

FINAL REPORT

DATE: 28 October 1998

PROJECT TITLE: Breeding Birds of the Restricted Pine-Juniper-Shrub Habitat in Southwestern South Dakota.

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The stated objectives of this project as provided in the contract were to:

1. Document diversity, species richness, and relative abundance of component bird species in the limited pine-juniper-shrub habitat in southwestern South Dakota using line transect and mist net sampling techniques.
2. Document nesting in Virginia's Warblers and other South Dakota Natural Heritage species, as well as other potential pine-juniper-shrub nesting species that are currently unrecorded during the breeding season in South Dakota.
3. Categorize the specific vegetative requirements for nesting of the species mentioned in Objective Two and compare characteristics of successful vs. unsuccessful nests and nest sites vs. non-nest sites.

INTRODUCTION

Pine-juniper habitat with a mahogany-sumac shrub understory is restricted in South Dakota to small areas of the southern Black Hills in Custer and Fall River counties (Great Plains Flora Association 1977, Peterson 1993, Van Bruggen 1996). These habitats in South Dakota exist on rocky hillsides and canyon breaks and contain Ponderosa Pine (*Pinus ponderosa*) and Rocky Mountain Juniper (*Juniperus scopulorum*) as dominant overstory species with a shrubby understory of Skunkbush Sumac (*Rhus aromatica*) and Mountain Mahogany (*Cercocarpus montanus*) (Great Plains Flora Association 1986, Van Bruggen 1996). The elevations where this habitat is found in the southwestern Black Hills ranges from about 4,500 to 5,500 feet. The region of the Black Hills where this habitat is located is relatively remote and has received very little ornithological investigation. The purpose of this study was to carefully document the breeding avifauna of the isolated and restricted pine-juniper-shrub habitat in the southwestern Black Hills of South Dakota concentrating on Virginia's Warblers and other Neotropical migrant species.

Census Data

Fairly open habitats, such as the pine-juniper-shrub habitat in this study, are well suited for line-transect census methods (Bibby et al. 1992). We established 10 one-kilometer line transects through appropriate habitat in Roby, Boles, and Redbird canyons in Custer County, South Dakota where this habitat type is prevalent (Fig. 1). Contiguous transects were separated by at least 200 m. Five of the transects were located in Boles canyon or side canyons/draws off of Boles canyon. The "Boles Upper" and "Boles Low" were located along the edge of the east slope of the canyon rim and the canyon bottom of Boles canyon beginning at the Forest Service boundary. The Jeep transects (1 and 2) followed an old four-wheel-drive trail that branched off of Boles canyon and continued up the canyon rim northwest toward Fanny Peak. A portion of these transects ran along the east edge of the canyon rim of Whoopup Creek canyon, just to the east of Boles Canyon. The final transect in this group was the Turkey Trail transect which followed a four-wheel-drive trail up a draw on the west side of Boles Canyon. The slopes

adjacent to the canyon bottoms had numerous pines and junipers, but these became scarce on top of the canyon rim. This latter area was dominated by shrub cover composed of skunkbush sumac and mountain mahogany. Three transects were established in Redbird canyon or side canyons. These included Redbird 1 and 2 and the Coyote Trail transect. The Redbird transects were located along the edge of the north slope of the canyon rim and the canyon bottom of Redbird canyon beginning at the Forest Service boundary. The Redbird 2 transect crossed the canyon bottom at 300 m (where private property began) and continued along the southern edge of the canyon until a large side canyon was encountered, upon which the transect proceeded up the side canyon. The Coyote Trail transect was entirely located within this side canyon. We ran the Redbird 2 transect for the first three weeks of the study period and replaced it with the Coyote Trail transect for the final four weeks of the study. The two Roby canyon transects were located entirely within the canyon bottom beginning where the canyon mouth opens into Boles canyon.

Transects were separated by at least 300 meters to avoid double-counting of birds (Bibby et al. 1992). Line transects were conducted according to Emlen (1971, 1977). In this method, individual observers walked slowly (1 km/hour) along the transect and recorded all individuals detected by sight or sound and whether they were inside or outside of a 25 m band on either side of the transect. This distance provides good detectability in open woodland habitat, even for soft-voiced species (Emlen 1977). Distance was measured with Ranging Model 620 rangefinders. Three transects were conducted simultaneously by different observers familiar with birds of the area and transect counts were complete between sunup and 1100 MDT. Each transect was censused once weekly throughout the seven-week study period, except for the Redbird 2 and Coyote Trail transects as described above. The initial census period began on 26 May and the final census period ended on 8 July. This coverage effort (i.e., number of transects and number of replicates) is sufficient to detect most species breeding in an area of open woodland (Bibby et al. 1992). The direction in which observers conducted transect counts was reversed on consecutive counts and observers were systematically rotated among the different transect lines to reduce observer bias. Transect counts were not conducted on days with precipitation or high winds.

Abundance for all birds and for individual species were calculated from all detections (sight and sound) according to Emlen (1977) for birds inside 25 m to estimate density (birds km^{-2}), and for all detections (inside and outside 25 m) to calculate relative abundances (birds/transect). Averages for species abundances for each transect were calculated from all replicate censuses.

A total of 53 species was observed on transect counts. Density calculations and Relative Abundance calculations were generally in agreement for most species, with the exception of species that were easily detectable over fairly great distances (e.g., Mourning Dove, White-throated Swift, Violet-green Swallow, Western Meadowlark). Chipping Sparrows were the most abundant species in this habitat, followed by Spotted Towhees and Dusky Flycatchers (Table 1). This is consistent with BBS data which suggest that Chipping Sparrows may be more abundant in the Black Hills than anywhere else in North America (Peterson 1993). Abundance estimates or temporal trends in abundance for several other species were noteworthy. Red Crossbills and Pine Siskins showed increases in abundance from no observations during the initial week of censusing to fairly high numbers during the latter part of the study period (Table 1). Both of these species are irruptive migrants that breed in the Black Hills (Peterson 1995) so perhaps the increasing abundances represent movement of adults and juveniles into this habitat following breeding. Chipping Sparrows and Spotted Towhees also exhibited a trend of increasing abundance over the study period, although not to the same degree as the irruptive species. These increases likely resulted from the recruitment of juveniles into the population during the latter part of the study period. Brown-headed Cowbirds were common in this habitat, ranking fifth in relative abundance and seventh in density (Table 1). This suggests that brood parasitism is a potential problem for host species breeding in this habitat. Virginia's Warblers, which were undocumented in South Dakota prior to 1997 (Martin 1997), were the ninth most common species in this habitat,

both by density and relative abundance calculations (Table 1). The relatively large population of Virginia's Warblers present suggests that this is not a new population, but a population that has been overlooked in the past. This population of Virginia's Warblers is the northeasternmost breeding population of this species, and extends the known breeding range by over 200 km. Two species, Gray Jay and Ovenbird, were located more commonly in this habitat than we expected. Gray Jays are usually associated with coniferous and mixed woodlands at higher elevations in the Black Hills (Peterson 1995), but they were regular in areas with stands of ponderosa pine in this location as well. Ovenbirds were found commonly near the bottoms of draws where the pine overstory was essentially complete. Previous reports indicate that Ovenbirds utilize old growth ponderosa pine and aspen stands in the Black Hills and prefer a multi-layered canopy (reviewed in Peterson 1995).

Relative abundances for individual transects ranged from 39.7 birds/transect on Redbird 2 to 86.14 birds/transect on Redbird 1 (Table 2). The overall average abundance for all 10 transects was 56.9 ± 12.8 birds/transect. Virginia's Warblers were detected on all transects and relative abundance for this species ranged from 0.57-3.14 birds/transect (Fig. 2). The overall relative abundance for all birds increased over the study period from 43.7 birds/transect in the last week of May to 68.2 birds/transect in the second week of July (Table 3). Least squares regression indicated that this increase in abundance with duration of the study period was a significant positive relationship ($R^2 = 0.87$, $P = 0.002$) best described as $\text{Relative Abundance} = 39.3 + 4.53(\text{Week of Study Period})$. The increase in abundance over the study period probably involves both the recruitment of juveniles into populations and the appearance of irruptive species (e.g., Red Crossbill, Pine Siskin) in this habitat (Table 3).

Mist Net Data

We erected mist nets (2.6 X 9 m, 30 mm mesh) five days per week from 25 May-6 July in pine-juniper-shrub habitat in Roby, Boles, and Redbird canyons. Generally, 6 nets were opened from 0630 to 1030 MDT, although in a few cases 2-4 or 7 nets were opened. On a very few occasions nets were also opened in the evening from 1830-2130 MDT. Net sites were located in areas where we had previously observed Virginia's Warblers and new locations were netted every day with the exception of one site that was visited twice. Audio tapes of Virginia's Warbler songs were played at each location to lure Virginia's Warblers to the nets and the tape player was rotated among nets for at least one hour per day at each net location. Eastern Screech-Owl (*Otus asio*) audio tapes were also used to attract birds to mist nets but proved largely ineffective, so their use was abandoned later in the season.

A total of 584.33 net hours was generated over the study period and a total of 180 individuals of 21 species was captured. This provided an overall capture rate of 30.8 birds/100 net hours. Chipping Sparrows were the most abundant species captured (Table 4). We captured and banded 27 Virginia's Warblers, 22 of which were males, and all of which were adults. Dusky Flycatchers were the third most commonly captured species (Table 4). Two species, Red-eyed Vireo and American Redstart, were captured but not detected on transects. Both of these species were represented by single captures.

The male Virginia's Warblers that we captured all had well-developed cloacal protuberances and the females had well-developed brood patches or eggs present in the reproductive tract. This physiological evidence indicates that Virginia's Warblers were breeding in this general habitat. We recorded mass, morphometrics, and fat score (on a scale of 0-5, Helms and Drury 1960) for all Virginia's Warblers captured. Mean mass was 8.4 ± 0.3 g ($n = 22$) for males and 8.9 ± 1.1 g ($n = 5$) for females. Unflattened wing chord was 61.6 ± 2.6 mm ($n = 21$) in males and 56.8 ± 1.6 mm in females. Tail length, measured from the base of the uropygial gland, was 50.3 ± 1.9 mm in males and 47.4 ± 1.0 mm in females. Furcular fat scores averaged 0.3 ± 0.5 in males and 0.8 ± 0.8 in females, while mean abdominal fat scores were 0.1 ± 0.4 in males

and 0.6 ± 0.9 in females. The values for wing chord were consistent with those listed for male and female Virginia's Warblers by Pyle (1997). Mean values for tail length in this population were at the upper end of the range reported by Pyle (1997) for both males and females, but different methods were used for measuring the tail length in our study.

Combined Census and Mist Net Data

A total of 55 species was detected by line transect censuses or mist net capture. Of these 55 species, 26 can be classified as Neotropical migrants with a substantial proportion of the total population wintering south of the United States border (AOU 1983). This yields 49.1% Neotropical migrants in the breeding-season avifauna of the pine-juniper-shrub habitat. This percentage is similar to that for riparian deciduous forests in southeastern South Dakota (50-53%, Liknes et al. 1994) and for woody draws in western North Dakota (49%, Faanes 1984), but lower than typical percentages (65-85%) of Neotropical migrant species in eastern deciduous forests or western montane or intermontane riparian forests (Morse 1980, Dobkin and Wilcox 1986, Terborgh 1989, Freemark and Collins 1992).

Census and mist net data were in general agreement regarding relative abundance of individual species. Chipping Sparrows were by far the most common species detected by either method (Tables 1 and 4). Several species had relatively high relative abundances by census methods but were not captured in high numbers. These included Red Crossbill, Brown-headed Cowbird, Violet-green Swallow, Pine Siskin, White-throated Swift, and Mourning Dove. These species probably avoided capture for a variety of reasons including remaining relatively high in pine trees, feeding on the wing in open areas, or generally avoiding the low shrubby areas where our capture effort was concentrated.

Nest Data

Nest searches were conducted in pine-juniper-shrub habitat according to Martin and Guepel (1993). Searches were usually focused in areas where singing male Virginia's Warblers were present because this species had not been previously documented as nesting in South Dakota, although data from nests of all bird species that we located were recorded. Nest data recorded included location, nest status (e.g., building, eggs present, nestlings present, vacant), nest substrate (e.g., tree species, ground), vegetation type in the immediate nest area, and height of the nest above the ground. Too few nests were found for individual bird species to adequately assess vegetative characteristics of the nests for each bird species, so we did not undertake intensive vegetative analyses of the nest area. We checked nests every 3-4 days to determine nest fate (successful or unsuccessful). For elevated nests we used mirrors attached to telescoping poles to view nest contents. Nests that fledged at least one nestling were considered successful. Fledging was determined by direct observation of fledgling birds in the immediate nest area. If direct observation of fledglings was not possible, nests that contained nestlings on the last check prior to the expected fledging date were considered successful (Kilgo et al. 1996).

We found a total of 30 nests from 15 species during the study period (Table 5). The largest number of nests for a single species was 5 for Chipping Sparrows. We did find one active Virginia's Warbler nest to document nesting of this species in South Dakota. This nest was located along a draw off of Roby Canyon. It was located on the ground against a rock beneath a small ponderosa pine tree about 3 m upslope from the bottom of the draw. The nest was in a relatively open area, not in the midst of heavy shrub cover which was present about 5 m farther upslope. The nest was found on 3 July and had four nestlings. The nest was still active and all four nestlings were still present on 9 July when the study period ended.

Of the 30 nests that we found, the contents of four were not visible so we could not determine nest fate. In addition, the Spotted Towhee nest found on 10 June and the Warbling Vireo nest found on 30 June (Table 5) were not checked again as the persons sent to check them

could not find the nests. Nine nests were still active at our last check in early July (Table 5). Of the 16 nesting attempts that were complete by the end of the study period, only seven (43.8%) were successful (Table 5). However, only one nest of the 26 nests for which nest contents were visualized was parasitized. This nest belonged to a pair of Chipping Sparrows and they fledged one cowbird. This rate of parasitism appears to be rather low given the relatively high abundance of cowbirds present in the habitat as detected by line transect census methods.

One other nest that we found merits special attention. This was the nest of the White-breasted Nuthatch. This nest was located in a vertical rocky cliff face behind some deciduous vegetation about 1 m above the ground. The entrance to the nest was a small opening in the rocky face that led to a crevice in which the nest was located. The crevice was far enough back from the cliff face that we could not see the nest or the nest cavity itself, but the female was flushed from the nest when we first discovered it and vocalizations from the crevice could be heard on several checks of the nest. This nest location is apparently unusual among nuthatches which usually nest in tree cavities (Pravosudov and Grubb 1993), but few dead snags and few woodpeckers, except for Northern Flickers, were present in this habitat (pers. obs.), so nest cavities in trees could be limited.

Nocturnal Sampling

For crepuscular or nocturnal species such as Common Poorwill (*Phalaenoptilus nuttallii*) and Northern Saw-whet Owl (*Aegolius acadicus*) we conducted surveys patterned after the U.S. Fish and Wildlife Service Breeding Bird Surveys in Boles, Roby, and Redbird canyons. These surveys began in pine-juniper-shrub habitat and extended into ponderosa pine forest in the upper reaches of these canyons. Surveys were initiated at civil twilight (approximately 2130 MDT) and consisted of stops along roads leading up these canyons at every mile. Each stop lasted for 5 minutes and consisted of the following protocol: 1 minute of silence followed by two 2-minute periods consisting of 1 minute of taped calls or whistled imitations followed by 1-minute of silence. These 2-minute periods were conducted for both both Common Poorwill and Northern Saw-whet Owl at each stop. The order in which the calls were played was reversed at each stop so that at one stop poorwill calls were given first and at the next stop saw-whet owl calls were given first. Locations and numbers of calling birds (Common Nighthawks, Common Poorwills, and Northern Saw-whet Owls) were recorded. Birds observed on the road between stations were also recorded. We conducted two surveys each in Roby and Redbird canyons and four surveys in Boles canyon. The roads leading up Roby and Redbird canyons were unimproved dirt roads and we had car problems on these roads so we only ran them twice each. Survey dates ran from 27 May-11 July for Boles canyon, 27 May-26 June for Redbird canyon, and 10 June-26 June for Roby Canyon.

Survey results are recorded as relative abundance (birds per station) because the number of stations varied among canyons. Mean relative abundance for Common Nighthawks was 0.32 birds/station in Boles canyon, 0.23 birds/station in Redbird canyon, and 0.17 birds/station in Roby canyon. Common Poorwill mean relative abundance was 0.27 birds/station in Redbird canyon, 0.28 birds/station in Roby canyon, and 0.79 birds station in Boles canyon. Finally, no saw-whet owls were detected in Redbird canyon, and mean relative abundances for saw-whet owls in Boles and Roby canyons were 0.03 and 0.06 birds/station, respectively. We also located at least 3 calling saw-whet owls along Forest Service road 301 east of Moon campground, Pennington County. A pair of owls was heard calling on 23 May, 1998 about ½-mile east of the campground and another individual was heard calling about 1-½ miles east of the campground on 25 May, 1998.

Common Poorwills were relatively common in the open pine-juniper-shrub areas, especially where open grassy areas were also present. Northern Saw-whet Owls were very uncommon, but because our surveys were conducted from late May-early July we probably missed some saw-whets because territory establishment occurs before this period in South Dakota

and fledglings generally appear in May and June (SDOU 1991, Peterson 1995). All of the saw-whet owl observations occurred in areas of ponderosa pine forest.

Conclusions

A diverse assemblage of birds occupies the restricted pine-juniper-shrub habitat in the southwestern Black Hills of South Dakota and almost half of these species are Neotropical migrants. This habitat also supports the northeasternmost breeding population of Virginia's Warblers. Documentation of this population of Virginia's Warblers extends the known breeding range of this species by over 200 km from the nearest known breeding locale southwest of Casper, Wyoming (Scott 1993). Combining our mist net sampling, line transects, and exploratory birding, we detected at least 40 different sites where singing male Virginia's Warblers were present in Redbird, Roby, Boles, and Whoopup Creek canyons. However, we sampled only a portion of the available habitat type in this area. This pine-juniper-shrub habitat is also present in the lower few miles of Buck Springs and Gillette canyons and in numerous side canyons and draws off the main canyons in this area. Much of the appropriate habitat in Buck Springs and Gillette canyons, however, is privately owned. We did some exploratory birding in pine-juniper-shrub habitat on National Forest land in lower Buck Springs canyon on one occasion in late May and found a pair of Virginia's Warblers. This represents our easternmost sighting. Given that we sampled only a fraction of the available habitat, I estimate that the breeding population of Virginia's Warblers in this area of South Dakota consists of at least 100 pairs. Pine-juniper-shrub habitat is present in adjacent portions of Wyoming as well and undoubtedly also supports breeding Virginia's Warblers, although we did not sample in Wyoming. The numbers of Virginia's Warblers in this area suggest that this is not a new population in a recently colonized habitat, but instead is a population that has been in this area for some time yet has gone undetected because of the minimal ornithological attention to this area.

Wherever Virginia's Warblers were present in this area, three habitat elements were consistently present. These included relatively dense shrub cover, steep slopes, and medium to large ponderosa pines (about 8 m minimum size). These elements are consistent with characteristics of Virginia's Warbler locales in similar habitats elsewhere (Ehrlich et al. 1988, Kaufman 1996). We often observed Virginia's Warblers foraging in the skunkbush sumac and mountain mahogany and presumably these shrubs could also be used as nesting cover, although the single nest that we found was in a relatively open area on a slope. The medium to large ponderosa pines were heavily utilized by males as singing perches.

We did not observe any other bird species in this habitat that have not been previously documented as breeding in South Dakota. This was noteworthy considering the restricted extent of this habitat in South Dakota and its proximity to the ranges of some species that have not been documented as breeders in South Dakota, such as Green-tailed Towhee and Black-throated Gray Warbler, that nest in similar habitats in central and southeastern Wyoming (Scott 1993). Future research should address nesting success and nest site characteristics of Virginia's Warblers in this habitat. These data would allow source-sink analyses of population dynamics and would precisely define characteristics important to successful nesting of Virginia's Warblers in this area. The low rate of cowbird parasitism that we observed, despite the relatively high abundance of cowbirds, is also noteworthy and merits further investigation. Perhaps the species for which we found nests are not common cowbird hosts in this area, although some of them have been previously reported as cowbird hosts (Friedmann and Kiff 1985). The potential impact of cowbird parasitism on Virginia's Warbler breeding success in this population is unknown and this information, along with a knowledge of relative nesting success, is needed for development of effective management strategies.

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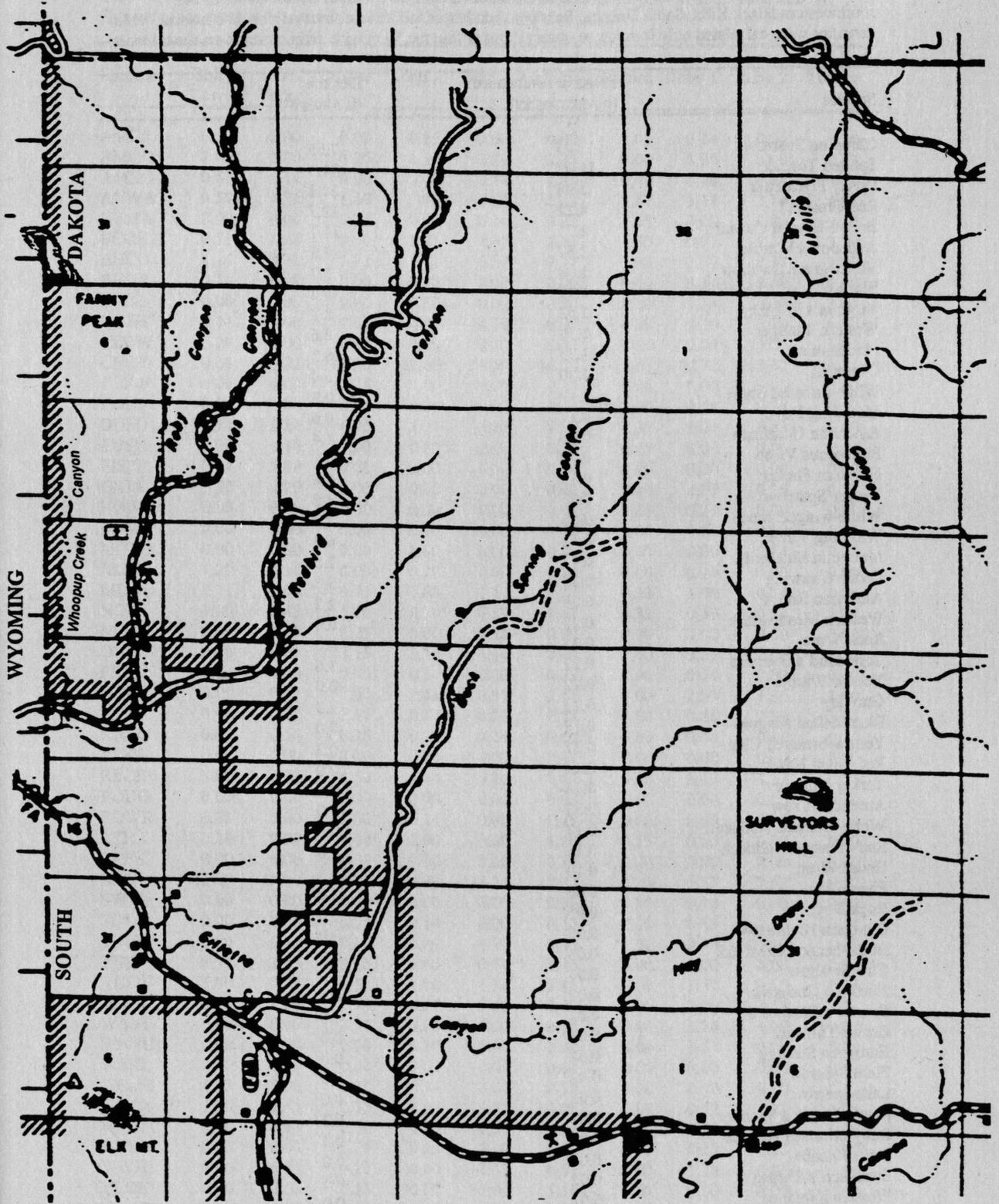


Figure 1: General area of the southwestern Black Hills, South Dakota, where the pine-juniper-shrub habitat surveyed in this study occurs.

Table 1: Relative abundances and estimated densities of birds in pine-juniper-shrub habitat in the southwestern Black Hills, South Dakota. Relative abundances utilized all observations on transects, while densities were calculated only from those observations within the 50 m wide strip centered on the transect.

Species	Relative Abundance (birds/transect)	Density (birds/km ²)
Chipping Sparrow	12.75	172.5
Spotted Towhee	11.00	81.3
Dusky Flycatcher	5.08	24.1
Red Crossbill	4.22	12.7
Brown-headed Cowbird	2.71	11.1
Audubon's Warbler	2.62	17.8
Violet-green Swallow	1.84	3.2
Black-capped Chickadee	1.79	16.8
Virginia's Warbler	1.52	8.3
Western Tanager	1.38	8.6
Pine Siskin	1.35	6.3
Ovenbird	1.30	5.4
White-throated Swift	1.19	0.0
Mourning Dove	1.17	0.6
American Goldfinch	0.86	4.4
Plumbeous Vireo	0.79	5.1
Northern Flicker	0.73	1.6
Vesper Sparrow	0.67	4.8
White-winged Junco	0.56	7.0
Warbling Vireo	0.51	6.3
Mountain Bluebird	0.43	2.5
Cedar Waxwing	0.30	3.8
American Robin	0.29	2.2
Western Meadowlark	0.29	0.0
Rock Wren	0.25	0.0
Townsend's Solitaire	0.22	1.6
Yellow Warbler	0.22	0.0
Gray Jay	0.21	1.3
Black-billed Magpie	0.19	0.0
Yellow-breasted Chat	0.17	0.3
Red-tailed Hawk	0.14	0.0
Turkey Vulture	0.14	0.0
American Crow	0.13	0.0
White-breasted Nuthatch	0.13	0.6
Red-breasted Nuthatch	0.11	0.0
House Wren	0.10	0.3
Pinyon Jay	0.06	0.0
Rock Dove	0.05	0.0
Common Nighthawk	0.03	0.0
Black-headed Grosbeak	0.03	0.0
Cliff Swallow	0.03	0.0
Northern Goshawk	0.02	0.3
Brewer's Blackbird	0.02	0.0
Brown Thrasher	0.02	0.0
European Starling	0.02	0.0
Field Sparrow	0.02	0.0
Lark Sparrow	0.02	0.0
MacGillivray's Warbler	0.02	0.3
Ruby-crowned Kinglet	0.02	0.3
Say's Phoebe	0.02	0.0
Swainson's Thrush	0.02	0.3
Western Kingbird	0.02	0.0
Wild Turkey	0.02	0.0

Table 2: Relative abundances of bird species for individual transects in the pine-juniper-shrub habitat. Species codes are the four-letter codes from the Bird Banding Laboratory.

Species	Boles Low	Boles Upper	Coyote	Jeep 1	Jeep 2	Redbird 1	Redbird 2	Roby 1	Roby 2	Turkey
AMCR	0.00	0.00	0.00	0.29	0.00	0.00	1.00	0.14	0.00	0.29
AMGO	2.00	1.00	0.25	1.14	0.29	2.71	0.00	0.00	0.00	0.43
AMRO	0.57	0.14	0.00	0.00	0.14	1.29	0.00	0.14	0.14	0.14
AUWA	0.57	1.71	1.50	1.86	3.86	2.43	2.67	3.14	3.14	4.86
BBMA	0.00	0.00	0.25	0.00	0.14	0.71	1.67	0.00	0.00	0.00
BCCH	0.71	1.86	3.50	1.71	1.57	2.43	1.33	0.71	2.29	2.29
BHCO	1.14	3.71	2.25	1.71	0.57	7.71	3.33	1.57	2.57	2.71
BHGR	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00
BRBL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00
BRTH	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
CEDW	0.29	1.00	0.00	0.00	0.00	1.43	0.00	0.00	0.00	0.00
CHSP	10.14	16.71	11.25	12.67	14.50	16.00	8.33	10.71	13.57	10.71
CLSW	0.00	0.00	0.25	0.00	0.00	0.14	0.00	0.00	0.00	0.00
CONI	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.29	0.14	0.00
DUFL	4.14	6.14	4.75	3.71	5.86	6.43	4.33	5.14	4.71	5.00
EUST	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FISP	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
GRJA	0.00	0.29	0.00	0.00	0.00	0.00	0.00	0.57	0.29	0.71
HOWR	0.00	0.00	0.00	0.00	0.00	0.43	0.33	0.29	0.00	0.00
LASP	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00
MGWA	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00
MOBL	1.29	0.14	0.00	0.29	0.00	1.86	0.00	0.29	0.00	0.00
MODO	1.71	1.00	0.75	0.86	1.14	2.71	0.33	1.00	0.71	0.86
NOFL	1.00	0.43	1.00	0.29	0.57	1.43	1.33	0.43	0.14	1.14
NOGO	0.00	0.00	0.25	0.00	0.14	0.00	0.00	0.00	0.00	0.00
OVEN	0.00	0.57	3.75	1.29	1.14	0.43	1.00	0.57	2.00	3.14
PIJA	0.00	0.00	0.00	0.14	0.00	0.29	0.00	0.14	0.00	0.00
PISI	0.29	0.71	1.00	2.43	0.57	2.14	0.00	2.57	1.86	1.00
PLVI	0.00	0.14	1.50	0.57	0.29	0.71	1.00	0.86	2.29	1.00
RBNU	0.00	0.14	0.25	0.29	0.14	0.00	0.00	0.00	0.14	0.14
RCKI	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00
RECR	1.00	3.14	4.50	4.71	5.29	5.57	0.00	3.43	4.57	7.71
RODO	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
ROWR	0.71	0.00	2.00	0.14	0.00	0.29	0.00	0.00	0.00	0.00
RTHA	0.14	0.00	0.00	0.00	0.00	1.00	0.33	0.00	0.00	0.00
SAPH	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00
SPTO	11.43	13.29	9.25	12.43	14.14	12.71	7.00	9.57	7.57	9.57
SWTH	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00
TOSO	0.00	0.00	0.25	0.14	0.00	0.14	0.00	0.43	1.00	0.14
TUVU	0.00	0.29	0.00	0.29	0.71	0.00	0.00	0.00	0.00	0.00
VESP	1.71	1.43	0.25	0.86	0.14	1.43	0.00	0.00	0.00	0.29
VGSW	3.00	0.71	6.50	1.00	1.14	2.86	0.00	3.71	0.29	0.14
VIWA	0.57	1.29	3.75	0.57	0.43	2.00	1.00	2.00	3.14	1.14
WAVI	0.00	0.00	0.75	0.00	0.00	0.00	0.00	2.86	1.29	0.00
WBNU	0.00	0.00	0.00	0.29	0.00	0.00	0.00	0.57	0.00	0.29
WEKI	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WEME	1.43	0.00	0.00	0.14	0.00	0.57	0.00	0.00	0.00	0.43
WETA	1.00	1.43	1.75	1.00	0.57	4.00	1.00	0.57	1.71	0.71
WITU	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WTSW	0.43	0.43	5.25	0.29	2.29	2.00	3.00	0.29	0.43	0.29
WWJU	0.00	0.57	0.25	0.00	0.43	0.71	0.00	1.29	0.86	1.00
YBCH	0.00	0.00	0.25	0.00	0.00	1.14	0.67	0.00	0.00	0.00
YWAR	1.43	0.57	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total	47.14	59.29	68.25	49.29	54.00	86.14	39.67	53.71	55.00	56.14

Figure 2: Relative Abundance (birds/transect) for Virginia's Warblers for the 10 transects we conducted in the pine-juniper-shrub habitat in the southwestern Black Hills of South Dakota.

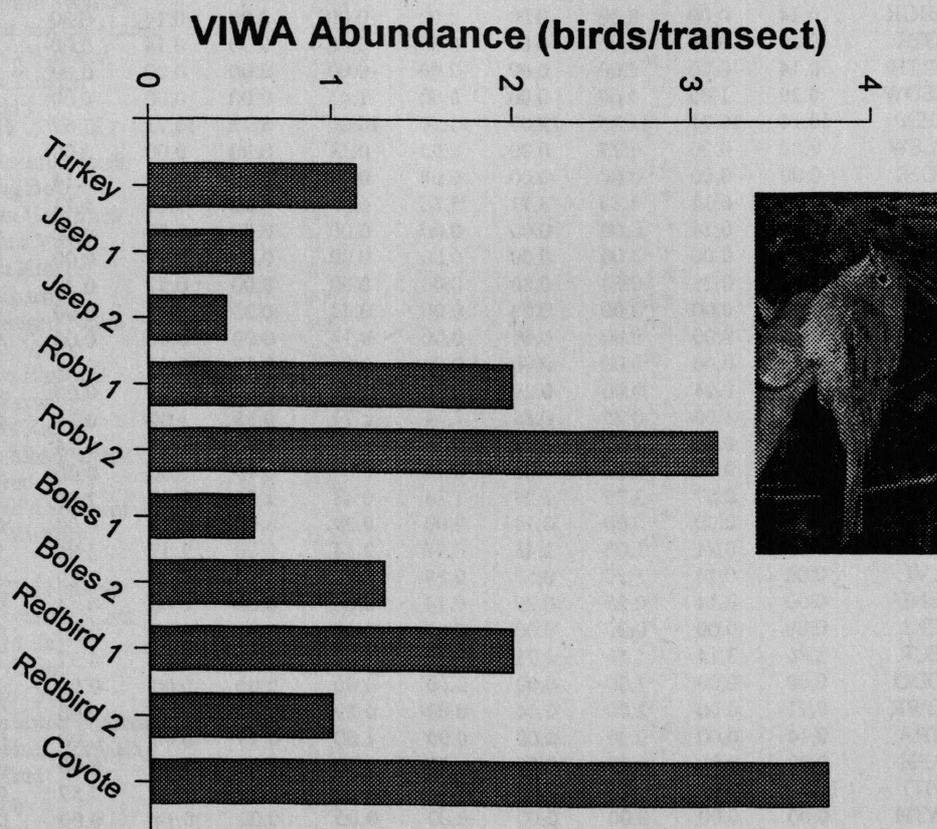


Table 3: Relative abundances of bird species in the pine-juniper-shrub habitat by week throughout the seven-week study period. Week 1 began on 25 May 1998. Species codes are the same as in Table 2.

Species	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
AMCR	0.11	0.44	0.11	0.22	0.00	0.00	0.00
AMGO	0.44	1.89	0.67	0.78	0.67	1.11	0.44
AMRO	0.22	0.33	0.33	0.00	0.11	0.67	0.33
AUWA	1.67	3.00	3.44	2.56	2.00	2.33	3.33
BBMA	0.44	0.22	0.33	0.22	0.11	0.00	0.00
BCCH	0.67	1.78	1.78	2.11	1.78	2.67	1.78
BHCO	3.89	2.33	2.56	2.67	2.67	2.67	2.22
BHGR	0.00	0.00	0.11	0.11	0.00	0.00	0.00
BRBL	0.00	0.11	0.00	0.00	0.00	0.00	0.00
BRTH	0.00	0.11	0.00	0.00	0.00	0.00	0.00
CEDW	0.00	0.00	0.00	1.22	0.00	0.56	0.33
CHSP	11.14	11.67	9.22	10.44	13.78	16.56	16.11
CLSW	0.00	0.00	0.00	0.11	0.00	0.11	0.00
CONI	0.00	0.00	0.11	0.00	0.11	0.11	0.00
DUFL	5.11	7.00	6.33	5.78	4.22	4.11	3.00
EUST	0.00	0.11	0.00	0.00	0.00	0.00	0.00
FISP	0.00	0.00	0.00	0.11	0.00	0.00	0.00
GRJA	0.22	0.00	0.00	0.00	0.78	0.22	0.22
HOWR	0.11	0.22	0.00	0.11	0.11	0.00	0.11
LASP	0.00	0.00	0.00	0.00	0.00	0.11	0.00
MGWA	0.00	0.00	0.00	0.00	0.00	0.11	0.00
MOBL	0.44	0.56	0.44	1.11	0.33	0.11	0.00
MODO	1.33	1.00	0.89	0.67	1.11	1.44	1.78
NOFL	0.44	0.56	0.67	0.33	0.78	0.78	1.56
NOGO	0.00	0.00	0.00	0.22	0.00	0.00	0.00
OVEN	1.22	1.67	1.33	1.33	1.22	0.67	1.67
PIJA	0.00	0.22	0.00	0.11	0.11	0.00	0.00
PISI	0.00	0.00	0.11	1.89	2.56	2.67	2.22
PLVI	0.89	0.56	1.33	0.33	0.67	0.67	1.11
RBNU	0.00	0.11	0.00	0.11	0.22	0.33	0.00
RCKI	0.00	0.00	0.00	0.00	0.11	0.00	0.00
RECR	0.00	0.33	1.44	3.11	8.00	6.78	9.89
RODO	0.00	0.00	0.00	0.00	0.22	0.22	0.00
ROWR	0.11	0.33	0.11	0.22	0.11	0.67	0.22
RTHA	0.00	0.11	0.33	0.11	0.11	0.11	0.22
SAPH	0.00	0.00	0.00	0.00	0.00	0.11	0.00
SPTO	8.67	8.56	8.56	12.56	12.78	12.22	13.67
SWTH	0.00	0.00	0.00	0.00	0.00	0.11	0.00
TOSO	0.00	0.11	0.22	0.67	0.33	0.11	0.11
TUVU	0.00	0.11	0.11	0.56	0.11	0.00	0.11
VESP	1.33	0.56	0.56	0.89	1.11	0.11	0.11
VGSW	3.44	0.56	1.33	1.78	3.44	0.78	1.56
VIWA	1.44	1.89	1.11	1.56	1.78	1.67	1.22
WAVI	0.33	0.44	0.44	0.56	0.78	0.67	0.33
WBNU	0.11	0.11	0.22	0.00	0.33	0.00	0.11
WEKI	0.11	0.00	0.00	0.00	0.00	0.00	0.00
WEME	0.22	0.78	0.44	0.22	0.22	0.00	0.11
WETA	1.22	1.11	0.33	1.44	2.00	1.00	2.56
WITU	0.00	0.00	0.00	0.00	0.00	0.11	0.00
WTSW	0.44	0.22	1.00	0.44	2.44	2.67	1.11
WWJU	0.33	0.44	0.56	0.78	0.33	0.78	0.67
YBCH	0.00	0.33	0.22	0.22	0.22	0.22	0.00
YWAR	0.00	0.67	0.00	0.44	0.33	0.11	0.00
Total	43.67	50.56	46.78	58.11	68.11	66.44	68.22

Table 4: Number of individuals captured and capture rate (birds/100 net hours) for bird species in the pine-juniper-shrub habitat over the seven-week study period (25 May - 6 July, 1998). A total of 584.33 net hours were generated.

Species	Number Captured	Capture Rate
Chipping Sparrow	66	11.3
Virginia's Warbler*	27	4.6
Dusky Flycatcher	23	3.9
Spotted Towhee	12	2.1
White-winged Junco	10	1.7
Audubon's Warbler	10	1.7
Black-capped Chickadee	6	1.0
American Goldfinch	6	1.0
Ovenbird	4	0.7
Pine Siskin	4	0.7
Yellow Warbler	2	0.3
Red-eyed Vireo	1	0.2
Warbling Vireo	1	0.2
Plumbeous Vireo	1	0.2
House Wren	1	0.2
American Robin	1	0.2
American Redstart	1	0.2
MacGillivray's Warbler	1	0.2
Yellow-breasted Chat	1	0.2
Vesper Sparrow	1	0.2
Western Tanager	1	0.2
Totals	180	30.8

* Taped calls of Virginia's Warblers were used to lure this species to the nets so capture rates are overestimated.

Table 5: Nest data for pine-juniper-shrub habitat in the southwestern Black Hills, South Dakota.

Species	Initial Status (Date)	Final Status (Date)	Vegetation	Location
White-breasted Nuthatch	Female incubating (5/26)	Unknown, couldn't see nest	Hidden behind Mahogany	Cliff face (Roby)
Dusky Flycatcher	Building (5/26)	Failed	Juniper (6 ft.)	Roby 1
Western Tanager	Building (5/27)	Failed	Near top of Pine (60 ft.)	Boles 1
White-winged Junco	4 eggs (5/27)	1 yg. on 6/10, Failed	Grass covered dirt bank	Boles 1
Plumbeous Vireo	Building (5/29)	4 fledged (7/3)	2/3 (50 ft.) up large pine	Turkey Trail
Dusky Flycatcher	Complete nest (6/1)	4 eggs (6/10), Failed	Juniper (9 ft.)	Roby 2
Chipping Sparrow	3 eggs (6/1)	4 eggs (6/10), Failed	Young pine (7ft.)	Roby 2
Spotted Towhee	5 eggs (6/2)	Failed	Skunkbush Sumac	Lower Boles
Yellow Warbler	5 eggs (6/2)	5 fledged	Deciduous shrub (5 ft.)	Lower Boles
Townsend's Solitaire	4 eggs (6/2), 3 yg., 1 egg (6/10)	3 fledged	Roadcut bank	Upper Boles
Spotted Towhee	4 young (6/9)	Failed	Skunkbush sumac	O.O. Roby Draw
Mourning Dove	3 eggs	Failed, washed away	On ground in draw	Boles
Mourning Dove	2 young (6/10)	2 fledged	Juniper (6 ft.)	Boles
Spotted Towhee	4 young (6/10)	Unknown	On ground at base of pine	Turkey Trail
Black-capped Chickadee	5 young (6/11)	5 fledged	Top of stump (2 ft.)	Sawmill Canyon
Plumbeous Vireo	Female on nest (6/18)	Unknown, couldn't see nest	Large pine at 25 ft.	Coyote Trail
Western Tanager	Building (6/23)	Unknown, couldn't see nest	Large pine	Boles
Chipping Sparrow	2 young (6/24)	2 fledged (7/1)	Young pine (6 ft.)	Roby 2
Black-capped Chickadee	Female on nest (6/24)	Unknown, couldn't see nest	Ponderosa snag	Boles
Chipping Sparrow	1 young (cowbird) (6/24)	1 cowbird fledged	Medium pine at 6ft., overhang	Roby
Ovenbird	4 young (6/26)	4 fledged (7/3)	On ground at base of small pine	Turkey Trail
Chipping Sparrow	4 eggs (6/26)	4 young (active, 7/9)	3 ft. up in small juniper	Roby 2
Mourning Dove	2 eggs (6/30)	2 eggs (active 7/2)	Large pine at 12 ft. on mid-branch	Boles 9
American Goldfinch	Building nest (6/30)	Nest complete (active, 7/9)	Large pine, near branch tip, 25 ft.	Lower Redbird
Warbling Vireo	2 or 3 eggs (6/30)	Unknown	Deciduous shrub (6 ft.)	Coyote Trail
Chipping Sparrow	3 young (7/1)	3 young (active, 7/9)	Large pine at 15 ft.	VIWA Draw
Ovenbird	4 naked young (7/1)	4 young (active, 7/9)	Cut bank w/ overhanging grass	VIWA Draw
Virginia's Warbler	4 young (7/3)	4 young (active, 7/9)	On ground against rock beneath small pine	VIWA Draw
Warbling Vireo	Complete nest (7/7)	2 adults present, Nest empty (7/7)	Deciduous shrub (5 ft.)	Upper Roby
Warbling Vireo	3 naked young (7/7)	Active (7/7)	Deciduous shrub (6 ft.)	

Year	Project Name	Location	Start Date	End Date	Status	Notes
1980	1. New York City	New York City	1980-01-01	1980-12-31	Completed	...
1981	2. Los Angeles	Los Angeles	1981-01-01	1981-12-31	Completed	...
1982	3. Chicago	Chicago	1982-01-01	1982-12-31	Completed	...
1983	4. San Francisco	San Francisco	1983-01-01	1983-12-31	Completed	...
1984	5. Dallas	Dallas	1984-01-01	1984-12-31	Completed	...
1985	6. Houston	Houston	1985-01-01	1985-12-31	Completed	...
1986	7. Phoenix	Phoenix	1986-01-01	1986-12-31	Completed	...
1987	8. San Diego	San Diego	1987-01-01	1987-12-31	Completed	...
1988	9. Seattle	Seattle	1988-01-01	1988-12-31	Completed	...
1989	10. Portland	Portland	1989-01-01	1989-12-31	Completed	...
1990	11. Denver	Denver	1990-01-01	1990-12-31	Completed	...
1991	12. Salt Lake City	Salt Lake City	1991-01-01	1991-12-31	Completed	...
1992	13. Minneapolis	Minneapolis	1992-01-01	1992-12-31	Completed	...
1993	14. St. Paul	St. Paul	1993-01-01	1993-12-31	Completed	...
1994	15. Kansas City	Kansas City	1994-01-01	1994-12-31	Completed	...
1995	16. Omaha	Omaha	1995-01-01	1995-12-31	Completed	...
1996	17. Lincoln	Lincoln	1996-01-01	1996-12-31	Completed	...
1997	18. Des Moines	Des Moines	1997-01-01	1997-12-31	Completed	...
1998	19. Omaha	Omaha	1998-01-01	1998-12-31	Completed	...
1999	20. Lincoln	Lincoln	1999-01-01	1999-12-31	Completed	...
2000	21. Des Moines	Des Moines	2000-01-01	2000-12-31	Completed	...
2001	22. Omaha	Omaha	2001-01-01	2001-12-31	Completed	...
2002	23. Lincoln	Lincoln	2002-01-01	2002-12-31	Completed	...
2003	24. Des Moines	Des Moines	2003-01-01	2003-12-31	Completed	...
2004	25. Omaha	Omaha	2004-01-01	2004-12-31	Completed	...
2005	26. Lincoln	Lincoln	2005-01-01	2005-12-31	Completed	...
2006	27. Des Moines	Des Moines	2006-01-01	2006-12-31	Completed	...
2007	28. Omaha	Omaha	2007-01-01	2007-12-31	Completed	...
2008	29. Lincoln	Lincoln	2008-01-01	2008-12-31	Completed	...
2009	30. Des Moines	Des Moines	2009-01-01	2009-12-31	Completed	...
2010	31. Omaha	Omaha	2010-01-01	2010-12-31	Completed	...
2011	32. Lincoln	Lincoln	2011-01-01	2011-12-31	Completed	...
2012	33. Des Moines	Des Moines	2012-01-01	2012-12-31	Completed	...
2013	34. Omaha	Omaha	2013-01-01	2013-12-31	Completed	...
2014	35. Lincoln	Lincoln	2014-01-01	2014-12-31	Completed	...
2015	36. Des Moines	Des Moines	2015-01-01	2015-12-31	Completed	...
2016	37. Omaha	Omaha	2016-01-01	2016-12-31	Completed	...
2017	38. Lincoln	Lincoln	2017-01-01	2017-12-31	Completed	...
2018	39. Des Moines	Des Moines	2018-01-01	2018-12-31	Completed	...
2019	40. Omaha	Omaha	2019-01-01	2019-12-31	Completed	...
2020	41. Lincoln	Lincoln	2020-01-01	2020-12-31	Completed	...
2021	42. Des Moines	Des Moines	2021-01-01	2021-12-31	Completed	...
2022	43. Omaha	Omaha	2022-01-01	2022-12-31	Completed	...
2023	44. Lincoln	Lincoln	2023-01-01	2023-12-31	Completed	...
2024	45. Des Moines	Des Moines	2024-01-01	2024-12-31	Completed	...
2025	46. Omaha	Omaha	2025-01-01	2025-12-31	Completed	...
2026	47. Lincoln	Lincoln	2026-01-01	2026-12-31	Completed	...
2027	48. Des Moines	Des Moines	2027-01-01	2027-12-31	Completed	...
2028	49. Omaha	Omaha	2028-01-01	2028-12-31	Completed	...
2029	50. Lincoln	Lincoln	2029-01-01	2029-12-31	Completed	...
2030	51. Des Moines	Des Moines	2030-01-01	2030-12-31	Completed	...
2031	52. Omaha	Omaha	2031-01-01	2031-12-31	Completed	...
2032	53. Lincoln	Lincoln	2032-01-01	2032-12-31	Completed	...
2033	54. Des Moines	Des Moines	2033-01-01	2033-12-31	Completed	...
2034	55. Omaha	Omaha	2034-01-01	2034-12-31	Completed	...
2035	56. Lincoln	Lincoln	2035-01-01	2035-12-31	Completed	...
2036	57. Des Moines	Des Moines	2036-01-01	2036-12-31	Completed	...
2037	58. Omaha	Omaha	2037-01-01	2037-12-31	Completed	...
2038	59. Lincoln	Lincoln	2038-01-01	2038-12-31	Completed	...
2039	60. Des Moines	Des Moines	2039-01-01	2039-12-31	Completed	...
2040	61. Omaha	Omaha	2040-01-01	2040-12-31	Completed	...
2041	62. Lincoln	Lincoln	2041-01-01	2041-12-31	Completed	...
2042	63. Des Moines	Des Moines	2042-01-01	2042-12-31	Completed	...
2043	64. Omaha	Omaha	2043-01-01	2043-12-31	Completed	...
2044	65. Lincoln	Lincoln	2044-01-01	2044-12-31	Completed	...
2045	66. Des Moines	Des Moines	2045-01-01	2045-12-31	Completed	...
2046	67. Omaha	Omaha	2046-01-01	2046-12-31	Completed	...
2047	68. Lincoln	Lincoln	2047-01-01	2047-12-31	Completed	...
2048	69. Des Moines	Des Moines	2048-01-01	2048-12-31	Completed	...
2049	70. Omaha	Omaha	2049-01-01	2049-12-31	Completed	...
2050	71. Lincoln	Lincoln	2050-01-01	2050-12-31	Completed	...

1990-2000: 10 years of data. 2001-2010: 10 years of data. 2011-2020: 10 years of data. 2021-2030: 10 years of data. 2031-2040: 10 years of data. 2041-2050: 10 years of data.

