Effects of Thinning and Prescribed Burning on Ponderosa Pine Forest Birds on City of Boulder Open Space

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Abstract

The foothill ponderosa pine forests along the Colorado Front Range are an important, unique and understudied habitat. Ponderosa pine forests are important to a variety of wildlife species, including Neotropical migrant and resident songbirds. Specific stands of ponderosa pine on City of Boulder Open Space are slated for thinning and/or burning to "maintain or enhance native plant and animal species, their communities, and the ecological processes that sustain them" (Goal #1 *of* City of Boulder Forest Ecosystem Management Plan 1999, p. iii). As part of this goal, in the spring and summer of 2000, we set up 6 study sites (2 control, 2 thinning and burning, and 2 burning) and gathered baseline data on abundance, diversity and nesting success of Neotropical migrant birds. Our data on 71 nests, territory information for the breeding season, and abundance data during fall migration provide insightful baseline information for use in future comparisons after treatment. In addition, our data suggest the nature of the bird community present in the plots, and the appropriate management for enhancing this community. Our data show that two of the plots, S3 North and S3 South support a depauperate avian community and a low rate of nesting. As a result, they offer a great opportunity for use of more extreme management measures. Watertank West and Watertank East plots show a diverse and abundant breeding bird community so lower intensity management will be appropriate for these stands. Finally, D2 and D3/D4 will serve as appropriate controls for these four treatment stands in future comparisons of bird community responses.

Introduction

Foothill ponderosa pine (*Pinus ponderosa*) is fairly common along the east slope of the Colorado Front Range, extending north and south along the entire length of the state (Little 1971). It 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. These include shrubs, herbaceous plants, mixed grass and rock outcrops (Forest Ecosystem Management Plan 1999). A number of Neotropical migrants breed in ponderosa pine and adjacent montane riparian and shrubland habitats of Boulder County, including the Broad-tailed Hummingbird (*Selasphorus platycercus*), Blue-gray Gnatcatcher (*Polioptila caerulea*), Western Wood-pewee (*Contopus sordidulus*), Hammond's Flycatcher (*Empidonax hammondii*), Dusky Flycatcher (*E. oberholseri*), Cordilleran Flycatcher (*E. occidentalis)*, Plumbeous Vireo (*Vireo Plumbeus*), Warbling Vireo (*Vireo gilvus*), Virginia's Warbler (*Vermivora virginiae*), Audubon's Warbler (*Dendroica coronata*), MacGillivray's Warbler (*Oporornis tolmiei*), Western Tanager (*Piranga ludoviciana*), Black-headed Grosbeak (*Pheucticus melanocephalus*), Spotted Towhee (*Pipilo macalatus*), Green-tailed Towhee (*P. chlorurus*), and Chipping Sparrow (*Spizella passerina*) (Cruz et al. 1999). Many of these species are considered sensitive across their southwestern range.

In addition to the sensitive breeding Neotropical migrant species, there are a also a number of migratory species that use ponderosa pine forests during the refueling of their migratory flights in the Spring and Fall. Many of these are members of populations listed above. Migration is a period of exceptional energy demands and small songbirds are generally incapable of storing enough fat reserves for a non-stop migration flight (Berthold 1975, 1993). Therefore, the availability of suitable habitats where depleted fat stores can be safely and rapidly replenished becomes critical to a successful migration (Moore et al. 1995). The fruiting shrubs of the ponderosa pine understory may be an important resource for songbirds during migration. As a result, timing and use of the ponderosa pine forest by fall and spring migrants is important to monitor.

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 (Forest Ecosystem Management Plan 1999). The proposed thinning and burning of ponderosa pine forests on City of Boulder Open Space should restore large-scale disturbance process 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 (Marshall 1963, Hejl 1994, Finch et al. 1997).

This situation presents a unique opportunity to experimentally study the effects of fire and thinning on ponderosa pine forest birds. In order to address this, in 2000 we began a study that will not only provide direct monitoring for the City of Boulder Open Space, but also provide a model by which southwestern pine forest managers can *a priori* evaluate the impacts of these techniques on the bird community. We have monitored the response of Neotropical migrants and residents during the breeding season, obtain demographic information (e.g., nest success, productivity), and evaluated the ponderosa pine forests as stop-over habitat during spring and fall migration. We collected baseline data prior to treatment so that in the future we can measure the responses of the resident bird community to forest burning and thinning.

Methods

Study sites

During the spring and early summer of 2000, we established six study sites with the assistance of City of Boulder staff. Our two control plots are 5.5 and 9.75 ha respectively and are located in the D-2 and D3/D4 stands. Our two burning only sites are located in the Watertank (WTE and WTW from here on) stand and are 11.5 and 10.75 ha each. Our two burning and thinning plots are located within the S3 stand (S3S and S3N) and are 6 and 5.25 ha respectively. We marked each plot with a grid pattern consisting of 50m x 50m cells with aluminum tree tags at each corner. We selected all plots so that whenever possible, they have similar overstory and understory before treatment.

Breeding Productivity

We located a total of 90 nests on the six study plots by observing nesting behavior (Ralph et al. 1993). Once found, we marked nests with a small blue flag > 10 m from the nest. Each nest was monitored at least once every three days from the day it was found until the nest was inactive. We observed nest contents directly or with a 6-m mirror pole. Efforts were made to not attract nest predators to the nest site (Picozzi 1975, Westmoreland and Best 1985, Major 1989). Following nest inactivity, vegetative parameters were measured following James and Shugart (1970), and as modified for the standardized protocol (BBIRD) developed by Martin and Ropper (1988). In addition, we measured distances from the nest to human impacts including: trails, roads, homes, canopy openings, power line right-of-ways, and livestock.

Avian Censusing

In order to measure avian abundance and diversity on the study plots, we used spot mapping. We completed maps by walking the 50-m grid lines on each plot six times during the breeding season and fall migration. Observation periods were between sunrise and four hours after sunrise. Each encounter with an individual was recorded as a location on the map along with the behavior of the individual. This information allowed us to create single-species maps of each of the study sites for the six-week census period. This then provided estimates of the minimum number of territories during the breeding season, or number of individuals detected during migration. Data from fall migration mapping was converted to estimates of average encounters for each species per hour of observation time on each plot. This was calculated using:

$$\frac{\text{Total number of observations for each species}}{\text{Total hours of observation on the study plot}}$$

Results

Breeding Productivity

Overall, we monitored a total of 90 nests of 20 different species. We had concrete success/failure data on 71 of those. The data on nest success as well as rate of parasitism and predation is presented in Tables 1-6. Overall, on all six plots, 59% of the nests were successful at fledging at least one young, 14% were preyed upon and another 26% failed for reasons ranging from abandonment of the nest to mortality of the young due to exposure or other factors. Interestingly, only one nest was found to be parasitized on all of the plots. This rate is much lower than that found by Cruz et al. (2000) in Boulder Mountain Parks between 1997-2000. The D2 control plot had the highest overall nest success (with the exception of S3S with success of the 1 nest in the plot) with 78% of the nests fledging young. The lowest level of nest success was on the WTE plot with only 42% of the nests fledging young.

Avian Abundance and Diversity

Breeding season avian species abundance and diversity data is shown in Table 7 as number of territories/hectare for each species by plot. The WTW plot showed the highest species diversity during the breeding season while the lowest overall diversity during the breeding season was on the S3N plot followed by the S3S plot. These plots show only a few species that are mostly resident species and bark-foraging birds. Overall, D2, D3/D4, WTW and WTE show the highest territory density with S3S and S3N showing the lowest number of territories per hectare.

Fall migration abundance and diversity data is shown in Table 8. Each species is represented by a measure of average observations/hour on each plot. These data show that the two plots S3S and S3N support a lower number of migratory species during this period. However, they do have high numbers of residents and bark-foraging birds. This corresponds quite closely to the data that we collected during the breeding season. The other four plots D2, D3/D4, WTE, WTW all show a relatively large number of migratory species using the plots.

Conclusions

The data we collected during 2000 provides a baseline from which to compare post-treatment avian communities and reproductive success. However, the single year of data does allow some preliminary comparison between sites. Perhaps the most striking feature of the nesting data is the low number of nests in the S3S and S3N sites. The possible reasons for this lie in the nature of the forests on these sites. The even-age structure and lack of understory structure and diversity provide a limited number of nesting resources, which are satisfactory for only a few species. Interestingly, D2 that has the highest success rate of nests also has the highest predation rate. One reason for this may be the open nature of the eastern side of the D2 plot. In addition, its high edge-interior ratio due to its mesa-top characteristic may provide access to more corvid nest predators using habitats surrounding the other plots. D3/D4 and WTW both have a diverse nesting community with an intermediate success rate. The diversity of nesting species suggests that these plots provide a variety of nesting resources attracting both understory and overstory nesting birds. The WTE plot also showed a high diversity of nesting species. However, it had the lowest success rate of all the plots. The reasons for this are unclear although these nests show an intermediate rate of predation and a high level of abandonment.

Breeding season data on territories also show some interesting trends between study plots. Similar to the nesting data, the number of territories during the breeding season was very low in the S3N and S3S plots. Again, this can be explained by the dense nature of these stands and the uniform and low diversity nature of resources available to birds, especially in the understory. D2, D3/D4, WTE and WTW all show high diversity and abundance of territorial birds. As a result, we conclude that these plots provide a diverse habitat and resources necessary for forest birds. Results are similar during the fall migration period. S3N and S3S both show low numbers of migratory species using the plots. This suggests that the forest on the plots does not have resources necessary for migratory species moving through the region.

These data provide some insight into the best management plans for maintenance of neotropical migrant and resident passerine birds on these plots. First of all, it is very clear from these findings that S3S and S3N do not provide good habitat for use by most forest songbirds. As a result, these plots should be treated with a more extreme management protocol. Extensive thinning will be necessary to mimic the type of forest structure present in the other plots that show a broader avian community.

The high diversity and abundance in the WTE and WTW plots show that these plots are more effective at providing habitat for songbirds during the breeding season as well as during migration. This suggests that management of these stands should be less severe perhaps with minimal thinning and low intensity, low heat fire. This treatment would be predicted to enhance the diversity of resources available for forest birds without sacrificing the existence of denser areas as well as more open areas. Because understory structure seems to be important to many birds, efforts to prevent high mortality of shrub roots and seed banks should be avoided by maintaining low intensity of any treatment fires.

The control plots, D2 and D3/D4 also show high diversity and abundance of forest birds with an active breeding bird community with a high rate of nest success. The high level of predation on the D2 plot shows the possible effects of fragmentation and forest edges in increasing predation of open cup nesting species. However, given these limitations of the D2 plot, D2 and D3/D4 appear to provide an excellent control for sites that will be treated with burning and or thinning. These sites both show a diversity of forest structure from more dense areas to open savanna-like forest. As a result, we suggest that these are not treated and left as reference areas that can be used as controls against which to compare the plots that will be treated.

The data that we collected during 2000 provides baseline data for the six plots that we have set up. Following treatment of the four plots S3N, S3S, WTE and WTW these data will allow us to compare changes in the forest bird community within each plot. As a result, we will be able to make appropriate conclusions about the nature of the bird community responses to management with appropriate control plots as well as baseline information on the community present in each plot prior to treatment.

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Table 1. Nest success of passerine birds on control plot D2- City of Boulder Open Space, 2000.

Species	N	Parasitism	Predation	Nest Success
American Robin	2	0%	0%	100%
Black-capped Chickadee	1	0%	0%	100%
Blue-gray Gnatcatcher	1	0%	0%	100%
Lesser Goldfinch	1	0%	0%	100%
Western Wood-pewee	4	0%	25%	50%
Total	9	0%	11%	78%

Table 2. Nest success of passerine birds on control plot D3/D4- City of Boulder Open Space, 2000

Species	N	Parasitism	Predation	Nest Success
American Robin	2	0%	0%	100%
Blue-gray Gnatcatcher	1	0%	0%	100%
Broad-tailed Hummingbird	5	0%	20%	80%
Chipping Sparrow	3	0%	33%	33%
Plumbeous Vireo	5	0%	0%	60%
Pygmy Nuthatch	1	0%	0%	100%
Western Tanager	3	0%	66%	0%
Western Wood-pewee	9	0%	33%	45%
Total	29	0%	4%	55%

Table 3. Nest success of passerine birds on treatment plot WTE- City of Boulder Open Space, 2000

Species	N	Parasitism	Predation	Nest Success
Black-capped Chickadee	2	0%	0%	100%
Blue-gray Gnatcatcher	1	0%	0%	0%
Chipping Sparrow	2	0%	0%	50%
Cedar Waxwing	1	0%	0%	0%
Mourning Dove	1	0%	0%	100%
Western Tanager	1	0%	0%	0%
Western Wood-pewee	4	0%	25%	25%
Total	12	0%	8%	42%

Table 4. Nest success of passerine birds on treatment plot WTW- City of Boulder Open Space, 2000

Species	N	Parasitism	Predation	Nest Success
American Robin	1	0%	0%	100%
Black-capped Chickadee	1	0%	0%	100%
Chipping Sparrow	3	0%	0%	33%
Mountain Chickadee	1	0%	0%	100%
Mourning Dove	1	0%	0%	100%
Northern Flicker	1	0%	0%	100%
Plumbeous Vireo	1	100%	0%	0%
Spotted Towhee	1	0%	100%	0%
Western Tanager	1	0%	0%	100%
Western Wood-pewee	5	0%	0%	60%
Total	16	6%	6%	63%

Table 5. Nest success of passerine birds on treatment plot S3N- City of Boulder Open Space, 2000

Species	N	Parasitism	Predation	Nest Success
Common Nighthawk	1	0%	0%	0%
Mountain Chickadee	2	0%	0%	100%
Townsends Solitaire	1	0%	0%	100%
Total	4	0%	0%	75%

Table 6. Nest success of passerine birds on treatment plot S3S- City of Boulder Open Space, 2000

Species	N	Parasitism	Predation	Nest Success
Chipping Sparrow	1	0%	0%	100%
Total	1	0%	0%	100%

Table 7. Number of territories/ha by site during 2000 breeding season for all six sites- City of Boulder Open Space, 2000.

Species	Number of Territories					
	D2	D3/D4	WTE	WTW	S3N	S3S
American Robin	0.90	0.41	0.17	0.47	0	0
Black-capped Chickadee	0.36	0.51	0.35	0.19	0.19	0.33
Blue-gray Gnatcatcher	0.36	0	0	0	0	0
Broad-tailed Hummingbird	0	0.51	0	0.37	0	0
Cedar Waxwing	0.18	0	0.26	0	0	0
Chipping Sparrow	0.55	0.61	0.70	0.47	0	0.66
Hammond's Flycatcher	0	0	0	0.09	0	0
House Finch	0.36	0.21	0.26	0.37	0	0
Lesser Goldfinch	0.36	0.51	0.44	0.19	0	0.33
MacGillivray's Warbler	0	0.10	0	0	0	0
Mountain Chickadee	0.73	0.10	0.09	0.47	0.76	0.5
Mourning Dove	0.55	0	0.35	0.47	0	0
Northern Flicker	0	0	0	0.19	0	0
Plumbeous Vireo	0	0.62	0.26	0.47	0	0.16
Pygmy Nuthatch	0.36	0.31	0.17	0.47	0.70	0.33
Spotted Towhee	0.36	0.82	0.52	0.93	0	0
White-breasted Nuthatch	0.36	0.41	0.17	0.65	0.70	0.5
Western Tanager	0.18	0.72	0.26	0.47	0.19	0
Western Wood-pewee	1.10	1.03	0.70	1.02	0.57	0.83

Table 8. Mean number of observations per hour of all species by plot during fall migration- City of Boulder Open Space, 2000

Species	Mean number of observations/hour					
	D2	D3/D4	WTE	WTW	S3N	S3S
American Goldfinch	0	0.9	2.1	0.15	0	0
American Robin	3.0	17.7	6.4	2.1	2.4	2.13
Black-capped Chickadee	5.1	0.5	2.7	1.1	1.33	0.53
Brown Creeper	0	0.62	0.9	1.28	0.13	0.67
Cedar Waxwing	0.43	0	0	0	0	0
Chipping Sparrow	1.48	2.8	0.7	.23	0	0.40
Dark-eyed Junco	0.87	2.7	4.7	1.5	0	0.13
Golden-crowned Kinglet	0	0	0	0.4	0	0
House Finch	2.69	2.7	2.4	.53	0	0
Lesser Goldfinch	0.17	3.2	0.9	0	0.27	0.40
MacGillivray's Warbler	0	0.08	0	0	0	0
Mountain Chickadee	0.96	8.88	1.3	3.5	3.47	5.87
Mourning Dove	0	0	0.13	0.15	0	0
Northern Flicker	0.52	2.04	0.9	0.23	0.27	0.53
Pine Siskin	3.13	0.98	0.5	0.15	0	0
Plumbeous Vireo	0	0.71	0	0.23	0.13	0.27
Pygmy Nuthatch	7.1	6.5	2.5	3.9	6.0	6.7
Red-breasted Nuthatch	0.17	6.93	0.4	0.45	1.33	0.27
Ruby-crowned Kinglet	0.26	0.8	1.5	0.6	0	0
Spotted Towhee	1.74	1.5	1.7	1.2	0	0.4
Townsends Solitaire	0.35	5.25	0.3	0.08	0.53	2.4
White-breasted Nuthatch	3.6	2.22	2.0	2.2	2.67	2.8
Yellow-rumped Warbler	0.35	0.8	0.4	0.53	0	0
Western Wood-pewee	0.08	0.09	0	0	0	0