

**Effects of Prescribed Burning and Trail Use on Ponderosa Pine
Forest Birds on Heil Ranch, Boulder County Open Space:
Analysis of Pre-treatment Years (1999 - 2000).**

Year-end Report

Submitted by:

Dr. Alex Cruz, Dr. John Prather, Jameson F. Chace,
and Heather Swanson,

Department of Environmental, Population, and Organismic Biology,
Campus Box 334, University of Colorado, Boulder, CO 80309-0334

Submitted to:

Therese Glowacki
and Mark Brennan

Boulder County Parks and Open Space
P.O. Box 471
Boulder, Colorado 80503

20 October 2000

BOULDER CO. PARKS AND
OPEN SPACE DEPT.
P.O. BOX 471
BOULDER, CO 80306



**Effects of Prescribed Burning and Trail Use on Ponderosa Pine
Forest Birds on Heil Ranch, Boulder County Open Space:
Analysis of Pre-treatment Years (1999 - 2000)**

Abstract

The foothill ponderosa pine forests along the Colorado Front Range are an important, unique and understudied habitat. Specific stands of ponderosa pine on Boulder County Open Space are slated for prescribed thinning and burning to maintain or enhance native plant and animal species, their communities, and the ecological processes that sustain them. Additionally, new trails are being added to Boulder County Open Space, at Heil Ranch, that may also impact the avian community. During the summers of 1999 and 2000 we gathered preliminary data on the distribution, abundance and breeding biology of bird populations on the Heil Ranch property. These data have been largely taken prior to the implementation of forest management plans, and the increase in human use associated with the opening of trails on this property. These data may now be used to look for changes associated with habitat modification and human disturbance in the future. We present here our pre-disturbance findings, predictions of how some species may be affected by the opening of the new trail system, and recommendations for further monitoring and research.

Introduction

Foothill ponderosa pine (*Pinus ponderosa*) along the east slope of the Colorado Front Range can be characterized by a park-like appearance of open canopy ponderosa pine, scattered Douglas fir (*Pseudotsuga menziesii*), and an understory composed of five major plant associations including shrubs, herbaceous plants, mixed grass and rock outcrops (Little, 1971; pers. obs.). A number of Neotropical migrants breed in ponderosa pine and adjacent montane riparian habitat of Boulder County, many of which are considered sensitive across their southwestern range. Among those species, the Broad-tailed hummingbird, Hammond's Flycatcher, Dusky Flycatcher, Cordilleran Flycatcher, Townsend's Solitaire, Plumbeous Vireo, Warbling Vireo, MacGillivray's Warbler, Virginia's Warbler, and Green-tailed Towhee, are considered species of concern across Arizona, New Mexico and Colorado (Winternitz and Crumpacker, 1985; Rich and Breadmore, 1997; Hall et al., 1997).

Years of fire suppression in the foothills of Boulder County have had a pronounced effect on the forest-grassland interface, and on the forest ecosystem itself. The extent of ponderosa pine forest now occurs at the lowest elevation in

recorded history (Veblen and Lorenz, 1991), and the stand is overstocked with a high density of trees, making the forest more susceptible to catastrophic fires and pine beetle infestations (Finch et al., 1997). The proposed prescribed burning of ponderosa pine forests on Boulder County Open Space should restore large scale disturbance processes that will dramatically alter the age-structure of the ponderosa pine forest. In turn, these changes should support a higher avian species diversity and maintain more stable populations of open-forest aerial insectivores, granivores, and tree-drilling bird species (Hejl, 1994; Finch et al., 1997). However, there is some confusion in predicting how the proposed burning of ponderosa pine forest will affect the avian community because the literature is wrought with methodological problems (Dobkin, 1994; Hejl, 1994; Hutto, 1995; Finch et al., 1997). Furthermore, our work has shown that cowbirds are likely to respond positively to canopy openings created in the ponderosa pine forest (Chace and Cruz, 1999). Avian nest predators, e.g., Steller's Jays, may respond to canopy openings similar to cowbirds and may also negatively impact open-cup nesting songbirds.

Non-consumptive recreational activities (e.g., hiking, nature study, biking, trail running) are generally thought to be inconsequential to wildlife. However, habitat modification and disturbance associated with trail use can negatively affect songbird productivity and survival, ultimately resulting in avian community changes (Knight and Cole, 1995; Anderson, 1995; Marzluff, 1997). Disturbance effects along trails are most significant during the early part of the nesting cycle (Gotmark, 1992). Recreationists may disturb nesting birds and inadvertently advertise nest locations to predators (Gutzwiller, 1995).

In our proposal submitted last fall we outlined three major goals for our research on the Heil Ranch property. These goals are listed below.

- 1: Compare the response of bird species richness and abundance to prescribed burning during the breeding season. Compare breeding season parameters, such as density and reproductive success, between treatments and controls.
- 2: Compare the response of bird species richness and abundance at sites with and without trails. Establish pre-trail surveys to compare with post-trail building surveys conducted at a later date. Determine species-specific responses to trail effects during the breeding season.
- 3: Model, using a geographic information system, the effects of

forest thinning and burning and trail construction on breeding bird populations in stands slated for future treatment.

Our research in 1999 and 2000 has given us a large amount of data on the breeding bird community of the Heil Ranch property prior to extensive habitat modification which will take place upon the implementation of the forest management plan, and largely prior to disturbance associated with the opening of trails for human use on the property. We report here our preliminary analysis of this data and propose continuing research as trails are opened and management plans implemented on Heil Ranch. These data may then be compared to data taken in the future to determine how the changes on Heil Ranch affect the bird community.

Methods

Point Count Station Establishment: In 1999 we established a total of 20 locations for point counts on the Heil Ranch property. In 2000, in accordance with our goals we increased this number to 30 stations, ten along each of 3 transects. These transects included a canyon (CANY) transect starting from the parking lot, running along the Lichen Trail and extending into Plumley Canyon, a proposed trail (PRTR) transect along the route of the new trail extending to the center of the property, and a no trail (NOTR) transect running to the west of the proposed trail in an area not slated for development.

Our transects for 2000 overlap broadly with our 1999 transects. All ten points on the CANY transect were represented in our GEER and PLUM transects in 1999. Our PRTR transect, while close to the HEIL transect of 1999 did not share any points. We changed the location of this transect and added more points so that they fell along the route of and extended coverage of the new trail. Comparisons of these two transects may be made, however, due to their proximity. The NOTR transect is an entirely new transect in an area not previously surveyed.

After July 16, each point location was pinpointed using a GPS unit, and the general habitat within 50 meters of each point was categorized. Our categories were; thick (often doghair) Ponderosa Pine (*Pinus ponderosa*) forest (PIPO), Ponderosa Pine/Douglas Fir (*Pseudotsuga menziesii*) forest (PIPO/PSME), Ponderosa Pine mixed with low elevation riparian woodland (PIPO/LERI) dominated by Chokecherry (*Prunus virginiana*), Willows (*Salix spp.*), Cottonwoods (*Populus spp.*), and Rocky Mountain Maple (*Acer montana*), and savannah like Ponderosa Pine woodland (PIPO/SAVA), with only scattered clumps of trees. In our 1999 preliminary report,

we did not separate PIPO and PIPO/SAVA habitats, but do so here due to large differences in the relative abundance of some species in these two forest types. We also dropped the 2 points in pure low elevation riparian areas due to the relative scarcity of this habitat on the Heil Ranch property.

Avian Censusing: From June 1 through July 16 we undertook point counts at the chosen locations along each of the transects above. Counts took place for 10 minutes and were performed 3 times at each location before July 15. During each count, all birds seen or heard within 50 meters were identified and recorded. Additional species within 150 meters were also noted. All counts took place between 5:30 and 10:00 A.M., with most counts being completed by 9:00 A. M. For each point a Relative Abundance Index (RAI) was determined using the following formula:

$$\frac{\text{Total Number of Independent Observations of Birds}}{\text{Total Number of Census Periods}}$$

Each singing male, pair or family group of birds observed or heard was considered an independent observation for purposes of this study. Only birds seen or heard within 50 meters of the point were tallied in the RAI.

Breeding Productivity: Through observations of nesting behavior (Ralph et al., 1993) and area searches, we located nests at three sites on the Heil Ranch property. These sites were the parking and picnic area and surroundings in Geer Canyon, the confluence of Plumley and Marietta Canyons, and a site along the east side of the loop of the new trail. These sites were used due to the high number of breeding birds using these areas and the opportunity to study the effects of disturbance, or lack thereof, on these breeding communities. Once found, nests were marked with a combination of blue and pink flagging approximately 10 m from the nest. Nests were monitored at least once every three days from the day they were found until the nest either failed or the young fledged. Nest contents were observed directly or with a 6-m mirror pole. Efforts were made not to attract nest predators to the nest site (Picozzi, 1975; Westmoreland and Best, 1985; Major, 1989). We analyzed nesting success of species for which we found more than 6 nests using the Mayfield method (Mayfield, 1975) with suggested adjustments made by Manolis et al. (2000). This method gives an estimate of the proportion of nests of a species that will fledge at least one young based on actual observations from nests of that species. Note, however, that this does not take into account cowbird parasitism.

Nest Site Selection: At the conclusion of the breeding season we measured vegetation variables around the nests of the following species; Western Wood Pewee, American Robin, Blue-gray Gnatcatcher, Plumbeous Vireo, Western Tanager, Chipping Sparrow, Lark Sparrow, and Lesser Goldfinch. The following variables were described at each nest site; nest height, nesting substrate, substrate height, average canopy height in an 11.3 m radius around the nest, number of trees (by size class and species) in an 11.3 m radius around the nest, number of woody stems (by species) in a 5 m radius around the nest, canopy cover at the nest site and at 4 locations 3 meters from the site, and percent of various ground cover types in a five meter radius around the nest. All vegetation variables were measured using standardized protocols (James & Shugart, 1970; Martin & Roper, 1988).

GIS Analysis: We intend to use data layers from Arcview to determine landscape level patterns of bird distribution, abundance, and nesting success on the Heil Ranch property. Specific variables used will include vegetation type, slope, aspect, canopy cover, and distance from trails and/or roads.

Results

Avian Censusing: In 2000, we successfully censused birds at all 30 of our established point count locations. Habitat classification of these points revealed we had 10 points in Ponderosa Pine forest, 9 in savannah-like Ponderosa Pine woodland, 8 in mixed Ponderosa Pine and Douglas Fir forest, and three in mixed Ponderosa Pine and Riparian woodland.

We detected a total of 40 bird species at our point count locations on Heil Ranch in 2000 (Appendix 1). Five of these species were found in only one habitat type, while 21 were encountered in at least three habitat types. Most species that occurred in only one or two habitats were species typically associated with riparian or grassland habitats, and those with specialized habitat requirements (e.g. Canyon Wren). Most coniferous forest species were widespread on the Heil Ranch property. The avian community on Heil Ranch appears to be similar to that of other Ponderosa Pine dominated open space properties in Boulder County.

One of the most interesting results is that there is a suite of species that are widespread on the property, but reach highest relative abundance in the savannah-like Ponderosa Pine habitat and areas where Ponderosa Pines are mixed with riparian vegetation. These species include Western Wood-Pewee, Plumbeous Vireo,

Western Tanager, and Lesser Goldfinch. This supports our observations from other locations in Boulder County. In contrast, Steller's Jay, Mourning Dove, and cavity-nesting species such as Mountain Chickadee and the nuthatches, were in more even numbers across habitats. A second suite of species was found largely in areas with mixed riparian vegetation. Two species, the Gray-headed (Dark-eyed) Junco, and the Audubon's Warbler, were largely restricted to areas with a mixture of Ponderosa Pine and Douglas Fir.

A comparison of abundance data between 1999 and 2000 suggests that most birds had relatively similar numbers between the two years. Two species, the Lesser Goldfinch, and the American Robin showed dramatic increases in abundance in 2000, and one species, the Brown-headed Cowbird, showed a dramatic decrease in numbers between 1999 and 2000.

We compared the relative abundance of birds at 6 point counts located near the recently opened parking lot and Lichen Trail to look for signs that the opening of the Heil Ranch property for public use was already impacting the breeding bird community. This comparison did not reveal any consistent trends in the relative abundance of bird species between 1999 and 2000. Many of the species common enough for analysis of the data were in similar numbers in both years, and about an equal number of species increased and decreased between 1999 and 2000 (Table 1).

Breeding Productivity: In 2000, we located and monitored 117 nests of 16 species. Additionally, we either confirmed, or found evidence for, breeding of 20 other species on Heil Ranch (Appendix 2). Most of these species were the same ones noted breeding in 1999. We located and monitored nests of two species, Blue-gray Gnatcatcher and Warbling Vireo, for which we had no nesting data in 1999. Additionally, we confirmed breeding in Blue Grouse, Canyon Wren, Western Bluebird, and Violet-green Swallow in 2000. We did not find nests of Common Poorwill, Townsend's Solitaire, or Pine Siskin in 2000, nor did we see evidence of breeding by Red-breasted Nuthatches.

Overall, we found approximately twice as many nests as in 1999, primarily due to greater amount of time spent nest-searching on the property. For the most common nesting species we generally found 1 - 2 times the number of nests located in 1999. However we found far higher numbers of nests of American Robins (11 vs. 4) and Lesser Goldfinches (14 vs. 1) in 2000. These species were also much more abundant in point counts in 2000 than in 1999. This further suggests a large increase in numbers of both of these species in 2000.

Analysis suggests that nesting success was similar for Western Tanagers,

Western Wood-Pewees, and Mourning Doves in 1999 and 2000 (Appendix 3). However, Chipping Sparrows showed much higher nesting success in 2000 (0.49) than in 1999 (0.16). Plumbeous Vireos also showed much higher nesting success (0.76) in 2000 than in 1999 (0.24), but their nests were heavily parasitized by cowbirds and most nests only fledged cowbird young. We do not have enough data from 1999 to compare nesting success of American Robins, Lark Sparrows, or Lesser Goldfinches.

Despite lower numbers of cowbirds detected during our point counts in 2000, 14 of 82 potential host nests (17.1%) were parasitized by cowbirds in 2000 (Appendix 3), as compared to only 5 of 48 potential host nests (10.4%) in 1999. This higher rate was mainly due to parasitism of Plumbeous Vireo nests. In 2000, 8 of 11 (72%) vireo nests parasitized, as compared to only 4 of 9 (44%) in 1999. This difference was not statistically significant (d.f. = 1, $X^2 = 1.664$, $P = 0.197$), however, probably due to small sample size. In general, 1999 was a very low year for cowbird parasitism across Boulder County, so 2000 levels may be more reflective of normal parasitism rates on Heil Ranch.

Of the 14 nests parasitized in 2000, only 2 had host young successfully fledge. The parasitized Chipping Sparrow nest fledged a cowbird and 3 sparrow young and one of the Plumbeous Vireo nests fledged a cowbird and 1 vireo young. All other parasitized nests that were not preyed upon only fledged a single young cowbird. One of the Pewee nests was parasitized before any Pewee eggs were laid, and was abandoned, but the same pair later had their second nest parasitized and this nest only fledged a single cowbird. Interestingly, the cowbird egg laid in the Warbling Vireo nest was ejected by the adults, although their nest later failed due to predation.

In order to look at how the opening of the Heil Ranch property was affecting nesting success of birds, we compared 1999 and 2000 nesting success for those nests located in and around the parking lot and picnic area (Table 2). In 1999, 10 nests fledged young (62.5%), and 6 were preyed upon. In 2000, nine nests fledged young (50.0%), 8 were preyed upon, and one was abandoned. In 1999, 3 of 16 nests (18.8%) were parasitized (18.8%), while in 2000, 3 of 18 nests (16.7%) were parasitized. These numbers for both parasitism and predation are very close and suggest there were no major changes in nesting success of birds breeding around the picnic area in 2000. The species of nesting birds found around the parking lot was also similar in both years.

Nest Site Selection: We are currently finishing data entry to analyze patterns in nest site selection by different species. These data will be presented in a later report.

GIS Analysis: As above, we are currently finishing data entry for this analysis. In addition we need to obtain GIS data layers for Heil Ranch from the county. These data will also be presented in a later report.

Discussion

A small portion of the Heil Ranch property was opened for public use this season, and work began on the new trail while the breeding season was progressing, suggesting that our 2000 data should be used to look for impacts of disturbance on the breeding bird community. However, these disturbances were relatively light and probably did not have much effect on the bird community this season. Point count data from the 6 points along the Lichen Trail as well as nesting data from around the parking lot, suggest that the bird community structure was relatively similar in both 1999 and 2000. Furthermore, the two most striking changes in the breeding bird community were the large increases in Lesser Goldfinch and American Robin abundance. There are no immediately obvious reasons for these increases, though the Lesser Goldfinch is known to vary greatly in numbers from year to year across its range (Watt, 1999), and was also much more common on our other study sites around Boulder in 2000. We therefore conclude that we may use data from both years in analysis of future changes due to higher levels of disturbance.

Our data suggest several aspects of research to be focused on in the future. These include the effects of human disturbance on particular species and groups of birds; the effects of increased human use on predator abundance and nest predation rates in "heavy use" areas, such as the parking lot; the effects of the removal of the cattle on the abundance of cowbirds on the Heil Ranch property; and the effects of forest thinning on the abundance of certain species seemingly associated with "savannah-like" Ponderosa Pine stands.

Increased use of the parking lot and trail system will undoubtedly cause increased disturbance near these areas. Monitoring of breeding birds will, therefore, be very important over the next 2-3 years to look at impacts. We believe that a suite of open ground nesting species are likely to be most affected by this increase in disturbance. These species include Common Nighthawk, Mourning Dove, Townsend's Solitaire, and Lark Sparrow. Because these species nest on the ground and do not hide their nests in thick shrubs, as do Spotted Towhees, they are more likely to be flushed by passing humans, and may be susceptible to predation by dogs, should Heil Ranch ever be opened to this use. We found a number of ground nests of these species near the new trail this year, and it will be interesting to see if we are

able to nests of these species near the trail after the trail is opened next year, or if numbers of these species are reduced on the property. We find relatively few nests of these species in Boulder Mountain Parks, where human use is far greater than at Heil Ranch. Additionally, the Mourning Dove is of particular concern because it is rather prone to abandoning its nests if disturbed often. In fact, we find relatively few nests of this. During our research on Heil Ranch we have had 5 Mourning Doves abandon their nests (2 in 1999, 3 in 2000) despite efforts to disturb these birds as little as possible. Doves seem to be most likely to abandon in the first few days after egg laying and numbers of humans passing near nests during this time period are likely to cause high rates of abandonment.

An additional effect of increased human use may be the attraction of higher numbers of predators, such as squirrels and jays, to the picnic area and surrounding habitat. Both squirrels and jays are known to increase in abundance around human-impacted areas, and both are common nest predators around Boulder County (Craig, 1997). We believe there may be an increase in the predation rate of nests around "high-use" areas, such as the picnic area, in future years.

The reduction in cowbird numbers on the Heil Ranch this season was unexpected, and may be directly related to the removal of cattle from the ranch property. However, brood-parasitism did not decrease this season, and cowbirds are known to fly great distances (>14 km) to parasitize nests (Curson, et al., 2000). Continued monitoring of cowbird numbers and rates of brood parasitism on potential host species, particularly vireos, will allow us to determine if the removal of cattle is having a positive effect on the breeding success of potential host species on the Heil Ranch property.

Finally, our data suggest that the thinning and burning of the Heil Ranch property to restore a more "savannah-like" aspect to the forest structure will positively impact a small suite of species, most notably Western Wood-Pewee, Plumbeous Vireo, Western Tanager, and Lark Sparrow. However, it is not clear how long this will take, nor whether thinning and burning will restore the forest structure that these species prefer. Furthermore, thinning of forest will make it much more open, which could produce negative effects, such as an increase in cowbird brood-parasitism. Again continued monitoring will give us the chance to assess changes in nesting success and breeding bird abundance and allow us to analyze the effects of changing vegetation structure on the forest bird community.

Literature Cited

- Anderson, S. H. 1995. Recreational disturbance and wildlife populations. Pp. 157-168 in R. L. Knight and K. J. Gutzwiller (eds.) *Wildlife and Recreationists: coexistence through management and research*. Island Press, Wash. D. C.
- Dobkin, D. S. 1994. Conservation and management of Neotropical migrant landbirds in the northern Rockies and Great Plains. Univ. of Idaho Press. Moscow, ID.
- Chace, J. F. and A. Cruz. 1999. The influence of landscape and cowbird parasitism on the reproductive success of Plumbeous Vireos breeding in Colorado. *Studies in Avian Biology* 19:200-204.
- Craig, D. P. 1997. An experimental analysis of nest predation in western coniferous forests: a focus on the role of corvids. Unpublished PhD. Dissertation. University of Colorado, Boulder.
- Cruz, A., J. F. Chace, J. J. Walsh, and J. Prather. 1999. Long-term monitoring of parasitism and predation impacts on sensitive Neotropical migratory songbirds in Boulder, Colorado. Year-end report to Boulder County Parks and Open Space.
- Curson, D. R., C. R. Goguen, and N. E. Mathews. 2000. Long-distance commuting by Brown-headed Cowbirds in New Mexico. *Auk* 117: 795-799.
- Finch, D. M., J. L. Ganey, W. Yong, R. T. Kimball, and R. Sallabanks. 1997. Effects and interactions of fire, logging, and grazing. Pp. 103-136 in W. M. Block and D. M. Finch (eds.), *Songbird ecology in southwestern ponderosa pine forests: a literature review*. Gen. Tech. Rep. RM-GTR-292. Fort Collins, CO: US Dept. of Agric., Forest Service, Rocky Mountain Forest and Range Experiment Station.
- Gaunt, A. S. and L. W. Oring (eds.). 1997. *Guidelines to the use of wild birds in research*. Ornithological Council, Washington, D. C.
- Gotmark, F. 1992. The effects of investigator disturbance on nesting birds. *Current Ornithology* 9:63-104.
- Gutzwiller, K. J., R. T. Wiedenmann, K. L. Clements, and S. H. Anderson. 1994. Effects of human intrusions on song occurrence and singing consistency in subalpine birds. *Auk* 111:28-37.
- Gutzwiller, K. J. 1995. Recreational disturbance and wildlife communities. Pp. 169-181 in R. L. Knight and K. J. Gutzwiller (eds.) *Wildlife and Recreationists: coexistence through management and research*. Island Press, Wash. D. C.
- Hall, L. S., M. L. Morrison, and W. M. Block. 1997. Songbird status and roles. Pp. 69-88 in W. M. Block and D. M. Finch (eds.), *Songbird ecology in southwestern ponderosa pine forests: a literature review*. Gen. Tech. Rep. RM-GTR-292. Fort Collins, CO: US Dept. Agric., Forest Service, Rocky Mountain Forest and Range Experiment Station.

- Hejl, S. J. 1994. Human-induced changes in bird populations in coniferous forests in western North America during the past 100 years. *Studies in Avian Biology* 15:232-246.
- Hutto, R. L. 1995. Composition of bird communities following stand -replacement fires in northern Rocky Mountain conifer forests. *Conservation Biology* 9: 1041-1058.
- James, F.C., Shugart, H.H., Jr. 1970. A quantitative method of habitat description. *Audubon Field Notes* 24:727-736.
- Knight, R. L. and D. N. Cole. 1995. Factors that influence wildlife responses to recreationists. Pp. 71-79 in R. L. Knight and K. J. Gutzwiller (eds.) *Wildlife and Recreationists: coexistence through management and research*. Island Press, Washington, D. C.
- Little, E.L. 1971. Atlas of United States Trees. Volume 1. Conifers and important hardwoods. Misc. Pub. 1146. Washington DC: U.S. Department of Agriculture, Forest Service.
- Manolis, J. C., D. E. Anderson, and F. J. Cuthbert. 2000. Uncertain nest fates in songbird studies and variation in Mayfield estimation. *Auk* 117: 615-626.
- Martin, T. E. and J. J. Roper. 1988. Nest predation and nest-site selection of a western population of the Hermit Thrush. *Condor* 90:51-57.
- Major, R. E. 1989. The effect of human observers on the intensity of nest predation. *Ibis* 132:608-612.
- Marzluff, J. M. 1997. Effects of urbanization and recreation on songbirds. Pp. 89-102 in, W. M. Block and D. M. Finch (eds.), *Songbird ecology in southwestern ponderosa pine forests: a literature review*. Gen. Tech. Rep. RM-GTR-292. Fort Collins, CO: US Dept. Agric., Forest Service, Rocky Mountain Forest and Range Experiment Station.
- Mayfield, H. F. 1975. Suggestions for calculating nest success. *Wilson Bulletin* 87: 456-466.
- Picozzi, N. 1975. Crow predation on marked nests. *Journal of Wildlife Management* 39:151-155.
- Ralph, C. J., G. R. Geupel, P. Pyle, T. E. Martin, and D. F. DeSante. 1993. Handbook of field methods for monitoring landbirds. Gen. Tech. Rep. PSW-GTR-144, Albany, CA, Southwest Research Station, Forest Service, US Dept. Agric.
- Rich, T., and C. Breadmore. 1997. Priority bird species by state in the western US: 1997 status report. Unpubl. Rep., Partners-in-Flight, Western Working Group.
- Veblen, T. T. and D. C. Lorenz. 1991. The Colorado Front Range, a Century of Ecological Change. University of Utah Press, Salt Lake City, Utah.

- Watt, D. J. 1999. Lesser Goldfinch (*Carduelis psaltria*). Pp. 1-24 in *The Birds of North America*, No. 256. The Academy of Natural Sciences, Philadelphia, Pennsylvania, and The American Ornithologists Union, Washington D. C.
- Westmoreland, D. and L. B. Best. 1985. The effect of disturbance on Mourning Dove nesting success. *Auk* 102:774-780.
- Winternitz, B. L., and D. W. Crumpacker (eds.). 1985. Species of special concern. Unpubl. Rep., Colorado Wildlife Workshop.

Table 1: A comparison of the pre-opening (1999) and post-opening (2000) relative abundance index (RAI) ^a of bird species along the Lichen Trail.

Species	1999 RAI	2000 RAI	Trend ^b
Broad-tailed Hummingbird	0.17	0.39	++
Western Wood-Pewee	0.22	0.39	+
Hammond's Flycatcher	0.17	0.06	--
Steller's Jay	0.17	0.17	=
Mountain Chickadee	0.28	0.22	=
Pygmy Nuthatch	0.00	0.17	++
White-breasted Nuthatch	0.00	0.11	+
Rock Wren	0.11	0.22	++
American Robin	0.61	0.56	=
Plumbeous Vireo	0.28	0.17	-
Western Tanager	0.41	0.41	=
Brown-headed Cowbird	0.17	0.11	-
Lark Sparrow	0.28	0.17	-
Chipping Sparrow	0.61	0.22	--
Spotted Towhee	0.33	0.11	--
Lesser Goldfinch	0.06	0.33	++

^a Only birds with relative abundance > 0.1 individuals/count are included.

^b Strongly Positive (++), Positive (+), No Trend (=), Negative (-), Strongly Negative (--).

Table 2: A comparison of the pre-opening (1999) and post-opening (2000) nesting success of birds at the Heil Ranch parking and picnic area.

Species	Year	# Nests	% Predated	% Parasitized
Mourning Dove	1999	1	0	0
	2000	1	0	0
Broad-tailed Hummingbird	1999	1	0	0
	2000		None Located	
Western Wood-Pewee	1999	4	0	0
	2000	4	25	25
Hammond's Flycatcher	1999	1	0	0
	2000	1	100	0
American Robin	1999	1	0	0
	2000	3	33	0
Plumbeous Vireo	1999	4	3	75
	2000	2	1	50
Western Tanager	1999	1	0	0
	2000	2	50	0
Lark Sparrow	1999		None Located	
	2000	1	100	0
Chipping Sparrow	1999	3	100	0
	2000	3	67	33
Lesser Goldfinch	1999		None Located	
	2000	2	50	0

Appendix 1: Relative abundance^a of selected bird species on the Heil Ranch property, 2000.

Species	PIPO (N = 10)	PIPO / PSME (N = 8)	PIPO / RIPE (N = 3)	PIPO / SAVA (N = 9)
Cooper's Hawk				#
Mourning Dove	0.20 ± 0.17	0.21 ± 0.25	0.33 ± 0.33	0.15 ± 0.24
Common Nighthawk				#
Broad-tailed Hummingbird	0.21 ± 0.24	0.50 ± 0.71	0.83 ± 0.24	
Hairy Woodpecker	#	#	0.11 ± 0.19	
Northern Flicker	#	#		#
Western Wood-Pewee	#		0.33 ± 0.29	0.41 ± 0.47
Cordillieran Flycatcher		#	0.78 ± 0.19	0.11 ± 0.11
Hammond's Flycatcher	#	0.22 ± 0.38	0.13 ± 0.17	
Violet-green Swallow	#	#	#	#
Steller's Jay	0.17 ± 0.23	0.10 ± 0.15	0.33 ± 0.17	0.11 ± 0.17
Common Raven	#	#	#	#
House Wren		#	0.78 ± 0.51	#
Canyon Wren			0.33 ± 0.33	
Rock Wren			0.11 ± 0.19	0.19 ± 0.29
Blue-gray Gnatcatcher				#
Mountain Chickadee	0.27 ± 0.22	0.33 ± 0.44	0.11 ± 0.19	0.26 ± 0.28
Black-capped Chickadee			0.22 ± 0.19	#
White-breasted Nuthatch	0.27 ± 0.30	0.25 ± 0.33	0.33 ± 0.17	0.11 ± 0.17
Pygmy Nuthatch	0.20 ± 0.32	0.46 ± 0.43		0.33 ± 0.24
American Robin	0.23 ± 0.22	0.46 ± 0.25	0.89 ± 0.19	0.52 ± 0.34

Appendix 1: Relative abundance^a of selected bird species on the Heil Ranch property.

Species	PIPO (N = 10)	PIPO / PSME (N = 8)	PIPO / RIPE (N = 3)	PIPO / SAVA (N = 9)
Townsend's Solitaire	0.20 ± 0.23	0.21 ± 0.25		#
Plumbeous Vireo		#	0.33 ± 0.33	0.29 ± 0.39
Warbling Vireo			0.33 ± 0.33	
Virginia's Warbler		#	0.56 ± 0.38	0.15 ± 0.24
MacGillivray's Warbler			0.44 ± 0.38	
Audubon's Warbler		0.17 ± 0.18		#
Western Meadowlark				0.18 ± 0.24
Western Tanager	0.20 ± 0.17	0.58 ± 0.43	0.56 ± 0.19	0.41 ± 0.40
Lazuli Bunting			0.78 ± 0.19	#
Black-headed Grosbeak			0.22 ± 0.19	#
Brown-headed Cowbird		#		0.11 ± 0.17
Spotted Towhee		#	0.33 ± 0.33	0.15 ± 0.29
Lark Sparrow				0.19 ± 0.24
Chipping Sparrow	0.37 ± 0.33	0.92 ± 0.43		0.52 ± 0.58
Gray-headed Junco		0.67 ± 0.25	0.11 ± 0.19	
Lesser Goldfinch	0.10 ± 0.16	0.13 ± 0.17	0.22 ± 0.38	0.44 ± 0.29
Pine Siskin	#			#
House Finch				#
Red Crossbill		#		#

^a Mean number of detections per location. A # indicates the species was detected in that habitat, but only as flyovers, or in relative abundance of less than 0.1 individual per point count.

Appendix 2: Breeding status of selected bird species on the Heil Ranch property, 2000.

Species	Nest Type	Breeding Status	Reason for Status
Blue Grouse	Ground	Confirmed	Fledged Young
Common Nighthawk	Ground	Confirmed	Nests Located (4)
Mourning Dove	Open Cup	Confirmed	Nests Located (11)
Broad-tailed Hummingbird	Open Cup	Confirmed	Nests Located (2)
Western Wood-Pewee	Open Cup	Confirmed	Nests Located (19)
Cordillieran Flycatcher	Open Cup	Confirmed	Fledged Young
Hammond's Flycatcher	Open Cup	Confirmed	Nests Located (2)
Violet-Green Swallow	Cavity	Confirmed	Fledged Young
Steller's Jay	Stick	Confirmed	Fledged Young
House Wren	Cavity	Confirmed	Fledged Young
Rock Wren	Cavity	Confirmed	Fledged Young
Canyon Wren	Cavity	Confirmed	Fledged Young
Blue-gray Gnatcatcher	Open Cup	Confirmed	Nests Located (3)
Mountain Chickadee	Cavity	Confirmed	Cavities Located
White-breasted Nuthatch	Cavity	Confirmed	Fledged Young
Pygmy Nuthatch	Cavity	Confirmed	Cavities Located
Common Bushtit	Hanging	Probable	Flock
American Robin	Open Cup	Confirmed	Nests Located (11)
Townsend's Solitaire	Open Cup	Confirmed	Fledged Young
Plumbeous Vireo	Open Cup	Confirmed	Nests Located (11)
Warbling Vireo	Open Cup	Confirmed	Nests Located (1)
Virginia's Warbler	Open Cup	Confirmed	Fledged Young
Audubon's Warbler	Open Cup	Probable	Territorial Male

Appendix 2: Breeding status of selected bird species on the Heil Ranch property (continued).

Species	Nest Type	Breeding Status	Reason for Status
MacGillivray's Warbler	Open Cup	Confirmed	Fledged Young
Western Tanager	Open Cup	Confirmed	Nests Located (10)
Lazuli Bunting	Open Cup	Confirmed	Nests Located (1)
Black-headed Grosbeak	Open Cup	Confirmed	Nests Located (3)
Brown-headed Cowbird	Brood Parasite	Confirmed	Parasitized Nests
Spotted Towhee	Open Cup	Confirmed	Nests Located (1)
Lark Sparrow	Open Cup	Confirmed	Nests Located (6)
Chipping Sparrow	Open Cup	Confirmed	Nests Located (13)
Gray-headed Junco	Open Cup	Confirmed	Fledged Young
Red Crossbill	Open Cup	Probable	Pairs
Pine Siskin	Open Cup	Probable	Pairs
Lesser Goldfinch	Open Cup	Confirmed	Nests Located (14)

Appendix 3: Breeding biology of selected bird species on the Heil Ranch Property, 2000.

Species	# Nests	# Abandoned	# Predated	# Parasitized	Mean ^a Clutch Size	Mayfield ^b Nest Success
Common Nighthawk	5	0	2	0	2.0 (n = 4)	--
Mourning Dove	11	3	3	0	2.0 (n = 11)	0.28
Broad-tailed Hummingbird	2	0	1	0	2.0 (n = 1)	--
Western Wood-Pewee	19	3	5	2	2.9 (n = 14)	0.62
Hammond's Flycatcher	2	0	2	0	4.0 (n = 2)	--
Blue-gray Gnatcatcher	3	0	1	1	---	--
American Robin	11	2	3	0	3.4 (n = 8)	--
Plumbeous Vireo	11	0	3	8	3.7 (n = 3)	0.70
Warbling Vireo	1	0	1	(1) ^c	---	--
Western Tanager	10	0	5	2	4.0 (n = 2)	0.36
Lazuli Bunting	1	0	0	0	---	--
Black-headed Grosbeak	2	0	2	0	3.0 (n = 1)	--
Spotted Towhee	1	0	0	0	3.0 (n = 1)	--
Lark Sparrow	6	0	3	1	3.5 (n = 4)	0.46
Chipping Sparrow	12	0	5	1	4.0 (n = 4)	0.49
Lesser Goldfinch	14	0	4	0	3.6 (n = 9)	0.72

^a Includes only non-parasitized nests found before egg-hatching.

^b Mayfield (1975).

^c The Warbling Vireo apparently rejected a cowbird egg from their nest.