

Distribution of Birds and Plants at the Western and Southern Edges of the Madrean Sky Islands in Sonora, Mexico

Aaron D. Flesch

School of Natural Resources, University of Arizona, Tucson AZ

Lisa A. Hahn

Boise, ID

Abstract—The western and southern edges of the Madrean Sky Island region are poorly defined and have received little study. After exploring mountains in these areas, we documented range extensions and additional records for several species of interest. Although many of these disjunct mountains have not been considered Sky Islands, their flora and fauna are similar to other areas within the region. Therefore, we suggest their biota indicate they require inclusion as part of the Madrean Sky Island region. Distribution and abundance of organisms within our study areas should be carefully inventoried while they remain relatively unaltered from human actions.

Introduction

Located between the highlands of the Mogollon Rim and the Sierra Madre Occidental, the Madrean Archipelago is a region of wooded mountain islands isolated by lowland seas of desertscrub, thornscrub, and grassland. Woodlands of evergreen oaks define these mountain islands and yield to pine-oak, pine, and mixed-conifer forest at higher elevations (McLaughlin 1995). Although the region has yet to be adequately defined it is thought to exist south of the Santa Teresa Mountains, west of the Animas Mountains, east of the Baboquivari Mountains and Sierra Cíbuta, and north or west of the large contiguous forests of the high Sierra Madre Occidental (Marshall 1957; McLaughlin 1995; Warshall 1995).

West of the Sierra Cíbuta and southwest of the Baboquivari Mountains are other wooded ranges that have not been considered part of the Madrean Archipelago (DeBano et al. 1995). Phillips and Amadon (1952), however, noted oaks in the Sierra San Juan (el Carrizal), Russell and Monson (1998) noted oaks in the Sierra el Humo, and Brown and Lowe (1980) mapped the westernmost Madrean evergreen woodland in these ranges (figure 1). Although known, ornithologists have spent only two hours among oaks of Sierra San Juan (Phillips and Amadon 1952) and three days in the Sierra el Humo (S. Russell, personal communication), and botanists have yet to visit these and many of the surrounding mountains (R. Felger, personal communication). Data on the distribution and abundance of plants and birds is therefore limited (Van Rossem 1945; Turner et al. 1995; Russell and Monson 1998).

West of the Sierra Madre Occidental in central Sonora are other mountains with Madrean evergreen woodland isolated by lowland thornscrub (Brown and Lowe 1980). Although the Sierra Aconchi and las Guijas have been considered part of the Sky Island region, others ranges with oak woodland to

the south, such as the Sierra de Mazatán, have not (DeBano et al. 1995). Presence of oak woodland in this and other nearby ranges indicates they may provide habitat for species found in the Madrean Archipelago.

We describe the distribution of birds, plants, and plant communities in selected mountains at the western and southern edges of the Madrean Archipelago. Based on these observations and past work, we attempt to define the western and southern limits of the region.

Study Area

We focused on four mountains west of the Sierra el Cíbuta and east of the Gran Desierto known or thought to have potential to support flora and fauna found in the Madrean Archipelago. From east to west these mountains and their elevation range are the Sierra San Juan (800-1,630 m), Sierra el Humo (720-1,650 m), Sierra el Cobre (860-1,350 m), and Sierra el Durazno (800-1,210) (figure 1). In central Sonora we selected the Sierra Mazatán (550-1,540 m), an isolated mountain approximately 70 km east of Hermosillo and south of the Sierra Aconchi (figure 1).

Methods

We visited each range for one to six days between 2000 and 2004 and attempted to reach the summits and all major vegetation communities. We described vegetation communities in upper elevation areas of each range and estimated area of oak woodland to the nearest km² by outlining its approximate extent on 1:50,000 m topographic maps.

We recorded all bird species detected and estimated maximum number of individuals observed per day during each visit. We noted the vegetation communities and elevation where

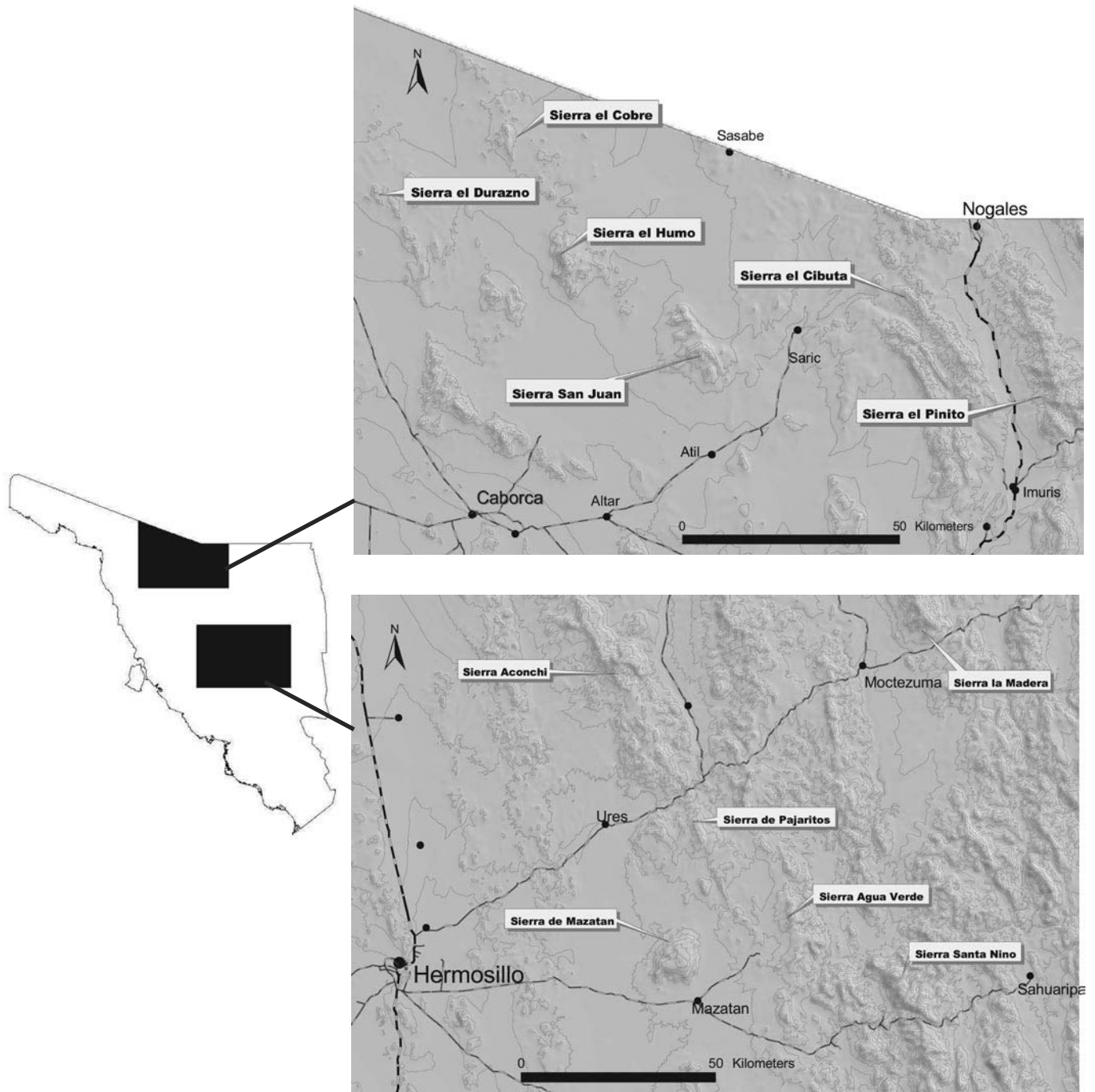


Figure 1—Maps of the western and southern edges of the Madrean Sky Island region in Sonora, Mexico, depicting selected mountain ranges, cities, roads, and topography within the study area.

each species occurred and described evidence of breeding. Because visits were not always made during the breeding season, we lack complete information on residency and breeding status. To determine the distributional significance and likely residency status of birds, we used published information (e.g., Marshall 1957; Phillips et al. 1964; Russell and Monson 1998). To determine similarity between bird communities with that in oak woodlands in the Madrean Archipelago, we compared bird species listed by Marshall (1957: 54-57) that prefer oak woodland with species we observed.

We collected voucher specimens of selected species of interest and deposited them in the University of Arizona Herbarium.

We noted whether species were common, uncommon, or rare and whether they were distributed in the upper or lower half of each range. To determine the distributional significance of species, we used published information (e.g., Bowers 1980; Turner et al. 1995; Felger et al. 2001), herbarium collections, and information from local experts. To determine floristic affinities, we compared a list of dominant or conspicuous species from the upper elevation half of each range with 195 floras from the United States and Mexico using methods outlined by McLaughlin (1992). To determine each range's similarity with the Madrean Archipelago, we compared the percentage of species in each range that occurred in all 10 floras in the Apachian District of

the Madrean Floristic Province because they are roughly co-incident (McLaughlin 1995). We focused on western ranges as floristic information for the Sierra de Mazatán is provided elsewhere (Sánchez-Escalante et al., this proceedings).

Results

We observed approximately 13 km² of oak woodland in the Sierra San Juan on slopes, ridges, and bottoms above 1,200 m. In the Sierra el Humo we observed approximately 10 km² of oak woodland in similar areas but often restricted to north- and east-facing slopes. In the San Juan, oak woodland occurred in a relatively contiguous block in the center of the range whereas in the Humo, higher topographic complexity produced patches separated by desert grassland or hopbush (*Dodonaea viscosa*), gumhead (*Gymnosperma glutinosum*), or *Mimosa* scrub. In both ranges closed-canopied encinal was restricted mainly to steeper north- or east-facing slopes and canyon bottoms. Mexican blue (*Quercus oblongifolia*) and Emory (*Q. emoryi*) oaks were dominant at lower elevations and often replaced by Arizona oak (*Q. arizonica*) >1,500 m. Common understory species included beargrass (*Nolina microcarpa*), silktassel (*Garrya wrightii*), and bunchgrasses. We observed few signs of domestic livestock grazing and numerous signs of wildfire >1,300 m in the Sierra el Humo and limited grazing in the San Juan. Oak woodland in the San Juan is approximately 30 km from similar vegetation in the Humo and 40 km from oak woodland in the Sierra Cíbata.

In the Sierra el Cobre, oak woodland was limited to a small (~100 m²) patch of Mexican blue oak along a northeast-facing drainage centered at 1,280 m. We observed extensive grasslands >1,200 m dominated by sotol (*Dasyllirion wheeleri*) and bunchgrass that included shrub live oak (*Q. turbinella*) on one north-facing hillside. Elsewhere, a jojoba (*Simmondsia chinensis*)-mixed scrub association dominated much of the range. In the Sierra el Durazno >1,000 m, we observed woodland and scrub dominated by shrub live oak on north- and east-facing slopes that reached heights of approximately five m. We did not observe juniper (*Juniperus* sp.) or pinyon (*Pinus* sp.) in the study area.

In the Sierra de Mazatán we estimated approximately 35 km² of oak woodland on flats and hills on the mesa and adjacent upper slopes. Woodland of Chihuahua oak (*Q. chihuahuensis*) dominated much of the range and was often replaced by closed-canopied encinal of Mexican blue and willow oak (*Q. viminea*) >1,350 m. On the upper slopes of a large west-facing canyon we observed a mosaic of roble (*Q. turberculata*) and foothill thornscrub dominated by *Bursera*, *Lysiloma*, and *Ceiba acuminata* that included palms (*Brahea brandegeei*) along the drainage. We did not observe pines (*Pinus* sp.).

Birds

West

Of the 15 diurnal species listed by Marshall (1957) that prefer oak woodland in the Madrean Archipelago, we detected 12 (80%) in the San Juan, 11 (73%) in the Humo, three (20%) in the Cobre, and one (7%) in the Durazno (table 1). Some

species such as hepatic tanager (*Piranga flava*) may occur but had not arrived at the time of our surveys. Acorn woodpeckers (*Melanerpes formicivorus*) were vocal and conspicuous in the San Juan in February 2004 but were not detected in November 2003.

We detected all eight oak woodland species listed by Marshall (1957) that are typically permanent residents in the San Juan and seven (88%) in the Humo. In the Humo, four Arizona woodpeckers (*Picoides arizonae*) drummed and called nearly simultaneously from neighboring ridges or slopes on the morning of March 2, 2004.

We observed other species often found among oaks in the Madrean Archipelago including a male and female elegant trogon (*Trogon elegans*) in the San Juan on November 17, 2003, but not during our subsequent visit in February 2004. Trogons were in a large north-facing canyon dominated by oaks. We observed spotted towhees (*Pipilo maculatus*) in the San Juan and Humo in mountain shrubland of oak, silktassel, beargrass, and bunchgrass. Spotted towhees were paired and singing in the Humo on March 2, 2004. We observed a single band-tailed pigeon (*Columba fasciata*) at 1,300 m in the San Juan on February 9, 2004.

Winter residents included one to three Townsend's warblers (*Dendroica townsendi*) per day in the San Juan, Humo, and Cobre. They were observed in oaks on both visits to the San Juan and in the only stand of Mexican blue oak in the Cobre. Other wintering species included two Lewis woodpeckers (*Melanerpes lewis*) and a Steller's jay (*Cyanocitta stelleri*) on February 8, 2004, in the San Juan and a Townsend's solitaire (*Myadestes townsendi*) on March 2, 2004, in the Humo, all in oaks.

Eight species we observed were at the westernmost limits of their range in Sonora and seven (88%) were associated with oak woodland (table 1). Arizona woodpeckers and buff-collared nightjars (*Caprimulgus ridgwayi*) in the Humo are the westernmost populations for these species.

South

In the Sierra de Mazatán we detected 11 of 15 (73%) diurnal oak woodland species listed by Marshall (1957) and seven of eight (88%) that are typically permanent residents (table 1). We detected only one pair of Arizona woodpeckers and one singing Hutton's vireo (*Vireo huttoni*). Mexican jays (*Aphelocoma ultramarina*) were conspicuously absent. We detected a whiskered screech-owl (*Otus trichopsis*) and two calling elegant trogons in tall Mexican blue oak woodland above 1,400 m and three northern pygmy-owls (*Glaucidium gnoma*) between 1,340 and 1,500 m. We detected pairs of ladder-backed (*Picoides scalaris*) and Gila (*Melanerpes uropygialis*) woodpeckers in oaks as high as 1,520 m and a singing brown-crested flycatcher (*Myiarchus tyrannulus*) and greater pewee (*Contopus pertinax*) in tall Mexican blue oak woodland at 1,500 m. A calling male black-vented oriole (*Icterus wagleri*) and two singing Sinaloa wrens (*Thryothorus sinaloa*) were present at the edge of a roble, thornscrub, palm association at 1,200 m. We also detected one pair and another singing white-striped woodcreeper (*Lepidocolaptes leucogaster*) in Mexican blue and willow oak woodland along a shallow north-facing canyon at 1,460 m.

We detected 11 of the 14 (79%) oak woodland species observed by Marshall (1957) that occur in the neighboring Sierra Aconchi. Other similarities with the Aconchi included absence of blue-gray gnatcatchers (*Polioptila caerulea*) and spotted towhees and presence of brown-crested flycatchers in encinal.

We observed 13 species at the western limits of their potential breeding range south of the latitude of Hermosillo, and 10 (77%) were listed by Marshall (1957) as oak woodland species. Closest known potential breeding localities for these 10 species to the east were 30-60 km away above La Estrella for six species and >130 km away near Sahuaripa for four species (Russell and Monson 1998). White-striped woodcreepers were at the westernmost known locality for the species.

Plants

West

We collected 43 voucher specimens of 22 species in and around the four mountain ranges. Ten species we observed were at the western or northernmost limits of their global distribution and 16 were at their westernmost limits in Sonora (table 2). Species at their westernmost limits in Sonora included southwestern chokecherry (*Prunus serotina* subsp. *virens*), Arizona spikenard (*Aralia humilis*), and white, Mexican blue, and Emory oak (table 2). Shrub live oak in the Humo, Cobre, and Durazno are the only known populations in mainland Mexico. Feather tree (*Lysiloma watsonii*) in the Humo is at its northwestern limits, California buckthorn (*Rhamnus californica*) in the San Juan appears to be the only known locality in Sonora, and Gentry indigo bush (*Dalea tentaculoides*) in the Humo is only the second known population in Sonora.

We identified 41 to 54 dominant or conspicuous species in the upper elevation half of each mountain range. On average, 25.5, 21.6, 17.7, and 11.6% of species found in the Sierra el Humo, San Juan, Cobre, and Durazno, respectively, occurred in all 10 Apachian floras used in the analysis. Similarity with Apachian floras was greater than for any other floristic area in all ranges except the Durazno where 18.0 and 13.9% of species were associated with the Central Gulf Coast and Sonoran Districts, respectively.

Discussion and Conclusions

Our work represents the first attempt to describe vegetation and avifauna in many of the mountains we visited. Many of the range extensions we observed are probably the result of little past field work rather than recent colonization events.

Although our timing was not sufficient to determine breeding status for most species, observations combined with published information enabled us to determine likely status for some species. Drumming and calling behavior by Arizona woodpeckers in spring is consistent with self-advertisement and pair formation that begins in March (Johnson et al. 1999). These behaviors, and the size and location of cavities we observed imply breeding. Acorn woodpeckers often move seasonally and although we observed no granaries, some breeding populations in encinal use natural holes for storage

(Stacey and Bock 1978). Acorn woodpeckers in the San Juan may breed in years of high acorn production, but the birds we observed had probably moved from higher elevations to the east sometime in mid winter in search of insects. The male and female trogon we observed in the San Juan may have bred, as the canyon appeared suitable for nesting or have been migrants from further north (Kunzmann et al. 1998). Hutton's vireos in the San Juan and spotted towhees in the Humo were singing in areas similar to those where they breed in the Baboquivari Mountains. Additional work will further elucidate breeding status of birds in these areas.

The small size and isolation of oak woodlands we visited offer insights into the area necessary to support populations for some species. Arizona woodpeckers are elevational migrants and rarely occur in lowland vegetation adjacent to their breeding grounds, and Mexican jays are virtually unknown in the lowlands (Phillips et al. 1964; Johnson et al. 1999). These species have likely persisted in the San Juan and Humo for many years. In comparison, all resident oak woodland species were absent in the small patch of Mexican blue oaks in the Cobre.

Although the Sierra San Juan and Humo have not been considered part of the Madrean Archipelago, bird communities in oak woodlands were similar to those found in Sky Islands to the east and dominant plants had greater affinity to Apachian floras than any other. Therefore, we suggest their biota indicates they require inclusion as part of the Madrean Archipelago. In contrast to Sky Islands to the east, these ranges are smaller, lower elevation, and almost completely surrounded by the Sonoran Desert. Although the Sierra el Cobre supported some oak woodland, it was too small or isolated to support birds typically found in the Sky Islands.

We suggest that mountains that support oak woodland surrounded by lowland vegetation be considered part of the Madrean Archipelago if they have conditions and resources to promote occupancy, survival, and reproduction of plants and animals found in the Sky Islands. Presence of resident birds with specialized habitat requirements and distributions associated with the Sierra Madre Occidental such as Arizona woodpecker are good indicators of the region's extent.

The Sierra de Mazatán also supported a bird community similar to that found in the Madrean Archipelago, yet the flora seems to have greater affinity to the Sierra Madre Occidental than to Apachian floras. The Mazatán are Sky Islands in a physiographic sense, yet it is not clear where we should draw the line between Apachian and Sierra Madrean biogeographic areas. Whether the Mazatán and other nearby ranges close to the Sierra Madre Occidental are part of the Madrean Sky Island region requires further study.

Despite limited information on the status of organisms along the United States-Mexico border, the region is of profound bi-national interest. The fate of some species may depend on actions occurring in neighboring countries, and Sonora populations may provide an important source of individuals for species that have declined in the United States. Anticipated development or climate change may alter these communities before they can be adequately described or protected. Therefore, organisms in this region should be carefully inventoried while it remains relatively unaltered.

Table 1—Distribution, maximum number detected per day, and notes for selected bird species found in five mountain ranges at the of days in each range. Visit dates are as follows: Sierra San Juan - 4/29/00, 1/12/02, 11/17/03, and 2/7 - 2/9/04. Sierra el Humo -

| Species | Location and effort | | | | |
|--|---------------------|----------|-----------|-------------|-------------|
| | West | | | | South |
| | San Juan (6) | Humo (5) | Cobre (3) | Durazno (1) | Mazatan (2) |
| Zone-tailed Hawk (<i>Buteo albonotatus</i>) | 2 | 2 | 1 | | 1 |
| Red-tailed Hawk (<i>Buteo jamaicensis</i>) | 3 | 1 | 2 | 1 | 2 |
| Peregrine Falcon (<i>Falco peregrinus</i>) | | 1 | | | |
| Montezuma Quail ^a (<i>Cyrtonyx montezumae</i>) | 4 | | | | 1 |
| Band-tailed Pigeon (<i>Columba fasciata</i>) | 1 | | | | |
| Western Screech-Owl (<i>Otus kennicottii</i>) | 2 | | 1 | | 1 |
| Whiskered Screech-Owl ^b (<i>Otus trichopsis</i>) | | | | | 1 |
| Northern Pygmy-Owl (<i>Glaucidium gnoma</i>) | | | | | 2 |
| Common Poorwill (<i>Phalaenoptilus nuttallii</i>) | 1 | 5 | | | 1 |
| Buff-collared Nightjar (<i>Caprimulgus ridgwayi</i>) | | 1 | | | |
| Costa's Hummingbird (<i>Calypte costae</i>) | 5 | | | 2 | |
| Anna's Hummingbird (<i>Calypte anna</i>) | 3 | | | | |
| Rufous Hummingbird (<i>Selasphorus rufus</i>) | | | 2 | | |
| Elegant Trogon (<i>Trogon elegans</i>) | 2 | | | | 2 |
| Acorn Woodpecker ^b (<i>Melanerpes formicivorus</i>) | 8 | | | | 15 |
| Lewis's Woodpecker (<i>Melanerpes lewis</i>) | 2 | | | | 1 |
| Arizona Woodpecker ^a (<i>Picoides arizonae</i>) | 3 | 5 | | | 2 |
| Northern Flicker (<i>Colaptes auratus</i>) | 6 | 7 | | | 1 |
| White-striped Woodcreeper (<i>Lepidocolaptes leucogaster</i>) | | | | | 3 |
| Greater Pewee (<i>Contopus pertinax</i>) | | | | | 2 |
| Nutting's Flycatcher (<i>Myiarchus nuttingi</i>) | | | | | 8 |
| Ash-throated Flycatcher ^b (<i>Myiarchus cinerascens</i>) | 2 | 3 | 2 | 2 | |
| Hutton's Vireo ^a (<i>Vireo huttoni</i>) | 10 | 1 | | | 1 |
| Steller's Jay (<i>Cyanocitta stelleri</i>) | 1 | | | | |
| Western Scrub-Jay (<i>Aphelocoma californica</i>) | 1 | | | | |
| Mexican Jay ^a (<i>Aphelocoma ultramarina</i>) | 10 | 8 | | | |
| Bridled Titmouse ^a (<i>Baeolophus wollweberi</i>) | 20 | 12 | | | 40 |
| Bushtit ^a (<i>Psaltriparus minimus</i>) | 10 | 5 | | | 10 |
| White-breasted Nuthatch (<i>Sitta carolinensis</i>) | | | | | 8 |
| Sinaloa Wren (<i>Thryothorus sinaloa</i>) | | | | | 3 |
| Bewick's Wren ^a (<i>Thryomanes bewickii</i>) | 12 | 20 | 1 | | 10 |
| Blue-gray Gnatcatcher ^b (<i>Poliopitila caerulea</i>) | | 1 | | | |
| Western Bluebird ^b (<i>Sialia mexicana</i>) | 10 | | | | |
| Townsend's Solitaire (<i>Myadestes townsendi</i>) | | 1 | | | |
| Black-throated Gray Warbler ^b (<i>Dendroica nigrescens</i>) | 4 | 1 | | | 4 |
| Townsend's Warbler (<i>Dendroica townsendi</i>) | 4 | 1 | 1 | | |
| Hepatic Tanager ^b (<i>Piranga flava</i>) | | | | | 4 |
| Spotted Towhee (<i>Pipilo maculatus</i>) | 5 | 12 | 6 | 3 | |
| Canyon Towhee (<i>Pipilo fuscus</i>) | 10 | 2 | 3 | | 10 |
| Rufous-crowned Sparrow ^a (<i>Aimophila ruficeps</i>) | 15 | 3 | | | 6 |
| Black-vented Oriole (<i>Icterus wagleri</i>) | | | | | 1 |
| Scott's Oriole ^b (<i>Icterus parisorum</i>) | | 2 | 1 | | 1 |

^a Indicates species listed by Marshall (1957) that prefer oak woodland that are likely permanent residents in the study area.

^b Indicates species listed by Marshall (1957) that prefer oak woodland that are likely migratory in the study area.

Acknowledgments

We are indebted to Steve McLaughlin for floristic analyses. We thank Steve Russell for information on birds in Sonora and Richard Felger, Ed Gilbert, Phil Jenkins, Ana L. Reina, Richard Spellenberg, and Tom Van Devender for help with plants. Walt Anderson and Sky Jacobs contributed to our observations on ≥1 field trip. We also thank local landowners for access and Steve Russell, Tom Van Devender, and Eric Wallace for reviews of the manuscript.

References

- Bowers, Janice E. 1980. Flora of Organ Pipe Cactus National Monument. *Journal of the Arizona-Nevada Academy of Sciences*. 15(1): 1-11; and 15(2): 33-47.
- Brown, David E.; Lowe C. H. 1980. Biotic communities of the Southwest. GTR-RM-78. Fort Collins, CO: U.S. Department of Agriculture, Forest Service. Rocky Mountain Range and Experiment Station.
- DeBano, Leonard F.; Ffolliott, P. F., Ortega-Rubio, A.; Gottfried, G. J.; Hamre, R. H.; Edminster, C. B., tech. coords. 1995. Biodiversity and management of the Madrean Archipelago: the Sky Islands of Southwestern United States and Northwestern Mexico; 1994 September 19-23; Tucson, AZ. Gen. Tech. Rep. RM-GTR-264.

| Comments | Significance |
|--|--|
| Nests along lowland drainages at Western sites | Few nests known in NW Son. |
| Soaring near large cliffs on west side | |
| Reported by local residents in Humo and Cobre | At or near the westernmost limits of range |
| Soaring above oak woodland | Westernmost locality in Son. |
| In small patch of oaks in Cobre | |
| Calling from blue oak woodland near summit at 1,500 m | At or near the westernmost limits of range |
| Calling at dawn at both camps | |
| Calling in S. Juan on evening of 11/16/03 | |
| Occurs on E, N, & NW sides of Humo | Westernmost localities in Son. |
| Present in S. Juan on 1/12/02 | |
| All females | |
| Migrating through highlands on 3/16/04 | |
| Found 11/03 in S. Juan, males calling in encinal >1,400 m in Mazatan | Westernmost locality in Son. in S. Juan |
| Present 2/04 but not 11/03 in S. Juan | Westernmost locality in Son. in S. Juan |
| In oak savannah | Not seen in San Juan since 1948 |
| 4 drumming simultaneously in Humo on 3/2/04, | Northwesternmost locality for sp. in Humo |
| In oak savannah and woodland | |
| In large blue/willow oak encinal, 1 pair and another singing | Northwesternmost locality for sp. |
| Singing in blue oak woodland near summit at 1,500 m | Rarely in pure encinal |
| All paired, near oak woodland - thornscrub ecotone to 1,260 m | |
| Detected in lowlands | |
| Several singing on 2/04 in S. Juan, only 1 singing in Mazatan | |
| On ridge at 1,500 m | Few records for W. Son. |
| In scrub at 1,100 m | |
| Noted between 1,600 and 1,100 m | Westernmost localities in Son. |
| Common throughout oak woodland and scrub | Westernmost localities in Son. |
| Common throughout oak woodland and scrub | Westernmost localities in Son. |
| 2 singing in thornscrub at 1,240 m, fresh nest in <i>Q. turberculata</i> | At or near the westernmost limits of range |
| Singing in woodlands | |
| In lowland riparian vegetation | |
| Flock in oak woodland | |
| In oak savannah | Few winter records in N. Son. |
| Wintering in oaks, no singing noted | Few winter records in N. Son. |
| Wintering in oaks | Only known winter localities in W. Son. |
| 1 pair and 2 singing males in blue/ willow oak encinal >1,400 m | |
| Paired and singing in Humo on 3/2/04 | |
| Paired and courting in Mazatan on 4/9/04 | |
| Singing in oak savannah and grasslands | |
| Male in <i>Brahea brandegeei</i> , <i>Q. turberculata</i> , thornscrub association | At or near the westernmost limits of range |
| All singing males | earliest Spring arrival (3/1/04) |

Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 669 p.

Felger, Richard S.; Johnson, M. B.; Wilson, M. F. 2001. The trees of Sonora, Mexico. New York: Oxford University Press. 391 p.

Johnson, Roy R.; Haight, L. T.; Ligon, J. D. 1999. Strickland's woodpecker (*Picoides stricklandi*). In: The birds of North America No. 474. Poole, A.; Gill, F., eds. Philadelphia, PA: The Birds of North America, Inc.

Kunzmann, Michael R.; Hall, L.S.; Johnson, R.R. 1998. Elegant trogon (*Trogon elegans*). In: The Birds of North America No. 357. Poole, A.; Gill, F., eds. Philadelphia, PA: The Birds of North America, Inc.

Marshall, Joe. T., Jr. 1957. Birds of pine-oak woodland in southern Arizona and adjacent Mexico. Pacific Coast Avifauna. 32: 1-125.

McLaughlin, Steven P. 1992. Are floristic areas hierarchically arranged? Journal of Biogeography. 19: 21-32.

McLaughlin, Steven P. 1995. An overview of the flora of the Sky Islands, southeastern Arizona: Diversity, affinities, and insularity. In: DeBano, L. F.; [and others], eds. Biodiversity and management of the Madrean Archipelago: the Sky Islands of Southwestern United States and Northwestern Mexico. Gen. Tech. Rep. RM-GTR 264. Fort Collins, CO: U.S. Department of Agriculture, Forest Service: 60-70

Phillips, Allan R.; Amadon, D. 1952. Some birds of northwestern Sonora, Mexico. Condor. 54: 163-168.

Phillips, Allan R.; Marshall, J. T., Jr.; Monson, G. 1964. The birds of Arizona. Tucson, AZ: University of Arizona Press. 219 p.

Russell, Stephen M.; Monson G. 1998. The birds of Sonora. Tucson, AZ: University of Arizona Press. 360 p.

Table 2—Distribution, abundance and significance of selected plant species observed in the Sierras at the western edge of the Madrean Arizona Herbarium.

| Family | Species | Distribution and | |
|---------------|---|------------------|------|
| | | San Juan | Humo |
| Anacardiaceae | <i>Rhus trilobata</i> Nutt. (skunkbush sumac) | U-H | U-H |
| Araliaceae | <i>Aralia humilis</i> Cav. (Arizona spikenard) | R-H | R-H |
| Asclepidaceae | <i>Asclepias linaria</i> Cav. (pineleaf milkweed) | U-H | |
| Asteraceae | <i>Carphochaete bigelovii</i> Gray (bristlehead) | C-H | U-H |
| | <i>Ambrosia carduea</i> (E. Green) Payne (Baja California ragweed) | | U-L |
| Burseraceae | <i>Bursera fagaroides</i> var <i>elongata</i> McVaugh & Rzed. (fragrant elephant tree) | U-L | U-L |
| Cactaceae | <i>Echinocereus rigidissimus</i> (Engelm.) Haage f. (rainbow cactus) | C-H | C-H |
| Fabaceae | <i>Acacia angustissima</i> (Mill.) Kuntze (white ball acacia) | U-H | U-H |
| | <i>Dalea tentaculoides</i> H.C. Gentry (Gentry indigo bush) | | R-H |
| | <i>Indigofera sphaerocarpa</i> Gray (Sonoran indigo bush) | R-H | R-H |
| | <i>Lysiloma watsonii</i> Rose (feather tree) | U-L | U-L |
| | <i>Zapoteca formosa</i> ssp <i>schottii</i> (Torr. ex S. Wats.) H. Hern. | | |
| Fagaceae | <i>Quercus arizonica</i> Sarg. (Arizona oak) | C-H | C-H |
| | <i>Quercus emoryi</i> Torr. (Emory oak) | C-H | C-H |
| | <i>Quercus oblongifolia</i> Torr. (Mexican blue oak) | C-H | C-H |
| | <i>Quercus turbinella</i> Greene (shrub live oak) | | U-H |
| Garryaceae | <i>Garryi wrightii</i> Torr. (silktassel) | C-H | C-H |
| Hydrangeaceae | <i>Fendlera rupicola</i> Gray (clif fendlerbush) | | U-H |
| | <i>Philadelphus microphyllous</i> Gray (mockorange) | U-H | U-H |
| Liliaceae | <i>Dasyilirion wheeleri</i> S. Wats. (sotol) | C-H | C-H |
| | <i>Nolina microcarpa</i> S. Wats. (beargrass) | C-H | C-H |
| Poaceae | <i>Elyonurus barbiculmis</i> Hack. (wooly bunchgrass) | C-H | C-H |
| | <i>Muhlenbergia emersleyi</i> Vasey (bullgrass) | C-H | C-H |
| | <i>Trachypogon secundus</i> (J. Presl) Scribn. (crinkleawn) | C-H | C-H |
| | <i>Schizachyrium cirratum</i> (Hack.) Woot. & Standl. (Texas bluestem) | C-H | C-H |
| Rhamnaceae | <i>Rhamnus californica</i> Eschsch. (California buckthorn) | R-H | |
| | <i>Rhamnus crocea</i> Nutt. (hollyleaf buckthorn) | | |
| | <i>Sageretia wrightii</i> S. Wats. (mock buckthorn) | | |
| Rosaceae | <i>Prunus serotina</i> subsp <i>virens</i> (Woot. & Standl.) McVaugh (southwestern chokecherry) | R-H | R-H |
| | <i>Vauquelinia californica</i> ssp <i>sonorensis</i> Hess & Hendr. (Sonora rosewood) | | U-H |
| Rutaceae | <i>Ptelea trifoliata</i> subsp <i>angustifolia</i> (Benth.) V. Bailey (hoptree) | | R-H |

^a Common, Uncommon, Rare at High, Low, or All elevations

Stacey, Peter, B.; Bock C. E. 1978. Social plasticity in the acorn woodpecker. *Science*. 202: 1298-1300.

Turner, Raymond M.; Bowers, J. E.; Burgess, T. L. 1995. Sonoran Desert plants: an ecological atlas. Tucson, AZ: University of Arizona Press. 504 p.

Van Rossem, A. J. 1945. A distributional survey of the birds of Sonora, Mexico. *Occasional Papers Museum of Zoology, Louisiana State University*. 21: 1-379.

Warshall, Peter. 1995. The Madrean Sky Island Archipelago: A planetary overview. In: DeBano, L. F.; [and others], eds. Biodiversity and management of the Madrean Archipelago: the Sky Islands of Southwestern United States and Northwestern Mexico. Gen. Tech. Rep. RM-GTR 264. Fort Collins, CO: U.S. Department of Agriculture, Forest Service: 7-18.

| Abundance ^a | | Comments | Significance |
|------------------------|---------|--|---|
| Cobre | Durazno | | |
| | | Near summits and along drainages | Few Sonora localities |
| | | Restricted to north facing drainages or rock piles | Westernmost localities in Sonora |
| | U-H | Among rocks or along drainages | Westernmost localities in Sonora |
| | | Among bunchgrass and <i>Nolina</i> in oak savannah | Westernmost locality for sp. |
| | | Common along washes on west side, rare east | Only known localities in northern Sonora |
| | | Only on west sides | Northwesternmost extant locality for sp. |
| U-H | | On rock outcrops in oak savannah or grassland | Westernmost localities for sp. |
| U-H | C-H | Often along drainages | Westernmost locality in Sonora |
| | | Along 1 drainage on west side at 1,260 m | Second known and westernmost locality in Sonora |
| | | Along north facing drainages | Westernmost locality in Sonora |
| U-H | C-H | On lower slopes and occasionally at base of Mts | Northwesternmost locality for sp. |
| | | Along drainages | Northwesternmost localities in Sonora |
| | | Dominant woodland tree >1500 m | Westernmost locality in Sonora |
| R-H | | Forms closed-canopy woodlands with next sp. | Westernmost locality in Sonora |
| R-H | | Limited to ~30 plants in Cobres | Westernmost locality in Sonora |
| R-H | C-H | On steep slopes just below summits | Only known localities in mainland Mexico |
| | | Along drainages and on slopes | Westernmost locality in Sonora |
| | | Near summitt >1550 m | Westernmost locality in Sonora |
| | | In north facing drainges and slopes | Westernmost locality in Sonora |
| C-H | | In oak savannah or grasslands | Northwesternmost localities in Sonora |
| C-H | | In oak savannah or grasslands >1200 m | Westernmost localities in Sonora |
| | | In oak savannah >1400 m | Westernmost localities for sp. |
| C-H | | In oak savannah and grassland | Westernmost localities in Sonora |
| | | In oak savannah >1400 m | Westernmost localites in Sonora |
| | | In oak savannah and grassland | Westernmost localities for Sonora |
| | | Along north-facing drainages | Only known locality in Sonora? |
| R-H | U-H | Dense stands along northeast facing shoot | Only known locality in W. Sonora |
| | | Resticted to 1 north facing drainage at 1200 m | Northwesternmost locality for sp. |
| | | Short trees along north facing drainages | Westernmost locality in Sonora |
| | | On or near rocky outcrops | Second known locality in Sonora |
| | | Near summits and along north-facing drainages | Westernmost locality in Sonora |