July 2007; accepted 8 April 2008