



Holloman Air Force Base Boles Wells Water System Annex

Bird Surveys

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Introduction

The Boles Wells Water System Annex (BWWSA) consists of three wellfields, the Boles Wells Well Field (BW) to the north, Douglas Wellfield (DW) in the middle, and San Andres Well Field (SW) to the south. The wellfields are 645, 1137, and 1019 ha, respectively (HAFB CES GIS data). The wellfields contain 14 wells, which provide water for Holloman Air Force Base (HAFB). HAFB has the subsurface water rights and owns BW and part of DW, while the rest of the wellfields are owned by the Bureau of Land Management (BLM).

DW and SW are on the bajada of the Sacramento Mountains, and BW is in the alluvial flat below the bajada. BW is in a more urbanized area than the other wellfields, with houses nearby and a state highway and railroad on one side. The other wellfields are relatively isolated from human impact. DW is in a rural area with very few houses, and SW is bordered by rangeland with no houses or highways nearby.

This report presents results from the third year of surveys begun in 2001 and 2002. We conducted migration and breeding bird surveys at all three wellfields in 2005.

Study Area and Methods

We surveyed birds at each wellfield during spring and fall migrations and the summer breeding season. In 2001, we established six permanent point transects in the BWWSA wellfields (Figure 1). Transects were located to maximize the habitat diversity and area sampled. Two transects were placed in each wellfield. Each transect has six or seven permanent points, 200 m apart. Each point is marked with a piece of rebar, about 1 m X 0.64 cm, marked with an aluminum tag and painted orange on top, although the orange paint has faded to white over the years. Five transects have all points in a straight line; transect 6 at BW has four points in a straight line and two more placed to target saltcedar woodland and old orchard habitats.

The two SW transects (1 and 2, Figure 1) are the southernmost transects. Both transects are situated in Creosotebush-Ocotillo Shrubland (*Larrea tridentata*, *Fouquieria splendens*), Sparse Creosote Shrubland with Mesquite Phase (*Prosopis glandulosa*), and a small amount of Sparse Creosotebush Shrubland. Creosotebush-Ocotillo Shrubland can be especially diverse with yucca and various species of cacti. Sparse Creosote Shrubland

with Mesquite Phase and Sparse Creosotebush Shrubland both have shrub canopies of about 40% in cover, mostly lack grasses and forbs, and have exposed soils or gravel desert pavement in the inter-shrub spaces. Most of transect 2 is also in a narrow band of Creosotebush/Mariola (*Parthenium incanum*) Shrubland and Arroyo Riparian vegetation classes, because it follows an arroyo that widens toward the mountain.

Creosotebush/Mariola Shrubland is more diverse than the other Creosotebush shrublands, having Mariola, broom snakeweed (*Gutierrezia sarothrae*) and several species of cactus. Arroyo Riparian is sparsely vegetated and includes desert willow (*Chilopsis linearis*) and apache plume (*Fallugia paradoxa*). The SW has elevations ranging from 1,251 m (4,104 ft) to 1,446 m (4,744 ft) (Muldavin et al. 2006).

Transect 3 in the DW is in Sparse Creosotebush Shrubland with Mesquite Phase and Sparse Creosotebush Shrubland, with a small amount of Creosotebush/Mariola Shrubland and Arroyo Riparian. Transect 4 in the DW is also surrounded by Sparse Creosotebush Shrubland with Mesquite Phase, but has more Creosotebush/Mariola Shrubland and Arroyo Riparian because it follows a small arroyo. The DW is hilly and rocky with a few large arroyos and has elevations ranging from 1,244 m (4,081 ft) to 1,353 m (4,439 ft) (Muldavin et al. 2006).

The two BW transects (5 and 6, Figure 1) are the northernmost transects and are primarily covered in Honey Mesquite Shrubland, containing a smaller percentage of Honey Mesquite/Feather Fingergrass (*Chloris virgata*) Shrubland (Muldavin et al. 1997). Honey Mesquite Shrubland is an open or moderately closed shrubland. At BW, it occurs on alluvial flats. This type of shrubland is dominated by honey mesquite and includes fourwing saltbush (*Atriplex canescens*), tarbush (*Flourensia cernua*), and lote bush (*Ziziphus obtusifolia*). Honey Mesquite/Feather Fingergrass is an open shrubland occurring in shallow swales and drainages. This shrubland is composed mostly of honey mesquite, with fourwing saltbush and tarbush. The understory of this shrubland is dominated by feather fingergrass, with scattered clumps of alkali sacaton (*Sporobolus airoides*). One of the outlying points on transect 6 is in the old orchard near the water tank, and the other is in Saltcedar Woodland. Saltcedar Woodland has an overstory dominated by saltcedar (*Tamarix ramosissima*) and an understory that may have alkali sacaton and saltgrass (*Distichlis spicata*). The old orchard has mature pear trees, apricot

trees, pecan trees, a pomegranate tree, and other domestic plants, as well as a grassy area. BW is flat and fenced with barbed wire and contains areas of bare, fine soil and several small gullies eroding the surface.

We conducted linear point counts (Bibby et al. 2000) at each of six transects on the HAFB BWWSA, twice in 2001, and three times each in 2002 and 2005. One transect from each of three wellfields was completed on three consecutive mornings, such that one complete set was finished within the same week. The second transect from each wellfield was surveyed one or two weeks later. The order in which the transects were run changed only twice due to vehicle problems before transect 2 in the fall of 2001 and access problems before transect 1 in the spring of 2005 (Table 1). All surveys except those in summer of 2001 and 2002 were spread over three weeks to sample a greater portion of the season. Transects were run in the same order, and two transects from the same wellfield were never run in the same week.

Table 1. Dates of transect point counts.

Season	Transect 6 (BW)	Transect 1 (SW)	Transect 4 (DW)	Transect 5 (BW)	Transect 2 (SW)	Transect 3 (DW)
Summer	5/30/01	5/31/01	6/1/01	6/4/01	6/5/01	6/6/01*
Fall	9/4/01	9/5/01	9/6/01	9/25/01	9/27/01	9/28/01
Spring	4/17/02	4/18/02	4/19/02	5/1/02	5/2/02	5/3/02
Summer	5/25/02	5/26/02	5/27/02	6/4/02	6/5/02	6/6/02*
Fall	9/3/02	9/4/02	9/5/02	9/24/02	9/25/02	9/26/02
Spring	4/20/05	4/22/05	4/21/05	5/5/05	5/6/05	5/7/05
Summer	5/25/05	5/26/05	5/27/05	6/9/05	6/10/05	6/11/05
Fall	9/7/05	9/8/05	9/9/05	9/21/05	9/22/05	9/23/05

* surveys run on consecutive weeks.

Point counts on the transects were always started early enough to survey during the dawn chorus, if one occurred. At each point, we waited for three minutes before beginning the count, which lasted for five minutes. During this five-minute period, we recorded all birds (number and species) seen and heard, including birds flying over. We recorded estimated distances from the point to the bird (0-25, 25-50, 50-100, and over 100 m), except for flyovers, which were noted.

Results

During all three years of surveys, we detected 71 species (Table 2; scientific names in Appendix 1), 44 species during spring migration, 47 species during summer (breeding season), and 55 species during fall migration. Only 33 (46%) of the 71 species were seen every year.

We detected the largest number of species in fall, followed by spring with only one fewer (Fig 2). Most species seen during the summer were also seen during the spring, fall, or both (Table 3). Most species were seen in fairly equal numbers over the three years of surveys, but some species were very unevenly distributed over the three years (Table 4). In summer we saw the highest average number of individual birds per transect run, followed by fall (Fig 3). The Shannon diversity index is much higher for fall than spring (Fig 4), indicating that the individuals seen in the fall were more equitably distributed across species than in spring.

Although species diversity was high in spring and fall and low in summer, the average number of species per transect is about the same for all the seasons (Fig 5). This discrepancy occurred because there was more overlap in species between the transects in the summer than in the spring and fall. When taken together, there are fewer species total on the transects in summer. In contrast, in the spring and fall, there are different species on different transects.

Fitting with the overall pattern, four of the six transects had higher numbers of individuals in the summer than in the fall and spring (Fig 6). Transects 1 through 4 had a higher average number of individuals per year in the summer, but transect 5 had a few more in the fall, and transect 6 had many more in the fall.

The diversity index calculated by transect and season (Fig 7) for the most part reflects the patterns in species number, but transect 3 had especially low diversity in the summer for the number of species recorded there, when compared to other transects in the summer. But the same transect had surprisingly high diversity in the fall in comparison to other transects. The mean number of individuals recorded by transect, season, and species (Figs 8-13) shows that the distribution of individual birds seen on transect 3 in the summer is especially weighted towards one or two species (black-throated sparrow and Scott's oriole), while other species are very low in number. Other

transect seasons are more evenly distributed and thus have a higher diversity. Transect 3 in the fall, in contrast, has a much more even distribution, accounting for the higher diversity.

Two species seen at the wellfields over the years are classified as sensitive by the U.S. Forest Service (USFS; loggerhead shrike and Brewer's sparrow; Table 5). Ten more species seen on the wellfields during surveys are classified as level one or level two in general concern by New Mexico Partners in Flight (NM PIF; Table 5). Another three species are classified by NM PIF as level one or level two in state concern because they are more restricted to New Mexico; thus, we have increased responsibility for these species (NM PIF 2006). Loggerhead shrike and crissal thrasher are on the Birds of Conservation Concern list (USFWS 2002).

Discussion

We detected more individual birds in the summer, but more species were seen in the spring and fall. Birds may be easier to detect in the summer because they are singing and are otherwise more noticeable. Migrating and recently arrived breeding birds probably sing less than breeding birds because they are not defending a breeding territory yet. Or there may actually be more individual birds in the area during the breeding season than during the migration season. A few breeding bird species were detected more frequently in the summer than during migration (e.g., Scott's oriole). All the individuals in the local breeding population of a species may not have arrived at the time of the first survey or they may have been singing less when recently arrived.

Migrants moving through the area overlapped with winter and summer residents during the spring and fall surveys. Most species present in the summer were also detected during spring, fall, or both. Conversely, many other species were detected only in the fall or spring. This caused higher species richness in spring and fall.

Although there were more species in the fall and spring than in the summer, when taken separately, the transects have roughly equal numbers of species between seasons. This is because transects have more of the same species in the summer than in the spring and fall. Breeding birds tend to be the same species on all transects, whereas migrating birds are more patchily distributed in the area. Breeders such as black-throated sparrows,

mourning doves, cactus wrens, and Gambel's quails occur on every transect in the summer, but migrants such as bank swallow and Cassin's kingbird only occurred on a few transects.

Transect 3 was notable because it had high diversity in the fall compared to transect 4, which had about the same number of species, and it also had low diversity in the summer, compared to transects 1, 4, and 5, which also had about the same number of species. This occurred because transect 3 was unusually homogenous. It was one of the few transects to run across the slope, instead of up towards the mountain, thus it has a constant elevation and a fairly constant plant community. This lack of plant diversity could cause the summer bird diversity to be weighted toward a few common breeding species because there is only one breeding habitat. In the fall, individual birds are distributed more evenly across all species than in other transects. Some common birds were less common on transect 3, making the distribution more even, numbers of individuals lower, and the diversity measure higher. For the most part, individual transects had a few very common species in a season.

Transects 2 and 6 had especially high numbers of species consistently in every season. This is probably due to the diversity of habitats at these two sites. Transect 2 starts on the low bajada and goes through four plant community types while it follows an arroyo which widens as it comes close to the mountain. The deep arroyo had species such as canyon towhee, canyon wrens, and migrating warblers, all unusual in the area. Lesser nighthawks and white-throated swifts were also found on this transect because they breed in the rocks and cliffs of the mountains.

Transect 6 sampled many habitats because, while it is in Honey Mesquite Shrublands, it is also adjacent to a residential area and has additional points in the old orchard and salt cedar woodlands. Bullock's orioles bred in the old orchard, and rock doves and band-tailed doves were seen near the residential area. Transect 6 is also fairly wet and supports breeding blue grosbeaks and migrating violet-green and bank swallows, Wilson's warblers, and sage thrashers.

Management Implications

There are several species of conservation concern found on the wellfields. Black-tailed gnatcatchers, classified as vulnerable by NHNM, bred at two of the wellfields. Loggerhead shrike, classified as general concern level two by NM PIF, sensitive by the USFS, and on the Birds of Conservation Concern list, probably bred on the wellfields, given the consistency with which they were seen during the summer surveys. Black-throated sparrow, the most common breeding species at the BWWSA, is classified as general concern level two by NM PIF.

The USFWS Birds of Conservation Concern list was intended to stimulate proactive conservation and was compiled to identify birds that, without additional conservation action, are likely to become candidates for listing under the Endangered Species Act of 1973.

The presence of rare breeding and migrating birds, especially in large numbers such as for black-throated sparrows, makes the BWWSA a very important area for bird conservation. This area needs continued monitoring and thoughtful management for continued support of these important species.

Table 2. Birds seen by species, season, and transect (1 through 6), averaged over years.

Rows for alternate transects are shaded dark and light

Transect	Season	Turkey Vulture	Sharp-shinned Hawk	Cooper's Hawk	Swainson's Hawk	American Kestrel	Scaled Quail	Gambel's Quail	Killdeer	Rock Dove	Band-tailed Pigeon	White-winged Dove	Mourning Dove	Greater Roadrunner	Lesser Nighthawk	White-throated Swift	Black-chinned Hummingbird	Broad-tailed Hummingbird	Ladder-backed Woodpecker	Northern Flicker	Say's Phoebe	Ash-throated Flycatcher	Cassin's Kingbird	Western Kingbird	Loggerhead Shrike
1	spring							1.0				1.0	7.0				3.0	4.0	1.0			1.0			2.0
1	summer						4.5	1.5					6.0		6.0		1.0	1.0	1.0			4.0		4.0	2.5
1	fall												3.0				1.0		2.0				1.0		2.7
2	spring											1.5	3.0	1.0	2.5		1.0	3.0	4.0			4.0		1.0	
2	summer						2.0	5.0					10.7		2.0	1.0						3.3		1.0	1.0
2	fall		1.0																1.7	1.0	1.0				3.3
3	spring							1.0					4.0			2.0	1.0	4.5			2.0	1.0		1.0	
3	summer						1.5	2.5				1.0	5.7	1.0	4.3		1.0	1.0				1.0			
3	fall					2.0		1.5					2.0				1.0		1.0				2.0		1.0
4	spring	1.0			2.0			5.0				1.0	3.5					1.0	2.0			3.0		4.0	
4	summer							1.0					3.0		4.0				1.0			3.0		6.3	1.0
4	fall							4.0				1.0	2.0	1.0			1.0	2.0	1.0				1.0		2.0
5	spring							7.0				2.0	3.0				3.0					2.0		4.0	1.0
5	summer							5.5				1.3	3.0		1.0		1.0	1.0	1.0			1.5		1.0	
5	fall				1.0			2.0		25.0			5.0						1.5						1.0
6	spring							10.0	1.0		5.0	2.5	3.0						1.0						7.5
6	summer	1.0		1.0				16.0				7.7	3.7				2.0	1.0	1.0			1.0		5.7	
6	fall				2.0	1.0		5.7	7.0			7.5	1.0	1.0			3.0		2.0					1.5	3.0

Table 2, continued.

Transect	Season	total	Western Scrub-Jay	American Crow	Chihuahuan Raven	Common Raven	Violet-green Swallow	Bank Swallow	Barn Swallow	Mountain Chickadee	Verdin	Cactus Wren	Rock Wren	Canyon Wren	Bewick's Wren	House Wren	Black-tailed Gnatcatcher	Gray Catbird	Northern Mockingbird	Sage Thrasher	Curve-billed Thrasher	Crissal Thrasher	European Starling	Phainopepla	Virginia's Warbler	Yellow-rumped Warbler	
1	spring	52.0				1.0						3.0	1.5				2.0		3.0								
1	summer	104.0										7.3	3.5		3.0		3.0		3.7		1.0						
1	fall	65.0									1.0	11.0	2.3				2.3				1.0	3.0					3.0
2	spring	79.5									1.0	6.5	2.0		2.0		1.0		8.0								
2	summer	83.8			1.0		1.0				2.0	5.3	1.5	1.0		1.0	4.3		4.3		1.0						
2	fall	75.2	3.0							1.0	2.3	5.3	4.7	2.0	1.0		3.0				3.0						2.0
3	spring	72.0			1.5						4.0	4.0					4.0		7.0								4.0
3	summer	69.3				3.0					1.5	4.3				2.0	1.7		2.0								
3	fall	71.3						1.0			7.0	2.0	3.5		1.0		3.0		1.0		4.0	2.0				1.0	
4	spring	64.5			1.0						3.0	3.0					4.0				2.0						2.0
4	summer	71.2			2.0		1.0				4.0	1.0	1.0		1.0		4.7		1.0			2.0					
4	fall	81.2	1.0								5.0	1.0					10.3				5.0	2.0					
5	spring	68.5									6.0	5.0			3.0		2.0	1.0	3.0								1.0
5	summer	65.5			1.0						4.7	3.7			1.0		2.0		9.0								
5	fall	98.2	1.0		1.0						4.5	2.3			2.0		2.7			3.0	2.5	5.0					2.0
6	spring	76.0	1.0	2.0			1.0				2.0	4.0			5.0		1.0		5.0		1.0	1.0					1.0
6	summer	97.8									4.0	5.0			1.0		4.0		7.0		1.0	1.0	2.0	1.0			1.0
6	fall	139.5	3.3				14.0	8.0	1.0		4.0	6.0			1.0	1.0	2.5		1.0		2.0	3.0					

Table 2, final page.

Transect	Season	total	Townsend's Warbler	MacGillivray's Warbler	Common Yellowthroat	Wilson's Warbler	Western Tanager	Green-tailed Towhee	Canyon Towhee	Chipping Sparrow	Brewer's Sparrow	Black-throated Sparrow	White-crowned Sparrow	Pyrrhuloxia	Black-headed Grosbeak	Blue Grosbeak	Red-winged Blackbird	Western Meadowlark	Great-tailed Grackle	Brown-headed Cowbird	Bullock's Oriole	Scott's Oriole	House Finch	Lesser Goldfinch	House Sparrow	Unidentified Bird
1	spring	52.0									1.5	9.5		1.0								5.0	2.5			2.0
1	summer	104.0								3.0	1.0	13.0		1.7								13.3	19.0			
1	fall	65.0					2.0		2.0	1.5	1.5	8.7				1.0						3.0	12.0			
2	spring	79.5							1.0		4.0	15.0		1.0	2.0						1.0	11.5	2.5			
2	summer	83.8									1.0	9.7		3.0							2.0	8.7	9.5			1.5
2	fall	75.2	1.0	1.0	1.0	1.0	5.0	1.5	5.0		4.0	7.0										4.0	5.7	2.0		1.7
3	spring	72.0									1.0	13.5		2.5							5.0	2.5	5.5			1.0
3	summer	69.3									1.0	16.3		4.0								8.0	5.5			1.0
3	fall	71.3		1.0		1.0	6.0	6.0	3.5	2.0		9.0											5.3			1.5
4	spring	64.5									2.0	14.0		2.5							1.0	1.0	5.0			1.5
4	summer	71.2										12.3		3.7							3.7	6.0	8.5			
4	fall	81.2				7.0	3.0				2.0	9.7				2.0						1.5	14.7	1.0		1.0
5	spring	68.5									4.5	6.0		3.0						3.0	1.0		7.0			1.0
5	summer	65.5										9.0		3.3		4.0		1.0			2.0		4.5			4.0
5	fall	98.2		1.0			2.0	2.5		3.0	3.0	5.0				1.0							13.7	3.0		2.5
6	spring	76.0										2.5	1.0	4.5						2.0		2.0	7.5			2.5
6	summer	97.8			1.0				1.0			4.3		4.0		3.0	2.0				4.0	1.5	6.0	2.0	1.0	1.0
6	fall	139.5				1.0	3.0		1.0	6.0	6.0	1.0		4.0		9.7	6.0				1.0		9.3		4.0	6.0

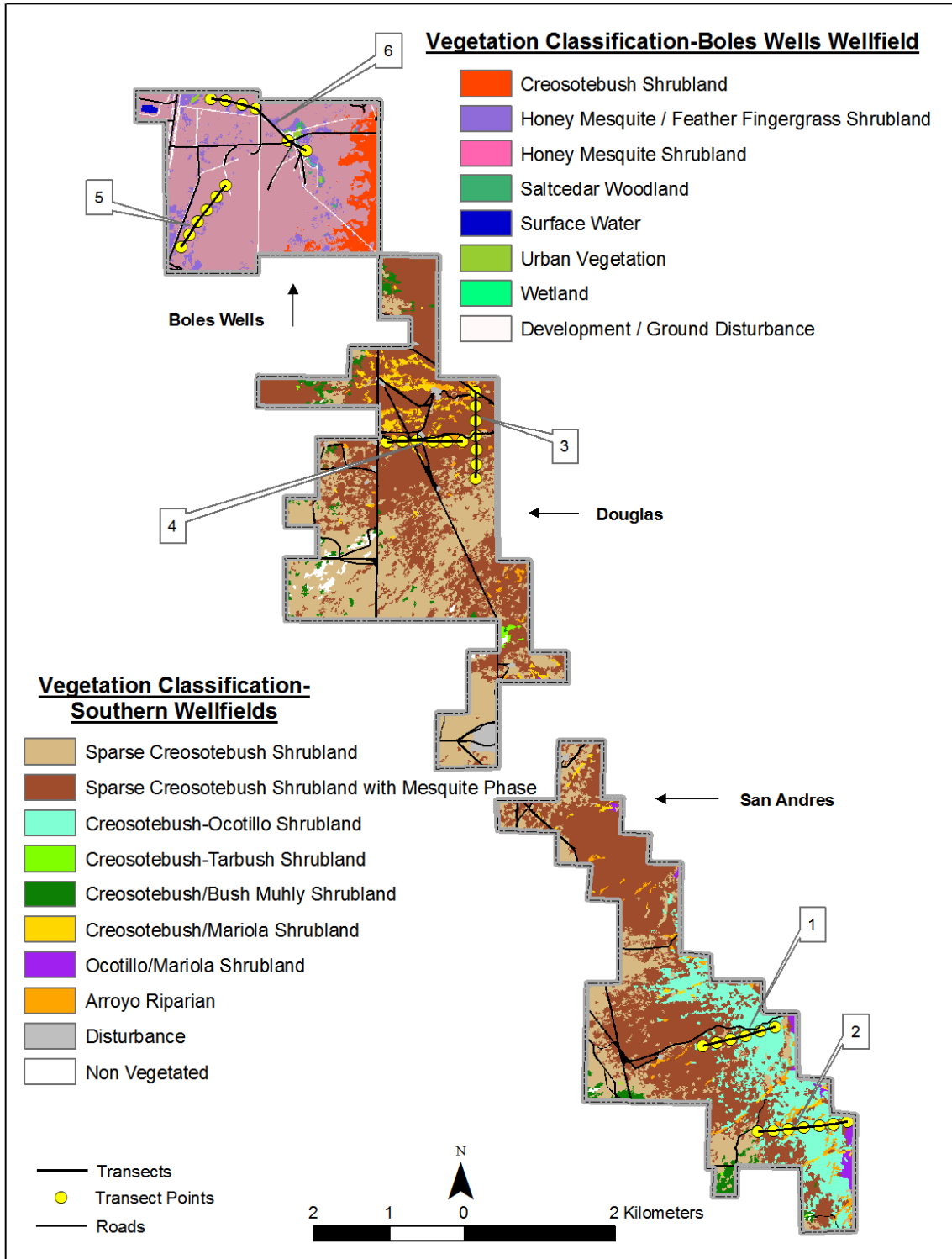


Figure 1. The Boles Wells Water System Annex wellfields showing transects labeled (1- 6) and transect points.

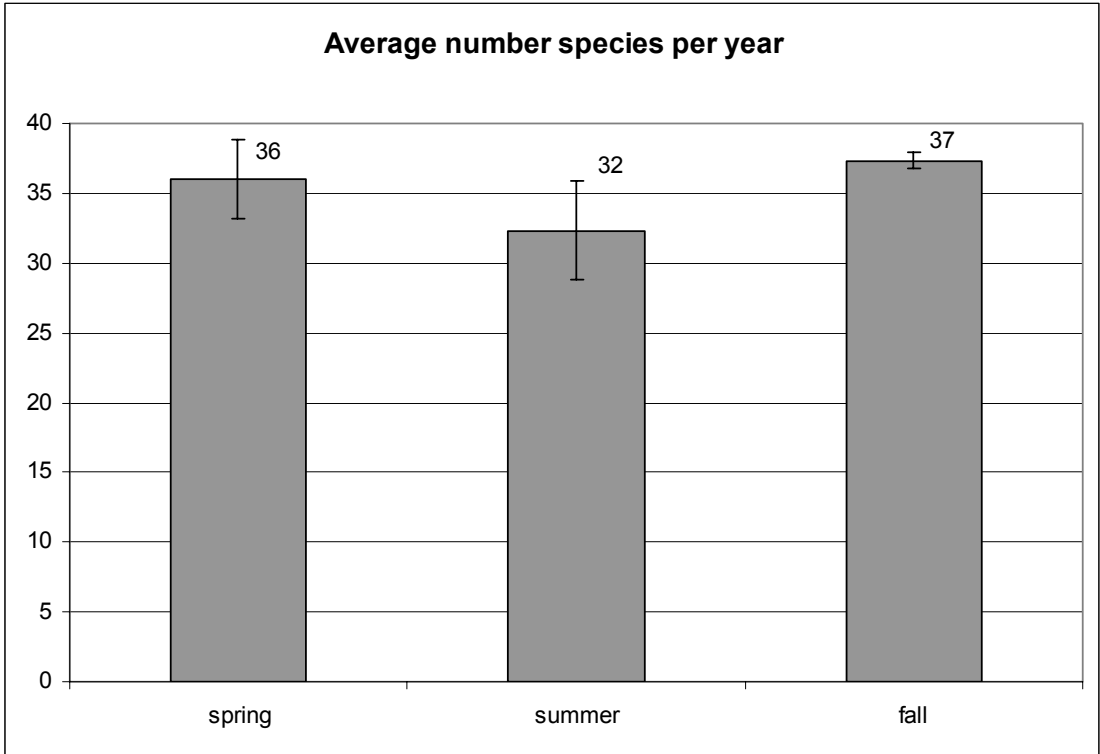


Figure 2. Number of species detected at BWWSA, averaged by year.

Table 3. Average number birds detected over the three years, by species and season.

Common name	Spring	Summer	Fall
American Crow	1	0	0
American Kestrel	0	0	1
Ash-throated Flycatcher	7.5	12	0
Band-tailed Pigeon	2.5	0	0
Bank Swallow	0	0	3
Barn Swallow	0	0	0.3
Bewick's Wren	7.5	3	2.3
Black-chinned Hummingbird	4.5	2.3	3.7
Black-headed Grosbeak	1	0	0
Black-tailed Gnatcatcher	9.5	14	23
Black-throated Sparrow	60.5	65	40
Blue Grosbeak	0	5.7	12
Brewer's Sparrow	9.5	1	8
Broad-tailed Hummingbird	8.5	1.7	0.7
Brown-headed Cowbird	1.5	9	0
Bullock's Oriole	3.5	1	0.3
Cactus Wren	22.5	25	26
Canyon Towhee	1	0.3	6.7
Canyon Wren	0	0.3	0.7
Cassin's Kingbird	0	0	1.3
Chihuahuan Raven	2	1.3	0.3
Chipping Sparrow	0	1	6.7
Common Raven	0.5	1	0
Common Yellowthroat	0	0.3	0.3
Cooper's Hawk	0	0.3	0
Crissal Thrasher	0.5	1	5
Curve-billed Thrasher	1.5	1	7.3
European Starling	0	0.7	0
Gambel's Quail	23	25	8.7
Gray Catbird	0.5	0	0
Greater Roadrunner	0.5	0.3	0.7
Great-tailed Grackle	2.5	0	0
Green-tailed Towhee	0	0	4.7
House Finch	26.5	31	61
House Sparrow	0	0.7	1.3
House Wren	0	1	0.3
Killdeer	0.5	0	2.3
Ladder-backed Woodpecker	4	1.7	7
Lesser Goldfinch	0	0.7	4
Lesser Nighthawk	2.5	17	0
Loggerhead Shrike	1.5	2.3	10
MacGillivray's Warbler	0	0	1
Mountain Chickadee	0	0	0.3
Mourning Dove	23.5	27	4.3
Northern Flicker	0	0	0.3

Common name	Spring	Summer	Fall
Northern Mockingbird	17	26	0.7
Phainopepla	0	0.3	0
Pyrrhuloxia	12	17	1.3
Red-winged Blackbird	0	0.7	2
Rock Dove	0	0	8.3
Rock Wren	2.5	3.7	9.3
Sage Thrasher	0	0	1
Say's Phoebe	1	0	0.3
Scaled Quail	0	4.7	0
Scott's Oriole	19.5	34	6.7
Sharp-shinned Hawk	0	0	0.3
Swainson's Hawk	1	0	1
Townsend's Warbler	0	0	0.3
Turkey Vulture	0.5	0.3	0
Unidentified Bird	6.5	3	11
Verdin	13.5	14	14
Violet-green Swallow	0.5	0.7	9.3
Virginia's Warbler	0	0	0.3
Western Kingbird	13	15	1
Western Meadowlark	0	0.3	0
Western Scrub-Jay	0.5	0	5.3
Western Tanager	0	0	8.7
White-crowned Sparrow	0.5	0	0
White-throated Swift	1	0.3	0
White-winged Dove	6.5	9.3	5.3
Wilson's Warbler	0	0	3.7
Yellow-rumped Warbler	4	0.3	3

Table 4. Total birds detected by species and year.

Common name	2001	2002	2005
Turkey Vulture	1	1	
Sharp-shinned Hawk	1		
Cooper's Hawk			1
Swainson's Hawk	3		2
American Kestrel	1		2
Scaled Quail	2	5	7
Gambel's Quail	34	59	53
Killdeer		1	7
Rock Dove	25		
Band-tailed Pigeon		5	
White-winged Dove	14	14	29
Mourning Dove	30	53	58
Greater Roadrunner	3		1
Lesser Nighthawk	26	17	12
White-throated Swift	1		2
Black-chinned Hummingbird	9	10	8
Broad-tailed Hummingbird		10	14
Ladder-backed Woodpecker	9	10	15
Northern Flicker			1
Say's Phoebe		3	
Ash-throated Flycatcher	11	21	20
Cassin's Kingbird	2		2
Western Kingbird	6	39	30
Loggerhead Shrike	10	11	19
Western Scrub-Jay	5	11	1
American Crow		2	
Chihuahuan Raven	1	2	6
Common Raven	3	1	
Violet-green Swallow	1	20	10
Bank Swallow	1		8
Barn Swallow	1		
Mountain Chickadee		1	
Verdin	20	41	51
Cactus Wren	61	69	68
Rock Wren	5	17	22
Canyon Wren		3	
Bewick's Wren	4	12	15
House Wren	3		1
Black-tailed Gnatcatcher	35	49	47
Gray Catbird			1
Northern Mockingbird	28	34	51
Sage Thrasher		3	
Curve-billed Thrasher		2	26

Common name	2001	2002	2005
Crissal Thrasher	16	3	
European Starling		2	
Phainopepla		1	
Virginia's Warbler	1		
Yellow-rumped Warbler	2	6	10
Townsend's Warbler		1	
MacGillivray's Warbler	2	1	
Common Yellowthroat		2	
Wilson's Warbler	1	8	2
Western Tanager		23	3
Green-tailed Towhee	10	2	2
Canyon Towhee	5	8	10
Chipping Sparrow	16	4	3
Brewer's Sparrow	3	18	25
Black-throated Sparrow	107	166	161
White-crowned Sparrow		1	
Pyrrhuloxia	18	36	25
Black-headed Grosbeak			2
Blue Grosbeak	18	19	16
Red-winged Blackbird	2	6	
Western Meadowlark	1		
Great-tailed Grackle		2	3
Brown-headed Cowbird	6	15	9
Bullock's Oriole	2	7	2
Scott's Oriole	42	73	46
House Finch	100	126	102
Lesser Goldfinch	4	2	8
House Sparrow	1	1	4
Unidentified Bird	7	24	23

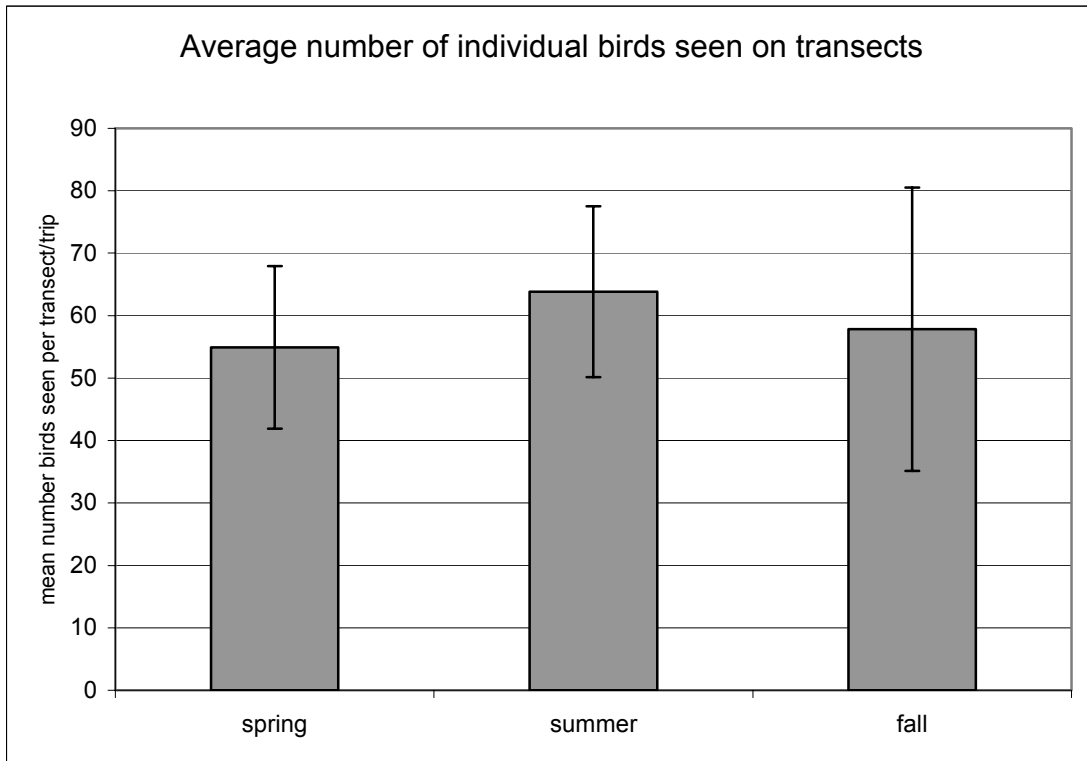


Figure 3. Average number of individual birds seen per transect run.

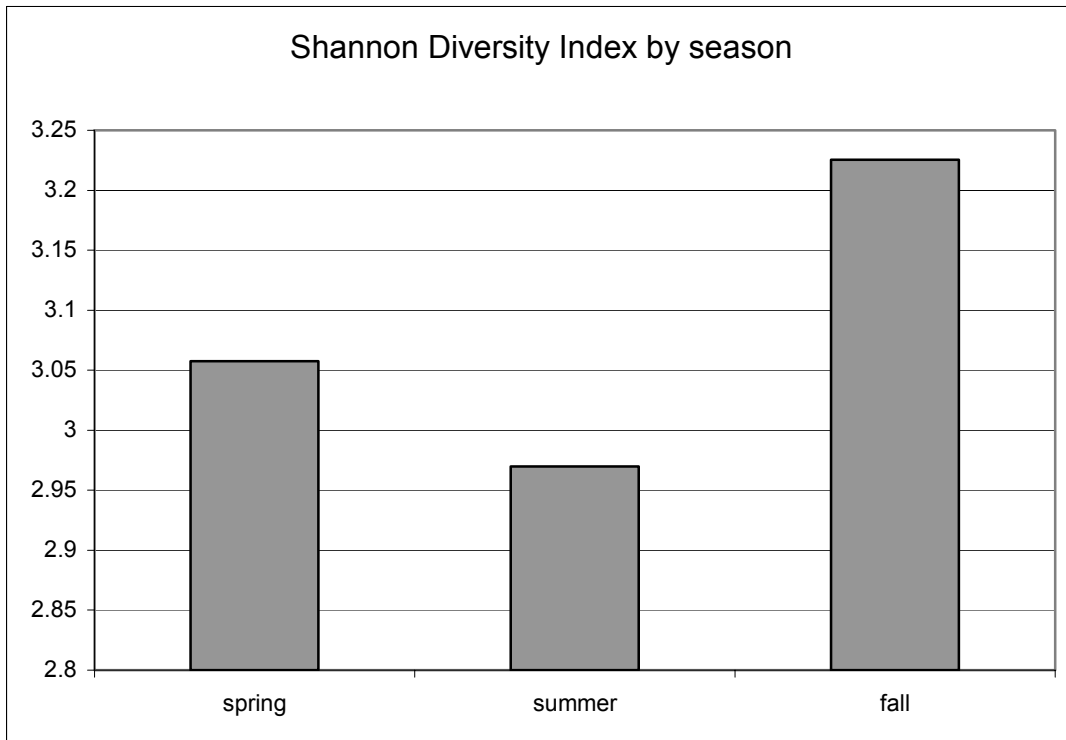


Figure 4. Shannon diversity index calculated by season (all transects and years taken together).

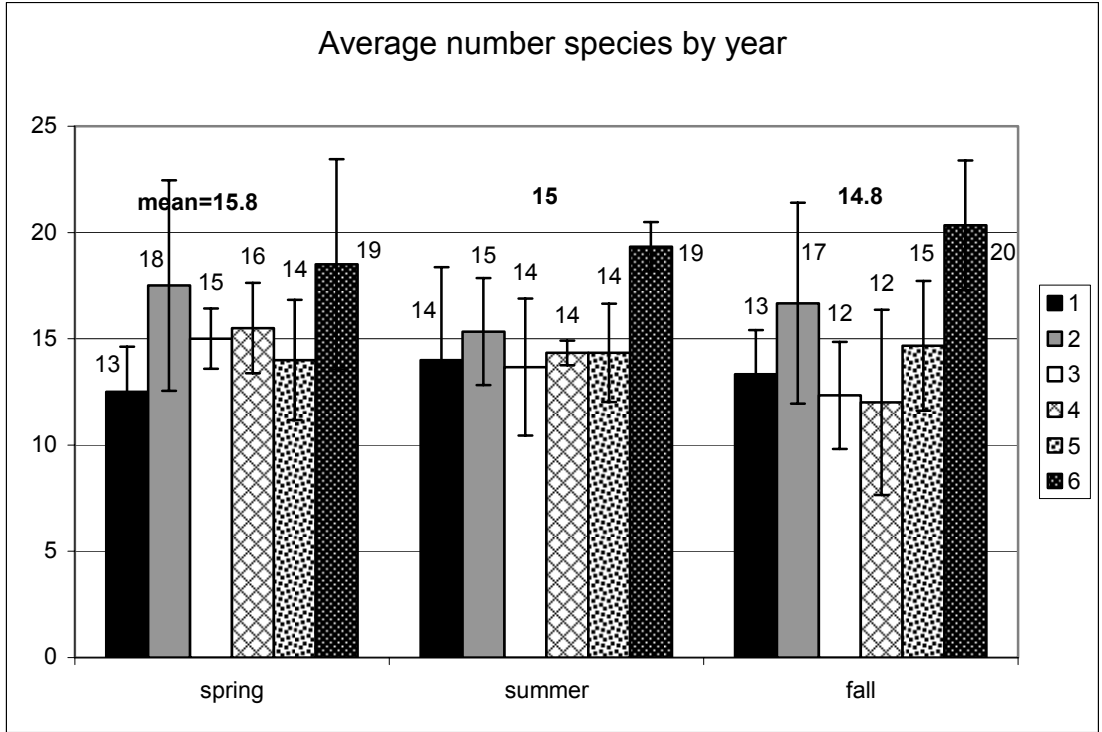


Figure 5. Number of species seen on each transect averaged over years. Numbers in bold are the mean number of species on a transect in that season.

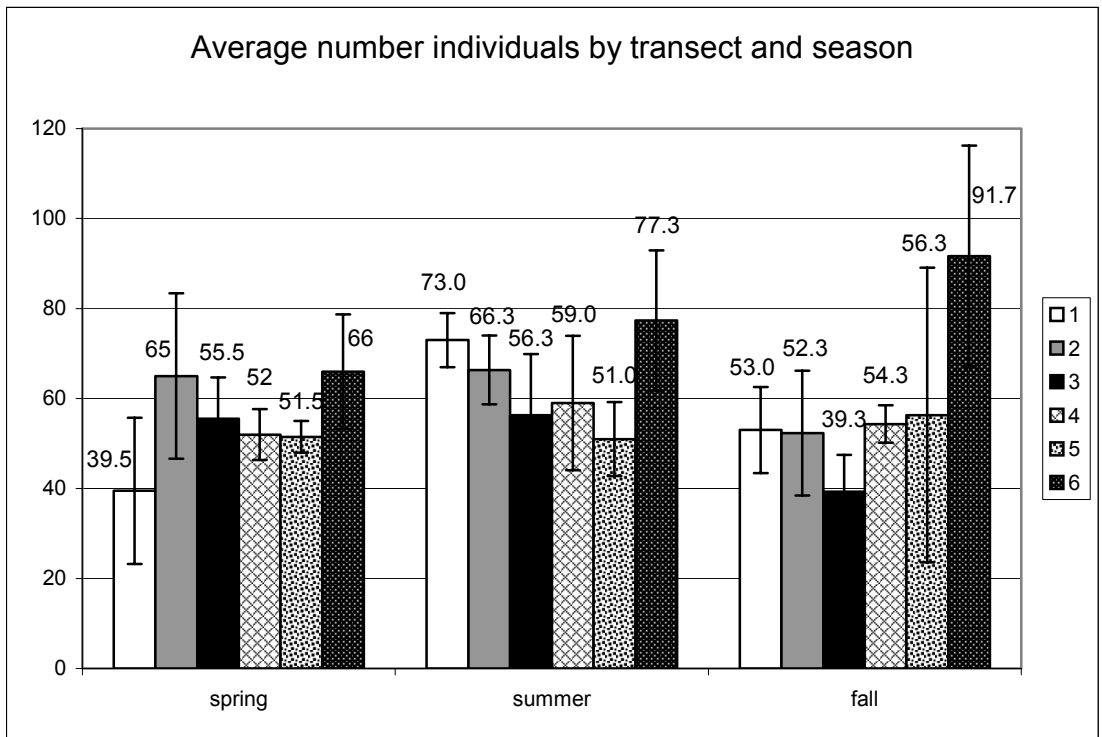


Figure 6. Average number of individuals for each transect and season, averaged over years.

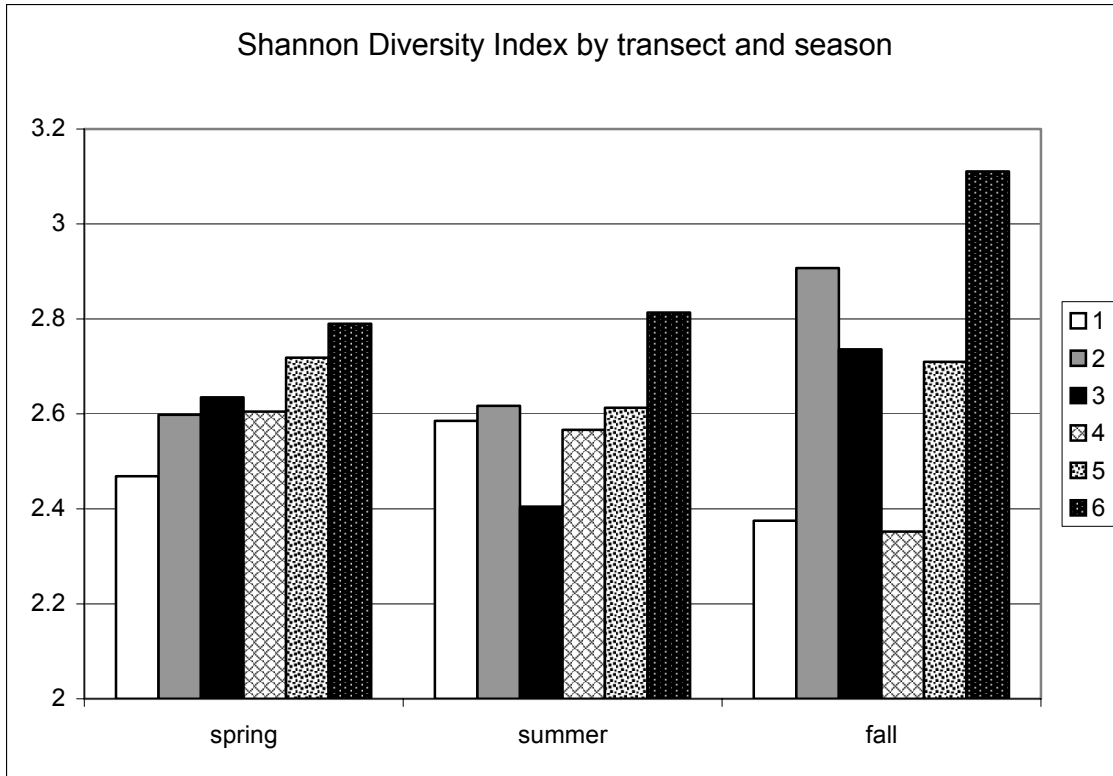


Figure 7. Shannon diversity index calculated for all species and individuals recorded on a transect, by season, all years taken together.

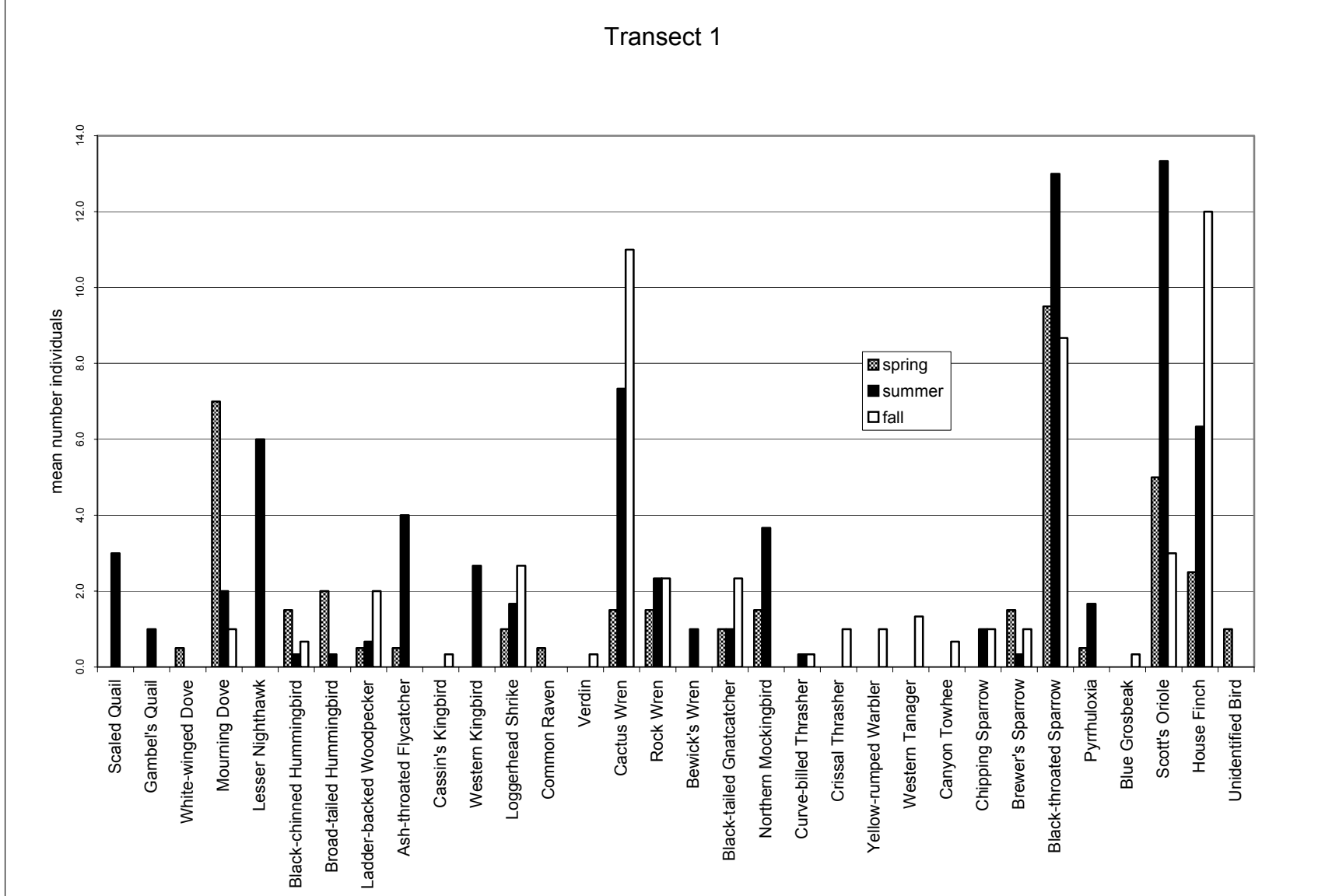


Figure 8. Mean number of individuals per year by species and season for transect 1.

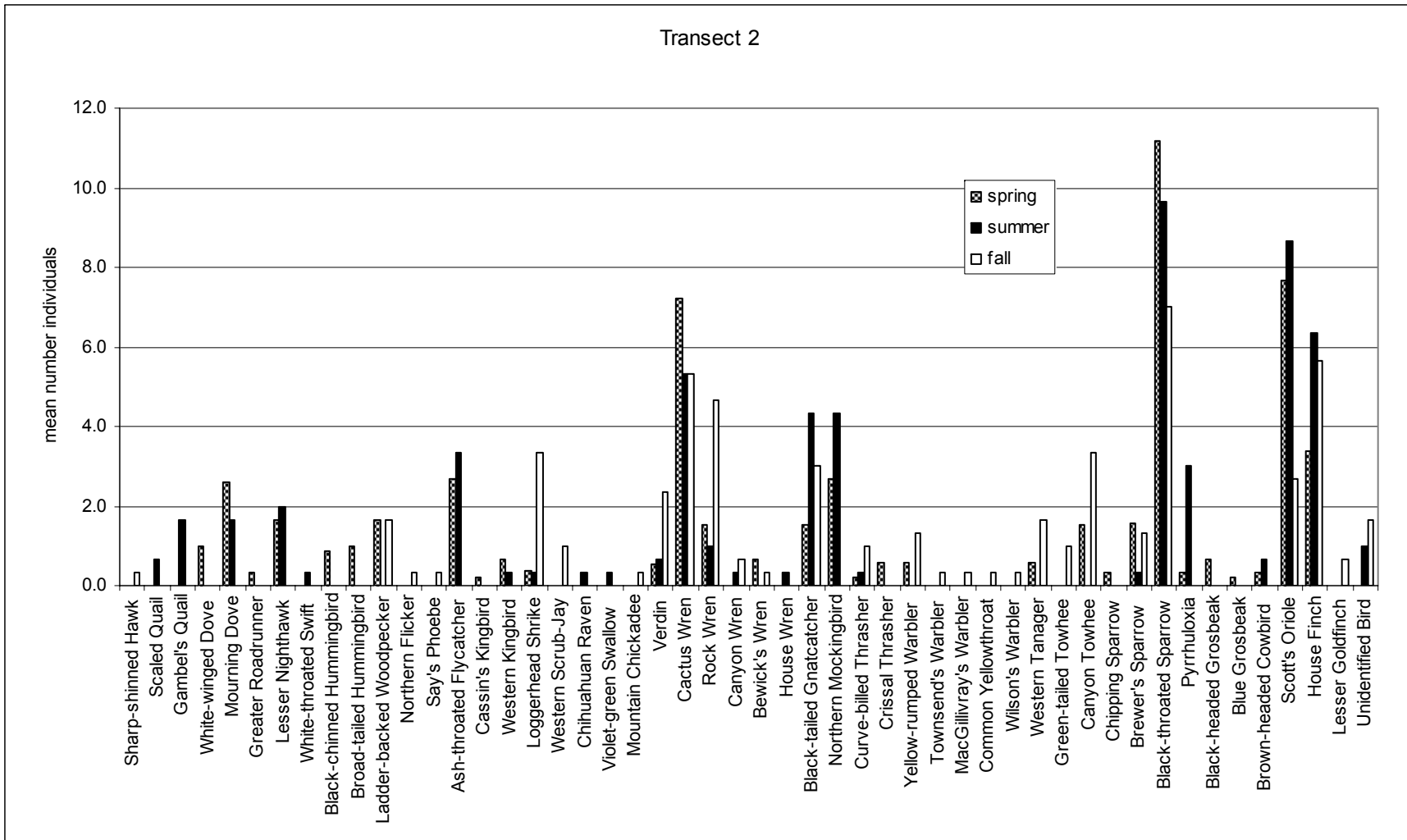


Figure 9. Mean number of individuals per year by species and season for transect 2.

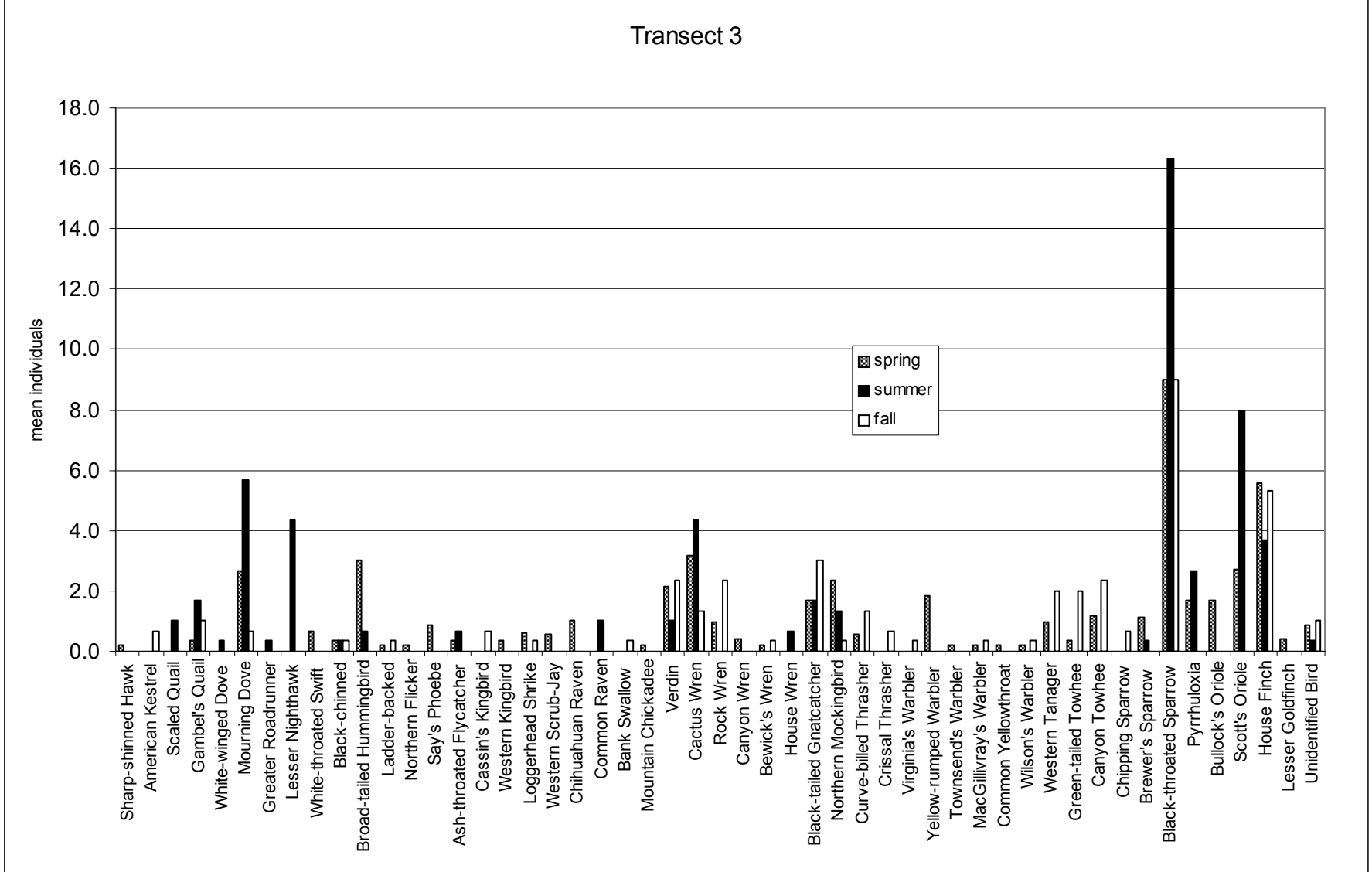


Figure 10. Mean number of individuals per year by species and season for transect 3.

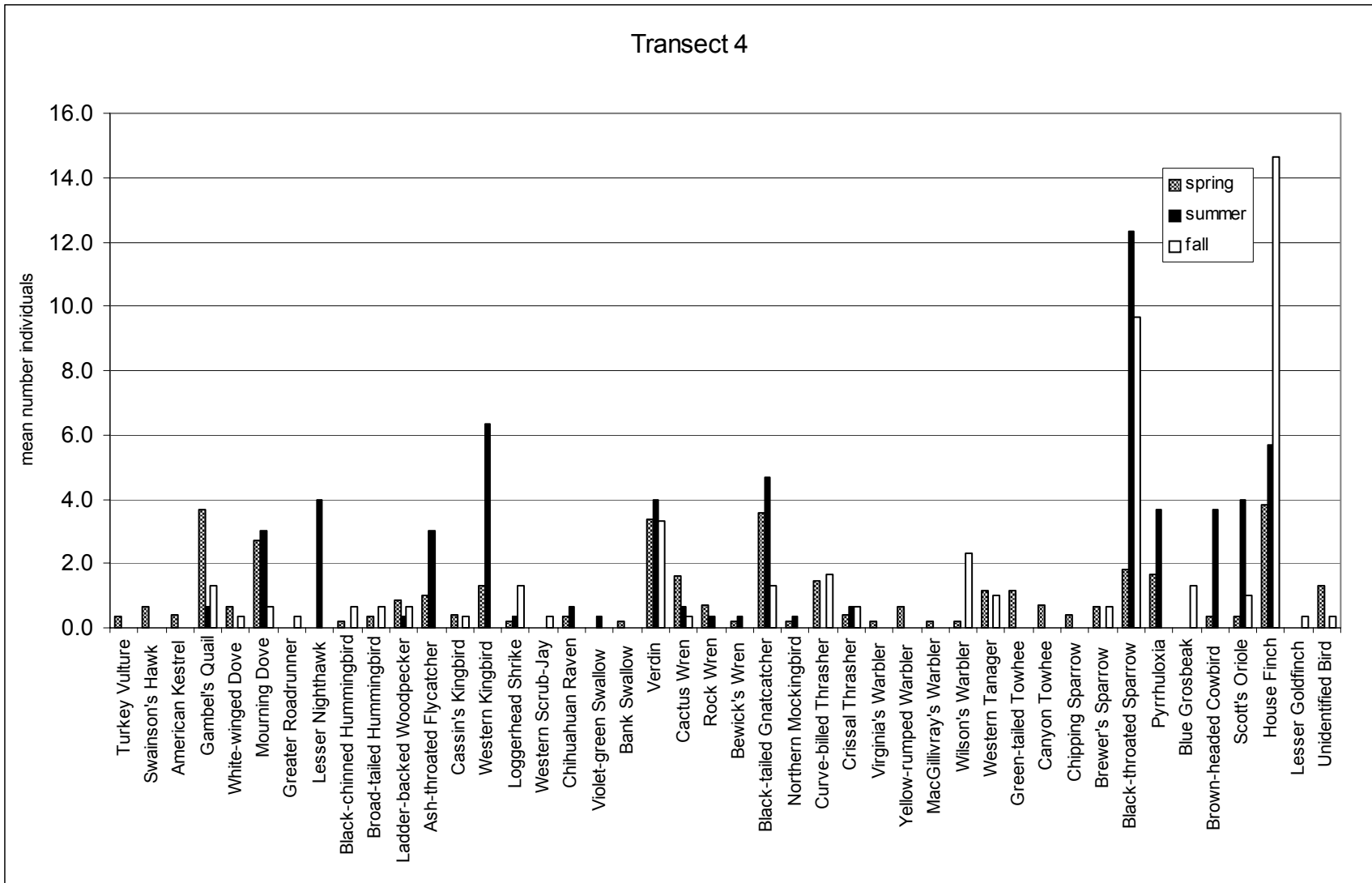


Figure 11. Mean number of individuals per year by species and season for transect 4.

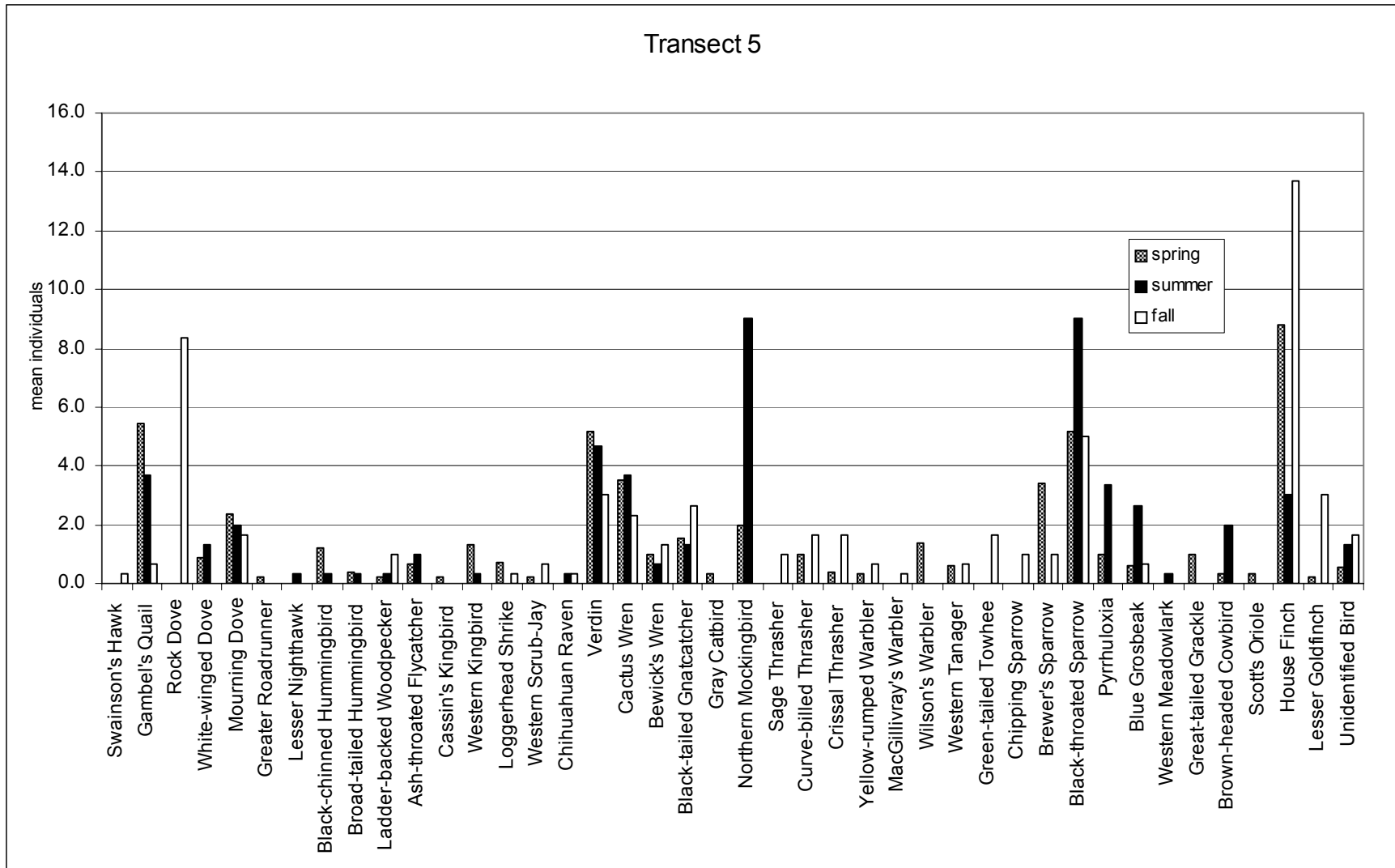


Figure 12. Mean number of individuals per year by species and season for transect 5.

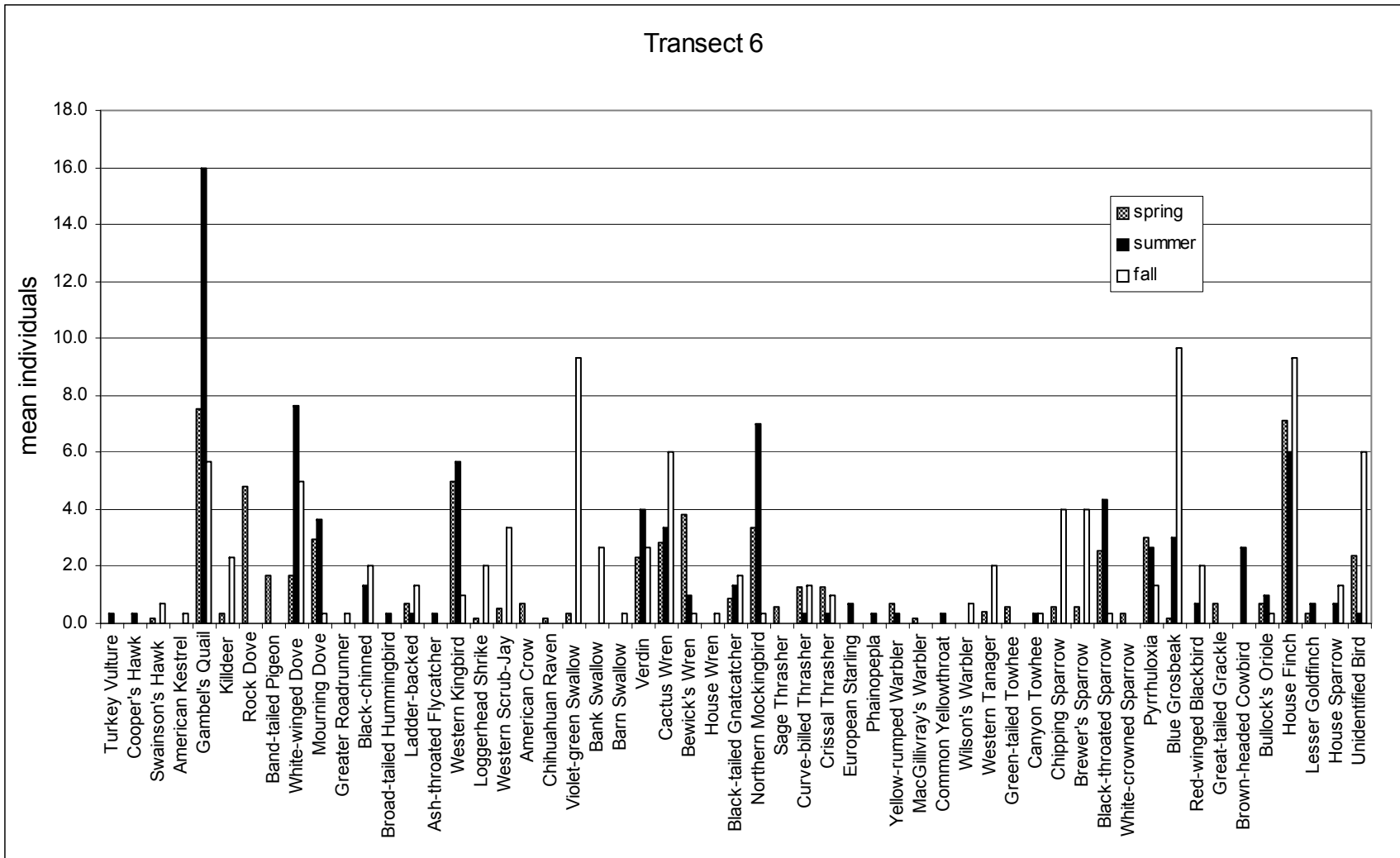


Figure 13. Mean number of individuals per year by species and season for transect 6.

Table 5. A list of all the species seen at the wellfields during surveys with their New Mexico Partners in Flight status, Heritage ranks, USFS status, Birds of Conservation Concern list (USFWS 2002), and if/where evidence of breeding was seen.

Common name	NM PIF status	Heritage state rank	USFS status	breeding	BCC USFWS	breeding location
Turkey Vulture		S5B,S5N				
Sharp-shinned Hawk		S4B,S4N				
Cooper's Hawk		S4B,S4N		yes		BW
Swainson's Hawk	general concern, level two	S4B,S4N		yes		BW
American Kestrel		S5B,S5N				
Scaled Quail	general concern, level two	S3B,S4N				
Gambel's Quail		S5B,S5N		yes		BW
Killdeer		S4B,S5N				
Rock Dove		SNA				
Band-tailed Pigeon	general concern, level two	S3B,S4N				
White-winged Dove		S5B,S5N				
Mourning Dove		S5B,S5N				
Greater Roadrunner		S5B,S5N				
Lesser Nighthawk		S5B,S5N				
White-throated Swift	general concern, level two	S3B,S4N				
Black-chinned Hummingbird		S4B,S4N		yes		BW
Broad-tailed Hummingbird		S4B,S4N				
Ladder-backed Woodpecker		S5B,S5N				
Northern Flicker		S5B,S5N				
Say's Phoebe		S4B,S4N				
Ash-throated Flycatcher		S5B,S5N				
Cassin's Kingbird		S5B,S5N				
Western Kingbird		S5B,S5N		yes		DW
Loggerhead Shrike	general concern, level two	S3B,S4N	sensitive		yes	
Western Scrub-Jay	general concern, level two	S5B,S5N				
American Crow		S5B,S5N				
Chihuahuan Raven		S4B,S5N				
Common Raven		S5B,S5N				
Violet-green Swallow		S3B,S4N				
Bank Swallow	state concern, level one	S2B,S5N				
Barn Swallow		S5B,S5N				
Mountain Chickadee		S5B,S5N				
Verdin		S4B,S4N				
Cactus Wren		S5B,S5N		yes		SW
Rock Wren		S5B,S5N				
Canyon Wren		S5B,S5N				
Bewick's Wren		S4B,S4N				
House Wren		S5B,S5N				
Black-tailed Gnatcatcher		S3B,S3N		yes		DW
Gray Catbird		S3B,S4N				
Northern Mockingbird		S5B,S5N		yes		BW
Sage Thrasher	state concern, level two	S3B,S4N				

Common name	NM PIF status	Heritage state rank	USFS status	breeding	BCC USFWS	breeding location
Curve-billed Thrasher		S5B,S5N				
Crissal Thrasher	general concern, level two	S4B,S4N			yes	
European Starling		SNA				
Phainopepla		S4B,S4N				
Virginia's Warbler	general concern, level one	S3B,S4N				
Yellow-rumped Warbler		S5B,S5N				
Townsend's Warbler		S4N				
MacGillivray's Warbler		S5B,S5N				
Common Yellowthroat		S4B,S4N				
Wilson's Warbler	state concern, level two	S2B,S5N				
Western Tanager		S4B,S4N				
Green-tailed Towhee		S3B,S4N				
Canyon Towhee		S5B,S5N				
Chipping Sparrow		S4B,S5N				
Brewer's Sparrow		S3B,S4N	sensitive			
Black-throated Sparrow	general concern, level two	S5B,S5N		yes		DW, SW
White-crowned Sparrow		S5B,S5N				
Pyrrhuloxia		S5B,S5N				
Black-headed Grosbeak		S5B,S5N				
Blue Grosbeak		S5B,S5N		yes		BW
Red-winged Blackbird		S5B,S5N				
Western Meadowlark		S5B,S5N				
Great-tailed Grackle		S5B,S5N				
Brown-headed Cowbird		S5B,S5N				
Bullock's Oriole	general concern, level two	S4B,S5N		yes		BW
Scott's Oriole		S4B,S5N		yes		SW
House Finch		S5B,S5N				
Lesser Goldfinch		S4B,S4N				
House Sparrow		SNA				

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Appendix 1. Common and Scientific names of all birds detected during surveys, BWWSA

Common Name	Scientific Name
Turkey Vulture	<i>Cathartes aura</i>
Sharp-shinned Hawk	<i>Accipiter striatus</i>
Cooper's Hawk	<i>Accipiter cooperii</i>
Swainson's Hawk	<i>Buteo swainsoni</i>
American Kestrel	<i>Falco sparverius</i>
Scaled Quail	<i>Callipepla squamata</i>
Gambel's Quail	<i>Callipepla gambelii</i>
Killdeer	<i>Charadrius vociferus</i>
Rock Dove	<i>Columba livia</i>
Band-tailed Pigeon	<i>Columba fasciata</i>
White-winged Dove	<i>Zenaida asiatica</i>
Mourning Dove	<i>Zenaida macroura</i>
Greater Roadrunner	<i>Geococcyx californianus</i>
Lesser Nighthawk	<i>Chordeiles acutipennis</i>
White-throated Swift	<i>Aeronautes saxatalis</i>
Black-chinned Hummingbird	<i>Archilochus alexandri</i>
Broad-tailed Hummingbird	<i>Selasphorus platycercus</i>
Ladder-backed Woodpecker	<i>Picoides scalaris</i>
Northern Flicker	<i>Colaptes auratus</i>
Say's Phoebe	<i>Sayornis saya</i>
Ash-throated Flycatcher	<i>Myiarchus cinerascens</i>
Cassin's Kingbird	<i>Tyrannus vociferans</i>
Western Kingbird	<i>Tyrannus verticalis</i>
Loggerhead Shrike	<i>Lanius ludovicianus</i>
Western Scrub-Jay	<i>Aphelocoma californica</i>
American Crow	<i>Corvus brachyrhynchos</i>
Chihuahuan Raven	<i>Corvus cryptoleucus</i>
Common Raven	<i>Corvus corax</i>
Violet-green Swallow	<i>Tachycineta thalassina</i>
Bank Swallow	<i>Riparia riparia</i>
Barn Swallow	<i>Hirundo rustica</i>
Mountain Chickadee	<i>Poecile gambeli</i>
Verdin	<i>Auriparus flaviceps</i>
Cactus Wren	<i>Campylorhynchus brunneicapillus</i>
Rock Wren	<i>Salpinctes obsoletus</i>
Canyon Wren	<i>Catherpes mexicanus</i>
Bewick's Wren	<i>Thryomanes bewickii</i>
House Wren	<i>Troglodytes aedon</i>
Black-tailed Gnatcatcher	<i>Poliophtila melanura</i>
Gray Catbird	<i>Dumetella carolinensis</i>
Northern Mockingbird	<i>Mimus polyglottos</i>
Sage Thrasher	<i>Oreoscoptes montanus</i>
Curve-billed Thrasher	<i>Toxostoma curvirostre</i>
Crissal Thrasher	<i>Toxostoma crissale</i>
European Starling	<i>Sturnus vulgaris</i>
Phainopepla	<i>Phainopepla nitens</i>
Virginia's Warbler	<i>Vermivora virginiae</i>
Yellow-rumped Warbler	<i>Dendroica coronata</i>

Townsend's Warbler	<i>Dendroica townsendi</i>
MacGillivray's Warbler	<i>Oporornis tolmiei</i>
Common Yellowthroat	<i>Geothlypis trichas</i>
Wilson's Warbler	<i>Wilsonia pusilla</i>
Western Tanager	<i>Piranga ludoviciana</i>
Green-tailed Towhee	<i>Pipilo chlorurus</i>
Canyon Towhee	<i>Pipilo fuscus</i>
Chipping Sparrow	<i>Spizella passerina</i>
Brewer's Sparrow	<i>Spizella breweri</i>
Black-throated Sparrow	<i>Amphispiza bilineata</i>
White-crowned Sparrow	<i>Zonotrichia leucophrys</i>
Pyrrhuloxia	<i>Cardinalis sinuatus</i>
Black-headed Grosbeak	<i>Pheucticus melanocephalus</i>
Blue Grosbeak	<i>Guiraca caerulea</i>
Red-winged Blackbird	<i>Agelaius phoeniceus</i>
Western Meadowlark	<i>Sturnella neglecta</i>
Great-tailed Grackle	<i>Quiscalus mexicanus</i>
Brown-headed Cowbird	<i>Molothrus ater</i>
Bullock's Oriole	<i>Icterus bullockii</i>