Effects of Thinning, Prescribed Burning, and Trail Use on Ponderosa Pine Forest Birds on Heil Ranch, Boulder County Open Space.

Year-end Report

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11 October 2001

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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, 2000, and 2001 we gathered data on the distribution, abundance and breeding biology of bird populations on the Heil Ranch property. These data have been taken prior to the implementation of forest management plans, and the increase in human use associated with the opening of trails on this property, and 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 (*Psuedotsuga 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 ponderosa pine forest occurs at a lower elevation than historically (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; Veblen et al., 2000). The proposed prescribed thinning and 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, granivorous, 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 in a manner similar to cowbirds and may also negatively impact open-cup nesting songbirds.

Nonconsumptive 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), and recreationists may disturb nesting birds and inadvertently advertise nest locations to predators (Gutzwiller, 1995).

In our original proposal submitted in 1999 we outlined three major goals for our research on the Heil Ranch property. These goals were to:

1: Compare the response of bird species richness and abundance to thinning and/or 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 over the past 3 summers 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 prior to high levels of disturbance associated with the opening of trails for human use on the property. We report here our analysis of these 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 and 2001, 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 and 2001 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 *(Psudotsuga 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.

Avian Censusing: From June 1 through July 15 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 0530 and 1000, with most counts being completed by 0900. For each point a Relative Abundance Index (RAI) was determined using the following formula:

Total Number of Independant Observations of Birds/Total Number of Census Periods

Each singing male, pair or family group of birds observed or heard was considered an independant observation for the purpose of this study. Only birds seen or heard withing 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 locations were marked with flagging placed 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. Contents were observed directly or with a 6-m mirror pole. Efforts were made not to influence natural rates of nest success using methods designed to prevent nest abandonment and the location of nests by predators(Picozzi, 1975; Westmoreland and Best, 1985; Major, 1989; Martin and Geupel, 1993).

We analyzed nesting success of species for which we found more than 6 nests using the Mayfield method (Mayfield, 1976) 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 1 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 the following vegetation variables 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 1 meter 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 and Shugart, 1970; Martin and Roppert, 1988).

We are currently in the process of analyzing all our nest site data and comparing it to data taken at random sites. This analysis should allow us to determine whether some species prefer specific microsite characteristics for their nests. we expect to complete this analysis over the next 6-9 months.

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. As above, this analysis is to be performed over the next 6-9 months.

Results for the 2001 Season

Avian Censusing: In 2001 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 37 bird species at our point count locations on Heil Ranch in 2001 (Appendix 1). Our 3 years of point counts indicate that species typical of riparian areas (e.g. Warbling Vireo, Black-headed Grosbeak) and foothills scrub habitat (e.g. Blue-Gray Gnatcatcher, Spotted Towhee) are generally uncommon on Heil Ranch, as there are few extensive patches of these vegetation types. Species typical of grasslands (e. g. Western Meadowlark, Lark Sparrow) are also present in low numbers in open meadows and savannah-like ponderosa areas. Species typical of Ponderosa Pine forests are widespread on the Heil Ranch property, and a few species typical of higher montane coniferous forests (e. g. Townsend's Solitaire, Gray-headed Junco) are present, especially near the western edge of the property. The avian community on Heil Ranch appears to be similar to that of other Ponderosa Pine dominated open space properties in Boulder County (pers. obs.).

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 (pers. obs.). In contrast, Steller's Jay, Mourning Dove, and cavity-nesting species such as Mountain Chickadees and nuthatches, were in more even numbers across habitats.

A comparison of abundance data over the period 1999-2001 suggests that most birds had relatively similar numbers between years. There was a significant production of cones by the ponderosa pines in 2001, resulting in dramatically increased numbers of Red Crossbills and Pygmy Nuthatches. However, Mountain Chickadees were in lower numbers, perhaps as a result of competition with Pygmy Nuthatches for nest sites. Additionally, numbers of Townsend's Solitaires and Broad-tailed Hummingbirds were greatly increased for unknown reasons, a trend that was apparent across all of our study sites in Boulder County. In general, numbers of other species appeared to be lower than in previous years, but none of these species showed dramatic changes in abundance.

Too look for signs that the opening of the Heil Ranch property for public use was already impacting the breeding bird community, we compared the relative abundance of birds at 6 point counts located near the recently opened parking lot and Lichen Trail. This comparison did not reveal any consistent trends in the relative abundance of bird species over the 3-year period (Table 1). In general, more species appeared to be declining than increasing. However, trends were not stong enough among species guilds to say this was due to the increased disturbance associated with use of the trail, and the trends probably reflect annual variation.

Breeding Productivity: In 2001, we located and monitored 101 nests of 15 species (Appendix 2). We located and monitored nests of 3 new species, Vesper Sparrow, Red Crossbill, and House Finch, for which we had no nesting data in previous years. Over the 3 year period we have located and monitored 278 nests of 22 species (Appendix 3). Additionally we have confirmed nesting by 14 other species (Appendix 3), primarily cavity nesters; nests of which we did not monitor.

Overall, we found slightly fewer nests in 2001 than we did in 2000. In general, we found lower numbers of nests of the more common ponderosa breeding species in 2000. Additionally, we found no nests of Common Nighthawks (5 nests in 2000) or Blue-gray Gnatcatchers (3 nests in 2000). However, we located higher numbers of nests of American Robins (20 vs. 11) and Lesser Goldfinches (20 vs. 14) in 2001 and

also found 3 nests of Townsend's Solitaires. We had only located 1 nest of this species in the previous 2 seasons. The latter species were also much more abundant in point counts in 2001 than in previous years.

Analysis of nesting success using the Mayfield method (Mayfield, 1976) shows that there is a large amount of annual variation in nesting success of the various avian taxa on Heil Ranch (Table 2). In 2001, nesting success of American Robins and Western Tanagers increased, while nesting success of Western Wood-Pewees and Lesser Goldfinches decreased in relation to previous seasons. Much of the predation of Wood-Pewee and Lesser Goldfinch nests took place after the young had hatched. We believe Steller's Jays are the most likely culprit. In any case, due to the large amount of annual variation in nesting success of the different species, changes in nesting success found in later studies should be interpreted with caution.

Of particular note is the very low nesting success of Mourning Doves in all seasons. This appears to be largely due to nest abandonment by the doves. Often, individuals of this species do not return to the nest if they are flushed early in the breeding cycle. Since most nests are located accidentally by flushing the bird, the result is a high rate of nest failure. Nest abandonment also appears to be more likely early in the breeding season, though we do not have enough data to state this conclusively. Other studies have shown that Mourning Doves are particularly susceptible to disturbance near their nests (Westmoreland and Best, 1985).

Cowbirds were detected less often in 2001 (2 detections) than in 2000 (4 detections) or 1999 (10 detections). Brood parasitism by cowbirds in 2001, did not decrease dramatically, however (Appendix 3). In 1999, at least 5 of 48 potential host nests (10.4%) were parasitized and in 2000, at least 14 of 82 potential host nests (17.1%) were parasitized. In 2001, at least 10 of 69 potential host nests (14.5%) were parasitized, compared to 5 of 48 (10.4%) nests in 1999, and 14 of 82 (17.1%) nests in 2000. In general, based on data from our other sites in City of Boulder Mountain Parks and Open Space, rates of cowbird parasitism appeared to increase in Boulder County in 2001, though cowbird numbers did not. We hypothesize the wet spring may have increased potential food supplies for cowbirds, allowing individual females to lay more eggs.

In order to look at how the opening of the Heil Ranch property was affecting nesting success of birds, we compared 1999, 2000, and 2001 nesting success for those nests located in and around the parking lot and picnic area (Table 3). In 1999, 10 nests fledged young (62.5%), and 6 were predated. In 2000, nine nests fledged young (50.0%), 8 were predated, and 1 was abandoned. In 2000, 16 of 24 nests fledged young (66.7%), 7 were predated, and 1 was abandoned. In 1999, 3 of 16 nests (18.8%) were

parasitized, while 3 of 18 nests (16.7%) were parasitized in 2000, and 3 of 24 (12.5%) nests were parasitized in 2001. These numbers for both parasitism and predation are close and suggest there were no major changes in nesting success of birds breeding around the picnic area in 2001. The species of nesting birds found around the parking lot was also similar in all 3 years.

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 and 2001 data should be used to look for impacts of disturbance on the breeding bird community. However, these disturbances were relatively light and our data suggest they 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 from 1999 through 2001. We therefore conclude that we may use data from these 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 in the immediate future and again 3-5 years in the future in order to assess impacts. We believe that a suite of ground nesting species are likely to be most affected by this increase in disturbance. These species include Common Nighthawk, Mourning Dove, Twonsend's Solitiare, and Lark Sparrow. Because they nest on the ground 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 over the past 3 years, and it will be interesting to see if nests of these species are found near the trail in the future. Numbers of these species detected on point counts should also be monitored to look for changes in abundance near the trail. We find

relatively few nests of these species in Boulder Mountain Parks, where human use is far greater than at Heil Ranch, suggesting these species avoid nesting in those areas. Additionally, the Mourning Dove is of particular concern because it is rather prone to abandoning its nests if disturbed often. During our research on Heil Ranch we have had 9 Mourning Doves abandon their nests (2 in 1999, 3 in 2000, 4 in 2001) 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 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 corvids, to the picnic area and surrounding habitat. Both squirrels and jays are known to respond positively to human disturbance (Craig, 1997; Knight and Cole, 1995), probably because they take advantage of the additional food left by hikers and picnickers, and both are common nest predators around Boulder County. 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. Cowbird parasitism is also often, but not always linked to human disturbance (Tewksbury et al., 1998). However, we feel that the removal of cattle from the Heil Ranch property in 1999 has probably resulted in the observed decrease in cowbird activity on the property. In ponderosa ecosystems cowbird abundance has been shown to decrease dramatically with distance from areas grazed by cattle (Goguen and Mathews, 2000), which are the primary feeding areas of cowbirds. Nevertheless, cowbird activity should be monitored closely in the future.

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 noteably the Western Wood-Pewee, Plumbeous Vireo, Western Tanager, and Lark Sparrow. Indeed, there is a small amount of evidence that thinning associated with the construction of the trail has resulted in new territories of some of the above species in areas where we did not previously detect them. However, these data are tentative as thinning operations have only just started on the property and were not yet extensive at the end of the 2001 field season. Furthermore, thinning of forest will make it much more open, which could produce negative effects, such as an increase in cowbird brood-parasitism (e.g. Chace and Cruz, 1999), and reduce numbers of species that like thicker woodlands, such as Townsend's Solitaire. 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.

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.

Dobkin, D. S. 1994. Conservation and management of Neotropical migrant landbirds in the northern Rockies and Great Plains. Univ. of Idaho Press. Moscow, ID.

Finch, D. M., J. L. Ganey, W. Yong, R. T. Kimball, and R. Sallabanks. 1997. Effects andinteractions 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.

Goguen, C. B. and N. E. Mathews. 2000. Local gradients of cowbird abundance and parasitism relative to livestock grazing in a western landscape. Conservation Biology 14: 1862-1869.

Gotmark, F. 1992. The effects of investigator disturbance on nesting birds. Current Ornithology 9: 63-104.

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., and H. H. Shugart 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 G. R. Geupel. 1993. Nest-monitoring plots: methods for locating nests and monitoring success. Journal of Field Ornithology 64: 507-519.

Martin, T. E. and J. J. Roppert. 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.

Picozzi, N. 1975. Crow predation on marked nests. J. of Wildlife Manage. 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.

Tewksbury, J. J., S. J. Hejl, and T. E. Martin. 1998. Breeding productivity does not decline with increasing fragmentation in a western landscape. Ecology 79: 2890-2903.

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.

Veblen, T. T., T. Kitzberger, and J. Donnegan. 2000. Climatic and human influences on fire regimes in ponderosa pine forests in the Colorado front range. Ecological Applications 10: 1178-1195.

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	2001 RAI	Trend [b]
Mourning Dove	0.11	0.20	0.17	=
Broad-tailed Hummingbird	0.17	0.39	0.11	?
Western Wood-Pewee	0.22	0.39	0.27	=
Hammond's Flycatcher	0.17	0.06	0.00	-
Steller's Jay	0.17	0.17	0.33	+
Mountain Chickadee	0.28	0.22	0.00	-
Pygmy Nuthatch	0.00	0.17	0.50	+
Rock Wren	0.11	0.22	0.11	?
American Robin	0.61	0.56	0.27	-
Plumbeous Vireo	0.28	0.17	0.22	=
Western Tanager	0.41	0.41	0.22	-
Brown-headed Cowbird	0.17	0.11	0.00	-
Lark Sparrow	0.28	0.17	0.11	-
Chipping Sparrow	0.61	0.22	0.33	?
Spotted Towhee	0.33	0.11	0.27	?
Lesser Goldfinch	0.06	0.33	0.11	?

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

[b] Increasing (+), Stable (=), Decreasing (-), No Trend or Unclear Trend (?)

Table 2: Annual variation in Mayfield Nest Success (MNS)[a] calculations for selected species on the Heil Ranch Property.

Species	1999 MNS	2000 MNS	2001 MNS
Mourning Dove	0.32	0.28	0.15
Western Wood-Pewee	0.68	0.62	0.33
American Robin	---	0.58	0.77
Plumbeous Vireo	0.24	0.70	0.52
Western Tanager	0.38	0.36	0.52
Chipping Sparrow	0.16	0.49	0.25
Lesser Goldfinch	---	0.72	0.44

[a] Proportion of nests successfully fledging young as estimated by the Mayfield (1976) method.

Table 3: A comparison of the pre-opening (1999) and post-opening (2000/2001) 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
	2001	0	-	-
Broad-tailed Hummingbird	1999	1	0	0
	2000	0	-	-
	2001	2	50	0
Western Wood-Pewee	1999	4	0	0
	2000	4	25	25
	2001	4	25	0
Hammond's Flycatcher	1999	1	0	0
	2000	1	100	0
	2001	1	0	100
American Robin	1999	1	0	0
	2000	3	33	0
	2001	6	13	0
Plumbeous Vireo	1999	4	75	75
	2000	2	50	50
	2001	2	50	50
Western Tanager	1999	1	0	0
	2000	2	50	0
	2001	2	0	50
Chipping Sparrow	1999	3	100	0
	2000	3	67	33
	2001	2	50	0
Lesser Goldfinch	1999	0	-	-
	2000	2	50	0
	2001	5	40	0

Appendix 1: Relative abundance[a] of selected bird species on the Heil Ranch property, 2001.

Species	PIPO (N = 10)	PIPO / PSME (N = 8)	PIPO / RIPE (N = 3)	PIPO / SAVA (N = 9)
Mourning Dove	0.29 ± 0.26	0.46 ± 0.39	0.22 ± 0.43	0.20 ± 0.23
Common Nighthawk				#
Broad-tailed Hummingbird	#	0.12 ± 0.35	0.44 ± 0.19	0.10 ± 0.16
Hairy Woodpecker	#	#		#
Northern Flicker	#	#		#
Western Wood-Pewee	#		0.33 ± 0.58	0.23 ± 0.35
Cordillieran Flycatcher	#	#	0.44 ± 0.51	0.10 ± 0.32
Hammond's Flycatcher		#	0.44 ± 0.51	#
Violet-green Swallow	#	#	#	#
Steller's Jay	#	0.17 ± 0.25	0.33 ± 0.17	0.20 ± 0.28
Common Raven		#		
House Wren		#	0.56 ± 0.19	
Canyon Wren			0.22 ± 0.19	
Rock Wren			0.22 ± 0.38	
Mountain Chickadee	0.11 ± 0.24		0.33 ± 0.33	#
White-breasted Nuthatch	0.27 ± 0.30	0.25 ± 0.33	0.33 ± 0.17	0.11 ± 0.17
Red-breasted Nuthatch			0.11 ± 0.19	
Pygmy Nuthatch	0.48 ± 0.34	0.17 ± 0.25		0.40 ± 0.41
American Robin	0.37 ± 0.20	0.42 ± 0.34	0.67 ± 0.33	0.30 ± 0.33
Townsend's Solitaire	0.33 ± 0.44	0.13 ± 0.25	0.22 ± 0.38	0.17 ± 0.32
Plumbeous Vireo	0.11 ± 0.17	#	0.11 ± 0.19	0.17 ± 0.23

Appendix 1: Relative abundance[a] of selected bird species on the Heil Ranch property (continued).

Species	PIPO (N = 10)	PIPO / PSME (N = 8)	PIPO / RIPE (N = 3)	PIPO / SAVA (N = 9)
Warbling Vireo			0.44 ± 0.51	
Virginia's Warbler			0.56 ± 0.38	
MacGillivray's Warbler			0.22 ± 0.38	
Audubon's Warbler		0.17 ± 0.36		
Western Meadowlark	#			0.17 ± 0.36
Western Tanager	0.15 ± 0.24	0.37 ± 0.37	0.67 ± 0.58	0.30 ± 0.33
Lazuli Bunting			0.67 ± 0.33	#
Brown-headed Cowbird			0.22 ± 0.38	
Spotted Towhee			0.33 ± 0.33	0.13 ± 0.32
Lark Sparrow	#			0.20 ± 0.32
Chipping Sparrow	0.41 ± 0.46	0.92 ± 0.15		0.57 ± 0.44
Gray-headed Junco		0.13 ± 0.17		#
Lesser Goldfinch	#	#	0.22 ± 0.38	0.13 ± 0.28
Pine Siskin		#		
House Finch	#			
Red Crossbill	0.15 ± 0.24	0.13 ± 0.17		#

[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 biology of selected bird species on the Heil Ranch Property, 2001.

Species	# Nests	# Abandoned	# Predated	# Parasitized	Mean [a] Clutch Size	Mayfield [b] Nest Success
Mourning Dove	9	4	1	0	2.0 (n = 7)	0.15
Broad-tailed Hummingbird	2	0	1	0	2.0 (n = 1)	- -
Western Wood-Pewee	14	1	7	0	2.8 (n = 12)	0.33
Hammond's Flycatcher	1	0	0	1	- - -	- -
American Robin	18	1	2	0	3.2 (n = 13)	- -
Townsend's Solitaire	3	0	1	0	4.0 (n = 2)	- -
Plumbeous Vireo	7	1	3	4	4.0 (n = 3)	0.52
Warbling Vireo	1	0	0	1	- - -	- -
Western Tanager	10	0	1	3	4.0 (n = 2)	0.52
Lark Sparrow	2	0	0	0	- - -	- -
Vesper Sparrow	1	0	0	0	4.0 (n = 1)	- -
Chipping Sparrow	09	0	3	1	3.0 (n = 2)	0.25
Lesser Goldfinch	20	1	7	0	4.0 (n = 14)	0.44
House Finch	1	0	1	0	3.0 (n = 1)	- -
Red Crossbill	1	0	0	0	- - -	- -

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

[b] Mayfield (1975).

Appendix 3: Breeding status of selected bird species on the Heil Ranch property, 1999 - 2001.

Species	Nest Type	Breeding Status	Reason for Status
Common Poorwill	Ground	Confirmed	Nests Located (01)
Common Nighthawk	Ground	Confirmed	Nests Located (06)
Mourning Dove	Open Cup	Confirmed	Nests Located (28)
Broad-tailed Hummingbird	Open Cup	Confirmed	Nests Located (07)
Hairy Woodpecker	Cavity	Probable	Cavities Located
Western Wood-Pewee	Open Cup	Confirmed	Nests Located (44)
Cordillieran Flycatcher	Open Cup	Confirmed	Fledged Young
Hammond's Flycatcher	Open Cup	Confirmed	Nests Located (04)
Violet-Green Swallow	Cavity	Confirmed	Cavities Located
Steller's Jay	Open Cup	Confirmed	Fledged Young
House Wren	Cavity	Confirmed	Fledged Young
Rock Wren	Cavity	Confirmed	Cavities Located
Canyon Wren	Cavity	Confirmed	Cavities Located
Blue-gray Gnatcatcher	Open Cup	Confirmed	Nests Located (03)
Mountain Chickadee	Cavity	Confirmed	Cavities Located
Red-breasted Nuthatch	Cavity	Probable	Pairs
White-breasted Nuthatch	Cavity	Confirmed	Cavities Located
Pygmy Nuthatch	Cavity	Confirmed	Cavities Located
Common Bushtit	Hanging	Probable	Flocks
American Robin	Open Cup	Confirmed	Nests Located (33)
Townsend's Solitaire	Open Cup	Confirmed	Nests Located (04)
Plumbeous Vireo	Open Cup	Confirmed	Nests Located (26)
Warbling Vireo	Open Cup	Confirmed	Nests Located (02)

Appendix 3: Breeding status of selected bird species on the Heil Ranch property (continued).

Species	Nest Type	Breeding Status	Reason for Status
Virginia's Warbler	Open Cup	Confirmed	Fledged Young
Audubon's Warbler	Open Cup	Confirmed	Fledged Young
MacGillivray's Warbler	Open Cup	Confirmed	Fledged Young
Western Tanager	Open Cup	Confirmed	Nests Located (10)
Lazuli Bunting	Open Cup	Confirmed	Nests Located (03)
Black-headed Grosbeak	Open Cup	Confirmed	Nests Located (05)
Brown-headed Cowbird	Brood Parasite	Confirmed	Parasitized Nests
Spotted Towhee	Open Cup	Confirmed	Nests Located (02)
Lark Sparrow	Open Cup	Confirmed	Nests Located (09)
Vesper Sparrow	Open Cup	Confirmed	Nests Located (01)
Chipping Sparrow	Open Cup	Confirmed	Nests Located (31)
Gray-headed Junco	Open Cup	Confirmed	Fledged Young
Red Crossbill	Open Cup	Confirmed	Nests Located (01)
House Finch	Open Cup	Confirmed	Nests Located (01)
Pine Siskin	Open Cup	Confirmed	Nests Located (01)
Lesser Goldfinch	Open Cup	Confirmed	Nests Located (35)