

# Bird Ecology and Conservation on the Northern Jaguar Reserve: Recent Lessons

Peter Warshall

Northern Jaguar Project, Tucson, Arizona

Aaron D. Flesch

School of Natural Resources and the Environment, University of Arizona, Tucson, Arizona

**Abstract**—*The Northern Jaguar Reserve is in the western foothills of the Sierra Madre Occidental and in a broad transition zone between Nearctic and Neotropical faunal realms. We have assessed the distribution and abundance of birds across all four seasons in foothills thornscrub, oak woodland, and adjacent riparian areas, and discuss issues relevant to conservation and management. Since 2007, we have observed 205 species of birds including 131 that are Neotropical migrants, 104 that likely breed on the reserve, and 35 species of binational conservation concern. Observations suggest this 20,140-ha reserve has significant conservation value to migratory birds that traverse an inland migratory flyway that includes the Sky Islands; breeding species that use foothills thornscrub, oak woodland, and riparian woodlands along the Rio Aros and its tributaries; and numerous species and populations of significant conservation value. Existing conservation efforts include land purchase, cattle exclusion, invasive plant removal, and habitat restoration on both neighboring private ranches and the reserve.*

## Background

The 20,140 hectare Northern Jaguar Reserve (NJR) sits at the northwestern foothills of the Sierra Madre Occidental, the “mainland” of mountains south of the Madrean Archipelago. It lies in the transition zone between the Nearctic/Neotropical faunal areas of the planet and between the coastal and high sierra montane regions of Sonora. The nearest Sky Islands that support pine-oak woodland are the Sierra la Madera and the Sierra Bacadehuachi.

The NJR is surrounded on three sides by the deep canyons of the Ríos Aros and Yaqui. This difficult-to-access region is among the largest and least fragmented regions in northwest Mexico and supports a population of jaguars (*Panthera onca*) (Brown and Lopez-Gonzalez 2001), which became the central focus for creating this private reserve. Naturalia (a Mexican conservation organization) owns the reserve and the Northern Jaguar Project and Naturalia manage it.

Before 2007, few ornithologists had visited this region of foothills thornscrub, oak woodland and shrubland, and riparian woodlands in east-central Sonora. Thus, there were few data on the occurrence, abundance, breeding and residency status of birds in the interior foothills of Sonora on the western edge of the Sierra Madre and little information to guide conservation and habitat management efforts. Between 2007 and 2011, we surveyed birds on and around the NJR and estimated the status and seasonal abundance of all bird species. This article discusses lessons we have learned about birds and their conservation implications. Estimates of seasonal abundance and status

of birds will be presented in a companion paper (Flesch and Warshall, in preparation).

## Methods

Detailed information on sampling methods and locations are described in Flesch (2007) and are not repeated here. To estimate bird abundance, we used distance sampling along eight line transects surveyed during each of four seasons over 1-2 years; seasons were defined by the breeding and migratory phenology of local species. To assess breeding, migratory and residency status, we observed bird behavior, conducted nest searches and used mist-netting and incidental observations from this and other efforts across the region.

## Lesson 1: An Inland Migratory Corridor for Birds

Data gathered during our efforts on the NJR suggest the importance of an inland (vs. coastal) flyway for many types of Neotropical migratory birds in Sonora. We observed 78 species of passage migrants, which represented 38% of all 205 species observed in the region. In addition to passage migrants that often move long distances between their winter and summer ranges, the reserve supports some species of short-range migrants including many that likely originate in the southwestern United States. Although determining the origin of these short-range migrants is difficult without extensive banding efforts or molecular techniques, probable short-range migrants that occur in the NJR include Turkey Vulture, Black Vulture, Common Blackhawk, Bald Eagle, Elegant Trogon, Costa’s Hummingbird, Lucy’s Warbler, Buff-collared Nightjar, Inca Dove, and Common Ground-Dove.

During winter, some short-distance migrants that occur on the NJR are elevational migrants that likely breed to the north and east in montane habitats of the Sky Islands and adjacent Sierra Madre.

---

In: Gottfried, Gerald J.; Ffolliott, Peter F.; Gebow, Brooke S.; Eskew, Lane G.; Collins, Loa C., comps. 2013. Merging science and management in a rapidly changing world: Biodiversity and management of the Madrean Archipelago III; 2012 May 1-5; Tucson, AZ. Proceedings. RMRS-P-67. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

These species include: White-eared Hummingbird, Buff-breasted Flycatcher, Tufted Flycatcher, Greater Pewee, Slate-throated Redstart, and Brown-backed Solitaire. At this relatively northerly latitude, Tufted Flycatcher and Slate-throated Redstart that breed locally to the east and southeast may migrate downslope, north and west into the NJR to winter.

Finally, there are migratory species of more tropical affinity many of which do not occur as far north as the Sky Islands of the United States, but may breed in the Mexican Sky Islands. They breed or are suspected to breed on the NJR reserve at or near the northern margins of their range and most migrate south in winter. These species may be short-distance migrants (Military Macaw, White-tipped Dove, White-striped Woodcreeper, Rose-throated Becard, Thick-billed Kingbird, Sinaloa Wren, Blue Mockingbird, Rufous-capped Warbler, Fan-tailed Warbler, and Five-striped Sparrow) or long-distance (Sulphur-bellied Flycatcher, Yellow-green Vireo).

The seasonal bird assemblages are additionally complex because different sub-populations of the same species may be permanent residents or dwell on reserve only as breeders in summer, over-winterers, or passage migrants. At times, it is not certain which sub-population (the migratory, resident) is present, although for some species such as Lucy’s Warbler mid-summer passage migrants often arrive several weeks after most spring breeders have departed. Without additional study and wider spatial coverage, the exact origin of migrants remains unknown.

In summary, the reserve is the first area in the foothills of the Sierra Madre Occidental in Sonora to be surveyed intensively for birds. Among seasons, bird populations include species that are Neotropical passage migrants, Neotropical summer breeders, elevational migrants that breed in Madrean environments in nearby mountains, permanent residents, and short-range over wintering migrants (table 1). Differences in density among seasons indicate large influxes of migratory species dominated by flycatchers, vireos, and warblers during spring and again during late summer and fall that together represented large proportions of total bird abundance compared to winter and summer residents (Flesch and Warshall, in preparation). About 60% (n = 131) of bird species have been categorized as Neotropical migrants by the U.S. Fish and Wildlife Service. When elevational migrants and subtropical summer breeders are considered, about 75% of bird species observed had migratory habits.

These fall and spring bird assemblages reveal the great complexity (table 1) that occurs in the Neotropical/Nearctic transition zone. They pose as yet-to-be-researched conservation challenges to understanding

Sky Island bird assemblages. For instance, does the reserve region represent a weak or strong “link” in the annual cycle of one or more populations of birds? Which habitat features and resources promote high rates of winter and summer resident survival and/or population growth? What are the high-quality foraging plant associations for passage migrants? Do the same species use the flyway in both spring and fall? Do migratory flyways shift away from the coastal plain to the foothills and mountains in fall? What species and habitats are most critical for conservation? To address some of these questions, we are now studying over-winter survival of migratory populations and continuing to monitoring abundance across space and time.

The potential importance of an inland corridor for migrants has changed conservation thinking about land purchase and habitat protection in inland Sonora. How many “stepping stones” are protected? How wide is the flyway? The closest reserves in the inland corridor to the NJR are the state reserve (Cerro Las Conchas/Arivechi) and the Ajos-Bavispe federal reserve, which includes the nearby Sierra la Madera and upper Rio Bavispe, and the more distance Sierra los Ajos, Buenas Aires and Purica. The NJR is the only protected area where logging, land clearing, and cattle grazing cannot occur. A proposed Presidential decree would also protect it from mining. In addition to the reserve, the Sanctuario Aquila Calva (that covers part of the NJR) and Sierra Huerfana have been proposed (Burquez and Martínez-Yrizar 2006). Elsewhere, habitat protection in east-central Sonora is de facto in origin and driven largely by the inaccessibility of these lands to people and livestock.

### Lesson 2: The Importance of Foothills Thornscurb and other Plant Associations

Vegetation in the uplands of the NJR is composed predominantly of foothills thornscurb (FT), which is drought deciduous, in leaf during and after the summer monsoon season from July through September, and defoliated during much of the winter and spring (Brown and Lowe 1980). The northern edge of foothills thornscurb occurs less than 50 km to the north and 100 km to the northwest, yet important dominants such as *Lysiloma divaricatum* and *L. watsonii*, *Bursera fagaroides*, and *Ceiba acuminata* occur at scattered localities as far north as the Baboquiviri and Rincon Mountains (Brown and Lowe 1980; Turner and others 1995). Our observations suggest that FT is an important and undervalued biotic community for migratory and breeding birds. The NJR is the only reserve in Mexico that protects extensive areas of FT.

**Table 1**—Seasonal bird assemblages on Northern Jaguar Reserve.

Spring	Summer	Fall	Winter
Residents	Residents	Residents	Residents (some may move locally)
Long-distance passage migrants from south	Southbound early “fall” passage migrants from north	Long-distance passage migrants from north	Overwintering migrants “long-distance” migrants from north
Early migrant breeders from south	Molt-migrants from the north	Short-distance passage migrants from north	Overwintering elevational migrants
Wintering species yet to depart for more northern breeding grounds	Summer breeders (some subtropical migrants; a few Neotrop migrants).	Over-wintering migrants from north	Over-wintering short-distance migrants from north
	Second breeding species that already bred further north?	Molt-migrants from north	

Foothills thornscrub is a diverse vegetation community with various discrete plant associations that occur at varying elevations and soils (Burgess 2009). Given this diversity, some plant associations and plant species within FT and their value to specific species and foraging guilds need to be defined so that this information can be

applied to developing more efficient conservation plans and priorities. Based on our knowledge of the natural history and ecology of birds and their habitats in this region, we began, for the first time, to define these various plant associations and assess their potential value to birds (table 2). For example, the tree ocotillo/tree morning

**Table 2**—Plant Communities and Plant Associations of the Northern Jaguar Reserve (based on Burgess 2009; Flesch and Warshall unpublished paper) mentioned in text.

Plant community and associations	Dominant species	Structure, habitat	Value to birds
Foothills Thornscrub (FT) on Hillslopes	<i>Bursera</i> , <i>Lysiloma</i> , <i>Ipomoea arborescens</i> , <i>Fouquieria macdougalii</i> ,	Trees, shrubs and cacti 3-10m tall; often on colluvial, volcanic soils.	Early breeding hummingbirds, foliage gleaners, aerial insectivores; cavity nesters; shrub specialists.
FT - Mesic Phase	<i>Lysiloma divaricatum</i> , <i>Ceiba</i>	8-12m tall, sheltered areas that promote high soil moisture.	Foliage gleaners, aerial insectivores, foragers. Possibly Military Macaw. Tall FT specialists.
FT - Rocky Canyon Bottoms	<i>Lysiloma</i> , <i>Ceiba</i> , <i>Sapindus</i> , <i>Havardia</i> , palms	Taller xeroriparian: woodland, often mixed with tropical deciduous forest species, oaks, riparian species	Monsoonal foliage gleaners and migrants, aerial foragers, bark gleaners, tall tree and cavity nesters
FT - Open arid scrub	<i>Bursera laxiflora</i> , <i>Stenocercus thurberi</i> , <i>F. splendens</i> , dense microphyllous shrubs	Xeric phase FT, short 1-3 m canopy, patchy depending on substrate	Scrub and desertscrub specialists, raptors, Costa's Hummingbird
FT – Hop bush pre-montane shrub	<i>Dodonaea viscosa</i> mixed with shrubs	2-4 m tall, often in homogenous stands with interspersed patches of FT shrubs. Volcanic and hydrothermal substrates.	Shrub specialists, ground foragers
FT - Upper elevation pre-montane scrub	<i>Yucca grandiflora</i> , <i>Sabal uresana</i> , <i>Dasyllirion</i> , <i>Lysiloma watsoni</i> , grasses	Tuft plants and bunchgrasses, scattered patches of short thornscrub often frost damaged	Scott's Oriole, Rufous-crowned Sparrow, grassland species, raptors, wintering sparrows
Oak-savanna mosaic	<i>Quercus chihuahuensis</i> , <i>Quercus toumeyi</i> , <i>L. watsoni</i> , <i>I. arborescens</i>	At elevations mostly above 900 m. Open short woodland or scrub with FT vegetation and grassy mosaic. Often frost damaged	Scott's Oriole, Rufous-crowned and Rusty Sparrows, Blue-gray Gnatcatcher. Grassland species, raptors, wintering sparrows
FT on limestone or other rocky hillsides	<i>Tecoma stans</i> , <i>Plumeria rubra</i> , <i>Agave sp.</i>	Localized shrubland on rocky outcrops and canyon walls	Hummingbirds, orioles.
Rio Aros riparian woodland and forest	<i>Salix bonplandiana</i> , <i>S. gooddingii</i> , <i>Sapindus</i> on floodplain	Tall but often patchy galleries of willow; 8-20 m tall along the river	Foliage gleaners, aerial insectivores, bark gleaners. Bald Eagle, other raptors.
Alluvial terrace xeroriparian and FT Xeroriparian	<i>Prosopis velutina</i> , <i>Havardia mexicana</i> , <i>Acacia occidentalis</i> , palms, with understory of <i>Celtis pallida</i> and other shrubs	Woodlands of tall microphyllous species; 4-20 m tall on deep sandy soils on higher terraces above rivers and main terraces along major tributaries	Foliage gleaners, aerial insectivores; nesting raptors (Common Blackhawk). Lucy's Warbler. Brown-backed Solitaire, Orioles.
Mesic pre-montane riparian woodland and Oak-Palm riparian woodland	<i>L. watsonii</i> , <i>Q. tuberculata</i> , palms, <i>Havardia</i> ; FT and Tropical Deciduous Forest riparian shrubs	Deep soil, north-facing canyons with semi-perennial water. Woodlands 10-15 m tall	Summer breeders, foliage and bark gleaners, aerial insectivores, wintering elevational migrants. Violet-crowned Hummingbird, White-striped Woodcreeper, Sulphur-bellied Flycatcher, Rufous-capped and Fan-tailed Warbler, Black-vented Oriole.
Sycamore riparian gallery forest	<i>Platanus</i> , <i>Q. tuberculata</i> , <i>Cephalanthus</i> , <i>L. watsoni</i> , palm, <i>Sideroxylon persimile</i>	Deep soils, often north-facing canyons with perennial water; woodlands 10-20 m tall; physiognomic diversity, complex structure	Summer breeders, foliage gleaners, aerial insectivores, bark gleaners, wintering elevational migrants Common Black-Hawk, Rufous-capped and Fan-tailed Warblers. Hooded Oriole.
Oak woodland	<i>Q. chihuahuensis</i> , <i>Q. tuberculata</i> , <i>Q. toumeyi</i> , <i>Q. albocincta</i>	Usually 900m or higher on north-facing slopes, ridges, canyons	Winter resident and migratory granivores. Hepatic tanager.

glory/Justicia association (*Fouquieria macdougalii* // *Ipomoea arborescens* // *Justicia* sp.) flowers in late winter and provides valuable nectar resources to migratory hummingbirds and orioles. Monsoon rains provide hillslope FT, open woodland FT, xeroriparian FT, mesic phase and rocky-bottom FT with abundant foliage and insects for foliage gleaners and aerial foragers. *Guacima*, *Lysiloma*, *Bursera*, *Cebia* and the fig species *Ficus pertusa* and *F. insipida* provide fruit for Military Macaws and other frugivores.

This new attention to FT has brought up new conservation and management questions. They include how fire (both natural and human-caused), freezing temperatures, and drought affect needs of various species of birds; how over-grazing and over-abundant native and non-native invasive plants affect bird species composition and density, and how harvesting of wild agaves affect populations of nectivores. As seasonal utilization of the plant associations and plant species that occur within FT becomes better known, restoration of previously grazed or cleared lands can be more intelligently designed. Thus far NJP and Naturalia have focused on more mesic riparian sites that support woodlands.

### Lesson 3: Importance of the Rio Aros and Riparian Vegetation

The reserve includes 37 km of waterfront along the Aros River, one of the few remaining large free-flowing rivers in Mexico. NJR and a federal reserve in its headwaters (Tutuaca) are the only areas with protected status along the river (Burguez and Martínez-Yrizar 2006). The Rio Aros on and around the NJR supports among the highest densities of breeding Common Black-Hawks in northern Mexico (Rodríguez-Estrella 1990; O'Brien and others 2006), the southernmost breeding population of Bald Eagle in the interior of Mexico, the northernmost breeding population of Military Macaw, and populations of many other species at the northern or southern end of their breeding and wintering ranges (Flesch and Warshall in preparation). One obvious lesson is that the vast lowland corridor formed by the Rio Aros, Yaqui, and Bavispe provides valuable habitat for birds that require riparian woodlands, tall trees, beachfront and riparian shrub communities, and that consume aquatic prey (table 2).

Efforts to protect habitat on and around the NJR have included land purchase, especially valuable riparian habitats; fencing of alluvial terraces and shorelines from cattle in partnership with neighboring ranches; establishing a plant nursery to support restoration work; partnerships with Mexican natural resource agencies and neighboring landowners to restore riparian vegetation including sycamore woodlands, and conversion of cattle tanks into more wildlife-friendly ponds. The goal of these efforts is in part to augment habitat for birds such as Bell's Vireo, Yellow and Wilson's Warblers, and Yellow-breasted Chat that are associated with or obligated to riparian habitats (Skagen 2005). On a river basin scale, conservation objectives include educating the public, collecting data to help prevent the construction of a dam on the Rio Aros, and limiting potential toxic chemical pollution into the river from mining.

### Lesson 4: Birds of Conservation Concern

Birds of concern are often classified at local, regional and continental scales to address variable threats to different populations among species and subspecies (Shuford and Gardali 2008). We identified 34 birds on the NJR (table 3) that are listed as birds of concern by USFWS, National Audubon Society, Partners in Flight and the Mexican Federal

Table 3—Birds of Concern on the Northern Jaguar Reserve.

Concern	Species
Continental assessments of birds of concern	Costas and Broad-tailed Hummingbirds, Elegant Trogon, Olive-sided Flycatcher, Bells and Warbling Vireos, Varied and Painted Buntings, Wilsons and Lucy Warblers, Brewer's Sparrow, Swainson's Hawk and Western and Summer Tanagers
Bird populations that are in steep decline (greater than 50% decline in the last 50 years)	Yellow-billed Cuckoo, Rufous Hummingbird, Rock Wren, Wilson's Warbler, Brewer's Sparrow and Grasshopper Sparrow
Mexican federal agency birds-at-risk	Sharp-shined, Cooper's, Swainson's, Zone-tail Hawks, Common Blackhawk, Bald Eagle, Peregrine Falcon, Military Macaw.
Potential molt migrants	<i>Western Wood-Pewee, Hammond's Flycatcher, Dusky Flycatcher, Gray Flycatcher, Pacific-slope Flycatcher, Cordilleran Flycatcher, Ash-throated Flycatcher, Western Kingbird, Bell's Vireo, Plumbeous Vireo, Cassin's Vireo, Black-throated Gray Warbler, Townsend's Warbler, Wilson's Warbler, Hepatic Tanager, Summer Tanager, Green-tailed Towhee, Chipping Sparrow, Clay-colored Sparrow, Brewer's Sparrow, Lark Sparrow, Grasshopper Sparrow, Black-headed Grosbeak, Hooded Oriole, and Lesser Goldfinch.</i>
<b>Bold:</b> Priority I species for Partners in Flight  <i>Italic:</i> Also Priority II or III species of Partners In Flight	
High priority Neotropical migratory birds of concern for overwintering survival (DeSante and others 2009)	Willow Flycatcher (endangered, rare migrant); Dusky Flycatcher (frequent migrant, uncommon winter resident); Warbling Vireo and Wilson's Warbler (common migrants); and Painted Bunting (uncommon fall migrant).

Government (Berlanga and others 2010; Partners in Flight 2006). These species include 28 migrants as well as subtropical breeders.

The NJR also supports molt migrants. Habitat protection for molt-migrants is a new and potentially important conservation objective. Many birds that breed in western North America leave their breeding grounds in July and August and migrate to the "Mexican monsoon region" where they use seasonally abundant resources to molt and refuel before continuing to their wintering grounds. Because molting is among the most energy-demanding events in the annual cycle of a bird, maintenance of high quality stopover habitat for these species is crucial to their persistence (Pyle 2009). Little was known of this phenomenon in the inland foothills of Sonora until NJP's recent studies.

Of 34 species of likely molt-migrants in the broader region (Pyle 2009), NJP has caught, measured, and banded 14 (40%) in 2011 (Hanunselka, personal communication; table 3). Nine of these species (table 3) are classified as Birds of Conservation Concern or Priority I species by Partners in Flight (2006). In addition to confirmed molt-migrants (Hooded Orioles, Black-headed Grosbeaks, and Summer Tanagers which all showed clear molting), we have also recorded eight "candidate" species of molt migrants (including two common passage migrants, Warbling Vireo and Wilson's Warbler).

These birds-of-concern lists, State of Sonora, Mexican and binational conservation initiatives as well as strategic surveys and monitoring on the NJR are crucial conservation tools to aid in recovery and forestall further listings.

Table 4—Birds mentioned in text.

Common name	Scientific name
Black Vulture	<i>Coragyps atratus</i>
Turkey Vulture	<i>Cathartes aura</i>
Common Black-Hawk	<i>Buteogallus anthracinus</i>
Bald Eagle	<i>Haliaeetus leucocephalus</i>
Sharp-shinned Hawk	<i>Accipiter striatus</i>
Cooper's Hawk	<i>Accipiter cooperii</i>
Swainson's Hawk	<i>Buteo swainsoni</i>
Zone-tailed Hawk	<i>Buteo albonotatus</i>
Peregrine Falcon	<i>Falco peregrinus</i>
Common Ground-Dove	<i>Columbina passerina</i>
Military Macaw	<i>Ara militaris</i>
Yellow-billed Cuckoo	<i>Coccyzus americanus</i>
Broad-tailed Hummingbird	<i>Selasphorus platycercus</i>
Costa's Hummingbird	<i>Calypte costae</i>
White-eared Hummingbird	<i>Hylocharis leucotis</i>
Rufous Hummingbird	<i>Selasphorus rufus</i>
Broad-tailed Hummingbird	<i>Selasphorus platycercus</i>
Elegant Trogon	<i>Trogon elegans</i>
White-striped Woodcreeper	<i>Lepidocolaptes leucogaster</i>
Tufted Flycatcher	<i>Mitrephanes phaeocercus</i>
Olive-sided Flycatcher	<i>Contopus cooperi</i>
Greater Pewee	<i>Contopus pertinax</i>
Western Wood-Pewee	<i>Contopus sordidulus</i>
Willow Flycatcher	<i>Empidonax traillii</i>
Hammond's Flycatcher	<i>Empidonax hammondii</i>
Gray Flycatcher	<i>Empidonax wrightii</i>
Dusky Flycatcher	<i>Empidonax oberholseri</i>
Pacific-slope Flycatcher	<i>Empidonax difficilis</i>
Cordilleran Flycatcher	<i>Empidonax occidentalis</i>
Ash-throated Flycatcher	<i>Myiarchus cinerascens</i>
Western Kingbird	<i>Tyrannus verticalis</i>
Plumbeous Vireo	<i>Vireo plumbeus</i>
Cassin's Vireo	<i>Vireo cassinii</i>
Warbling Vireo	<i>Vireo gilvus</i>
Yellow-green Vireo	<i>Vireo flavoviridis</i>
Rock Wren	<i>Salpinctes obsoletus</i>
Rose-throated Becard	<i>Pachyramphus aglaiae</i>
Chihuahuan Raven	<i>Corvus cryptoleucus</i>
Brown-backed Solitaire	<i>Myadestes occidentalis</i>
Blue Mockingbird	<i>Melanotis caerulescens</i>
Black-throated Gray Warbler	<i>Setophaga nigrescens</i>
Townsend's Warbler	<i>Setophaga townsendi</i>
Fan-tailed Warbler	<i>Basileuterus lachrymosa</i>
Wilson's Warbler	<i>Cardellina pusilla</i>
Slate-throated Redstart	<i>Myioborus miniatus</i>

Table 4—Cont.

Spotted Towhee	<i>Pipilo maculatus</i>
Green-tailed Towhee	<i>Pipilo chlorurus</i>
Chipping Sparrow	<i>Spizella passerina</i>
Clay-colored Sparrow	<i>Spizella pallida</i>
Brewer's Sparrow	<i>Spizella breweri</i>
Lark Sparrow	<i>Chondestes grammacus</i>
Five-striped Sparrow	<i>Amphispiza quinquestrata</i>
Grasshopper Sparrow	<i>Ammodramus savannarum</i>
Hepatic Tanager	<i>Piranga flava</i>
Summer Tanager	<i>Piranga rubra</i>
Western Tanager	<i>Piranga ludoviciana</i>
Black-headed Grosbeak	<i>Phaeucticus melanocephalus</i>
Varied Bunting	<i>Passer inavensicolor</i>
Painted Bunting	<i>Passer inaciris</i>
Hooded Oriole	<i>Icterus cucullatus</i>
Lesser Goldfinch	<i>Spinus psaltria</i>

## Conclusions

The fully protected NJR provides essential wintering and stopover habitat for migratory and important breeding habitat for over 200 species of birds. Foothills thornscrub, the Rio Aros, arid oak woodlands and an inland migration flyway are very likely essential components in the annual cycle of many Neotropical migratory species. Foothills thornscrub is apparently an undervalued biotic community for migratory birds. Data collected by NJP and their cooperators have established a baseline for monitoring long-term trends in the presence, abundance, and dispersal of birds in this region that may be due to the impacts of climate change or, we hope, to habitat protection efforts.

## Acknowledgments

We would like to thank Alberto Burguez, Diego Ezrre, Alan Craig, Megan Southern, Richard Hutto, and Noel Snyder for help on this manuscript, and many birders (Flesch and Warshall, in preparation), especially Sky Jacobs. Support for this project was provided, in large part, by grants by U.S. Fish and Wildlife Service, Aros/Yaqui Rivers Habitat Conservation NMBCA Grant Awards 3543, 4072, 4520, 4770, 5054 and the University of Arizona, School of Natural Resources and the Environment.

## References

- Brown, D.E. and C.H. Lowe, Jr. 1980. Biotic communities of the Southwest. USDA Forest Service and University of Utah Press, Salt Lake City.
- Brown, David E., López González, Carlos A. 2001. Borderland Jaguars. University of Utah Press. 170 p.
- Burgess, Tony. 2009. Framework to Interpret Vegetation of the Los Pavos, Northern Jaguar Reserve. Unpublished paper on file at: Northern Jaguar Project, Tucson, AZ. 12 p.
- Búrquez, Alberto and A. Martínez-Yrizar. 2006. Conservation and Landscape Transformation in Northwestern Mexico. In: Felger, R.S. and Broyles, B.

- (Eds Dry Borders: Great Natural Reserves of the Sonoran Desert. The University of Utah Press. Salt Lake City. 750 p.
- DeSante, D., Romo de Vivar Alvarez, C., Morales, S. 2009. MoSI (Monitoreo de Sobrevida Invernal = Monitoring Overwintering Survival) Manual. Contribution 214, The Institute for Bird Populations. Pt. Reyes, CA.
- Flesch, Aaron D. and P. Warshall (in preparation). Status and seasonal variation in bird abundance in thornscrub and riparian vegetation in east-central Sonora, Mexico.
- Flesch, A. D. 2008. Migratory and resident birds of the Northern Jaguar Reserve of east-central Sonora, Mexico. Report to Northern Jaguar Project and Naturalia A.C. On file at: Northern Jaguar Project, Tucson, AZ.
- Hanunskela, Adam. 2011. [Letters to Northern Jaguar Project]. Five data sheets, September and November 2011. On file at: Northern Jaguar Project, Tucson, AZ.
- Hutto, R. L. 2000. On the importance of en-route periods to the conservation of migratory landbirds. *Studies in Avian Biology* 20: 109-114.
- O'Brien, C.A. D. Flesch, E. Wallace, M. Bogan, [and others]. 2006. Biological Inventory of the Rio Aros, Sonora, Mexico: A river unknown. Final Report to T&E, Inc by School of Natural Resources and U.S. Geological Survey, Sonoran Desert Research Station.
- Partners in Flight. 2006. Species Assessment Data Base. Global Scores. Online: [www.rmbo.org](http://www.rmbo.org).
- Pyle, Peter, W.A. Leitner, L. Lozano-Angulo, [and others]. 2009. Temporal, spatial, and annual variation in the occurrence of molt-migrant passerines in the Mexican monsoon region. *Condor* 111: 583-590.
- Rodríguez-Estrella, R. and B. T. Brown. 1990. Density and habitat use of raptors along the Rio Bavispe and Rio Yaqui Sonora Mexico. *Journal of Raptor Research* 24: 47-51.
- Shuford, W. David, and Gardali, T., editors. 2008. California bird species of special concern: A ranked assessment of species, subspecies, and distinct populations of birds of immediate conservation concern in California. *Studies of Western Birds* 1. Western Field Ornithologists and California Department of Fish and Game.
- Skagen, Susan K., J.F. Kelly, C. Van Riper, [and others]. 2005. Geography of spring landbird migration through riparian habitats in southwestern North America. *Condor* 107: 212-227.
- Turner, Ray M., J. E. Bowers, and T. L. Burgess. 1995. Sonoran Desert plants: an ecological atlas. University of Arizona Press, Tucson, AZ.

---

The content of this paper reflects the views of the authors, who are responsible for the facts and accuracy of the information presented herein.