

Riparian Raptor Breeding Season Report Big Bend National Park, Texas 2016



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Photographs: Stacy M. Sirotnak, Big Bend National Park
Cover photos: Common Black-Hawk at Rio Grande Village and Gray Hawk at Daniels Ranch

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ABSTRACT

The following report summarizes the breeding activity of riparian raptors during the summer of 2016 in Big Bend National Park, Brewster County, Texas. Efforts were focused on two Species of Concern due to their vulnerability to disturbance and loss of riparian habitat, the Common Black-Hawk (*Buteogallus anthracinus*) and the Gray Hawk (*Buteo plagiatus*). During the 2016 breeding season, a total of 130 visits were made to nesting territories. There were five territorial pairs, six occupied nests, and four successful nests by three raptor species. Of those, two successful nests were recorded for Common Black-Hawks with two possible fledged young and one successful nest was recorded for Gray Hawks with two possible fledged young. In addition, one successful nest was recorded for Swainson's Hawk (*Buteo swainsoni*) with one possible fledged young. Management goals and conservation efforts should be aimed at maintaining the quality of riparian habitat and adjacent mesquite woodland needed for these Species of Concern.

INTRODUCTION

The following report summarizes the breeding activity of riparian raptors during the summer of 2016 in Big Bend National Park, Brewster County, Texas. Efforts were focused on two Species of Concern due to their vulnerability to disturbance and loss of riparian habitat. The Common Black-Hawk (*Buteogallus anthracinus*) and the Gray Hawk (*Buteo plagiatus*) are migrants in the southwestern United States. Both species' populations (breeding) are listed with a threatened status at the state level (Texas Parks and Wildlife 2015). Monitoring goals were to document presence (arrival and departure of the area), nesting chronology, and reproductive success of each species.

The Common Black-Hawk (hereafter Black Hawk) is a resident from northern Mexico extending south through Central America and into northern South America as well as occurring in Cuba. During migration, the northern breeding population extends into the southwestern United States (Arizona, New Mexico, south-eastern corner of Utah, and far west Texas) (Schnell 1994, Rodríguez-Flores et al. 2010). Migrants arrive in March and depart usually September/October. In the U.S., the Black Hawk breeding population is dependent upon riparian habitat (Schnell 1994). Nesting territories are found in mature riparian gallery forests, which usually include cottonwood and willow trees. Nest sites are in tall trees, especially cottonwoods, and are situated along perennial streams with a mostly permanent water flow and in areas of low human disturbance (Schnell 1994, Kaufman 1996).

The Black Hawk has a variable diet depending upon food availability which consists of fish, frogs, lizards, small birds, snakes, rodents, and a variety of insects (grasshoppers and caterpillars) (Schnell 1994). Black Hawk breeding season begins early April and ends in July/August. Nests are built in close proximity to surface water (1-242 meters), 30-90 feet (9-30 meters) above ground, and consist of a platform of sticks and twigs lined with green leaves (Schnell 1994). Copulation occurs on a branch or rock about 50-295 feet (15-90 meters) from the nest (Steinwand 2001). Clutch size is usually 1-2 eggs (Kaufman 1996). Incubation is by both parents; however, the female spends more time in the nest (Rodríguez-Flores et al. 2010).

Incubation lasts 37-40 days and the fledging period is between 41-52 days (Schnell 1994). Adults continue feeding juveniles for another 5-8 weeks (Schnell 1994).

The Gray Hawk, a resident throughout Mexico, Central America, and South America, is a short-distance migrant in the northern part of their range. Gray Hawk breeding populations arrive in the southwestern U.S. (Arizona, south Texas, and occasionally New Mexico) in March and depart by October (Bibles et al. 2002). Nesting territory habitats include mature riparian gallery forests, along or near permanent streams and adjacent to mesquite woodlands (bosques) (Bibles et al. 2002). Gray Hawks exhibit high nest site fidelity (Kropp 2002) and use tall trees, primarily cottonwood trees, for nesting, with adjacent mesquite woodland. Bibles' research (2002) states that mesquite is a primary requirement for breeding. Historical records in Arizona reported Gray Hawks nesting in mesquites > 30 feet tall (Bibles and Mannan 2004). Bibles and Mannan (2004) suggest that Gray Hawks probably select the most dominant/tallest trees for nesting; typically the tallest trees in the riparian areas in Arizona are cottonwoods as there are few remaining large stature mesquites.

The gray hawk diet consists mostly of vertebrates, especially reptiles, but also includes beetles and grasshoppers (Bibles et al. 2002, Cornell Lab of Ornithology 2015). Nests are usually well hidden (Kaufman 1996), in the upper half to upper third of the tree canopy, and in branches away from the trunk (Bibles et al. 2002). It is constructed with sticks, green leafy twigs, and lined with leaves. Clutch size in the U.S. is usually 2-3 eggs in early May (Kaufman 1996). Incubation is by the female and lasts 32-34 days and fledging occurs at about 42 days (Bibles et al. 2002).

STUDY AREA

Big Bend National Park is located in southern Brewster County, Texas, and encompasses 801,163 acres. The Rio Grande/Rio Bravo is the park's southern boundary and the international border between the United States and Mexico. The park is the largest protected area of the Chihuahuan Desert in the United States. The diverse landscape of canyons, mountains, desert, and river support the high species diversity within the park. Elevations range from 1,750 feet at the Rio Grande up to 7,825 feet at the top of Emory Peak, the highest peak in the Chisos Mountains. Average maximum temperatures range from 60.9 degrees F in January to 94.2 degrees F in June at Panther Junction Park Headquarters (3,750 feet). Average precipitation recorded in Panther Junction is about 15 inches/year with the majority of it received during the summer monsoon.

Black Hawks and Gray Hawks are known to occupy historical nesting areas within the riparian corridors of the park. Three areas were targeted for monitoring: Terlingua Abajo, Cottonwood Campground, and the Rio Grande Village-Daniels Ranch area. During the 2016 breeding season, known Black Hawk nesting territories included Rio Grande Village and Terlingua Abajo. Known Gray Hawk nesting territories included Cottonwood Campground, Daniels Ranch, and Terlingua Abajo (suspected).

Nesting Territory Habitat Descriptions

Terlingua Abajo, a group of primitive roadside campsites in the west side of the park, is adjacent to Terlingua Creek. The territory is just up the creek from Terlingua Abajo, approximately 0.4 miles. Terlingua Creek, an intermittent stream with a perennial reach in the west side of the park, is a tributary of the Rio Grande near Santa Elena Canyon. The creek takes a bend about three miles upstream from the confluence where there usually is pooled water and a wide flood plain. The area consists of mature dense stands of cottonwoods (*Populus fremontii*), willows (*Salix exigua*) along the banks, exotic grasses and some salt cedar (*Tamarix spp.*) in the flood plain, and mesquite-acacia (*Prosopis spp.*, *Acacia spp.*) thickets on both sides of the creek.

Cottonwood Campground is a developed campground in the west side of the park near Castolon. The campground is manicured and maintained (mowed and irrigated) with an open understory and contains mature cottonwood trees (*Populus spp.*) of the same age/height and smaller stature native deciduous trees such as desertwillow (*Chilopsis linearis*), honey mesquite (*Prosopis glandulosa*), huisache (*Acacia farnesiana*), and a dense mesquite-acacia thicket that surrounds most of the area.

Rio Grande Village (hereafter, RGV) is a developed area and the primary visitor use hub in the east side of the park. The visitor center, store, and campgrounds (main, group, and RV) are located here; the grounds are manicured and maintained with irrigation ditches running through the area along the roadsides. The main campground consists of mature cottonwoods of the same age/height, mesquite, acacias, ash (*Fraxinus spp.*), and NewMexico locust (*Robinia neomexicana*) trees and is surrounded by dense mesquite/woody shrub thickets. Adjacent to the main campground is a wetland area (RGV Wetlands) with a small, but mature cottonwood canopy, willows, cattails (*Typha latifolia*), alkali sacaton (*Sporobolus airoides*), and mesquite/woody shrub thickets. The group campground contains an open understory with ash and locust trees and a more dispersed mature cottonwood canopy (same age/height). The RV campground is adjacent to an open field and mature cottonwoods, mesquites, and acacias along the road/irrigation ditch.

Since the early 2000's, the Black Hawk's historical nesting territory in RGV has been designated a sensitive nesting area. Signage indicates the area is closed and compliance is voluntary. The area is characterized by mature cottonwoods (mostly of the same age/height; however, some medium-sized trees are present that appear to be volunteers), a relatively open understory (Johnson grass, *Sorghum halepense*, present in about half of the area), with mature mesquite and acacia trees and thickets to the west and south, and the irrigation ditch to the north. The area is not maintained during the breeding season.

Along the north and south side of the road leading to Daniels Ranch from the Black Hawk nesting area are two groves of cottonwoods, ash, locust, and mesquite trees. Cottonwoods and sycamores line the south side of the road at the irrigation ditch. The area is manicured and maintained. A continuous stand of mesquite-acacia/woody shrub thicket borders these groves.

Daniels Ranch is a manicured and maintained visitor day-use area at RGV. The area consists of a mature cottonwood canopy, an open understory, and is bordered on the north and east by a continuous dense stand of honey mesquite and other woody shrubs. Beyond those stands is open desert. The cottonwoods are of the same age/height. An irrigation ditch borders the west and south side of the area at the road and to the northwest of the area are two settling ponds.

METHODS

Monitoring was conducted from March 15-August 30, 2016. The two species of concern, Black Hawk and Gray Hawk, were the focus of the monitoring efforts; however, other raptor species were recorded as well. No specific protocol was followed; however, observations, data collection, and reporting was largely based on the Raptor Breeding Season Report for Pinnacles National Monument (Emmons 2008) and elements of the American Peregrine Falcon Monitoring Program in Big Bend National Park (Powell 2003).

Observations were conducted opportunistically, as part of routinely scheduled tasks, and in conjunction with other work tasks based on the location. The nesting territories in the RGV-Daniels Ranch area were visited on a weekly basis, usually the same day of the week and at approximately the same time.

Territories were visited by vehicle and/or hiking. During a visit, the observer used binoculars/spotting scope and/or walked around the site to confirm presence of individuals, either by sight or sound. Observations were of a short duration and made from locations to maximize visibility and from concealed spots when possible to minimize disturbance. All visits and observations were recorded and photo/video documented as needed. The number of visits was based on visits to each species' territory within an area. For example, a weekly visit to RGV to monitor Black Hawks and Gray Hawks and their respective nest sites resulted in one visit for each species. Visits were performed by the primary observer, Stacy M. Sirotnak.

A variety of equipment (park and personal) were used during monitoring. Equipment included: tripod and Nikon spotting scope (20x60), Eagle Optics binoculars (8x42) and (10x50), digital cameras, Nikon 70-300mm lens, and a digiscoping digital camera adapter.

Reproductive success was measured in terms of productivity (the number of young that reach the minimum acceptable age for assessing success) and success of a nest (a nest which at least one young reaches the minimum acceptable age for assessing success) (Steenhof and Newton 2007). Nesting productivity was reported for all breeding raptors which included the number of: territorial pairs, nesting pairs, occupied nests, successful nests, possible fledglings, and fledglings per nest. A breeding summary was reported per nesting territory which included: the number of young hatched, the number of possible fledglings (young in or at the nest at the estimated minimum acceptable age), the number of known fledglings that were visually confirmed away from the nest/nest tree, estimated arrival/departure dates of the species into the area, and details of the nest used during the breeding season. Nest phenology was reported per nesting territory which included the estimated arrival date, onset of incubation, hatch, and fledge date, potential abandoned/failed date, and the numbers of nestlings and fledglings.

The minimum acceptable age for assessing success (MAA) is 80% of the nestling age prior to fledging (Steenhof and Newton 2007).

Black Hawk: 80% of average fledge period (46.5 days) = 37.2 days; 9.3 days from fledging

Gray Hawk: 80% of average fledge period (42 days) = 33.6 days; 8.4 days from fledging

Nesting chronology was based on actual date observations or as calculations using the following data:

Black Hawk: Hatch date calculated using average incubation period of 38.5 days; Fledge date calculated using average fledging period of 46.5 days (Schnell 1994).

Gray Hawk: Hatch date calculated using average incubation period of 33 days; Fledge date calculated using average fledging period of 42 days (Bibles et al. 2002).

The appendix contains the terminology used in this report which is largely derived from Postupalsky (1974), the Raptor Research and Management Techniques manual (Steenhof and Newton 2007), and the Prairie Falcon Monitoring Protocol for Pinnacles National Monument (Emmons et al. 2011).

RESULTS

During the 2016 breeding season, a total of 130 visits were made to nesting territories (Table 1). There were five territorial pairs, six occupied nests, and four successful nests by three raptor species. Of those, two successful nests were recorded for Black Hawks with two possible fledged young and one successful nest was recorded for Gray Hawks with two possible fledged young (Table 2). In addition, one successful nest was recorded for Swainson's Hawk with one possible fledged young.

Table 1. Number of visits made to nesting territories during the 2016 breeding season.

2016								
Species / Territory	March	April	May	June	July	Aug	Sept	Subtotals
Common Black-Hawk								
<i>RGV Black-Hawk Nesting Area</i>	3	4	7	5	5	4		28
<i>Terlingua Abajo</i>	1	3	2	3	4			13
Gray Hawk								
<i>RGV Wetlands</i>	3	4	5	5	4	6		27
<i>RGV-Daniels Ranch</i>	3	4	6	5	5	5		28
<i>Cottonwood Campground</i>	1	3	4	1				9
<i>Terlingua Abajo</i>	1	3	2	3	4			13
Swainson's Hawk								
<i>Terlingua Abajo</i>	1	3	2	2	4			12
								0
Subtotals	13	24	28	24	26	15	0	
Total								130

Table 2. 2016 Breeding Raptor Nesting Productivity.

Species	Territorial Pairs	Nesting Pairs	Occupied Nests	Successful Nests	# Possible Fledglings	# Fledglings / Nest
Common Black-Hawk	2	2	3	2	2	1.0
Gray Hawk	2	2	2	1	2	2.0
Great-horned Owl	U	U				ID
Swainson's Hawk	1	1	1	1	1	1.0
ID = Insufficient data; U = Unknown						

Table 3. 2015-2016 Breeding Raptor Nesting Productivity.

Species	YEAR	Territorial Pairs	Nesting Pairs	Occupied Nests	Successful Nests	# Possible Fledglings	# Fledglings / Nest
Common Black-Hawk	2015	2	2	2	2	2	1.0
	2016	2	2	3	2	2	1.0
Gray Hawk	2015	2	2	2	2	5	2.5
	2016	2	2	2	1	2	2.0
Great-horned Owl	2015	1	1	1	1	2	2.0
	2016	U	U				ID
Peregrine Falcon	2015	1	1	1	U	U	ID
	2016	ND	ND				
Swainson's Hawk	2015	1	1	1	U	2	ID
	2016	1	1	1	1	1	1.0
ND = Not detected; ID = Insufficient data; U = Unknown							

Observations are summarized by species below (Black Hawk, Gray Hawk, and Other). All observations were recorded by Sirotnak unless noted otherwise. Additional observations from other sources were included to supplement breeding season data.

Common Black-Hawk

Territory - RGV Black Hawk Nesting Area

The Black Hawks were first seen on March 15 when an adult was observed refurbishing the 2015 nest, one of the three known historical nests, in the nesting area. The nest tree, a mature cottonwood, was approximately 60 feet tall. The nest, in the upper one-half of the tree, was constructed of sticks and twigs, cone-shaped with the trunk completing its frame, and fairly protected/concealed with hanging branches. The nest tree was approximately 670 feet from the Rio Grande and 50 feet from the irrigation ditch (distances calculated using Google Earth).

An adult was observed adding fresh twigs to the occupied nest on March 22. Fresh greenery at the top of the nest was noted on April 5. The pair was observed perched together in the nesting area and later soaring/circling together over the nesting area on March 29. Incubation began on/before April 19 with visual confirmation of an adult hawk in the nest. Incubation date was recorded as between April 13-19 (the pair was perched together on April 13, which was the last visit prior to April 19). The adult in the nest, stood up, and was heard softly vocalizing on April 26 while the other adult was perched in a nearby tree. No hawks were seen or heard on May 3. There did not appear to be a bird in/at the nest on May 10, however an adult was perched in a nearby tree. No hawks were seen or heard on May 17 but remnants of a Black Hawk egg (presumably) were found at the base of the nest tree directly under the nest. The egg shell was about 2/3 intact, one larger piece with a few fragments, white with small dark marks, and measured 39 x 52 mm. The shell still had moist, sticky yolk-like material attached to it and the substance was on the adjacent ground and grass. No mass or embryo was found.

The Black Hawks began a second nesting attempt and were observed moving around in the nest, facing each other, in an alternate nest on May 19 (David Larson, pers. comm.). The alternate nest was one of the known historical nests in the nesting area. The nest tree, a mature cottonwood approximately 60-80 feet tall (the tallest one in the nesting area), is about 80 feet away from the previously used nest tree. The nest, in the upper one-third of the tree, was constructed of sticks and twigs, shallow bowl-shaped with several large branches completing its frame, and fairly protected overhead with the tree canopy. The new nest was more visible from the observation area (no leafy branches hanging over the nest); however, it was much higher, making it difficult to see into the nest from ground level. The new nest tree was approximately 580 feet from the Rio Grande and 135 feet from the irrigation ditch (distances calculated using Google Earth).

An adult was observed at the nest on May 21. Visits to the nesting area from May 24 through May 31 did not result in confirmation of a bird in the nest; however there was usually an adult perched in a nearby tree. Incubation began on/before June 3 with visual confirmation of an adult hawk sitting in the nest (tail was visible). Incubation date was recorded as between May 21-June 3 due to visibility difficulties (inability to detect the presence of a bird in the nest). An adult was observed in the nest on the June 6, 14 (preening), 21, and 28 (preening) visits. The adult in the nest on July 7 exhibited behavior consistent with the possibility that hatching had begun (adult sitting and moving around, looking down into nest, appearing very alert and attentive). The pair exhibited behavior consistent with hatching in progress or that an egg had recently hatched on July 12. One adult was at the edge of the nest, looking down frequently, with an alert posture. The other adult flew into the area and delivered food to the nest and remained, whereby both adults began softly vocalizing. The second adult flew off while the first adult repositioned at the nest edge and ate.

A nestling was first seen, covered in yellow down and wobbly head movement, on July 15. Hatch date was recorded as between July 7-15. An adult hawk was observed performing nest maintenance by adding a live tree branch to the nest on July 28. The nestling issued a food beg call and an adult responded with a food drop (prey item undetermined) on August 16. The

nestling/young hawk was observed branching on August 24 (perched on a branch behind and close to the nest) while an adult was perched in a nearby tree. An adult was perched in a tree in the nest area while the fledgling was seen perched nearby, in a low branch of a tree near the nest tree, much concealed by leafy branches, on August 30. Fledge date was recorded as between August 24-30. The last visit to the nesting area was August 30.

Additional observations of Black Hawks included an adult soaring with a group of turkey vultures over the main campground area of RGV on July 12 and an adult soaring/circling in the RGV Wetlands area on August 17 (approximately 0.89 miles from the RGV Black Hawk Nesting Area). Presumably, the individuals seen were of the nesting pair within the RGV Black Hawk Nesting Area territory.

Figure 1. 2016 Black Hawk occupied nest (second) at RGV Black Hawk Nesting Area, Black Hawk adult at nest (second), Black Hawk nestling.



Territory - Terlingua Abajo

The adult pair of Black Hawks was first observed in the nesting territory on March 31. The pair was seen perched together in the 2015 nest tree. Incubation began on/before April 21 with visual confirmation of an adult hawk sitting in the nest. Incubation date was recorded as between April 1-21.

The 2016 occupied nest was the same nest used in 2015 and was in a mature cottonwood, approximately 60-80 feet tall, west of Terlingua Creek. The nest was in the upper one-third of the tree in a group of dead branches off of the main trunk. The nest was somewhat loosely constructed of sticks and twigs, lacking in a defined shape, and set on the smaller branches for support with the main branch completing its frame. The nest was fairly exposed with little foliage providing shelter from the weather. The nest tree was approximately 200 feet from the creek where there was pooled and intermittent running surface water (distances calculated using Google Earth).

An adult was observed in the nest during subsequent visits on April 28 and May 5. One nestling was confirmed on May 25; nestling moved wobbly head and extended a wing. Hatch date was recorded as between May 5-25. An adult was perched and calling in a nearby tree on June 1; however, the nestling was not visible. The nestling was seen sitting at edge of nest, moving

around and flapping wings on June 8, while an adult was perched up the creek from nest, calling. An adult was perched and calling in a nearby tree on June 24; however, the young raptor (nestling or fledgling) was not visible in or near the nest. The fledgling and adult were perched together in a tree (not the nest tree) on July 6. Fledge date was recorded as between June 24-July 6. The adult pair was observed in the area on July 13 issuing alarm calls; the juvenile was not seen but presumed to be in the area based on the adults' behavior. The juvenile was observed down creek from the nest area on July 20 and July 27. On both dates, an adult was observed in the area as well. The last visit to the nesting area was July 27.

Figure 2. 2016 Black Hawk nesting territory at Terlingua Abajo, Black Hawk fledgling and adult.



Table 4. 2016 Common Black-Hawk Breeding Summary.

Nesting Territory	Arrival Date	Date Last Seen/Heard	Date Last Search/Visit	# Young Hatched	# Possible Fledglings	# Known Fledglings	Nest Used
RGV Black Hawk Nesting Area	< 3/15	9/21*	8/30	1	1	1	1st attempt - 2015; 2nd attempt - alternate, history of use unknown
Terlingua Abajo	< 3/31	7/27	7/27	1	1	1	2015
*Reported by D. Larson							

Gray Hawk

Territory - Cottonwood Campground

No Gray Hawks were seen or heard on three visits to the campground on March 21, April 1, and April 21. A Gray Hawk was heard calling in the distance, outside of the campground, on April 28, May 3, and May 5. No hawks were seen or heard on May 20 and May 25. Larson reported a second year (SY) Gray Hawk perched in a cottonwood in the front campsites on May 25. No hawks were seen or heard on June 8. The last visit to the nesting area was June 8.

Larson reported an adult hawk flew over the campground on June 24. Clint Boal (pers. comm.) reported that the Gray Hawks were present and the nest was found on April 14. Mark Flippo

(pers. comm.) also reported seeing the Gray Hawks in the campground early in the breeding season, but then disappeared. There was insufficient data to determine the presence of a territorial pair or breeding status.

Territory - Daniels Ranch

An adult Gray Hawk was first observed in the nesting area on March 22 (none were seen or heard on March 15). The adult pair of Gray Hawks was confirmed and exhibited courtship behavior on March 29 which included flying/soaring together, courtship flying with a talon grab/touch, and an adult carrying a stick to the nest tree (same nest tree as 2015, but did not observe the hawk at the 2015 nest). An adult was seen perched in the nest area and heard issuing defensive calls on the April 5, 13, and 19 visits.

The new occupied nest for the 2016 season was confirmed on April 26. The Gray Hawks nested in same nest tree as 2015, a mature cottonwood, one of the tallest trees in the 60-80 foot range. The occupied nest was in the upper one-third of the tree, in the branch/stem off of the main trunk. The nest was constructed of sticks and leafy twigs, funnel-shaped, and less concealed than the 2015 nest. The nest tree was approximately 500 feet from the Rio Grande and about the same distance to the settling ponds. The distance from the nest tree to the irrigation ditch was approximately 160 feet and 130 feet to the mesquite thicket. The Gray Hawk nesting territory was approximately 0.4 miles from the Black Hawk nesting territory.

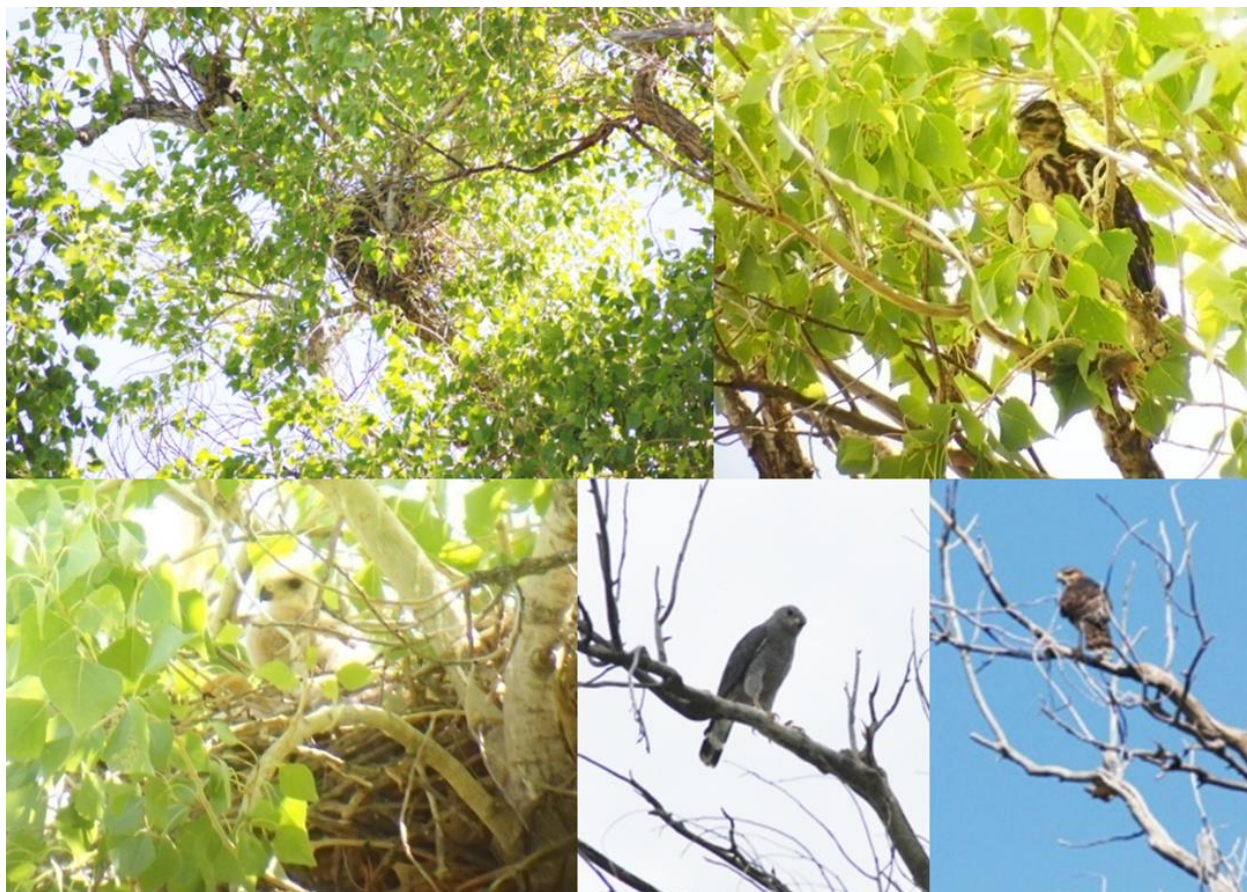
An adult was confirmed in the nest on April 26. Incubation began on/before April 26. Incubation date was recorded as between April 19-26. An adult was observed in the nest or just recently flushed from the nest on the May 3, 10, 17, 24, and 27 visits. An adult was perched on a dead limb behind the nest on May 31, then flew away to perch in a nearby tree and issued alarm calls. An adult flew from the nest and perched in a nearby tree and issued alarm calls on June 3. A nestling was first seen in the nest, covered in pale yellow down, on June 6. The following week, June 14, two nestlings were seen in the nest. Hatch dates were recorded as between June 3- 6 for the first nestling (June 3 was the last visit/sighting of an adult in/at the nest) and between June 6-14 for the other nestling.

Two nestlings were seen in the nest through July 3. Two nestlings were visible on July 7, one nestling was sitting up in the nest and the other nestling was observed branching near the nest. Fledglings were not seen or heard on the July 12 and July 15 visits; however, the adult pair was present in the area and exhibited behavior consistent with the recent fledglings being in the area, just not detected. The pair perched and flew from tree to tree while issuing defensive/alarm calls. Fledge date was recorded as between July 7-12 for both nestlings.

A juvenile Gray Hawk was heard, but not located, in the nesting area on July 28. Flippo reported seeing the adult pair and a juvenile in the groves, east of Daniels Ranch, on August 3. No Gray Hawks were seen or heard in the nesting area or the adjacent grove area on August 9 or August 10. An adult was observed gliding low among the medium sized trees in the south grove on August 16. Additionally, on August 16, the adult pair was observed in the nesting area, perched near each other, calling, and then flew off towards the river. An adult was observed perched on

a utility pole on the main road leaving RGV, north of the nesting area on August 18. The hawk flew off in the direction of the nesting area. A juvenile Gray Hawk was observed perched in a cottonwood tree in the north grove on August 24 and later a juvenile was seen soaring high above the Daniels Ranch parking lot (unknown if same juvenile). A juvenile was observed perched in a tree in the back of the nesting area on August 30 and later a juvenile was seen perched at the top of a cottonwood tree in the north grove (unknown if same juvenile). The last visit to the nesting area was August 30.

Figure 3. 2016 Gray Hawk occupied nest at Daniels Ranch, Gray Hawk young branching, Gray Hawk nestling, Gray Hawk adult, and Gray Hawk fledgling.



Territory - RGV Wetlands

No Gray Hawks were seen or heard on March 15 or March 22. An adult Gray Hawk was observed perched on a utility pole on April 5, and later that visit, an adult was seen perched on a dead branch of a live cottonwood tree in the wetlands area. An adult was observed perched in a cottonwood tree (same as April 5) on April 13, and later that visit, an adult was seen flying over the open desert scrub area adjacent to the wetlands. A Gray Hawk (age class unknown) was heard calling in the area on April 19. No hawks were seen or heard on April 26, May 3, or May 10.

A SY Gray Hawk was seen perched on the same utility pole along service road on May 17 and May 24. No hawks were seen or heard on May 31. A Gray Hawk (age class unknown) was heard calling, repeatedly, from the wetlands area while Sirotnak was working in the main campground on June 3. A Gray Hawk was heard calling and then seen flying/circling over the wetlands area (unable to determine age class) on June 6. The SY hawk was seen perched on different utility poles in the area on June 14 and June 21. No hawks were seen or heard in the area on June 28 or July 7; however, Flippo reported seeing an adult in the wetlands area on June 22 and July 6. The SY hawk was observed perched on different utility poles in the area on July 12 and July 19 and was seen perched at the top of a dead cottonwood tree in the main campground on July 28. Flippo reported seeing the SY in the campground on August 9; it flew by a Zone-tailed hawk that was eating (see Zone-tailed hawk observation below).

No hawks were seen or heard on August 10. An adult was seen perched in a cottonwood tree in the area on August 16. An adult was seen perched in the same cottonwood tree on August 18 and the SY was observed nearby, flying from one utility pole to the other. The adult was seen later perched on a utility pole near the wetlands and campground entrance. A Gray Hawk (age class unknown) was observed north of the wetlands and service road on August 24. No hawks were seen or heard on August 30. The distance from the RGV Wetlands area to the Gray Hawk nesting area at Daniels Ranch was 1.2 miles. The last visit to the potential nesting area was August 30.

Also noted on these visits, was the onset of the SY's molt cycle and progression from juvenal plumage to a partial adult plumage. The first change was noted on June 21 with gray lores and thin black barring on legs. The gray on the face extended to the cheeks, some thin black barring visible on breast, belly, and flanks, and a few inner secondary flight feathers appeared gray on July 12. The SY appeared to be about halfway through the molt on July 28, with additional gray wing feathers, black and white banded tail feathers; brown crown and nape visible with very little juvenal breast streaking. It is unknown if the SY achieved full adult plumage.

Figure 4. 2016 Gray Hawk potential nesting territory at RGV Wetlands, Second year Gray Hawk.



Territory - Terlingua Abajo

A Gray Hawk was heard and seen circling overhead with a Swainson's hawk on the first visit to the area on March 31. The adult pair was confirmed in the suspected nest area on April 1 but the nest was not located. Boal confirmed the pair and reported the nest found during his April 14 visit. An adult was seen perched in the suspected nest area and the nest was located (with Boal's coordinates) on April 21; however, no nesting activity was observed. An adult was perched in a dead tree in the nest area and the other adult was flushed from the nest on approach to the area on April 28; the pair remained in the area issuing alarm calls.

The nest tree was a mature cottonwood, one of the tallest trees in the 60-80 foot range, in a very dense stand of similarly sized trees. The occupied nest was in the upper one-third of the tree, in the branch/stem off of the main trunk, and under the main canopy. The nest was constructed of sticks and leafy twigs, compact and slightly cone-shaped, and mostly concealed due to the density of the stand. The nest tree was approximately 470 feet from Terlingua Creek and approximately 75 feet to the continuous, adjacent mesquite bosque that paralleled the cottonwood stand. The Gray Hawk nesting territory was approximately 0.22 miles from the Black Hawk nesting territory and approximately 0.34 miles from the Swainson's hawk nesting territory (distances calculated using Google Earth).

Incubation began on/before April 28. Incubation date was recorded as between April 21-28. An adult was believed to be in the nest initially on May 5 and May 25 and then flushed; however, there was no positive (photographic) confirmation. An adult was perched nearby, issuing alarm calls, on those visits. There was no activity observed at the nest on June 1; however, the pair was active in the area. An adult was seen perched on a dead tree with prey but flew away as the other adult flew in, wailing. The wailing adult flew away in the same direction as the adult with prey.

The nesting area was visited repeatedly throughout the remaining of the breeding season (June 8-July 27). The adults were largely absent from the nesting area and at least one adult appeared to have moved across the creek to a smaller stand of cottonwoods/mesquite bosque along a canal and the creek edge. The Gray Hawks were observed often when approaching or departing the Swainson's Hawk nesting area.

An adult was observed perched in a cottonwood tree near the creek edge on June 8. Later, during the same visit, an adult was heard calling in the nesting area and the other adult responded from the direction of the earlier sighting, across the creek. No hawks were seen or heard in the area on June 24. An adult was heard calling from across the creek while the other adult vocalized repeatedly from the nesting area on July 6. The adult in the nesting area flew away in the general direction of the other adult. No nest activity was observed and the nest appeared to be deteriorating. An adult was perched in the foliage of a cottonwood across the creek on July 13 and no hawks were seen or heard in the nesting area. No hawks were seen or heard in the area on July 20. A medium-sized raptor, presumed to be an adult Gray Hawk, was observed flying through the cottonwood canopy across the creek (same areas as other sightings) on July 27. The last visit to the area was July 27.

Figure 5. 2016 Gray Hawk nesting territory at Terlingua Abajo, Gray Hawk occupied nest, Gray Hawk adult.



An additional Gray Hawk observation included one by Flippo while he conducted the yellow-billed cuckoo survey this season. Flippo reported an adult pair of Gray Hawks with a fledged juvenile at the Grand Canyon Farm (yellow-billed cuckoo) survey site on July 10. The three hawks were flying and displaying together, with much vocalizing, and perched in proximity in a tall snag south of the old Sublett bluff house.

Table 5.2016 Gray Hawk Breeding Summary.

Nesting Territory	Arrival Date	Date Last Seen/Heard	Date Last Search/Visit	# Young Hatched	# Possible Fledglings	Known Fledglings	Nest Used
Cottonwood Campground	< 4/14	6/24*	6/8	U	U	U	U
Daniels Ranch	3/15-22	8/30	8/30	2	2	2	New nest (same tree as 2015)
Terlingua Abajo	< 3/31	7/27	7/27	A/F**	A/F**	A/F**	Existing; history of use unknown
*Reported by D. Larson							
**Unsuccessful nest due to abandonment or failure (unknown) or nonbreeding status							

OTHER SPECIES

Broad-winged hawk, *Buteo platypterus*

A juvenile Broad-winged hawk was seen perched in a dead tree in the RGV Wetlands area on April 19.

Great-horned Owl, *Bubo virginianus*

Great-horned owls were reported in Cottonwood Campground early in the season; however, their breeding status was not determined and they appeared to not be present later in the season. No owls were seen or heard on March 21 and April 1. One owl was observed in a cottonwood tree in one of the campsites on April 28. It was suspected that more than one owl was present due to the number and behavior of visitors actively observing the nearby trees. It was also discovered that the 2015 nest was occupied by a very active beehive.

Boal reported the owls present but a nest was not located on his April 14 visit. Flippo reported the owls present as well early in the season. Flippo also reported seeing owls east of the campground, near the old road to Santa Elena, and wondered if they were the campground pair.

Mississippi Kite, *Ictinia mississippiensis*

A Mississippi Kite (age class undetermined) was observed kiting/hunting over the main campground on June 6. The bird was later seen circling over the wetlands/pond area where it stooped and then returned to circling and soaring.

Osprey, *Pandion haliaetus*

A juvenile Osprey was observed flying over RGV campground with a group of Turkey Vultures on June 6.

Peregrine Falcon, *Falco peregrinus*

Flippo reported a pair of Peregrine Falcons very active (and vocal) around the cliffs of the Lower Burro Mesa pour-off on April 12 and April 27.

Rough-legged Hawk, *Buteo lagopus*

A Rough-legged Hawk (age class undetermined) was observed soaring high above Daniels Ranch on April 13.

Swainson's Hawk, *Buteo swainsoni*

RGV area

An adult was observed soaring with Turkey Vultures over the RGV store area on March 22.

Terlingua Abajo

An adult pair of Swainson's Hawks (light morph) was confirmed and the nest was located at Terlingua Abajo on March 31. The pair was seen soaring together over the nest and defending their territory (successfully) against an adult pair of Red-tailed Hawks (*Buteo jamaicensis*).

The nest area at Terlingua Abajo was located upcreek of the Black Hawk nest, just above the bend in the creek. There are small stands of cottonwoods situated along the drainage leading to the creek. The nest area consisted of these outermost cottonwoods and the adjacent desert scrub/grassland. The nest tree was in a dense mature cottonwood, approximately 50 feet tall, at the far edge of the cottonwood stand. The occupied nest was in the upper one-half of the tree, at the outer edge of one of the branches off of the main trunk. The nest was constructed of sticks and twigs, platform-bowl shaped set in the smaller branches for support, and was fairly concealed by foliage. The nest tree was approximately 640 feet from the creek where there was pooled and intermittent running surface water and 380 feet from the ephemeral drainage (distances calculated using Google Earth). This was the same nest used in 2015.

An adult was observed flying over the adjacent grassland area with prey (appeared to be a rodent) on April 21. Incubation began on/before April 28 with confirmation of an adult in the

nest. Incubation date was recorded as between April 21-28. The adult was seen in the nest on May 5 and May 25 while the other adult was soaring nearby with Turkey Vultures. An adult delivered food to the adult in the nest on June 8. An adult was in the nest and a nestling was confirmed on June 24 when the other adult delivered food and fed the nestling. Hatch date was recorded as between June 8-24. An adult was observed positioned at the nest edge and the nestling sat up and moved around on July 6. There were two food drops to the nestling on July 13. The nestling/young was observed branching on July 20 in the nest tree near the nest. The young hawk extended and flapped its wings and ruffled its feathers, but did not attempt flight. The fledgling was flushed from the nest tree on July 27. Fledge date was recorded as between July 20-27. The last visit to the area was July 27.

Figure 6. 2016 Swainson's Hawk nesting territory at Terlingua Abajo, Swainson's Hawk adult and nestling, Swainson's Hawk nestling, Swainson's Hawk occupied nest.



Zone-tailed Hawk, *Buteo albonotatus*

Flippo observed an adult Zone-tailed Hawk perched in a cottonwood in the RGV campground, eating a recently captured yellow-headed blackbird on August 9.

A summary of nesting phenology and success for Black Hawk and Gray Hawk as follows:

Table 6. 2016 Nest Phenology and Success for Common Black-Hawk (CBHA) and Gray Hawk (GRHA).

Species	Nesting Territory	Arrival Date	Begin Incubation	Hatch Date	Fledge Date	Abandon Date	Failed Date	# of Nestlings	# Possible Fledglings	# Known Fledglings
CBHA	RGV Black Hawk Nesting Area	< 3/15	4/13-19				< 5/17	0	0	0
CBHA	RGV Black Hawk Nesting Area		5/21-6/3	7/7-15	8/24-30			1	1	1
CBHA	Terlingua Abajo	< 3/31	4/1-21	5/5-25	6/24-7/6			1	1	1
GRHA	Cottonwood Campground	< 4/14	U	U	U					
GRHA	Daniels Ranch	3/15-22	4/19-26	6/3-6 N1; 6/6-14 N2*	7/7-12 for both			2	2	1
GRHA	Terlingua Abajo	< 3/31	4/21-28			6/1**	6/1**	0	0	0
*N = Nestling; N1, N2, etc. to differentiate between individuals										
**Unsuccessful nest due to abandonment or failure (unknown) or nonbreeding status										
U = Unknown										

DISCUSSION

Consistent with the 2015 observations, there were obvious challenges encountered in the interpreting of observations during the 2016 breeding season. Hatch dates were difficult to determine as it was not possible to see into the nest and observations from the ground did not reveal a hatchling/nestling until it had developed the strength and mobility to become visible (> 4 days old). The posture and behavior of the attending adult(s) became a fairly reliable indicator that hatching was underway. Fledge dates were difficult to determine as well. It was difficult to differentiate between a young raptor that was branching and a young raptor that had in fact fledged but returned to perch in the nest tree or near the nest. Whether the young was branching or had in fact fledged, it was concluded that the nest was a successful nest because the young raptor had reached the MAA for assessing success.

Usually, detecting young raptors in the post-fledging period could be achieved. However, detecting and differentiating between multiple fledglings/juveniles from a given nest was much more difficult. The Gray Hawk Daniels Ranch territory produced two possible fledglings, with one young branching (and presumably fledging) before its sibling. After fledging, only one juvenile was observed at a time. It is not known if this was the same individual seen each visit. Using the MAA for assessing success helps with the issues of detection in the post-fledging period.

Other challenges included the weather and physical injury. Periodic precipitation events and a very productive monsoon season resulted in the inability to physically visit the Terlingua Abajo nesting territories. High water, copious amounts of slick mud, and the threat of the creek flashing (from local and regional rain events) were deterrents in being able to visit the area. Further, the field season and observations ended prematurely due to personal injury of the primary observer; hence, post-fledging follow-up observations and the departure of the migrants went undocumented.

The Black Hawks first nesting attempt ended with the discovery of the egg fragments on May 17. There was a fair amount of yellow yolk-like content in and on the egg fragments and on the area (ground and grass) surrounding the egg fragments. It is unknown if there was an embryo present. Predation did not seem like the initial cause of failure because the egg was mostly intact; however, if there was an embryo, it could have been scavenged after the egg was broken. The first nesting attempt was recorded as an unsuccessful nest because no young were fledged due to the egg was damaged from an unknown cause.

The Black Hawks second nest location was more open and less concealed by leafy branches from the observation point, but higher up. It was extremely difficult to determine if a bird was sitting in the nest due to the height of the nest, viewing angle from the ground, and the shape of the nest (large bowl-shaped platform). This resulted in a broad date range for incubation. It was possible that a bird was in the nest but it was just not visible from the observation point on the ground. Because of the successful second nesting attempt, it is assumed the Black Hawks will remain in the area longer than usual, most likely until October when the young will be fully independent.

The Gray Hawk Cottonwood Campground territorial and nesting pair went unconfirmed this season due to insufficient data. Various reports from others (including seasonal campground hosts) indicated an unknown status for presence and breeding. Potential territorial or predatory threats from other species may have had an impact. There were reports of an adult Red-tailed Hawk in the campground as well as Great-horned Owls. The owls were also reported in the area and then disappeared; this may be due to the fact that the 2015 season cavity nest was occupied by a large bee hive this year. The SY Gray Hawk presence is significant and could result in potential expansion of territory.

The Gray Hawk nesting territories varied in their productivity and breeding status. Overall, as a species, they were less productive this season (Table 3); however, there is evidence of potential expansion of territory on both sides of the park. The same challenges present during the 2015 season existed during the 2016 season with the Daniels Ranch nesting territory. The two possible fledged young were never seen together or at the same time. Additionally, the adults and juveniles did not seem as conspicuous this season, which made it difficult to locate them during the post-fledging period.

Gray Hawks occupied the potential nesting territory at RGV Wetlands. An adult was observed during the 2016 season (also seen in 2015) as well as a SY hawk. These two individuals were not recorded as a pair (territorial or nesting) because territorial or courtship behavior was not observed and potential nest was not located. They were both, however, present throughout the breeding season and were observed perched on various utility poles and in trees (repeatedly the same ones) in the area. This area should be monitored next year for the presence of a new territorial and nesting pair of Gray Hawks.

The Gray Hawks at Terlingua Abajo appeared to be nesting this season. They exhibited territorial and nesting behavior and were recorded as a territorial and a nesting pair. The nest was recorded as an occupied nest because of the following: "...3) one adult was observed sitting low in the nest, presumably incubating, 4) 2 adults present on or near the nest, regardless of any current nest refurbishment,...and 6) or a recently repaired nest with fresh sticks." With regard to the terminology in this report, the occupied nest cannot be categorized as successful; however, it is not definitively an unsuccessful nest either because it is not known if any eggs were laid. It is unclear if the nest was abandoned, failed, or perhaps it was a nonbreeding pair. No other nesting activity was detected within the nesting area or across the creek.

Flippo's report of an adult pair and juvenile Gray Hawk in the Grand Canyon Farm area is significant. It is the discovery of a previously undetected potential territory and nesting pair or expansion of Gray Hawk territory in the park. This is also significant because it supports the possibility that the hawks are using historical nesting habitat consisting of large stature mesquite woodlands as suggested by Bibles and Mannan (2004). Flippo described the Grand Canyon Farm area as an extensive mesquite dominated habitat. He also confirmed that there are large mesquite trees in the depressions between the farm's old irrigation berms. This area is located in the west side of the park, approximately 3.8 miles southeast of the Gray Hawk

Terlingua Abajo nesting territory and approximately 3.6 miles northwest of the Gray Hawk Cottonwood Campground nesting territory, along the Rio Grande river. While the report was of an obvious successful nesting attempt, it was not included in the productivity findings of this report because it was an unconfirmed nesting territory and/or nest. This area should be monitored next year for any activity.

The Swainson's Hawk nests in open desert, grasslands, and riparian corridors. They are also migrants and nesting species in the Park. In the appropriate habitat, the Park's Bird Checklist lists them as "fairly common" during the spring and fall and as "uncommon" during the summer (Flippo 2013). These observations were a significant addition to the nesting records for this species.

Observations of the Black Hawks (and others) at Terlingua Abajo were conducted more frequently than during the 2015 season; however, not as often as needed. The seasonal appointment timing, other work priorities, and rain events resulted in the 2-3 week gaps between observations. To obtain more complete phenology data, more frequent visits would be required.

In measuring productivity and documenting nesting chronology, it was not necessary to use the MAA or the calculated averages to determine the success of a nest. In all cases this season, at least one fledgling was visually confirmed from each nest with at least one possible fledgling. The data presented in the Nesting Phenology table (Table 6) represents actual date observations from the field.

There were significant observations during this breeding season. Of importance are the presence of second year Gray Hawks (on both sides of the park) and that expansion of Gray Hawk territory is imminent and may have already taken place. Presumably, the SY Gray Hawks that were observed this season were 2015 hatch year birds that have returned to their natal territories. Conservation efforts should be directed at maintaining, improving, and expanding the riparian habitat for these breeding populations. This should include the preservation of the mature cottonwood dominated gallery forests and promote mesquites maturing into large woodlands that provide adequate foraging and nesting habitat (beneficial for yellow-billed cuckoo habitat as well).

MANAGEMENT CONSIDERATIONS

The Black Hawk and the Gray Hawk, Species of Concern in Big Bend National Park, are vulnerable to loss of habitat (largely a result of forest/woodland clearing and a depletion of groundwater) (Schnell 1994, Bibles et al. 2002, Bibles and Mannan 2004, Cornell Lab of Ornithology 2015). The Black Hawk, an obligate riparian breeding species associated with mature, riparian gallery forests (Schnell 1994), exhibits a low reproductive rate (Steinwand 2001). The Gray Hawk depends upon riparian habitat for breeding with adjacent areas of mesquite bosques for hunting. Both species exhibit high nest site fidelity and territories are fairly consistent from year to year. Of the two species, Black Hawks are more sensitive to human disturbance near nests and have been known to abandon nesting areas (Schnell 1994,

Kaufman 1996, Bibles et al. 2002). Maintaining adequate habitat in protected areas for these raptors may be the best way to ensure that future riparian and woodland habitat is available for these breeding populations.

Management goals and conservation efforts should include:

- Monitor and manage riparian gallery forests along the Rio Grande/Rio Bravo, Terlingua Creek, and other perennial streams or rivers and the stands of mature cottonwoods/mesquite bosques in the developed visitor use areas to maintain the quality of riparian habitat needed for these species.
- Promote forest growth and tree regeneration, either naturally or hand planting where necessary to supplement existing stands of mature trees. This action may require regular irrigation, especially to encourage successful growth of young cottonwoods.
- Maintain mesquite woodlands adjacent to riparian forests (beneficial for yellow-billed cuckoo habitat as well).
- Maintain adequate levels of groundwater in cottonwood forests/stands and mesquite bosques to ensure long-term presence of habitat.
- Continue to limit human disturbance in key nesting areas.

NOTES

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REFERENCES

- Bibles, B.D., Glinski, R.L., and Johnson, R.R. 2002. Gray Hawk (*Buteo plagiatus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: <http://bna.birds.cornell.edu/bna/species/652doi:10.2173/bna.652>. Accessed June 23, 2016.
- Bibles, B. D. and Mannan, R. W. 2004. Productivity and Nest-site Characteristics of Gray Hawks in Southern Arizona. *Journal of Raptor Research* 38 (3):238-242.
- Clark, W. S., 2007. Raptor Identification, Ageing, and Sexing. In: Bird, D.M., Bildstein, K.L. (Eds.), *Raptor Research and Management Techniques*. Hancock House, Surrey, British Columbia, Canada, pp. 47-55.
- Cornell Lab of Ornithology. 2015. AllAboutBirds: Gray Hawk (Internet). Ithaca: Cornell Lab of Ornithology; Accessed September 23, 2015 at http://www.allaboutbirds.org/guide/Gray_Hawk/id
- Emmons, G. 2008. Raptor breeding season report for Pinnacles National Monument-2008. Natural Resource Technical Report NPS/SFAN/NRTR-2008/087. National Park Service, Fort Collins, Colorado.
- Riparian Raptor Breeding Season Report, Big Bend National Park, Texas – 2016

Emmons, G., Petterson, J., Koenen, M., and Press, D. 2011. Raptor monitoring protocol for Pinnacles National Monument: narrative - version 2.3. Natural Resource Report NPS/SFAN/NRR-2011/466. National Park Service, Fort Collins, Colorado.

Flippo, M. 2013. Bird checklist: Big Bend National Park, Rio Grande Wild and Scenic River, Texas. Big Bend Natural History Association, Big Bend National Park, Texas.

Kaufman, K. 1996. Lives of North American Birds. Houghton Mifflin, Boston and New York. 704pp.

Kropp, R. 2002. *Asturina nitida* (On-line), Animal Diversity Web. Accessed September 23, 2015 at http://animaldiversity.org/accounts/Asturina_nitida/

Powell, M. A. 2003. Status of American Peregrine Falcons in Big Bend National Park-2003. Unpublished material. Integrated Resource Management Applications, National Park Service.

Postupalsky, S., 1974. Raptor reproductive success: some problems with methods, criteria, and terminology. In: Hamerstrom Jr., F.N., Harrell, B.E., and Olendorff, R.R. (Eds.), Management of Raptors: Proceedings of the Conference on Raptor Conservation Techniques, Fort Collins, Colorado, 1973 (Part 4). Raptor Research Foundation, Inc., Vermillion, South Dakota, pp. 21-31.

Rodríguez-Flores, C., C. Soberanes-González & M.C. Arizmendi. 2010. Common Black Hawk (*Buteogallus anthracinus*), Neotropical Birds Online (Internet; T. S. Schulenberg, Editor). Ithaca: Cornell Lab of Ornithology; Available from Neotropical Birds Online: http://neotropical.birds.cornell.edu/portal/species/overview?p_p_spp=125236

Schnell, J.H. 1994. Common Black-Hawk (*Buteogallus anthracinus*), The Birds of North America Online (A. Poole, Ed.). Ithaca: Cornell Lab of Ornithology; Retrieved from the Birds of North America Online: <http://bna.birds.cornell.edu/bna/species/122>. Accessed June 23, 2016.

Steenhof, K., Newton, I., 2007. Assessing Nesting Success and Productivity. In: Bird, D.M., Bildstein, K.L. (Eds.), Raptor Research and Management Techniques. Hancock House, Surrey, British Columbia, Canada, pp. 181-192.

Steinwand, J. 2001. "*Buteogallus anthracinus*" (On-line), Animal Diversity Web. Accessed September 24, 2015 at http://animaldiversity.org/accounts/Buteogallus_anthracinus/

Texas Parks and Wildlife Department. 2015. Federal and State Listed Bird Species (Internet). Accessed September 21, 2015 at http://tpwd.texas.gov/huntwild/wild/wildlife_diversity/nongame/listed-species/birds.phtml

Appendix. Terminology.

Term	Definition
Alternate nest	One of multiple nest structures within the nesting territory of one pair of birds. Nests may be in the same tree or adjacent trees; history of use of the nest is unknown ⁴
Axillaries	Wing pits
Brancher/Branching	Nestling/young raptor that has moved to branches adjacent to nest (still in nest tree) just prior to fledging ^{1, 5}
Breeding season	The period from courtship and nest preparation to independence of fledged young ^{3, 6}
Courtship behavior	An adult pair engaged in activities that included nest site preparation, display flights, food exchanges, and copulation
First-year (FY, HY)	First year age classification based on calendar based system (Jan 1 - Dec 31), also called Hatch-year (hatching), HY; a juvenile
Fledge	When a young bird voluntarily leaves the nest tree for the first time
Fledgling	A young bird recently fledged or has become capable of flying from the nest tree; still dependent on adults ⁶
Immature	A young bird that has not attained adult plumage and is not aged as an adult. For this report, birds not hatched during the current breeding season and non-adults are immatures
Juvenal plumage	First complete plumage acquired before a bird leaves the nest; for raptors, usually worn for 7 months to almost one year ²
Juvenile	A young bird in its first/juvenal plumage; not an adult bird. For this report, first-year (hatching year) birds are juveniles
Minimum Acceptable Age for Assessing Success (MAA)	A standard nestling age at which a nest can be considered successful; 80% of the nestling age before fledging. ⁶ (For this report, a young raptor seen branching has achieved the minimum age in infer a successful nest).
Nesting activity	Activities that support nest building, egg laying and hatching, and rearing of young. Activities included nest building/maintenance/attendance, food exchange between adults, food wail/call and other vocalizations, young sitting in nest, and food drops
Nesting pair	A pair of raptors nesting in a specific territory confirmed by at least one of the following: 1) incubation of eggs or hatchlings at nest, 2) feeding of hatchlings or nestlings at nest, 3) feeding of fledglings at or near nest ³
Nesting territory	A defended area that contains (currently or historically) one or more nests within the range of a mated pair ^{4, 6}
Nestling	A young raptor in nest, covered in natal down initially, and unable to fly; dependent upon parental care and feeding
Nestling period	The period between the first egg hatching and when the first young voluntarily leaves the nest (fledges) ⁶

Occupied nest	A nest that satisfied at least one of the following during a breeding season: 1) young were raised, 2) eggs were laid, 3) one adult was observed sitting low in the nest, presumably incubating, 4) 2 adults present on or near the nest, regardless of any current nest refurbishment, 5) one adult and one bird in immature plumage at or near a nest, if mating behavior was observed, 6) or a recently repaired nest with fresh sticks. Excluded these scenarios: 1) one adult near an empty unrepaired nest, or 2) 2 adults seen together during the breeding season with no known nest. ⁴ For this report, successful and unsuccessful nests are considered occupied nests.
Pin feathers	A developing feather that is encased in a waxy sheathing
Productivity	The number of young that reach the minimum acceptable age for assessing success
Rectrices	Tail feathers
Remiges	Primary and secondary feathers of the wings
Second-year (SY)	Second year age classification based on calendar based system (Jan 1 - Dec 31), the year after hatching; an immature
Successful nest	A nest in which at least one young reaches minimum acceptable age for assessing success, there was at least one confirmed fledgling ^{4,6} , or at least one nestling was observed branching (for this report, a brancher is assumed to have reached the minimum acceptable age for assessing success as they are on the verge of fledging)
Territorial behavior	Included perching, flying, territorial disputes and defense, stooping, scold and defensive/alarm calling
Territorial pair	A pair of raptors occupying a specific territory confirmed by at least one of the following: 1) an adult pair actively defending and sleep-roosting in an area, 2) adults engaged in courtship or reproductive activity or nest defense/affinity, 3) incubation 4) feeding of young at or near nest. Included pairs that did not nest, may have had a nest failure, or may have abandoned a territory ³
Unsuccessful nest	An occupied nest from which there are no young fledged due to: 1) no eggs were laid, 2) eggs were destroyed or otherwise lost, 3) eggs failed to hatch, or 4) young hatched, but are known to have died prior to fledging (nest failure) ⁴
1 = (Bibles et al. 2002); 2 = (Clark 2007); 3 = (Emmons et al. 2011); 4 = (Postupalsky 1974); 5 = (Schnell 1994); 6 = (Steenhof and Newton 2007)	