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Pre-breeding behavior of Ridgway's Hawks (*Buteo ridgwayi*) in Punta Cana, Dominican Republic

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Cover Page: A female Ridgway's Hawk (*Buteo ridgwayi*) in Punta Cana, Dominican Republic, in March 2016. Photographer: Thomas Hayes.

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Abstract

Recent conservation work by The Peregrine Fund has established a translocated population of the Critically Endangered Ridgway's Hawk (*Buteo ridgwayi*) in Punta Cana, Dominican Republic. Although Ridgway's Hawk has been the focus of extensive conservation work, relatively little has been published about this species' pre-breeding behavior. In this study, we collected behavioral observations and vocalization recordings of three established pairs of Ridgway's Hawks in Punta Cana in January 2018, in order to better characterize this species' pre-breeding behavior. Consistent with prior studies of Ridgway's Hawks in Los Haitises National Park, Dominican Republic, our behavioral observations of hawks in Punta Cana suggest social and sexual monogamy in this species. Notably, our observations suggest a higher frequency of copulations between members of a pair in Punta Cana than was previously observed in the Los Haitises population. These observations provide additional context for understanding this species' pre-breeding behavior and sexual behavior, particularly in this small but growing translocated population.

Keywords

behavior, *Buteo ridgwayi*, Dominican Republic, Ridgway's Hawk, vocalizations

Resumen

Comportamiento pre-reproductivo del Gavilán de La Española (*Buteo ridgwayi*) en Punta Cana, República Dominicana • Los recientes trabajos de conservación de The Peregrine Fund han establecido una población translocada del Gavilán de La Española (*Buteo ridgwayi*), especie en peligro crítico de extinción, en Punta Cana, República Dominicana. Aunque este gavilán ha sido objeto de un extenso trabajo de conservación, se ha publicado relativamente poco sobre el comportamiento pre-reproductivo de esta especie. En este estudio, recolectamos observaciones conductuales y grabaciones de vocalización de tres parejas establecidas de Gavilán de La Española en Punta Cana en enero de 2018, con el fin de caracterizar mejor el comportamiento pre-reproductivo de esta especie. Nuestras observaciones de comportamiento de esta especie en Punta Cana sugieren monogamia social y sexual en ella, en consonancia con estudios previos de individuos de Gavilán de La Española en el Parque Nacional Los Haitises, República Dominicana. En particular, nuestras observaciones sugieren una mayor frecuencia de cópulas entre miembros de una pareja en Punta Cana que la observada previamente en la población de Los Haitises. Estas observaciones proporcionan un contexto adicional para comprender el comportamiento pre-reproductivo y sexual de esta especie, particularmente en esta pequeña pero creciente población translocada.

Palabras clave

Buteo ridgwayi, comportamiento, Gavilán de La Española, República Dominicana, vocalizaciones

Résumé

Comportement prénuptial de la buse de Ridgway (*Buteo ridgwayi*) à Punta Cana, République dominicaine • Le Peregrine Fund a récemment établi une population de Buse de Ridgway (*Buteo ridgwayi*) – une espèce en danger critique d'extinction –

à Punta Cana, en République dominicaine. Bien que la Buse de Ridgway ait fait l'objet d'un important travail de conservation, relativement peu de choses ont été publiées sur le comportement prénuptial de cette espèce. Dans cette étude, nous avons recueilli des observations comportementales et des enregistrements de vocalisations de trois couples établis à Punta Cana en janvier 2018, afin de mieux caractériser le comportement prénuptial de l'espèce. Conformément à des études antérieures sur les Buses de Ridgway dans le Parc national de Los Haitises, en République dominicaine, nos observations du comportement de ce rapace à Punta Cana indiquent une monogamie sociale et sexuelle chez cette espèce. Il ressort notamment de nos observations que la fréquence des copulations entre les membres d'un couple est plus élevée à Punta Cana que celle observée précédemment dans la population de Los Haitises. Ces observations fournissent des informations supplémentaires pour comprendre le comportement préreproducteur et le comportement sexuel de l'espèce, en particulier dans cette population transférée, encore réduite mais croissante.

Mots clés
Buse de Ridgway, *Buteo ridgwayi*, comportement, République dominicaine, vocalisations

The Ridgway's Hawk (*Buteo ridgwayi*), endemic to the island of Hispaniola, is among the most critically endangered raptors in the world, with only around 161 known breeding pairs as of 2019 (BirdLife International 2020, 2021). Formerly extirpated from much of the island due to habitat loss, illegal hunting, and parasitic fly larvae (*Philornis* spp.; Hayes 2019) the Ridgway's Hawk population has been increasing in recent years, due in large part to conservation efforts led by The Peregrine Fund (Anderson *et al.* 2021). Prior to translocation, the only known extant population of Ridgway's Hawks in the Dominican Republic was in Los Haitises National Park, located on the country's northeast coast. A successful translocation of individuals from the Los Haitises population has established a new, stable population with c. 26 breeding pairs (as of 2022) on the private property of Puntacana Resort and Club in Punta Cana, Dominican Republic, > 100 km from Los Haitises (McClure *et al.* 2017, Anderson *et al.* 2021). As of 2022, 121 young have fledged from wild nests in the translocated Punta Cana population, with the last formal releases of translocated hawks taking place in 2017 (TIH unpubl. data).

Despite recent conservation focus on this unique species, not much has been published about its pre-breeding behavior. These birds are considered sexually and socially monogamous, with pairs establishing and defending year-round territories (Woolaver *et al.* 2013). Basic vocalization patterns and behaviors of this highly vocal species were characterized in Wiley and Wiley (1981), which demonstrated that male and female hawks differ in the frequency of certain pre-breeding behaviors. No further study has been done on the vocalizations of this species, and no studies have been published comparing aspects of pre-breeding behavior in the Punta Cana population to the population in Los Haitises. This study aims to further characterize the behavior and vocalizations of Ridgway's Hawks, and to compare the behavior of pairs in the Punta Cana population to the behavior of pairs documented in Los Haitises by Wiley and Wiley (1981).

Methods

Field Site

This study took place at the Puntacana Resort and Club, Punta Cana, Dominican Republic (18°30'58"N, 68°22'44"W). Over 100 individual Ridgway's Hawks have been released at this site between 2009 and 2017, and wild pairs began successfully breeding in this population in 2013. All hawks in this population are marked with a uniquely coded, color-anodized leg band (©Acraft) provided by The Peregrine Fund.

Focal Pairs

Our observations of pre-breeding behaviors focused on three pairs of hawks. Pairs were selected for their proximity to each other and the accessibility of their home ranges via trails and roads, increasing our likelihood of detecting them regularly during surveys. All three pairs were composed of Ridgway's Hawks that hatched in Los Haitises National Park and were translocated and released as juveniles in Punta Cana. Pair 1 consisted of a fifth-year female (hatched in 2014) and a fourth-year male (hatched in 2015). Pair 2 consisted of a fourth-year male and a fourth-year female (both hatched in 2015). Pair 3 consisted of a fifth-year male and a fifth-year female (both hatched in 2014; TIH unpubl. data).

Observations

We conducted observations between the hours of 0630 and 1930 AST, from 8 January to 22 January 2018, for a total of c. 18.5 hr of observation and 34 separate observation events (Pair 1 $n = 13$, Pair 2 $n = 8$, Pair 3 $n = 5$, unknown ID $n = 8$). During surveys, typically conducted with 2–3 individual observers, we searched for birds by walking within the known home range of a focal pair. On 13 January, we also scanned for birds from an elevated observation tower located by the water treatment ponds behind the Grupo Puntacana Foundation; this observation tower provided a more complete view of one focal pair's home range (as well as a limited view of one other focal pair's home range). Most observations were conducted from 0630 to 0930 and from 1600 to 1930.

We observed individual birds and pairs from a distance of c. 20 m, which seemed not to influence their behavior. We followed pairs until both birds had flown out of sight, and recorded GPS locations, behaviors, and vocalizations for each individual. We attempted to minimize disturbance to birds by avoiding coming between them and a potential nest tree, seeking more covered areas from which to observe, and by monitoring their behavior for signs of stress or disturbance.

Recordings and Analysis

We classified behaviors into 9 categories (Table 1) and vocalizations into 3 classes (Table 2) based on the same three vocalization classes described in Wiley and Wiley (1981): 1) Long call "Kleeah!"; 2) Short call "Weep!"/"Weeup!"; and 3) Whistle-squeal. Wiley and Wiley (1981) describe these three call types as the main call types of this species. We recorded vocalizations

Table 1. Ethogram of behavioral categories used to evaluate the context of different vocalization types of Ridgway's Hawks (*Buteo ridgwayi*) in Punta Cana, Dominican Republic.

Behavioral Categories	Description of Behavior
Perched alone	focal hawk perched alone, with no conspecific within 2 m of its perch
Perched together	focal hawk perched together with another hawk, both within 2 m of each other
Flying alone	focal hawk flying alone or flying first from a perch, if other bird present
Flying together	focal hawk flying together with one or more other hawks; focal hawk following another hawk in flight (including courtship flights); focal hawk flying to a perch beside another hawk
Carrying nesting material	carrying or gathering nesting material in beak or talons
Nest construction	construction activities on nest (moving or placing sticks)
Copulation	copulation
Eating	eating or tearing at prey item
Hunting	hunting, indicated either by focal hawk scanning from a perch followed by a short dive, or when the focal hawk enters vegetation or lands on ground and then appears with prey in its beak or talons

using a Marantz PMD MKII recorder with a shotgun microphone (Carlsbad, CA, USA), and visualized recordings using Raven Pro 1.5 (Cornell Lab of Ornithology, Ithaca, NY, USA). Recorded vocalizations were compared visually, when possible, with sonograms of Ridgway's Hawks from Wiley and Wiley (1981).

Results

Courtship Flights

We observed one courtship flight on 13 January 2018. The pair observed in flight was likely Pair 1 based on location, but we were too distant to confirm the identity of this pair by color bands during the observation. The flight began when a presumed male began soaring in slow, ascending circles followed closely by another hawk, presumed female due to observation of the same two birds copulating prior to the courtship flight. The presumed female hawk descended back to the trees after c. 5 min of closely following the other member of the pair, and the presumed male continued to soar until encountering another Ridgway's Hawk. The first hawk made repeated stoops at the second Ridgway's Hawk, before the two separated and the first hawk continued to soar. The flight ended when the first presumed male descended to the tree level near where his flight had begun.

Pair Spacing

In all three focal pairs, males and females roosted near each other at dusk, and frequently perched side by side during the day. Throughout the study we never observed any pair of hawks perched < 450 m from another pair of hawks. We did, however, observe a banded juvenile female on 19 January following a known pair of hawks (Pair 1) in a soaring flight. During the flight, the juvenile and one adult approached each other and lowered their legs at each other in close range. This juvenile female was also sighted by The Peregrine Fund staff with this same pair on at least one other occasion, and she was seen within the pair's known home range at least two additional times during the study period, within 100 m of the pair's nest site. We did not observe this juvenile bird engaging in copulations or any other breeding behavior. This juvenile female was not a released hawk; she hatched from a wild nest in Punta Cana in 2017 (TIH unpubl. data).

We did not collect enough spatial data to calculate home range sizes, but the closest distance between any sightings of Pair 1 and Pair 2 was c. 460 m (maximum distance 840 m, n = 13 confirmed sightings Pair 1, n = 8 confirmed sightings Pair 2), the closest distance between any sightings of Pair 1 and Pair 3 was 2,540 m (maximum distance 2,980 m, n = 5 confirmed sightings Pair 3), and the closest distance between any sightings of Pair 2 and Pair 3 was 2,790 m (maximum distance 3,080 m). The closest distance between potential nest sites of each pair (defined as trees where birds were seen delivering nest material) was c. 760 m between nest sites for Pair 1 and Pair 2, c. 2,920 m between Pair 1 and Pair 3, and c. 3,080 m between Pair 2 and Pair 3.

Vocalization Descriptions and Sonograms

The "Kleeah" call was primarily heard when birds were seen perched alone or flying alone. This call was longer than all other call types identified. We did not obtain a recording of this call type, but it was identified based on the sonogram and call descriptions by Wiley and Wiley (1981) and Anderson *et al.* (2021). Of 11 total observations of this type of vocalization (Table 2), 1 was given by a male hawk, 2 by female hawks, and 8 by hawks of unknown sex.

The most common vocalization we observed was the "Weep!" or "Weeup" call (Fig. 1), as identified in Wiley and Wiley (1981). This call consisted of distinct, short, loud elements sometimes repeated and sometimes produced singly, and was the most frequent call type exchanged between members of a pair during non-copulation interactions. This was also the most frequent vocalization heard when individual birds were seen flying alone or perched alone, and this call type sometimes crescendoed into a "Kleeah" call type. Of 52 total observed vocalizations of this type (Table 2), 22 were given by males, 10 by females, and 20 by hawks of unknown sex.

We observed the "Whistle-Squeal" call (Fig. 2) most often during or just prior to copulations between members of a pair. Calls were produced vigorously during copulation, commencing as the male mounted the female's back and continuing through the entire sequence of copulation. We observed 22 vocalizations

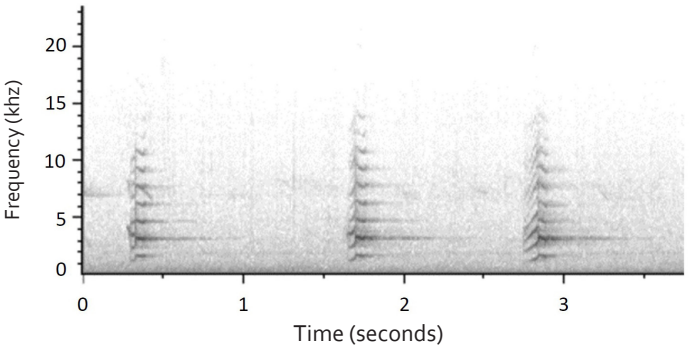

Fig. 1. Three "Weep!" vocalizations given by a single individual Ridgway's Hawk, 18 January 2018, Punta Cana, Dominican Republic.

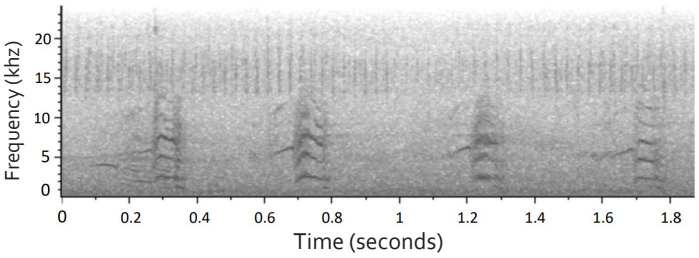

Fig. 2. Four "Whistle-Squeal" vocalizations given by a Ridgway's Hawk during a copulation. 18 January 2018, Punta Cana, Dominican Republic.

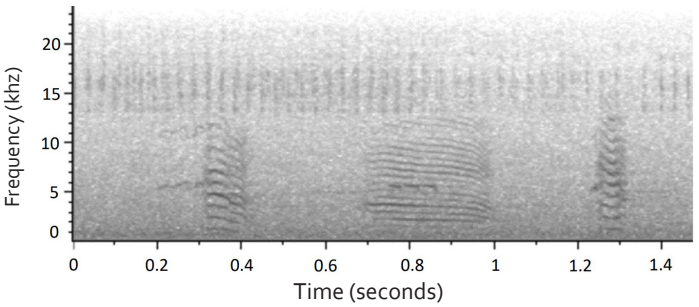

Fig. 3. Three nasal vocalizations, variable in length, given by an individual Ridgway's Hawk at the end of a copulation. 18 January 2018, Punta Cana, Dominican Republic.

of this call type (Table 2), including during copulations of all three pairs (Pair 1 *n* = 12 total "Whistle-squeal" calls, Pair 2 *n* = 1, Pair 3 *n* = 9). Ten whistle-squeal vocalizations we observed were given by male hawks, five by female hawks, and seven by hawks of unknown sex.

Rarely a bird would give a soft whistle just before or after a departure from a perch, a type of vocalization classified separately from the other three main vocalization categories as in Wiley and Wiley (1981).

Copulation

We observed copulations in all three pairs, a total of 19 copulations (Pair 1 *n* = 7 copulations, Pair 2 *n* = 3, Pair 3 *n* = 8, unknown ID *n* = 1). We observed copulations typically post-dawn (0630 to 0800) or pre-dusk (1700 to 1930), and occasionally multiple

Table 2. Vocalization types and associated behavioral contexts of Ridgway's Hawks (*Buteo ridgwayi*) in Punta Cana, Dominican Republic.

	Class of Vocalization		
Vocalization Context	*Kleeah*	*Weep!/ Weeup*	*Whistle-squeal*
Perched alone	5	25	0
Perched together	1	2	1
Flying alone	2	11	3
Flying together	1	3	2
Carrying nesting material	1	3	2
Nest construction	0	0	0
Copulation	0	0	13
Eating	0	0	1
Hunting	0	0	0
Unknown[1]	1	8	0
Total	11	52	22

[1]focal hawk out of sight/ behavioral context not recorded

times a day for a single pair (mean 0.86 ± 0.25 SE copulations observed per pair per day of observation, range 0–5, *n* = 21 pair observation days). On 18 January 2018, Pair 3 copulated five times during the course of one observation between 0635 and 1036. Copulations typically occurred on a bare perch, such as a standing snag or electrical pole. On at least one occasion, a copulation was initiated with one bird making a short vocalization ("Weep!"). The initiating bird would generally fly to the perch of the other, and almost immediately copulate. During copulation, the male mounted the female's back and lowered himself over her while vocalizing (Whistle-squeal), often with his wings spread, pushing her tail aside with his. The female would crouch, making her back more horizontal during this sequence. In two instances, one member of the pair was heard making distinct nasal vocalizations during the copulation (Fig. 3).

Nesting and Nest Construction

Each of the three pairs of hawks in this study had at least one potential nesting site to which they brought material (Pair 1 *n* = 2 nests, Pair 2 *n* = 1, Pair 3 *n* = 1); all of these nests were in palm trees. Most hawk nests observed from current and previous years were constructed atop Palmchat (*Dulus dominicus*) nests, some of which were concurrently in use. All three pairs visited nests that had been constructed in a previous season, and all three focal males and all three focal females were identified carrying nesting material at least once each. We were able to determine the sex of birds carrying nesting material on 17 occasions; 9 were males and 8 were females. In most cases where we observed birds gathering branches, hawks collected thin branches by physically breaking them from trees. Only once did a bird pick up a branch off the ground and carry it to a nest. Of six total

observations of birds constructing (moving or placing sticks) a nest, a female was observed five times, and a male only once. However, all of our observations of a female constructing were of a single individual female on five occasions.

The nests in this study were located around populated areas. One was located < 10 m from a residence, and another < 5 m from a road with frequent foot and vehicle traffic. Hawks showed no signs of being disturbed by anthropogenic activity. We observed them perched with one foot tucked up, eating, and copulating, in some instances with a human standing or walking directly beneath them. Also notable was an observation of a hawk flying directly into a glass window of a residence after departing a potential nest site.

Discussion

This study aimed to 1) better characterize the behavior and vocalizations of Ridgway's Hawks, and 2) compare the behavior of pairs in the Punta Cana population to the behavior of pairs documented in Los Haitises by Wiley and Wiley (1981).

The behavioral contexts of vocalizations observed in Punta Cana are similar to those observed in Los Haitises. Although this study is limited by a small sample size, both short "Weep!"/"Weeup" calls and "Kleeah" calls were used in a similar diversity of behavioral contexts, suggesting that these call types are the most flexible and behaviorally versatile vocalizations made by this species. Often used when a hawk is perched alone, these specific calls may aid primarily in longer-distance communication between members of a pair, or potentially in territorial contexts. This is consistent with behavioral contexts of these calls as noted by Wiley and Wiley (1981), with "Kleeah" calls observed primarily in more aggressive contexts, and "Weeup" calls given during a range of behaviors including displays and food exchanges. Whistle-squeal calls were primarily given when members of a pair were close together, especially during copulations, suggesting that this vocalization is primarily used in closer communication between members of a pair. This is consistent with behavioral contexts of these calls as noted by Wiley and Wiley (1981), with "Whistle-squeal" vocalizations documented in high-intensity interactions like copulations and food exchanges.

With respect to spacing of pairs, our observations suggest that the areas used by breeding pairs of Ridgway's Hawks did not overlap, which is similar to previous findings (Wiley and Wiley 1981, Woolaver *et al.* 2015). Wiley and Wiley (1981) reported average home range size for Ridgway's Hawk to be 53.7 ha., with an average distance of 727 m between nests of neighboring pairs. The closest we observed any two pairs to each other perched was 460 m, and this close proximity of breeding pairs suggests that Ridgway's Hawks have a small breeding home range compared to many other *Buteo* species, consistent with Wiley and Wiley (1981). Although we conducted our study before the birds had laid eggs, the closest distance between our observed potential nest sites for the three pairs was 760 m, similar to the average distance of 727 m between nest sites calculated in Wiley and Wiley (1981). These results suggest that home range sizes and distances between neighbor nest sites may be comparable in Punta Cana to Los Haitises, although more data is needed to fully characterize the average home range size of hawks in Punta Cana.

Although none of the focal individuals were seen in close proximity to other pairs aside from one documented territorial flight, we did observe one juvenile female interacting with an adult pair on 19 January. Notably, this juvenile hawk eventually joined that pair as a polygynous trio in 2018, and again in the three subsequent breeding seasons (Hayes *et al.* 2022). The male of this pair was later documented copulating with both females, and both females incubated eggs, fed nestlings, and defended the nest territory (Hayes *et al.* 2022). Our single observation of the juvenile bird and one of the adult hawks lowering their legs in flight in close proximity to each other appeared consistent with aggressive flight displays documented by Wiley and Wiley (1981), but we observed no other evidence of aggression during these early encounters between the juvenile female and the pair. Other Ridgway's Hawks in Punta Cana have been documented attempting to breed in their second year (TIH pers. obs.), but this is uncommon for the species overall (Anderson *et al.* 2021). To date, polygyny has only been documented in the Punta Cana population, never in the Los Haitises population, and polygynous events account for about 8% of occupied nests in Punta Cana between 2011–2021 (Hayes *et al.* 2022).

Even though the average laying date of Ridgway's Hawks in Punta Cana is mid-February (TIH pers. obs.), we observed frequent copulations during the first half of January. We observed 19 copulations in 18.5 cumulative hours of observation of 3 focal pairs of hawks, compared to 19 copulations documented by Wiley and Wiley (1981) in 363 hours of observation of 3 focal pairs in Los Haitises National Park between March and April. Although we collected observations of copulations in different months, hawks in Los Haitises began nest construction in late February and early March (Wiley and Wiley 1981), compared to January in Punta Cana, suggesting that our copulation observations were collected during similar stages of the pre-breeding season in both populations. The pairs observed in Los Haitises completed nest building by the end of March, so presumably some number of those copulations in March and April could have produced fertile eggs. By comparison, all 19 copulations we observed in Punta Cana were during the nest building stage, before egg-laying occurred. Although the timing within the pre-breeding season is not perfectly comparable between these two studies, especially since observations in Wiley and Wiley (1981) spanned the entire breeding period from nest construction to young fledging, the high number of copulations in Punta Cana during nest building still stands out by comparison.

The function of frequent copulations in the pre-laying period is worth exploring in future studies. It is possible that these copulations are a behavioral mechanism that reinforces social and sexual monogamy, lessening the perceived risk of cuckoldry for male hawks and reducing the need for intense mate guarding as the birds approach the breeding season. Frequent pre-breeding copulations between social mates are sometimes evidence of a form of paternity guarding by the male against sperm competition from other males (Møller and Birkhead 1991). We did not resight any member of a known pair in the near vicinity of a bird from any other social pair (aside from one observation of a territorial flight), suggesting at least initially that these hawks were not seeking extra-pair copulations or courtship. This supports past research demonstrating that this species is socially

and sexually monogamous (Woolaver *et al.* 2013). Given that these copulations were observed more than a month before the typical egg-laying date, it also seems unlikely that these copulations would have produced any fertilized eggs. Perhaps with a higher-density population of hawks, an overall younger population in Punta Cana than in Los Haitises, and a higher frequency of polygamous events (Hayes *et al.* 2022), male hawks in Punta Cana have greater need for forms of mate guarding such as frequent copulations.

Further study should assess rates of extra-pair paternity in Ridgway's Hawk broods in Punta Cana, especially in broods raised by polygynous trios like those documented in Hayes *et al.* (2022). If rates of extra-pair paternity are higher in Punta Cana than in Los Haitises, where hawks appeared to be strictly monogamous, this could help explain frequent copulations between members of a social pair. The Punta Cana population provides a unique natural laboratory for studying how sexual and territorial behavior changes in more urban or developed habitats as well as in populations with a higher density of breeding pairs. In some other raptor species, such as the Cooper's Hawk (*Accipiter cooperii*), rates of extra-pair paternity are elevated in urban populations (Rosenfield *et al.* 2015), suggesting that raptors in higher-density populations in a food-rich environment may shift away from strict sexual monogamy. If this pattern holds true in Ridgway's Hawks, this could have implications for understanding and then monitoring the genetic diversity of this small, translocated population. Extra-pair paternity in this population would mean, for example, that biologists cannot rely on social pairings to analyze the extent of inbreeding in the population, which could have implications for management decisions (Forsdick *et al.* 2021).

Future studies compiling data on the average home range size of Ridgway's Hawks in Punta Cana compared to Los Haitises would help provide context to observations of this species' pre-breeding behavior in each population. Observing pairs to document whether one sex appears to follow the other disproportionately would provide additional context to our observations of frequent pre-breeding copulations. If males frequently follow females, this might suggest mate guarding, with one hawk preventing its partner from engaging in extra-pair copulations. Further study of mate guarding behavior and copulations, particularly as the egg-laying period approaches, would also help clarify the role of frequent copulations.

Better understanding the breeding behavior of these unique raptors may also help provide more information to conservationists' monitoring efforts in the time leading up to the breeding season. Understanding how habitat characteristics, population density, and species management affect breeding biology and behavior would also help conservationists assess the health and viability of reintroduced raptor populations for Ridgway's Hawks in other regions and possibly for other raptor species as well.

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