

Avian diversity in a priority area for conservation in North America: the Janos-Casas Grandes Prairie Dog Complex and adjacent habitats in northwestern Mexico

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Abstract. From February 1994 to January 2004, we studied the avifauna of a 25,000-ha area centered on the Janos-Casas Grandes Prairie Dog Complex of Northwestern Chihuahua, Mexico. Avian diversity totalled 227 species, of which 86 (38%) were residents, 78 (35%) winter migrants, 30 (14%) summer migrants, 27 (11%) transients, and 6 (2%) accidental vagrants. Around 84 (38%) species were observed in at least two habitat types, with riparian areas supporting the highest observed diversity of birds (112 species). Of the 143 species observed in only one habitat type, 44 (30%) occurred in riparian areas, 35 (26%) in association with ponds and aquatic vegetation, 28 (20%) in grasslands, 16 (11%) in the oak woodland–grassland ecotone, 12 (9%) in mesquite scrubland, 5 (3%) around human settlements, and 3 (2%) in crop fields. In particular, summer rains influenced the abundance and/or distribution of several species in grasslands such as the long-billed curlew (*Numenius americanus*). The present study, which was part of a larger effort to document the merits of establishing a large biosphere reserve in the area, confirmed the importance of the prairie dog complex and grasslands to many species of conservation concern, including the threatened mountain plover (*Charadrius montanus*), a winter resident. With the higher-elevation habitats yet to be surveyed, the local diversity of bird species here already places the proposed reserve among the most important protected areas in all of Mexico. The establishment of the reserve is urgently needed, especially for the protection of grasslands and their associated fauna.

Introduction

Located in northwestern Chihuahua, Mexico, the Janos-Casas Grandes (JCG) Prairie Dog Complex covers more than 20,000 ha and includes the single largest prairie dog town in North America (Ceballos et al. 1999, 2005). It lies within a mosaic of lowland vegetation types dominated by grasslands and scrublands. The area is also dotted with ranches and rural communities, including ejidos (a form of communal land ownership) and towns inhabited

by Mennonites, together with crop fields, unpaved roads, and power lines (Cartron et al. 2005; Ceballos et al. 2005).

For more than a decade, the JCG Prairie Dog Complex has been the focus of extensive research aimed at determining its ecological importance and conservation status (e.g., Ceballos et al. 1993, 1999; List and Macdonald 1998; Manzano Fischer et al. 1999, 2000; List et al. 2003; Desmond 2004). This research finds much of its significance in the fact that, across North America, prairie dogs (*Cynomys* spp.) have disappeared from ca. 98% of the area they occupied early in the 20th century (Marsh 1984; Miller et al. 1994). In turn, the widespread disappearance of prairie dogs may have negatively affected many species, and in particular was largely responsible for the extinction in the wild of the black-footed ferret (*Mustela nigripes*) (Clark 1989). The demise of the black-tailed prairie dog (*C. ludovicianus*), the species represented in the JCG region, likely has had negative effects throughout native ecosystems at local, regional, and even larger geographic scales, as it is considered both a keystone species and an ecosystem engineer (Kotliar et al. 1999; Ceballos et al. 1999; Kotliar et al. 2000; Miller et al. 2000). As large prairie dog towns have become very rare, most studies of the relationship between species diversity and prairie dogs have been conducted focusing on small to very small colonies (Butts and Lewis 1982; Baker et al. 2000; Kotliar et al. 2000). The results of those studies may be misleading because large colonies of prairie dogs likely have more pronounced landscape effects (see Lomolino and Smith 2003). In this context, the evaluation of the biodiversity associated with large prairie dog colonies or complexes is extremely important.

As pointed out by Ceballos et al. (2005), the ecological importance of the JCG area extends beyond that of just the prairie dog complex. In part, this may be due to the geographic position of the area, at the western edge of the Chihuahuan Desert and adjacent to the slopes of the Sierra Madre Occidental. A large Mexican federal biosphere reserve is being proposed to encompass the prairie dog complex, together with surrounding large tracts of lowland and higher-elevation habitats. The present study was part of a larger effort to document the merits of establishing the protected area, with a specific focus on the avifauna of the prairie dog complex as well as other lowland habitats (see Ceballos et al. 2005). In particular riparian areas and ponds, have the potential to contribute very largely to the diversity of birds in the area, given the aridity of the climate (see Cartron et al. 2000b; Rodríguez Estrella, et al. 2005 for a discussion of riparian areas in southwestern North America). The current study provides the first thorough assessment of the avifauna of the JCG area across lowland vegetation types, with information on seasonality and frequency of occurrence. More limited information was published in earlier studies of the prairie dog complex's avifauna by Manzano Fischer et al. (1999) and Desmond (2004).

Study area and methods

Study area

The study was conducted in the JCG prairie dog complex and in its immediate surrounding area. The JCG complex is located in the northwestern part of the state of Chihuahua (30°57.8' N, 108°23.9' W; 30°37.5' N, 108°17.3' W; 30°43' N, 108°12.5' W; 30°50' N, 108°40.3' W), about 75 km south from the Mexico–USA border. The area is a large plain that extends south and west from the arid scrubs of the Chihuahuan Desert and north and east from the foothills of the Sierra Madre Occidental (for a detailed description of the area see Ceballos et al. 2005).

The climate is arid with hot summers and cold winters. Mean annual temperature is 15.7 °C (Garcia 1973), with extremes ranging between –15 °C in winter and 50 °C in summer. Annual precipitation averages 307 mm, most of it in July and August and, to a lesser extent, during the winter (Rzedowski 1981). Grasslands dominate the area and are characterized by grasses (e.g., *Bouteloua gracilis*, *B. curtipendula*, *B. hirsuta*, *Aristida hamulosa*, *Festuca imbricata*, and *Hilaria mutica*), annual forbs, and a few shrubs (e.g., *Fouquieria splendens* and *Prosopis laevigata*) (COTECOCA 1978). Patches of cholla (*Opuntia* spp.), yucca (*Yucca* spp.) and Mormon tea (*Ephedra trifurca*) are interspersed within the grasslands. Large areas formerly covered by grasslands have been invaded by mesquite scrub (*Prosopis* spp.). Grasslands are also invaded by oaks (*Quercus* spp.) and alligator juniper (*Juniperus deppeana*) in the ecotone with oak–woodland in the foothills of the Sierra Madre Occidental. Riparian vegetation is found near small streams and seasonal rivers and is characterized by the presence of trees, mainly sycamore (*Platanus wrightii*), Arizona walnut (*Juglans major*), and willows (*Salix* spp., List et al. 1999). Additionally, there are cattle ponds, small reservoirs, and crops scattered throughout the area.

From 1993 to 1996 northwestern Mexico suffered a severe drought, which in addition to overgrazing, greatly reduced vegetation cover in the study area. As a result, extensive areas had exposed bare ground during this study.

Field methods

We conducted point count surveys along transects (Hutto et al. 1986) from February 1994 to November 1995, from July 2000 to November 2001, in June 2002, and in February 2003, for a total of 1477 point counts in 194 days of surveys. For this intensive survey work, point counts were 250 m apart, this distance allowing for independence of point counts for small land birds (Hutto et al. 1986). We recorded all birds within a fixed 50-m radius, beyond the 50-m radius and between point counts. Point count duration was 5 min. Surveys began 30 min after sunrise and lasted 3 h. Counts were not made during precipitation events or when wind velocities exceeded 24 km/h. Species were

identified using field guides (Robbins et al. 1983; National Geographic Society 1987; Edwards 1989), and all names reported here follow the American Ornithologists' Union Checklist of North American Birds (1983) and Supplements (American Ornithologists' Union 2000, 2002). Scientific and common names can be found in Table 1.

We also compiled information from 9 Christmas Bird Counts (CBC, 1995–2003) and 2 Bird Breeding Surveys (BBS, 1998 and 2003) conducted in the study area. Two of us, PMF and RL, participated in 6 of the 9 CBCs, which represented a total of 322 people×hours of surveys on foot and 317 people×hours of survey from a vehicle during 10 days of observations (Dieni et al. 2003). The 2 BBSs (PMF participated in 1 BBS) combined for a total of 200 point counts in 4 days of surveys. All surveys (our four extensive studies and all CBCs and BBSs) during the 10-year study period amounted to coverage of 4 falls, 10 winters, 2 springs, and 5 summers.

Every time a species was detected, information was also recorded on locality, habitat type, and observed number of individuals. Precise geographic coordinates were obtained with a Magellan GPS for the four extensive studies. Habitat types surveyed were grasslands, mesquite scrub, grassland–oak forest ecotone, riparian areas, ponds/aquatic vegetation, croplands, and areas with human settlements. Grasslands included those with and without prairie dogs. Generalist species were those found in more than one habitat type. Each habitat type was visited at least once during every round of surveys.

In reviewing the data, species were classified according to seasonal and annual patterns of occurrence. Every species within its reported range belonged to one of four groups based on seasonal occurrence: (1) residents (i.e., species observed year-round in the area); (2) summer migrants (species breeding or spending the summer in the area); (3) winter migrants (species spending the winter in the area); and (4) transients (species passing by during migration). Accidental vagrants (species outside their reported range) were considered separately and made up a fifth group of species. We also divided the avifauna into four categories based on annual patterns of occurrence: (1) regular species (observed virtually every year); (2) irregular species (observed during most years); (3) occasional species (observed every few years); and (4) casual species. The annual occurrence status of every species was determined primarily based on results of our surveys but also using Howell and Webb (1995).

Results

Species richness

We recorded a total of 223 species, belonging to 15 orders, 49 families, and 141 genera (Table 1). Most observed species belonged to the Order Passeriformes (128) and the family Emberizidae (26). Of the total number of species, 71 (32%) seemed regular, 45 (20%) irregular, 52 (23%) occasional, and 59

Table 1. Bird species of the Janos-Casas Grandes Prairie Dog Complex and surrounding area, northwestern Chihuahua, Mexico, with information on habitat associations, seasonality, annual occurrence, and conservation status in Mexico.

Species	Common name	^a Habitat	^b Season	^c Annual occurrence	^d Status
PODICIPEDIFORMES					
Podicipedidae					
<i>Podiceps nigricollis</i>	Eared grebe	AqV	Wi	Cas.	
CICCONIIFORMES					
Ardeidae					
<i>Ardea herodias</i>	Great blue heron	AqV	Re	Reg.	
<i>Ardea alba</i>	Great egret	AqV	Re	Occ.	
<i>Butorides virescens</i>	Green heron	AqV	Re	Cas.	
<i>Nycticorax nycticorax</i>	Black-crowned night-heron	AqV	Wi	Cas.	
Threskiornithidae					
<i>Plegadis chihui</i>	White-faced ibis	Gr	Re	Cas.	
Cathartidae					
<i>Cathartes aura</i>	Turkey vulture	Gr, Me, To	Re	Reg.	
<i>Coragyps atratus</i>	Black vulture	To, Ri	Re	Irr.	
ANSERIFORMES					
Anatidae					
<i>Chen caerulescens</i>	Snow goose	Cr	Wi	Reg.	
<i>Chen rossii</i>	Ross's goose	Cr	Wi	Occ.	
<i>Cygnus columbianus</i>	Tundra swan	AqV	AV	Cas.	E
<i>Aix sponsa</i>	Wood duck	AqV	Wi	Cas.	
<i>Anas strepera</i>	Gadwall	AqV	Re	Irr.	
<i>Anas americana</i>	American wigeon	AqV	Wi	Irr.	
<i>Anas platyrhynchos</i>	Mallard	AqV	Re	Co	
<i>Anas cyanoptera</i>	Cinnamon teal	AqV	Re	Occ.	
<i>Anas clypeata</i>	Northern shoveler	AqV	Wi	Irr.	
<i>Anas acuta</i>	Northern pintail	AqV	Wi	Occ.	
<i>Anas crecca</i>	Green-winged teal	AqV	Wi	Irr.	
<i>Aythya americana</i>	Redhead	AqV	Tr	Cas.	

Table 1 (Continued).

Species	Common name	^a Habitat	^b Season	^c Annual occurrence	^d Status
<i>Bucephala albeola</i>	Bufflehead	AqV	Wi	Irr.	
<i>Mergus merganser</i>	Common merganser	AqV	Wi	Occ.	
<i>Oxyura jamaicensis</i>	Ruddy duck	AqV	Re	Occ.	
FALCONIFORMES					
Accipitridae					
<i>Pandion haliaetus</i>	Osprey	Gr	Tr	Occ.	
<i>Elanus leucurus</i>	White-tailed kite	Cr, Gr	Wi	Irr.	
<i>Haliaeetus leucocephalus</i>	Bald eagle	Gr, Ri	Wi	Reg.	E
<i>Circus cyaneus</i>	Northern harrier	Gr, Cr	Re	Reg.	
<i>Accipiter striatus</i>	Sharp-shinned hawk	Ri, To	Wi	Reg.	SP
<i>Accipiter cooperii</i>	Cooper's hawk	Gr	Wi	Irr.	SP
<i>Asturina nitida</i>	Gray Hawk	Ri	AV	Cas.	
<i>Parabuteo unicinctus</i>	Harris' hawk	Ri, Me	Re	Reg.	SP
<i>Buteo swainsoni</i>	Swainson's hawk	Gr, Me, Ri	Su	Irr.	SP
<i>Buteo albonotatus</i>	Zone-tailed hawk	Gr	Su	Occ.	SP
<i>Buteo regalis</i>	Ferruginous hawk	Gr, Me	Wi	Reg.	SP
<i>Buteo jamaicensis</i>	Red-tailed hawk	Gr, Ri, Me, Ec	Re	Reg.	
<i>Buteo lagopus</i>	Rough-legged hawk	Gr	Wi	Occ.	
<i>Aquila chrysaetos</i>	Golden eagle	Gr, Ri	Re	Reg.	Th
Falconidae					
<i>Falco sparverius</i>	American kestrel	Gr, Me, Ri	Re	Reg.	
<i>Falco columbarius</i>	Merlin	Gr	Wi	Irr.	
<i>Falco femoralis</i>	Aplomado falcon	Gr	Re	Occ.	SP
<i>Falco peregrinus</i>	Peregrine falcon	Gr	Re	Occ.	SP
<i>Falco mexicanus</i>	Prairie falcon	Gr	Re	Reg.	Th
GALLIFORMES					
Phasianidae					
<i>Melospiza gallopavo</i>	Wild turkey	Ri	Re	Cas.	SP

Odontophoridae									
<i>Callipepla squamata</i>	Scaled quail	Gr, Me, Ri	Re	Reg.					
<i>Callipepla gambelii</i>	Gambel's quail	Me	Re	Reg.					
<i>Cyrtonyx montezumae</i>	Montezuma quail	Ec	Wi	Cas.					SP
GRUIFORMES									
Rallidae									
<i>Rallus limicola</i>	Virginia rail	AqV	Wi	Cas.					SP
<i>Porzana carolina</i>	Sora	AqV	Wi	Cas.					
<i>Fulica americana</i>	American coot	AqV	Re	Occ.					
Gruidae									
<i>Gris canadensis</i>	Sandhill crane	Cr	Wi	Irr.					SP
CHARADRIFORMES									
Charadriidae									
<i>Charadrius vociferus</i>	Killdeer	Gr, Ri, AqV	Re	Reg.					
<i>Charadrius montanus</i>	Mountain plover	Gr	Wi	Irr.					Th
Recurvirostridae									
<i>Recurvirostra americana</i>	American avocet	AqV	Su	Cas.					
Scolopacidae									
<i>Tringa melanoleuca</i>	Greater yellowlegs	AqV	Wi	Occ.					
<i>Tringa flavipes</i>	Lesser yellowlegs	AqV	Wi	Cas.					
<i>Tringa solitaria</i>	Solitary sandpiper	AqV	Tr	Occ.					
<i>Actitis macularia</i>	Spotted sandpiper	AqV	Wi	Occ.					
<i>Numenius phaeopus</i>	Whimbrel	Gr	AV	Cas.					
<i>Numenius americanus</i>	Long-billed curlew	Gr	Re	Reg.					
<i>Calidris mauri</i>	Western sandpiper	AqV	Tr	Cas.					
<i>Calidris minutilla</i>	Least sandpiper	AqV	Wi	Occ.					
<i>Limnodromus scolopaceus</i>	Long-billed dowitcher	AqV	Wi	Occ.					
<i>Gallinago delicata</i>	Wilson's snipe	AqV	Wi	Irr.					
<i>Phalaropus tricolor</i>	Wilson's phalarope	AqV	Tr	Cas.					
<i>Phalaropus lobatus</i>	Red-necked phalarope	AqV	Tr	Cas.					
Laridae									
<i>Larus delawarensis</i>	Ring-billed gull	AqV	Wi	Cas.					

Table 1 (Continued).

Species	Common name	^a Habitat	^b Season	^c Annual occurrence	^d Status
COLUMBIFORMES					
Columbidae					
<i>Columba livia</i>	Rock dove	To	Re	Reg.	
<i>Patagioenas fasciata</i>	Band-tailed pigeon	Ec	Re	Cas.	
<i>Streptopelia decaocto</i>	Eurasian collared-dove	To	Su	Cas.	
<i>Zenaidura asiatica</i>	White-winged dove	To, Me	Re	Reg.	
<i>Zenaida macroura</i>	Mourning dove	Gr, Ri, Me	Re	Reg.	
<i>Columbina inca</i>	Inca dove	Gr, Ri, To	Re	Reg.	
<i>Columbina passerina</i>	Common ground-dove	Ri	Re	Occ.	
CUCULIFORMES					
Cuculidae					
<i>Geococcyx californianus</i>	Greater roadrunner	Me	Re	Reg.	
STRIGIFORMES					
Tytonidae					
<i>Tyto alba</i>	Barn owl	Ri, To	Re	Occ.	
Strigidae					
<i>Megascops kemmickii</i>	Western screech-owl	Me	Re	Cas.	
<i>Megascops trichopsis</i>	Whiskered screech-owl	Ec	Re	Cas.	
<i>Bubo virginianus</i>	Great horned owl	Ri, Gr	Re	Reg.	
<i>Glaucidium gnoma</i>	Northern pygmy-owl	Ri	Wi	Cas.	
<i>Athene cunicularia</i>	Burrowing owl	Gr	Re	Reg.	
<i>Asio flammeus</i>	Short-eared owl	Gr	Wi	Irr.	
CAPRIMULGIFORMES					
Caprimulgidae					
<i>Chordeiles acutipennis</i>	Lesser nighthawk	Gr	Su	Irr.	
<i>Chordeiles minor</i>	Common nighthawk	Me	Su	Cas.	
<i>Phalaenoptilus nuttallii</i>	Common poorwill	Ri	Re	Cas.	

APODIFORMES**Apodidae***Aeronautes saxatalis*

White-throated swift

Re

Irr.

Trochilidae*Amazilia violiceps*

Violet-crowned hummingbird

Su

Cas.

Archilochus alexandri

Black-chinned hummingbird

Su

Occ.

Selasphorus platycercus

Broad-tailed hummingbird

Su

Occ.

Selasphorus rufus

Rufous hummingbird

Tr

Cas.

CORACIFORMES**Alcedinidae***Ceryle alcyon*

Belted kingfisher

Wi

Irr.

PICIFORMES**Picidae***Melanerpes formicivorus*

Acorn woodpecker

Re

Occ.

Sphyrapicus thyroideus

Williamson's sapsucker

Wi

Cas.

Sphyrapicus nuchalis

Red-naped sapsucker

Wi

Cas.

Sphyrapicus ruber

Red-breasted sapsucker

Tr

Occ.

Picoides scalaris

Ladder-backed woodpecker

Re

Reg.

Picoides villosus

Hairy woodpecker

Re

Irr.

Colaptes auratus

Northern flicker

Re

Reg.

PASSERIFORMES**Tyrannidae***Contopus cooperi*

Olive-sided flycatcher

Tr

Occ.

Contopus pertinax

Greater pewee

Su

Cas.

Contopus sordidulus

Western wood-pewee

Tr

Occ.

Empidonax traillii

Willow flycatcher

Tr

Cas.

Empidonax minimus

Least Flycatcher

AV

Cas.

Empidonax hammondi

Hammond's flycatcher

Tr

Cas.

Empidonax wrightii

Gray flycatcher

Tr

Irr.

Empidonax oberholseri

Dusky flycatcher

Tr

Occ.

Empidonax occidentalis

Cordillera flycatcher

Tr

Cas.

Sayornis nigricans

Black phoebe

Re

Reg.

Table 1 (Continued).

Species	Common name	^a Habitat	^b Season	^c Annual occurrence	^d Status
<i>Sayornis saya</i>	Say's phoebe	Gr, To, Me	Re	Reg.	
<i>Pyrocephalus rubinus</i>	Vermilion flycatcher	Ri, To	Re	Irr.	
<i>Myiarchus tuberculifer</i>	Dusky-capped flycatcher	Ri	Su	Cas.	
<i>Myiarchus cinerascens</i>	Ash-throated flycatcher	Me, Ri, Gr, Ec	Su	Irr.	
<i>Myiarchus tyrannulus</i>	Brown-crested flycatcher	Ri	Su	Cas.	
<i>Tyrannus vociferans</i>	Cassin's kingbird	Ri, To, Ec	Su	Occ.	
<i>Tyrannus crassirostris</i>	Thick-billed kingbird	Ri	Su	Occ.	
<i>Tyrannus verticalis</i>	Western kingbird	Ri, Ec, Me, Gr	Su	Irr.	
Laniidae					
<i>Lanius ludovicianus</i>	Loggerhead shrike	Gr, Me, Ec	Re	Reg.	
Vireonidae					
<i>Vireo bellii</i>	Bell's vireo	Ri	Su	Occ.	
<i>Vireo vicinior</i>	Gray vireo	Ri	Wi	Cas.	
<i>Vireo plumbeus</i>	Plumbeous vireo	Ri, Ec	Tr	Cas.	
<i>Vireo huttoni</i>	Hutton's vireo	Ec	Re	Irr.	
<i>Vireo gilvus</i>	Warbling vireo	Ri, Ec	Su	Cas.	
Corvidae					
<i>Aphelocoma californica</i>	Western scrub jay	Ec	Wi	Occ.	
<i>Aphelocoma ultramarina</i>	Mexican jay	Ec	Re	Irr.	
<i>Corvus cryptoleucus</i>	Chihuahuan raven	Me, To, Ec, Gr	Re	Reg.	
<i>Corvus corax</i>	Common raven	Me, Ec	Re	Reg.	
Alaudidae					
<i>Eremophila alpestris</i>	Horned lark	Gr, Ec	Re	Reg.	
Hirundinidae					
<i>Tachycineta bicolor</i>	Tree swallow	Gr, To	Tr	Occ.	
<i>Tachycineta thalassina</i>	Violet-green swallow	Gr, Ec	Su	Occ.	
<i>Stelgidopteryx serripennis</i>	Northern rough-winged swallow	Gr, Ri	Tr	Cas.	
<i>Riparia riparia</i>	Bank swallow	Gr, Ri	Tr	Cas.	
<i>Petrochelidon pyrrhonota</i>	Cliff swallow	Gr, Ri	Su	Occ.	
<i>Hirundo rustica</i>	Barn swallow	Gr, Ri, To	Su	Irr.	

Table 1 (Continued).

Species	Common name	^a Habitat	^b Season	^c Annual occurrence	^d Status
<i>Mimus polyglottos</i>	Northern mockingbird	Ri, Me, Gr	Re	Reg.	
<i>Oreoscoptes montanus</i>	Sage thrasher	Me	Wi	Reg.	
<i>Toxostoma rufum</i>	Brown Thrasher	Ri	Wi	Cas.	
<i>Toxostoma bendirei</i>	Bendire's thrasher	Ri	Re	Occ.	
<i>Toxostoma curvirostre</i>	Curve-billed thrasher	Gr, Ri, Ec	Re	Reg.	
<i>Toxostoma crissale</i>	Crissal thrasher	Ri	Re	Reg.	
Sturnidae					
<i>Sturnus vulgaris</i>	European starling	To, Ri	Re	Reg.	
Motacillidae					
<i>Anthus rubescens</i>	American pipit	Ri	Wi	Reg.	
<i>Anthus spragueii</i>	Sprague's pipit	Gr	Wi	Reg.	
Bombycillidae					
<i>Bombycilla cedrorum</i>	Cedar waxwing	Ri	Wi	Occ.	
Ptilononidae					
<i>Phainopepla nitens</i>	Phainopepla	Ri, Ec	Re	Reg.	
Parulidae					
<i>Vermivora celata</i>	Orange-crowned warbler	Ri	Tr	Irr.	
<i>Vermivora ruficapilla</i>	Nashville warbler	Ri	Tr	Cas.	
<i>Vermivora luciae</i>	Lucy's warbler	Gr, Ri, Ec, Me	Su	Occ.	
<i>Dendroica petechia</i>	Yellow warbler	Ri	Su	Cas.	
<i>Dendroica coronata</i>	Yellow-rumped warbler	Ri, Me, Gr	Wi	Reg.	
<i>Dendroica nigrescens</i>	Black-throated gray warbler	Ri, Ec	Tr	Cas.	
<i>Dendroica townsendi</i>	Townsend's warbler	Ri	Tr	Cas.	
<i>Dendroica cerulea</i>	Cerulean warbler	Ri	Tr	Cas.	
<i>Setiurus noveboracensis</i>	Northern waterthrush	Ri	Tr	Cas.	
<i>Oporornis tolmiei</i>	MacGillivray's warbler	Ri, Me	Tr	Occ.	Th
<i>Geothlypis trichas</i>	Common yellowthroat	Ri	Re	Occ.	
<i>Wilsonia pusilla</i>	Wilson's warbler	Ri, Ec, Me	Tr	Cas.	
<i>Icteria virens</i>	Yellow-breasted chat	Ri	Su	Occ.	

Thraupidae									
<i>Piranga ludoviciana</i>	Western tanager	Ri, Ec	Su						Occ.
Emberizidae									
<i>Pipilo chlorurus</i>	Green-tailed towhee	Ri, Me	Wi						Irr.
<i>Pipilo maculatus</i>	Spotted towhee	Me, Ri	Re						Reg.
<i>Pipilo fuscus</i>	Canyon towhee	Ri, Ec, Me	Re						Reg.
<i>Aimophila cassinii</i>	Cassin's sparrow	Gr	Re						Irr.
<i>Aimophila ruficeps</i>	Rufous-crowned sparrow	Ec	Re						Irr.
<i>Spizella passerina</i>	Chipping sparrow	Me, Ri, Ec, Gr	Wi						Reg.
<i>Spizella pallida</i>	Clay-coloured sparrow	Ri	Tr						Occ.
<i>Spizella breweri</i>	Brewer's sparrow	Gr, Ri, Me	Wi						Reg.
<i>Spizella atrogularis</i>	Black-chinned sparrow	Me	Wi						Irr.
<i>Pooecetes gramineus</i>	Vesper sparrow	Gr	Wi						Reg.
<i>Chondestes grammacus</i>	Lark sparrow	Gr, Me, Ri	Re						Irr.
<i>Amphispiza bilineata</i>	Black-throated sparrow	Me, Gr	Re						Reg.
<i>Amphispiza belli</i>	Sage sparrow	Me	Wi						Occ.
<i>Calamospiza melanocorys</i>	Lark bunting	Gr, To, Ri	Re						Reg.
<i>Passerculus sandwichensis</i>	Savannah sparrow	Gr	Wi						Reg.
<i>Ammodramus savannarum</i>	Grasshopper sparrow	Gr	Wi						Irr.
<i>Ammodramus bairdii</i>	Baird's sparrow	Gr	Wi						Irr.
<i>Passerella iliaca</i>	Fox sparrow	Gr	Wi						Cas.
<i>Melospiza melodia</i>	Song sparrow	Gr, Ri	Wi						Reg.
<i>Melospiza lincolni</i>	Lincoln's sparrow	Ri	Wi						Reg.
<i>Melospiza georgiana</i>	Swamp sparrow	AqV	Wi						Cas.
<i>Zonotrichia albicollis</i>	White-throated sparrow	Me	Wi						Occ.
<i>Zonotrichia leucophrys</i>	White-crowned sparrow	Me	Wi						Reg.
<i>Junco hyemalis</i>	Dark-eyed junco	Gr, Ri, Ec	Wi						Reg.
<i>Calcaricus mccownii</i>	McCown's longspur	Gr	Wi						Reg.
<i>Calcaricus ornatus</i>	Chesnut-collared longspur	Gr	Wi						Reg.
Cardinalidae									
<i>Cardinalis cardinalis</i>	Northern Cardinal	Ri	Wi						Irr.
<i>Cardinalis sinuatus</i>	Pyrrhuloxia	Ri	Re						Reg.
<i>Phoenicurus melanocephalus</i>	Black-headed grosbeak	Me	Su						Cas.

Table 1 (Continued).

Species	Common name	^a Habitat	^b Season	^c Annual occurrence	^d Status
<i>Passerina caerulea</i>	Blue grosbeak	Ri, Me	Su	Irr.	
Icteridae					
<i>Agelaius phoeniceus</i>	Red-winged blackbird	Gr, Ri, To	Re	Reg.	
<i>Icterus bullockii</i>	Bullock's oriole	Ri, Me, To	Su	Irr.	
<i>Sturnella magna</i>	Eastern meadowlark	Gr, Ec	Re	Reg.	
<i>Sturnella neglecta</i>	Western meadowlark	Gr	Re	Reg.	
<i>Xanthocephalus xanthocephalus</i>	Yellow-headed blackbird	Gr, To	Wi	Reg.	
<i>Euphagus cyanocephalus</i>	Brewer's blackbird	Ri, To	Wi	Reg.	
<i>Quiscalus quiscula</i>	Common grackle	To	Wi	Occ.	
<i>Quiscalus mexicanus</i>	Great-tailed grackle	To	Re	Reg.	
<i>Molothrus ater</i>	Brown-headed cowbird	Gr, Ri, Ec	Re	Reg.	
<i>Icterus parisorum</i>	Scott's oriole	Ri, Ec	Su	Occ.	
Fringillidae					
<i>Carpodacus cassinii</i>	Cassin's finch	Ec	Wi	Cas.	
<i>Carpodacus mexicanus</i>	House finch	Gr, Ri, Ec	Re	Reg.	
<i>Carduelis pinus</i>	Pine siskin	Gr	Wi	Cas.	
<i>Carduelis psaltria</i>	Lesser goldfinch	Ri	Re	Irr.	
<i>Carduelis lawrencei</i>	Lawrence's goldfinch	Ri	Wi	Occ.	
<i>Carduelis tristis</i>	American goldfinch	Ri	Wi	Occ.	
Passeridae					
<i>Passer domesticus</i>	House sparrow	To	Re	Reg.	

^aHabitat: AqV – Aquatic vegetation; Ri – Riparian; Ec – ecotone grassland oak-forest; Gr – Grassland; Me – Mesquite scrub; To – Town; Cr – Crop land.

^bSeasonality: Re – Resident; Wi – Winter migrant; Su – Summer migrant; Tr – Transient; AV – Accidental Vagrant.

^cAnnual Occurrence: Reg. – Regular; Irr. – Irregular; Occ. – Occasional; Cas. – Casual.

^dConservation Status in Mexico: E – Endangered; Th – Threatened; SP – Subject to Special Protection.

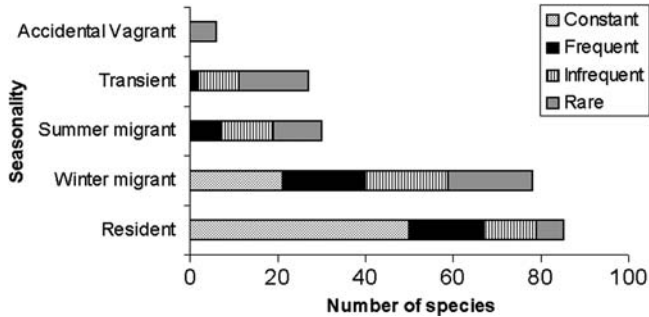


Figure 1. Occurrence and seasonality of bird species in the Janos-Casas Grandes Prairie Dog Complex and surrounding area of northwestern Chihuahua, Mexico.

(25.6%) casual (Figure 1). According to our observations, most resident species were regular. In contrast, winter migrants were evenly distributed between regular (27%), irregular (24.3%), occasional (24.3%) and casual (24.3%). Summer migrants were chiefly occasional (40%) and casual (30%), while the rest were irregular (23.3%). Transients appeared to be mostly casual species (56%, Figure 1).

There were 86 resident species, including the scaled quail (*Callipepla squamata*), mourning dove (*Zenaida macroura*), and Chihuahuan raven (*Corvus cryptoleucus*), three of the most abundant birds in the study area. Migratory species accounted for 48% of all species recorded. Winter migrants (78 spp.), such as the ferruginous hawk (*Buteo regalis*), bald eagle (*Haliaeetus leucocephalus*) and sandhill crane (*Grus canadensis*), were found from October to March. In contrast, summer migrants (30 spp.) were found from March to late September or early October. Among them the Swainson's hawk (*Buteo swainsoni*), Bullock's oriole (*Icterus bullockii*) and American avocet (*Recurvirostra americana*) all bred in the area. Twenty-seven other species, including the osprey (*Pandion haliaetus*), tree swallow (*Tachycinetta bicolor*) and willow flycatcher (*Empidonax traillii*) were considered transients. The six accidental vagrants included the tundra swan (*Cygnus columbarius*) and the gray catbird (*Dumetella carolinensis*) (Table 1).

Interestingly, a few of the resident species received an influx of migratory individuals. For example, the horned lark (*Eremophila alpestris*) had a small resident population, which increased during autumn and winter due to migrants. The local population of burrowing owls (*Athene cunicularia*) increased during the breeding season, mostly in the summer.

Species distribution across habitat types

Most species (143) were recorded in just one habitat type, while the rest were found in two to four habitat types (Table 1). Not surprisingly, the highest number of habitat specialists was found in riparian vegetation (e.g., cedar

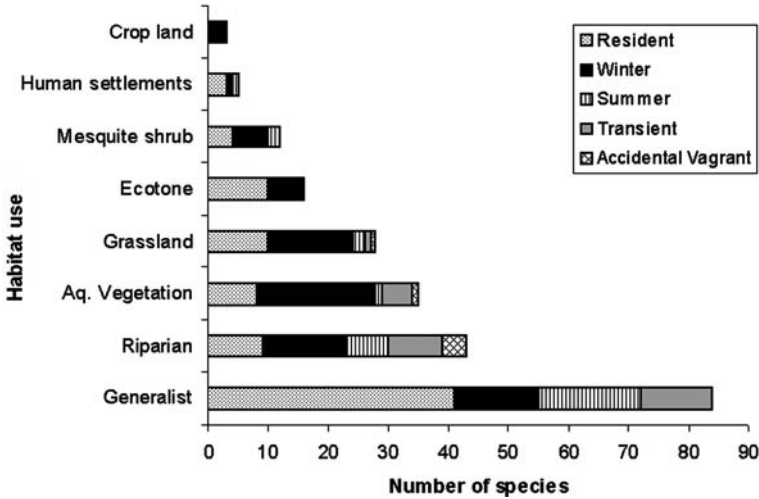


Figure 2. Seasonality of bird species per habitat use in the Janos-Casas Grandes Prairie Dog Complex and surrounding area of northwestern Chihuahua, Mexico.

waxwing *Bombycilla cedrorum*), followed by ponds and aquatic vegetation (e.g., wood duck *Aix sponsa*), grassland (e.g., prairie falcon *Falco mexicanus*), grassland–oak forest ecotone (e.g., western bluebird *Sialia mexicana*), mesquite scrub (e.g., black-throated sparrow *Amphispiza bilineata*), human settlements (e.g., rock dove *Columba livia*) and croplands (e.g., sandhill crane).

Regarding annual occurrence across habitat types, birds from riparian areas and ponds and aquatic vegetation seemed mostly occasional or casual; in grassland, birds were mainly regular or irregular; in the grassland–oak woodland ecotone they seemed mainly irregular and casual; in mesquite shrublands they appeared evenly distributed between all categories; and in and around human settlements and croplands they were mostly regular or irregular. Most habitat generalist species were regular (47), while 13 appeared to be irregular, 14 occasional, and 10 casual (Table 1). Forty-one habitat generalists were resident, 31 were migrants, and 12 were transients. Riparian, grassland, mesquite and ponds/aquatic vegetation species were predominantly migratory; species found in the oak–woodland ecotone and around human settlements were residents; and cropland species were winter migrants (Figure 2).

Discussion

During this study, a total of 227 bird species were observed in the 250,000 ha study area, all of which would be included in the proposed biosphere reserve. Riparian areas and ponds and aquatic vegetation were associated with the

largest numbers of species. A number of regular species, such as the crissal thrasher (*Toxostoma crissale*, a local resident) and the American pipit (*Anthus rubescens*, a winter migrant) appeared to be obligate riparian birds in the study area. Orange-crowned warblers (*Vermivora celata*) were transients detected in most years in riparian vegetation, and overall this habitat seemed especially important for two families, the Tyrannidae and Parulidae. Many riparian species appeared to be occasional or casual. However, this observed pattern probably was due to the fact that many riparian birds were transients and therefore were less likely to be seen, unless they occurred in large numbers and/or for weeks at a time. Not surprisingly, ponds and aquatic vegetation tended to have their own distinctive bird community, particularly a large number of ducks and shorebirds (Table 1). Grasslands and the grassland–oak woodland ecotone also contributed substantially to total avian diversity. Summer rains appeared to influence the distribution and/or abundance of some species in grasslands, and likely contributed to increase avian diversity in this habitat. On August 23, 2001, JLEC counted approximately 400 long-billed curlews in an inundated grassland area. Species appearing in the summer around inundated grasslands included the red-winged blackbird (*Agelaius phoeniceus*) and the white-faced ibis (*Plegadis chihi*).

Even without including higher-elevation species, which remain to be tallied, avian diversity in the JCG area is higher than that documented for some already established protected areas of Mexico: Mapimí (130 spp., 103,000 ha), El Pinacate y Desierto de Altar (99 spp., 714,556 ha), La Michilía (178 spp., 35,000 ha), and Maderas del Carmen (126 spp., 208,381 ha) (Ceballos, unpublished data). Its bird diversity is also comparable to the Wildlife Protection Area of Sierra de Álamos-Arroyo Cuchujaqui (270 spp., 92,900 ha), a reserve that lies in Sonora, at the transition between temperate and tropical zones (Ceballos, unpublished data). In contrast to all those other reserves, however, the lowlands of the JCG area appear to lack species endemic to Mexico. This is a rather peculiar pattern in Mexico, where most localities harbour relatively large percentages of endemic taxa. At the same time, it is not surprising considering that the JCG area is adjacent to the US and that its flat topography and habitat connectivity likely have allowed free movement of species across the border, effectively preventing endemism.

The avifauna of the study area (and proposed biosphere reserve) is characterized by an important percentage (48%) of migrants and transient birds. In more humid habitats in Mexico migrant species tend to represent about 20% of a bird community. For example 21% of species in tropical forest in the Selva Lacandona in Chiapas were migrants (Gonzalez-Garcia 1993), and migrants made up 19.8% of species in tropical deciduous forest in La Mancha in Veracruz (Ortiz-Pulido et al. 1995). Drier areas such as the *Valle de Tehuacan* desert more closely resemble the JCG area, with up to 50% of migrant species (Arizmendi and Espinosa de los Monteros 1996).

In a recent analysis for prioritizing areas for the conservation of the birds of Mexico, it was found that the creation of 10 reserves would be required to

include all species within at least one of the protected areas. The JCG region was among the three most important of the required areas (Ceballos et al. 2002), and if protected it would be among the five most important reserves in the country. In particular it would add a substantial number of avian species to the system of protected areas, including *Chen rossii*, *Bucephala clangula*, *Buteo lagopus*, *Grus canadensis*, *Baeolophus ridgwayi*, *Toxostoma rufum*, and *Calcarius mccownii* (Ceballos et al. 2005), as these currently are not represented in other reserves. Ignoring such species would be a costly mistake, with important conservation implications. By being at the periphery of the range of many species the conservation value of the area is increased (Channell and Lomolino 2000).

What the JCG area lacks in endemism it makes up for with its high number of conservation sensitive species. Twenty-one species found in the study area are listed as birds at risk by the Mexican federal government (SEMARNAT 2002). The JCG area provides a key nesting or wintering area in particular for some widely distributed, and threatened species such as the mountain plover (*Charadrius montanus*). This species has been detected in most years in the study area and can be observed from September to May (mainly during the winter). The largest flock we observed (in December 1995) had between 90 and 120 individuals, and according to our most conservative estimate, around 200 mountain plovers may inhabit the JCG area during the winter. This number represents about 2% of the estimated total population (10,000–12,000 individuals; Knopf, personal communication) for all of North America, a population restricted to only about 50,000 ha of prairie dog towns and overgrazed grasslands. For bird conservation at the scale of North America, the high number of migrant species adds further to the importance of the site. Combined with results obtained for other vertebrates (Pacheco et al. 1999; Ceballos et al. 2005), all of these findings point to the importance of the JCG for the maintenance of Mexican biodiversity (CONABIO 2000; Manzano Fischer et al. 2000) and the merits of establishing the proposed reserve within the National System of Protected Areas.

We disagree with a prevailing notion that marginal species should be ignored when selecting priority sites for conservation (see Rodrigues and Gaston 2001 for a review). In our study area, at least 13 species occur in the study area at the (southern, northern, eastern, or western) edge of their distribution, and several more enter marginally into Mexico, including endangered or threatened taxa such as the bald eagle. The value of marginal species in prioritising conservation areas should be based on their role in the structure and functioning of the local ecosystems and on the importance of the site for the conservation of the species. Due to anthropogenic effects critically endangered or conservation sensitive species may survive or remain common only at the periphery of their historical distribution (Channell and Lomolino 2000; see also following section). With only about 30 records from further west, in northern Sonora (Russell and Monson 1998), the ferruginous hawk is essentially at the western edge of its distribution in the JCG area. Yet, this raptor is a common winter

migrant (Dieni et al. 2003) in the JCG area and likely plays an important role as a top predator in the local grassland ecosystem.

The prairie dog complex and grassland species

The JCG prairie dog complex is a unique ecosystem that supports a very diverse fauna and flora, and it is recognized as a priority area for conservation in Mexico and North America (List et al. 1998; CONABIO 2000; Manzano Fischer et al. 2000). The black-tailed prairie dog is a good example of a species at the edge of its historical distribution yet playing a very important role in maintaining high biodiversity. Its burrows are crucial for maintaining the high numbers of burrowing owls in the area while its grazing activity maintain the vegetation short enough for a number of local insectivorous and granivorous birds. Our study reinforces the notion that prairie dogs increase avian diversity of the grassland (Barko et al. 1999; Kotliar et al. 1999; Manzano Fischer et al. 1999; Lomolino and Smith 2003; Desmond 2004), as we found 28 species to be exclusively present in grasslands.

The black-tailed prairie dog also contributes to high avian diversity more indirectly. Prairie dogs have modified the JCG area creating and maintaining a mosaic of different habitats, especially as they inhibit mesquite growth (Koford 1958; Weltzin et al. 1999). Prairie dogs cut down vegetation thus increasing the area covered by grassland (R. List, unpublished data). Natural grasslands were among most widespread biomes in the World, but today they are among the most transformed and less protected, with less than 1% of its surface falling within some sort of protection regime worldwide (Coupland 1979; Henwood 1998). The North American continent has not escaped the massive scale of the destruction and fragmentation of grasslands, which has resulted in negative impacts at both the landscape and species levels (Clark 1989; Miller et al. 1994; Flores 1996; Hornaday 2002; Gauthier et al. 2003). Populations of many species of plants and animals have suffered severe declines associated with the disappearance of grasslands. The bison (*Bison bison*), elk (*Cervus elaphus*), grizzly bear (*Ursus arctos*), wolf (*Canis lupus*), swift fox (*Vulpes velox*), golden eagle (*Aquila chrysaetos*), and eskimo curlew (*Numenius borealis*), are some of the best known species associated with grasslands that have declined in numbers or disappeared from some or most of their range. This trend of destruction of a large percentage of their habitat, and the extensive fragmentation of the remnants continues, affecting whole groups of species, and in recent years, populations of grassland birds have shown a sharp, consistent decline, and many species are now considered of conservation concern, threatened, or endangered in the United States, Canada and Mexico (McNicholl 1988; Knopf 1996; Manzano Fischer et al. 1999; Ceballos and Márquez 2000; Shmutz et al. 2001). Although there is a lack of quantitative data on Mexican grasslands, it is well documented that habitat loss leads to bird species extinction and endangerment (Pimm et al. 1995; Helzer and Jelinski 1999).

Biodiversity in small prairie dog colonies surrounded by a matrix of suburban and agro-pastoral habitats tends to decline, and such colonies do not maintain a full set of the original species. Factors associated to the decline include changes in the structure and functioning of the grassland ecosystem, as well as species composition, vegetation cover, food availability, predation, and refuges (Vickery et al. 1992; Weltzin et al. 1997; Helzer and Jelinski 1999; Madden et al. 1999; O'Leary and Nyberg 2000). While the loss of prairie dogs has not been studied as a direct cause of the decline of grassland bird species, the dependence of many of these species on prairie dogs suggests that their loss has contributed to the decline of some avian species (Olendorff 1973; Butts and Lewis 1982; Agnew et al. 1986; Cully 1991; Samson et al. 1997; Knowles and Knowles 1998, 2001; Lomolino and Smith 2003).

Threats

The size of the JCG Prairie Dog Complex has decreased by about 45% since 1988, due to prairie dog eradication by local farmers and expansion of irrigated crop fields. If it continues, the decline of the complex will have an important impact on species relying on prairie dogs for habitat, especially mountain plovers and burrowing owls. It will also impact raptors that feed on the prairie dogs, such as ferruginous hawks and golden eagles (see Manzano Fischer et al. 1999).

Overgrazing occurs in the JCG area, contributing to mesquite encroachment upon native grasslands (Ceballos et al. 2005). In addition, Desmond (2004) found that overgrazed ejido lands within the prairie dog town complex supported only eight wintering species. Plots on an adjacent ranch also within the complex showed no signs of overgrazing, and they had a total of 19 wintering species. As stated by Desmond (2004), overgrazed areas of the prairie dog complex may provide little value to grassland birds with the exception of horned larks. Overgrazing is the main threat also to riparian areas. Cattle are allowed free access year-round to the riparian areas, a practice that has resulted in trampling of soil and vegetation, destruction of the river bank, and lack of tree regeneration (R. List, personal obs.). The loss of riparian vegetation can result in an important reduction of the number of species present in the area (see Cartron et al. 2000b).

Since 1999, the carcasses of at least 112 raptors, 178 ravens, and 2 great blue herons (*Ardea herodias*) have been found under power poles in both grasslands and shrublands of the study area (Cartron et al. 2000a, 2005; J. Cartron, unpublished data; J. Watson, personal communication). The dead raptors were chiefly red-tailed hawks (*Buteo jamaicensis*), but also included ferruginous hawks and golden eagles, along with nine other raptor species. All ravens identified to species were Chihuahuan ravens. In most cases, evidence of electrocution was found, typically singed feathers. Nearly all poles with documented bird mortality were concrete poles with steel cross-arms. These

poles are conductive (see Cartron et al. 2005), and the bird is grounded when it perches on the cross-arm and can be electrocuted by touching only one wire. With many of the local power lines installed 10–20 years ago, it is likely that the documented number of electrocuted birds grossly underestimates actual mortality. One hundred and seventy-eight of all the dead birds recorded in the area were found during just 1 year, the only year with monthly surveys (Cartron et al. 2005). Although some of the powerlines have now been retrofitted using wooden cross-arms, electrocution continues to be an important cause of mortality among raptors and Chihuahuan ravens.

Agricultural practices in the study area likely have other negative impacts besides prairie dog poisoning and expansion of crop fields. Excessive well drilling probably led to the loss of perennial stream flow in the only reach that was not seasonal (R. List, personal obs.). Some Mennonite farmers use the flowable form of carbofuran (commercial name Furadan) to protect their crops against insects (J. Cartron, personal obs.). Although not as lethal as the granular form, flowable carbofuran is highly toxic to wildlife. Mortality of waterfowl and songbirds has been documented (Agriculture Canada 1993). Within 50 m of crops sprayed with the pesticide, burrowing owls experience a 50% reduction in both the number of successful pairs and number of fledglings per successful nest (Fox et al. 1989). Exposure to carbofuran is likely to rise if the prairie dog complex becomes increasingly fragmented due to agricultural expansion. Herbicide or insecticide application may be responsible for observed mortality among passerines along field edges in the JCG area (J. Cartron, personal obs.).

The establishment of the proposed biosphere reserve is urgently needed, especially for the protection of local grasslands and riparian areas, and their associated faunas. The establishment of this reserve is warranted by the existence of the prairie dog complex, the largest remaining anywhere. It is also warranted by the number of conservation sensitive species, particularly those associated with grasslands. Finally, as documented here, total avian diversity is high, and would place the proposed biosphere reserve among the main protected areas in Mexico. The long-term survival of the JCG complex and surrounding area depends on the establishment and implementation of conservation measures, coupled with the understanding and assistance of local people, scientists and regional government.

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