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Avian Post Development Monitoring of Restoration Sites Along the Lower Colorado River, Breeding Season 2005



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Boulder City, NV 89006**

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Avian Post Development Monitoring of Restoration Sites, Along the Lower Colorado River, Breeding Season 2005

**Bureau of Reclamation Lower Colorado Region
Multi Species Conservation Program**



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Abstract

This report compares avian abundance, diversity and richness between the Pratt Restoration Site, the Beal Lake Restoration Site and the Cibola Nature Trail Restoration Site. Mean relative abundance of total individual birds and birds per species, species richness, species diversity and evenness were compared between the three sites. Mean relative abundance of all individual birds was highest at the Cibola Nature Trail Site. The Cibola Nature Trail Site had higher species richness than the Beal Lake Site; average species diversity was higher at the Pratt Site than the Cibola Nature Trail Site. The yellow warbler, Arizona Bell's vireo and summer tanager were the only Lower Colorado River Multi-Species Conservation Plan (LCR-MSCP) species detected at the three sites. The Pratt Site contained the largest population of yellow warblers. The Cibola Nature Trail Site contained more habitat generalists than the Pratt Site, specifically the great-tailed grackle and house finch, due to its small patch size surrounded by agricultural fields and more open habitat within the site. Reclamation has gained valuable information from avian monitoring of the three restoration sites. Small patch sizes of riparian habitat surrounded by agricultural fields appear to attract a large number of habitat generalists and few riparian obligate species. Riparian associated species, such as the song sparrow and the common yellowthroat, benefit from a site that is near a fresh water source such as the Beal Lake Site. Issues that should be considered in the planning of future sites are patch size of habitat, fresh water source near the site, and standing water or moist soils on portions of the site.

Introduction

The lower Colorado River (LCR) travels from Lees Ferry, south of Glen Canyon Dam, to the Gulf of California in Mexico, supplying water for over 25 million people and 3.5 million acres of agricultural lands in the United States and Mexico (LCR MSCP HCP 2004). Flowing through the Mohave and Sonoran deserts, the LCR provides a large expanse of riparian vegetation in an arid environment (American Bird Conservancy 2003). Over 90% of riparian habitat along the LCR has been lost to river channelization, agricultural land conversion, habitat destruction, urban development, mining, overgrazing, and invasion of salt cedar (*Tamarix sp.*) (Rosenberg *et al.* 1991, Powell and Stiedl 2000). Three species of fish and two species of birds that inhabit the LCR are on the United States Fish and Wildlife Service's (USFWS) "*Federal list of endangered and threatened wildlife and plants*" (<http://www.fws.gov/endangered/wildlife.html>, August 2004).



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Section 7(a) (2) of the 1973 endangered species act requires Reclamation to consult with the USFWS to ensure that flow and non-flow related actions do not jeopardize the existence of threatened or endangered species (LCR MSCP HCP 2004). Reasonable and Prudent Alternative 14 of the 1997 Biological and Conference Opinion on Routine Operations and Maintenance of the Lower Colorado River required Reclamation to establish small demonstration restoration sites to study ecological restoration techniques (USFWS 1997). The Lower Colorado River Multi-Species Conservation Plan (LCR MSCP), signed on April 4th 2005, will provide 50 years of continuing coverage for Reclamation's flow and non-flow related activities (LCR MSCP HCP 2004). The LCR MSCP requires Reclamation and partners to restore 5,940 acres of cottonwood-willow habitat, 1320 acres of honey mesquite and 512 acres of marsh (LCR MSCP HCP 2004). Currently, Reclamation has established two small demonstration sites (12 acre and 24 acre) to fulfill RPA 14 of the 1997 biological opinion and one larger restoration site (200 acres) to fulfill restoration research requirements of the LCR MSCP. Avian post development monitoring during the breeding season has been conducted at restoration sites along the LCR since 2002. The purpose of avian post development monitoring is to collect avian abundance, composition, diversity and richness data at each restoration project for use in developing future restoration projects. The purpose of this report is to compare avian abundance, composition, diversity and richness between three demonstration restoration sites with different planting regimes and habitat characteristics for the 2005 breeding season. This data will be used in the adaptive management process of the LCR MSCP.

Study Area

Cibola Nature Trail Restoration Site

The Cibola Nature Trail Restoration Site was established in 1999 as a joint effort between Reclamation and the Cibola National Wildlife Refuge (CNWR) to create specific habitat for the southwestern willow flycatcher (Raulston 2003). The site is a 9.1 hectare restoration site located at the CNWR that contains three distinct areas: (1) 5.5 ha mixture of honey (*Prosopis glandulosa*) and screwbean mesquite (*Prosopis pubescens*), (2) 2.6 ha of Goodding willow (*Salix gooddingii*), and (3) 1 ha of Fremont cottonwood (*Populus fremontii*). For further description of this site refer to "Avian post development monitoring at the Cibola Nature Trail Restoration Site breeding season 2005" (USBR 2005).

Pratt Restoration Site

The Pratt Restoration Site was established in 1999 as a joint effort between Reclamation and the Bureau of Land Management to create habitat for the southwestern willow flycatcher (Raulston 2003). The site is a 4.9 hectare restoration site, located near Yuma, Arizona, that was planted with Fremont cottonwoods, Goodding willows and coyote willows (*Salix exigua*). Currently, the site is being managed to promote different size classes, with an overstory, a sub-canopy, and a dense shrub layer, through harvesting poles and cuttings in certain areas (BLM 2004). For further description of this site, refer to "Avian post development monitoring at the Pratt Restoration Site breeding season 2005" (USBR 2005).



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Beal Lake Restoration Site

The Beal Lake Restoration Site is a three phase restoration project that was initiated in the spring of 2003 and is currently in the third stage of development. The 81 hectare restoration site is a joint effort between Reclamation and the Havasu National Wildlife Refuge (HNWR) with the purpose of evaluating riparian restoration techniques for the improvement of habitat for southwestern willow flycatchers and other terrestrial and marsh species of concern (USBR 2003). When complete, the site will contain approximately 40 hectares of Fremont cottonwood and willow (*Salix exigua* and *Salix gooddingii*) habitat and 40 hectares of honey and screwbean mesquite habitat (USBR 2003). For further description of this site, refer to “*Avian post development monitoring at the Beal Lake Restoration Site breeding season 2005*” (USBR 2005).

Methods

The following avian surveys were conducted during the 2005 breeding season: 1) tape play back surveys for the southwestern willow flycatcher (Sogge *et al.* 1997) at the Cibola Nature Trail and Pratt Restoration Sites; 2) avian area searches (Ralph *et al.* 1993) at the Cibola Nature Trail and Pratt Restoration Sites; 3) fixed radius point counts (Great Basin Bird Observatory 2003) at the Beal Lake Restoration Site and 4) constant effort mist netting station according to Monitoring Avian Productivity and Survivorship (MAPS) protocol (Desante *et al.* 2003) at the Cibola Nature Trail Restoration Site. For more detailed methodology on the avian surveys, refer to the following reports: “*Avian post development monitoring at the Beal Lake Restoration Site breeding season 2005*”, “*Avian post development monitoring at the Pratt Restoration Site breeding season 2005*”, “*Avian post development monitoring at the Cibola Nature Trail Restoration Site breeding season 2005*”, “*Results of the 2005 Southwestern Willow Flycatcher (Empidonax trallii extimus) Surveys on the Pratt Agriculture and Cibola Nature Trail Restoration Sites*” and “*FINAL Report for the Operation of Two Monitoring Avian Production and Survivorship (MAPS) stations on the Lower Colorado River, 2005 breeding season*” (USBR 2005).

A standardized protocol for each avian survey was used so comparison between sites could be made. Avian area searches or fixed radius point counts were conducted on each site, using standardized avian census techniques, so relative abundance, species richness, diversity and evenness could be compared between surveys (Ralph *et al.* 2003). The method was chosen based on patch size of habitat; in large patch sizes fixed radius point counts were conducted and in small patch sizes avian area searches were conducted. Mist netting is a more intensive survey that is conducted in select areas that gives indexes of survivorship, productivity, bird condition and sex ratios. Tape play back surveys for the southwestern willow flycatcher are conducted on sites where habitat is mature enough to support the species.



Species richness, diversity and evenness were calculated at each site. Species richness was calculated as total number of species present. A species diversity index provides more information about community composition than species richness; it takes the relative abundance of different species into account. Evenness is a measurement of species similarity; it is the equitability with which individuals are distributed among the different species. Species diversity and evenness were determined using a natural logarithm version (Nur *et al.* 1999) of Shannon's Index (Krebs 1989). The equation using natural logarithms is:

$$H' = \sum_{i=1}^{i=S} (p_i)(\ln p_i), \quad i = 1, 2, \dots, S$$

where S = number of species in the sample, and p_i is the proportion of all individuals belonging to the i th species. The transformation of H' is given by $e^{H'}$ that is labeled as N_1 (MacArthur 1965). N_1 is used because it expresses diversity in terms of species whereas H' is expressed in bits. Species distribution is maximally even when $S = N_1$. Evenness expressed as $H'/H_{\max} = H'/\ln S$ is a measurement of how similar the abundance of different species are. Evenness is equal to 1.0 when there are similar proportions of all species. Community similarity between the three phases was measured with the Renkonen index (Percentage Similarity index):

$$P = \sum \text{minimum}(p_i^A, p_i^B)$$

whereas p_i^A is the percentage of species i in sample A and p_i^B is the percentage of species i in sample B and S is the number of species found in either sample (Nur *et al.* 1999). The Renkonen index is a quantitative index which compares similarity in community composition between sites (Nur *et al.* 1999). The Renkonen index measures community similarity on a scale of 0 to 1, with 0 meaning that there is no overlap of species between sites and 1 meaning that there is complete species similarity between sites (Nur *et al.* 1999).

A single factor ANOVA test was used to determine significant difference of relative abundance, species richness, species diversity and evenness between sites. If there was a significant difference of means between sites, a tukey multicomparison test was used to determine in which sites the means differed. Resident species were used in comparisons and analysis; migrant birds were excluded from the analysis.



Results

Comparison of total mean relative abundance, mean relative abundance per species, species richness, species diversity, and species evenness during the breeding season between sites are shown in Figure 1 and Table 1. Refer to Appendix 1 for a list of common names, scientific names and American Ornithological Union (AOU) codes of species detected at all three restoration sites. Mean relative abundance of all individual birds was significantly higher ($p < .05$) at the Cibola Nature Trail Site than the Beal Lake and Pratt Sites during the breeding season of 2005. There was a significantly higher ($p < .05$) average species richness (per visit) detected at the Cibola Nature Trail Site than the Beal Lake Site during the breeding season of 2005. There was a significantly higher ($p < .05$) average species diversity (per visit) detected at the Pratt Site than the Cibola Nature Trail Site during the breeding season of 2005. Significant differences ($p < .05$) of mean relative abundance existed between the Cibola Nature Trail and Pratt Sites during the breeding season of 2005 for the following species: great-tailed grackle, house finch, Lucy's warbler, northern mockingbird, western kingbird, and the yellow warbler. Significant differences ($p < .05$) of mean relative abundance existed between the Beal Lake and Cibola Nature Trail Sites during the breeding season of 2005 for the following species: western kingbird, song sparrow, killdeer, and the yellow-headed blackbird. Significant differences ($p < .05$) of mean relative abundance existed between the Beal Lake and Pratt Sites during the 2005 breeding season for the following species: song sparrow, killdeer, blue grosbeak, yellow-headed blackbird, and yellow warbler. The Renkonen index between the Beal Lake, Cibola Nature Trail and Pratt Sites was .291881. Fourteen migratory willow flycatchers were detected at the Cibola Nature Trail Site and 5 migratory willow flycatchers were detected at the Pratt Site during May of 2005; none were confirmed as southwestern willow flycatchers (*Empidonax traillii extimus*). For more extensive results of southwestern willow flycatcher surveys refer to "Results of the 2005 Southwestern Willow Flycatcher (*Empidonax traillii extimus*) Surveys on the Pratt Agriculture and Cibola Nature Trail Restoration Sites (USBR 2005). For more extensive results of species composition and other avian parameters measured at each site, refer to the following reports: "Avian post development monitoring at the Beal Lake Restoration Site breeding season 2005", "Avian post development monitoring at the Pratt Restoration Site breeding season 2005", "Avian post development monitoring at the Cibola Nature Trail Restoration Site breeding season 2005 and "FINAL Report for the Operation of Two Monitoring Avian Production and Survivorship (MAPS) stations on the Lower Colorado River, 2005 breeding season" (USBR 2005).



Discussion

Avian abundance, richness and diversity varied between three demonstration restoration sites along the LCR during the breeding season of 2005. The community similarity index between the three sites showed little overlap of species between sites. Some variance in species composition can be expected due to the different habitat characteristics and stages of development of each site. Total relative abundance was higher at the Cibola Nature Trail Site than the Beal Lake Site. During the 2005 breeding season, approximately 30 hectares of riparian habitat was present at the Beal Lake Site compared to 12 hectares at the Cibola Nature Trail Site. Lower numbers at the Beal Lake Site could be due to fact that the habitat is in an earlier successional stage. Species diversity was higher at the Pratt Site than the Cibola Nature Trail Site. The Cibola Nature Trail Site is larger in patch size and contains a mesquite bosque as well as cottonwood-willow habitat (USBR 2005); therefore, Reclamation expected the Cibola Nature Trail Site to have a higher species diversity index.

Western Kingbirds were the most abundant at the Cibola Nature Trail Site; possible reasons for this were the height of the Fremont cottonwoods (*Populus fremontii*) (USBR 2005) and location of power lines near the site. The height of Fremont cottonwoods at the Cibola Nature Trail Site was significantly larger in height and DBH than the Fremont cottonwoods at the Beal Lake and Pratt Sites. The Cibola Nature Trail Site is adjacent to more man made structures, such as power lines, than the other two sites. Western kingbirds are associated with areas where two habitat types converge, such as riparian zones dominated by Fremont cottonwoods bordered by desert grasslands, shrubs, cultivated fields or pasture land (Gamble and Bergin 1996). Structures such as power lines and fences, make habitats more suitable (Gamble and Bergin 1996). Song sparrows were the most abundant at the Beal Lake Restoration Site, possibly due to its close proximity with water. The Beal Lake Restoration Site is adjacent to a water source (Beal Lake) whereas the other two sites are not. Song sparrows are limited to forest, shrub and riparian habitats that are adjacent to fresh water (Arcese *et al.* 2002). The Lucy's warbler was more abundant at the Cibola Nature Trail Site than the Pratt Site, potentially due to larger acreage of mesquite habitat. The Pratt Site does not contain any mesquite habitat whereas the Cibola Nature Trail Site contains 5.5 hectares of mesquite habitat (USBR 2005). Lucy's warblers are associated with dense lowland mesquite riparian woodlands (Johnson *et al.* 1997).

LCR MSCP covered species detected at these sites were yellow warblers, Arizona Bell's vireo and one summer tanager. One possible reason why the yellow warblers were the most abundant at the Pratt Site is the larger acreage of mature cottonwood-willow habitat. The habitat at the Pratt Site is small in patch size and does not have a constant supply of water, but yellow warblers are utilizing this habitat. A restoration site with a larger patch size and a constant water source has the potential for a larger population of yellow warblers. Yellow warblers are associated in wet areas dominated by willows (Lowther *et al.* 1999).



Reclamation's goal in future restoration projects is to attract more LCR MSCP covered species and other riparian associated species. Standing water or moist soils are not maintained throughout the breeding season at the three current restoration sites. Standing water or moist soils create habitat that is more suitable to many riparian obligate species, including LCR MSCP covered species such as the yellow warbler, southwestern willow flycatcher, Bell's vireo, yellow-billed cuckoo and the vermilion flycatcher. Another reason for the lack of LCR MSCP species at these sites may be the small patch size and lack of maturity of the habitat. The Pratt and Cibola Nature Trail Sites are in later stages of development than the Beal Lake Restoration Site.

Reclamation has gained valuable information from avian monitoring of the three restoration sites. Small patch sizes of riparian habitat surrounded by agricultural fields appear to attract a large number of habitat generalists and few riparian obligate species; especially those sites that contain areas where trees are not planted densely or a large number of trees have died leading to open habitat within the site. Riparian associated species such as the song sparrow and the common yellowthroat benefit from a site that is near a fresh water source such as the Beal Lake Site. Issues that should be considered in the planning of future sites are patch size of habitat, fresh water source near the site, and standing water or moist soils on portions of the site.

Area searches and constant effort mist netting were conducted on the Cibola Nature Trail Site. Area search data was used in the comparison between sites due to the fact that area searches detect all species of birds and constant effort mist netting does not (Ralph *et al.* 1993). It should be noted that constant effort mist netting detected more Bullock's orioles, ash-throated flycatchers and Lucy's warblers than area searches did. One possible reason for this is that since juveniles of these species do not sing or call they may be harder to detect in an area search survey than a constant effort mist netting where aural surveying is not required.

Table 1: Mean relative abundance of total individual birds, species richness, species diversity and evenness for the Beal Lake, Cibola Nature Trail and Pratt Restoration Sites, breeding season 2002-2005.

Site-Year	Mean Relative Abundance	Species Richness	Species diversity	Evenness
Beal Lake 2005	87.16	24	13.43	.8174
Beal Lake 2004	67.67	20	12.18	.8248
Cibola Nature Trail 2005	137.34	34	12.48	.7159
Cibola Nature Trail 2004	103.50	33	13.94	.7535
Cibola Nature Trail 2003	121.25	20	8.78	.7247
Cibola Nature Trail 2002	120.83	22	9.53	.7292
Pratt 2005	75.10	32	14.43	.7775
Pratt 2004	59.67	30	15.90	.8118
Pratt 2003	69.50	26	13.73	.8137
Pratt 2002	63.67	18	5.71	.6021



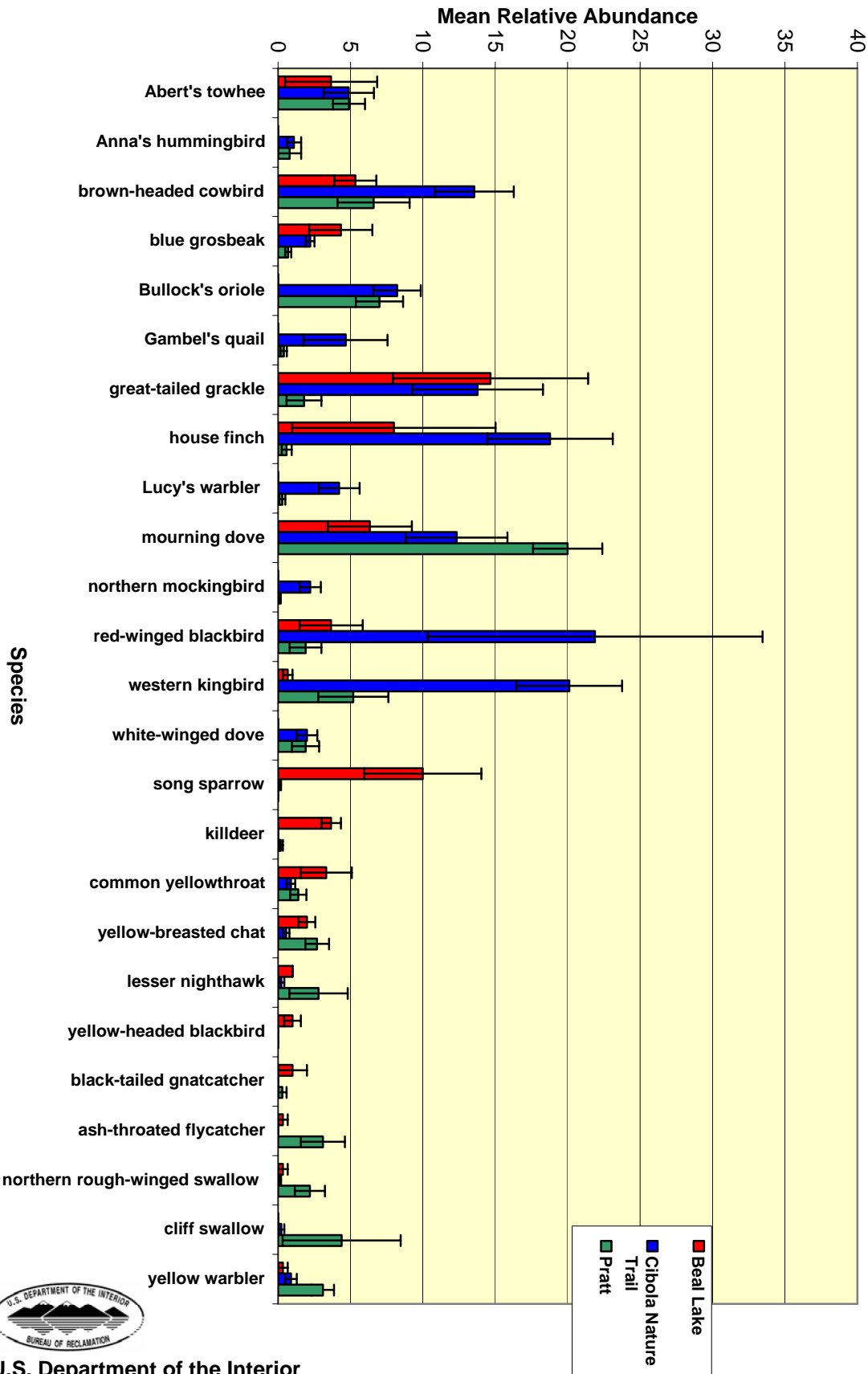


Figure 1: Mean Relative Abundance per species and standard error bars at the Beal Lake, Cibola Nature Trail and Pratt Restoration Sites, breeding season 2005



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Appendix 1

Common names, scientific names, standard AOU (American Ornithological Union) codes for all species detected in three restorations sites during the breeding season of 2005

<u>Code</u>	<u>Common Name</u>	<u>Scientific Name</u>
GAQU	Gambel's quail	Callipepla gambelii
WWDO	white-winged dove	Zenaida asiatica
MODO	mourning dove	Zenaida macroura
COGD	common ground-dove	Columbina passerine
LENI	lesser nighthawk	Chordeiles acutipennis
BCHU	black-chinned hummingbird	Archilocus alexandri
ANHU	Anna's hummingbird	Calypte anna
LBWO	ladder-backed woodpecker	Picoides scolaris
WWPE	western wood pee-wee	Contopus sordidulus
WIFL	willow flycatcher	Empidonax trailii
WEFL	western flycatcher	Empidonax difficilis /occidentalis
PSFL	Pacific-slope flycatcher	Empidonax difficilis
BLPH	black phoebe	Sayornis nigricans
ATFL	ash-throated flycatcher	Myiarchus cinerascens
WEKI	western kingbird	Tyrannus verticalis
LOSH	loggerhead shrike	Lanius ludovicianus
BEVI	Bell's vireo	Vireo belli
NRWS	northern rough-winged swallow	Stelgidopteryx serripennis
CLSW	cliff swallow	Petrochelidon pyrrhonota
VERD	verdin	Auriparus flaviceps
RBNH	red-breasted nuthatch	Sitta Canadensis
BEWR	Bewick's wren	Thryomanes bewickii
MAWR	marsh wren	Cistothorus palustris
BTGN	black-tailed gnatcatcher	Polioptila melanura
SWTH	Swainson's thrush	Catharus ustulatus
NOMO	northern mockingbird	Mimus polyglottos
LUWA	Lucy's warbler	Vermivora luciae
YWAR	yellow warbler	Dendroica petechia
COYE	common yellowthroat	Geothypis trichas
YBCH	yellow-breasted chat	Icteria virens
SUTA	summer tanager	Piranga rubra
ABTO	Abert's towhee	Pipilo aberti
SOSP	song sparrow	Melospiza melodia
BHGR	black-headed grosbeak	Phueciticus melanocephalus
BLGR	blue grosbeak	Guiraca caerulea
LAZB	lazuli bunting	Passerina amoena
RWBL	red-winged blackbird	Agelaius phoeniceus
WEME	western meadowlark	Sturnella neglecta
YHBL	yellow-headed blackbird	Xanthocephalus xanthocephalus
GTGR	great-tailed grackle	Quiscalus mexicanus
BHCO	brown-headed cowbird	Molothrus ater
BUOR	Bullock's oriole	Icterus bullockii
HOFI	house finch	Carpodacus mexicanus



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