2008 Final Report

Stopover use of thinned vs. unthinned Ponderosa pine forests by neo-tropical migrant passerines in Boulder County, Colorado

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Abstract:

The ecological benefits that natural Ponderosa pine forests provide for both plants and animals are immensely important. However, fire suppression during the past century has prevented natural and frequent ground fires that burn the forests and provide the space and nutrients needed for the growth of new plants. Over the past several decades, forest managers have come to realize the dangers of fire suppression. Current management strategies now include prescribed burns and mechanical thinning. Both strategies have been used in Boulder County to help return Ponderosa pine forests to their natural state. The effects of this management on local wildlife are not well understood however, particularly for actively migrating birds. For this study, we used point counts in two study areas (one thinned, one unthinned) to quantify the abundance, richness and diversity of migrating birds in these areas. This data was then used to compare stopover usage between areas in order to gain a better understanding of how forest thinning impacts migrating passerines.

Introduction:

Preferring drier conditions and moderate elevations, Ponderosa pine forests cover sections of the western United States, including the mountains west of Boulder, Colorado. The ecological benefits these natural forests provide for both plants and animals are immensely important. Ponderosa pines naturally tend to form open sunny forests with wide spaces between trees. The space between trees forms gaps in the canopy, which allows sunlight to penetrate areas of the forest floor and encourage the growth of grass, flowers, seeds and insects that provide the food and habitat for many of the species that live there. (City of Boulder Open Space and Mountain Parks).

The openness of Ponderosa forests results from frequent, natural forest fires that are common in the western U.S. (Christopherson no date). Native wildlife has evolved within this regime. However over a century of fire suppression has prevented these natural and frequent ground fires that burn the forests and provide the space and nutrients needed for the growth of new plants (Christopherson n.d.). In the 1970s, the previous "century of well-intention but misguided land management" (Easing Logging Regulations 2002) was addressed when foresters demonstrated that policies of aggressive suppression had actually been detrimental to forest health and productivity. This change in thought has led to management strategies aimed at reducing the over-accumulation of fuel by mechanical thinning (Wilma 2003).

The impacts of thinning on bird communities are not well understood. Several studies have been conducted to better understand the relationship between bird communities and forests, as well as the birds' ability to acclimate to changes in the understory. For instance, woodpeckers (migrants and residents), flycatchers (migrants), seed-eaters (migrants) and purple martins (migrant) have all been shown to benefit from the habitat created by fires (Hutto 1995, McKelvey et al. 1996, Saab 1997, Caton 1996). However, several studies we found (Caton 1996, Hitchcox 1996) actually indicated that forest thinning could have a negative impact on certain cavity nesting species.

While these studies indicate potentially complex relationships between forest fire suppression and nesting bird communities, we found no literature on the impact of thinning on neo-tropical migrants during their migration. While much research has been done on the ecology of migratory species during their breeding and wintering seasons (Moore et al. 2005), research about their stopover ecology has only just begun. Research on this vital part of migratory species' life cycles will be important to their future conservation efforts.

The goal of our research is to study the impact of Ponderosa pine forest thinning on migratory birds during their spring migration. Local records indicate that many neo-tropical migrants are known to inhabit Ponderosa pine forests in Boulder County during their migration and the health of these forest ecosystems is vital to successful migration and breeding. However, it is unclear what effect forest thinning has had on these species. Swanson (2004) found that insect abundance did vary between forest habitats but found little evidence that this change in abundance effected breeding bird foraging behavior. She did find, however, that insectivorous birds do appear to change their foraging behavior due to shifts in resource abundance more than other guilds.

Since the birds we are investigating are insectivorous, we expect them to show changes in their behavior based on insect abundance. At stopover locations, a migrating bird's top priority is to regain lost fat supplies.Their ability to do so is directly related to the amount of food they can locate (Moore et al. 2005). Since thinned forests have been shown to contain a higher abundance and diversity of insect herbivores than unthinned forests (Ahrens 2004, Adams 2006), we hypothesize that thinned areas will provide better habitat for migrants and thus will contain more migrating individuals than unthinned areas. If this hypothesis is confirmed, it will provide valuable support for the efforts of Boulder County to improve the health of Ponderosa pine forests through thinning. We would also like to emphasize that while this proposal will only apply to one field season, we hope it will lead to a longer term monitoring effort that will provide even more data for future POS decisions.

Methods:

To address the question of how Ponderosa pine thinning has impacted neo-tropical migratory birds, we collected data regarding species abundance, richness and diversity in both thinned and unthinned forests on the Heil Valley Ranch Open Space. Our study site was divided into two areas: one thinned and one unthinned. These areas were approximately the same size in order to limit species variation due to area. Study areas were determined using maps provided by Park and Open Space staff showing past thinning activities on the Ranch.

Within each study area, we established 15 point count locations, each with a 50-meter radius following the methods of Swanson (2004) (Figure 1). The number of points was chosen in order to adequately survey the entire study area. Since these locations were determined from a map, investigators used a handheld GPS unit to locate each point and mark its location using brightly colored flagging prior to conducting counts. After the final count at each location, flagging was removed.

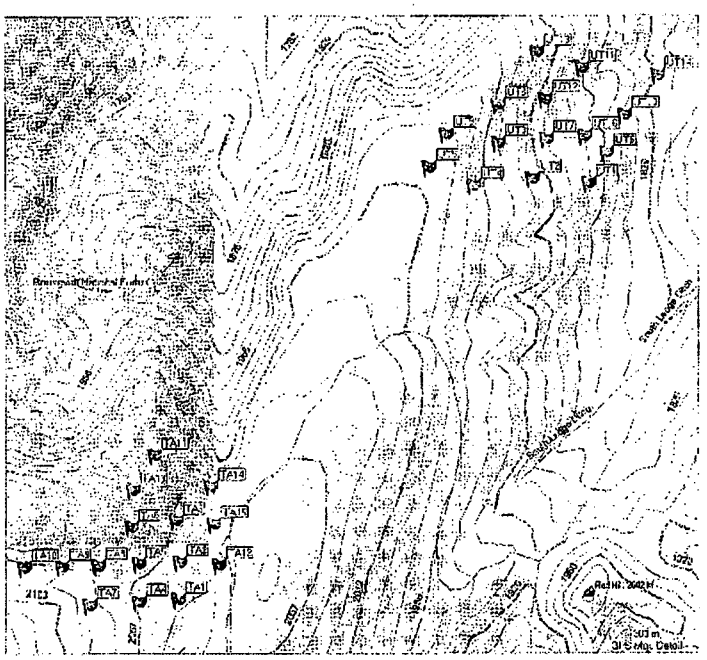


Figure 1: Map of Study Areas and Point Count Locations (TA= thinned, UT=unthinned)

Each point was located at least 150m from its nearest neighbor to assure independence of samples. Investigators conducted 4 point counts for each location during the last two weeks of April and the first two weeks of May. Counts were finished within 4 hours of sunrise in order to observe birds during their most active times. To limit temporal variation, counts were conducted simultaneously in each study area by separate teams of two. At least one observer in each team had experience in identifying birds by both site and sound.The remaining observers were trained prior to conducting counts to assure they had adequate ID skills for birds addressed in this study. To minimize bias based on observer skills, teams alternated study areas each week.

Upon arriving at each point location, observers waited 2 minutes before recording data to allow birds to acclimate to the presence of the observers. Each count lasted 8 minutes and all birds seen and heard within a 50m radius of the point center were recorded, along with their approximate distance from the point center. Although we recorded all birds seen and heard, Table 1 lists only the species used to analyze the impact of forest management on neo-tropical migrants. Only birds actively using the forests (perching, foraging, searching, etc.) were recorded. Thus, no birds observed flying high over the forests were used in the final analysis. Although the timing of this research should have helped limit our observations to birds actively migrating, some birds listed in Table 1 have been recorded nesting within our study site. However, we did not observe any individuals of species listed in table 1 performing any obvious breeding behavior and thus all sittings were considered to be migrants.

Table 1: Bird species included in point count observations

Species:
Hammond's Flycatcher
Western Wood-Pewee
Ruby-crowned Kinglet
Plumbeous Vireo
Warbling Vireo
Orange-crowned Warbler
Virginia's Warbler
Yellow-rumpd Warbler
Townsend's Warbler
Wilson's Warbler
Yellow-breasted Chat
Western Tanager
Black-headed Grosbeak
Lazuli Bunting
Green-tailed Towhee
Chipping Sparrow
White-crowned Sparrow

After all fieldwork was completed, data from each study area was compiled for analysis. First, the total number of individuals of each species was totaled for each of the 4 point count events. Next, the richness, mean diversity (using the Shannon diversity index) and mean species

abundance were calculated for each study area. For this study, richness is defined as the total number of species recorded in each study area. Mean diversity is defined as the mean of the Shannon diversity index calculated for each of the 4 point count events. Mean species abundance is defined as the mean of the number of individuals recorded during each of the 4 point count events.

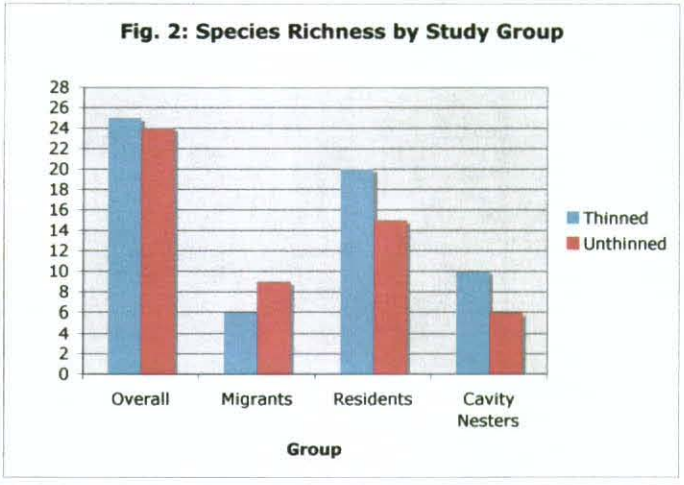
Because the total number of migrants observed was quite low, we decided to also analyze differences in the overall bird community, as well as between residents and cavity nesting species. Due to identification difficulty of Hairy vs. Downy woodpeckers, these two were treated simply as one species in abundance and diversity calculations. However, because both species were positively identified in both study areas, they were treated as two species for the total richness of each area. Differences in the mean diversity of each group mentioned above were analyzed using a paired t-test.

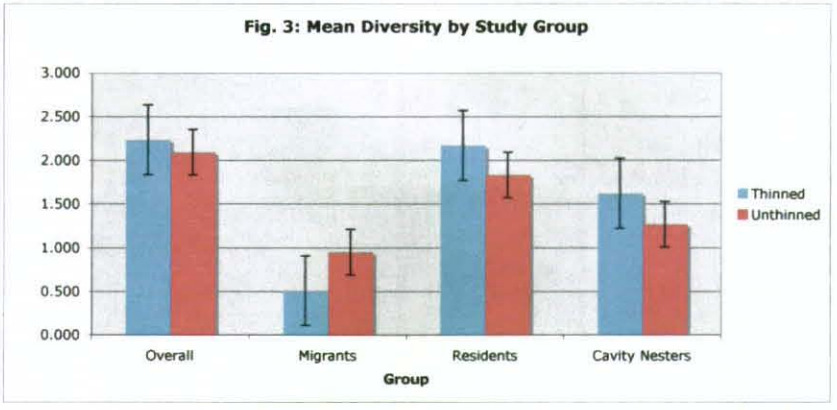
Results:

As mentioned above, the number of migrants recorded during the investigation was much smaller than anticipated (see Table 3). Therefore, we chose to analyze differences in the overall bird communities (Table 2) between the two study areas as well as the differences between residents (Table 4) and cavity nesters (Table 5) diversity. Despite clear differences in the habitat of the two study areas, no significant differences in mean diversity were seen for any of the groups mentioned above (Figure 3, Tables 2-5).

Table 2: Species Recorded (by order of abundance) * indicates species unique to study area

	Thinned	Unthinned
	American Robin (*Turdus migratorius*0	Pygmy Nuthatch (*Sitta pygmaea*)
	Dark-eyed Junco (*Junco hyemalis)*	Dark-eyed Junco (*Junco hyemalis)*
	Mountain Chickadee (*Poecile gambeli*)	Mountain Chickadee (Junco gambeli)
	Chipping Sparrow (*Spizella passerina*)	Hairy/Downy Woodpecker (*Picoides sp.*)
	Pygmy Nuthatch (*Sitta pygmaea*)	Chipping Sparrow (*Spizella passerina*)
	Pine Siskin (*Carduelis pinus*)	White-breasted Nuthatch (*Sitta carolinensis*)
	Red Crossbill (*Loxia curvirostra*)	American Robin (*Turdus migratorius*)
	White-breasted Nuthatch (*Sitta carolinensis*)	Morning Dove (*Zenaida macroura*)
	Red-breasted Nuthatch (*Sitta canadensis*)	Pine Siskin (*Carduelis pinus*)
	Hairy/Downy Woodpecker (*Picoides sp.*)	Ruby-crowned Kinglet (*Regulus calendula*)
	Yellow-rumped Warbler (*Dendroica coronata)*	Steller's Jay (*Cyanositta stelleri*)
	Northern Flicker (*Coloptes auratus*)*	Red-breasted Nuthatch (*Sitta canadensis*)
	Morning Dove (*Zenaida macroura*)	Red Crossbill (*Loxiz curvirostra*)
	Gold Finch (*Carduelis tristis)**	Western Tanager (*Piranga ludoviciana*)
	Ruby-crowned Kinglet (*Regulus calendula*)	Western Meadowlark (*Sturnella neglecta*)*
	Wild Turkey (*Meleagris gallopavo*)	Yellow-rumped Warbler (*Dendroica coronata*)
	Common Raven (*Corvus cryptoleucus*)	Wild Turkey (*Meleagris gallopavo*)
	Mountain Bluebird (Sialia currucoides)*	Virginia's Warbler (*Vermivora virginiae*)*
	Black-capped Chickadee (*Poecile atricapilla*)*	Spotted Towhee (*Pipila maculatus*)*
	Steller's Jay (*Cyanositta stelleri*)	Common Raven (*Corvus cryptoleucus*)
	Eastern Bluebird (*Sialia sialis*)*	Blue-gray Gnatcatcher (*Polioptila caerulea*)*
	Clark's Nutcracker (*Nucifraga columbiana*)*	Hammond's Flycatcher (*Empidonax hammondii*)*
	Western Tanager (*Pirganga ludoviciana*)	Swainson's Thrush (*Catharus ustulatus*)*
	Townsend's Solitaire (*Myadestes townsendi*)*	
Total Richness	25	24
Number of Species unique to study area	7	6
Mean Diversity	2.236	2.093





In regards to the overall bird communities, species richness was nearly identical between the two areas (Figure 2). Despite the similarity in numbers, each area did contain species only recorded in that area (Table 3). However, these unique species included a range of types (e.g. migrants, residents, aerial feeders, gleaners, cavity nesters, etc.) and no clear trend could be determined. In addition, mean diversity was not significantly different between the study areas (df=6, t=0.446, p=0.671) (Figure 3).

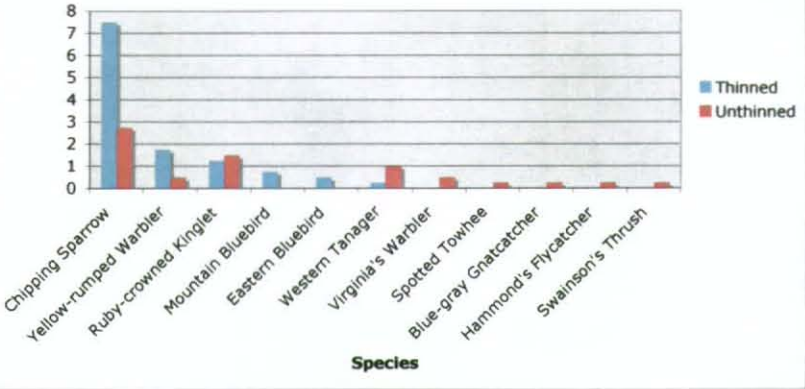
Migrant communities in the two study areas were also very similar. Species richness was fairly close between the areas (Figure 3) and the mean diversity was not significantly different between the two areas (df=6, t=1.123, p=0.304) (Figure 3). Despite our expectations, both richness and mean diversity were slightly higher in the unthinned area (Figure 2) but with such low numbers these differences could easily be due to sampling bias or the unpredictability of observing migrants.

Table 3: Migrant Species Recorded by Study Area

Species	Thinned	Unthinned
Chipping Sparrow	7.5	2.75
Yellow-rumped Warbler	1.75	0.5

Ruby-crowned Kinglet	1.25	1.5
Mountain Bluebird	0.75	0
Eastern Bluebird	0.5	0
Western Tanager	0.25	1
Virginia's Warbler	0	0.5
Spotted Towhee	0	0.25
Blue-gray Gnatcatcher	0	0.25
Hammond's Flycatcher	0	0.25
Swainson's Thrush	0	0.25
Total Richness	**6**	**9**
Mean Diversity	**0.51**	**0.95**

Fig. 4: Mean Migrant Abundance by Study Area



Similar to the migrant communities, neither residents nor cavity nesters differed significantly between the two study areas. Richness was slightly higher in the thinned area for both groups (Figure 2), though as with the migrants the difference was small. Mean diversity was also slightly higher in the thinned area for both groups, but not significantly (residents: df=6, t=1.132, p=0.234; cavity nesters: df=6, t=2.304, p=0.061) (Figure 3).

Table 4:Resident Species Recorded by Study Area

Species	Thinned	Unthinned
American Robin	17.75	2.25

Dark-eyed Junco	11.75	5
Mountain Chickadee	7.5	4.75
Pygmy Nuthatch	4	6.75
Pine Siskin	3.75	2
Red Crossbill	3	1
White-breasted Nuthatch	2.75	2.5
Red-breasted Nuthatch	2.75	1.25
Hairy/Downy Woodpecker	2	4.75
Northern Flicker	1.75	0
Morning Dove	1.5	2
Gold Finch	1.5	0
Turkey	1	0.5
Raven	1	0.25
Mountain Bluebird	0.75	0
Black-capped Chickadee	0.75	0
Clark's Nutcracker	0.5	0
Steller's Jay	0.5	1.25
Townsend's Solitaire	0.25	0
Western Meadowlark	0	0.75
Total Richness	**20**	**15**
Mean Diversity	**2.171**	**1.833**

Fig. 5: Mean Resident Abundance by Study Area

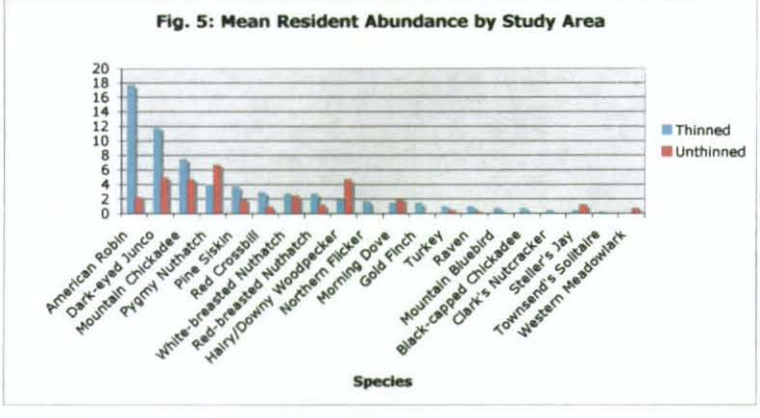
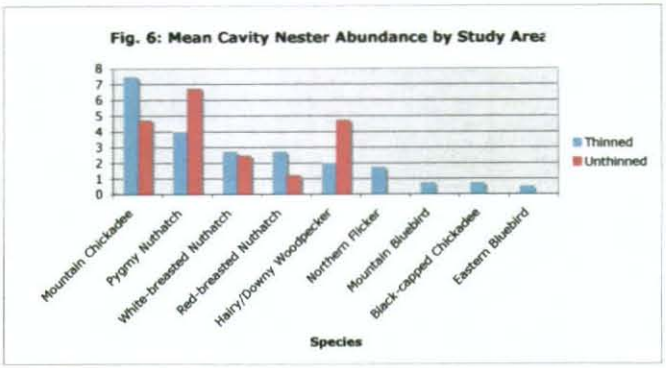


Table 5: Cavity Nesting Species Recorded by Study Area

Species	Thinned	Unthinned
Mountain Chickadee	7.5	4.75
Pygmy Nuthatch	4	6.75
White-breasted Nuthatch	2.75	2.5
Red-breasted Nuthatch	2.75	1.25
Hairy/Downy Woodpecker	2	4.75
Northern Flicker	1.75	0
Mountain Bluebird	0.75	0
Black-capped Chickadee	0.75	0
Eastern Bluebird	0.5	0
Total Richness	**10**	**6**
Mean Diversity	**1.624**	**1.27**



Discussion:

Prior to this study, we expected the forest thinning used by Boulder County to have influenced the bird communities of the Heil Valley Ranch. After nearly a century of fire suppression, the thinning was expected to return the forest to a more natural state. Because the birds that commonly use Ponderosa forests, both for breeding and migration stopovers, evolved in a fire-dependent ecotype, we expected forest thinning to help increase the abundance, richness and diversity of the native bird communities. This result has already been observed for bats foraging at the Heil Valley Ranch (Adams 2006). However based on the results of this study, the forest management strategies used by Boulder County Parks and Open Space on the Heil Valley Ranch do no appear to have had a significant impact on the bird communities of that area, which does not support our original hypothesis. Several explanations could account for the similarity between the two areas. First, the thinning simply had no impact on the habitat selection of the bird species we observed. Secondly, there could be additional factors that counteract the benefits of thinning. For example, although insect abundance has been reported to be higher in thinned areas (Swanson 2004, Adams 2006), these measurements were taken during the breeding season. Earlier in the year when birds are migrating and insect hatching has not yet reached its peak, insect abundance may not be significantly different between the two areas. There is evidence that birds time their migration and breeding to match insect hatches (Both et. al. 2006), which may imply that during migration (and during our study), insect abundance had not yet reached this maximum level. Another confounding factor could be predation. Birds foraging to during the day would be more susceptible to avian predators such as Cooper's and Sharp-shinned hawks than bats foraging at night and may thus prefer unthinned areas for protection. However, no predatory birds were seen during the study and thus it seems unlikely that they are present at high enough levels to strongly influence foraging of other birds. In addition, birds could be responding to thermal conditions in addition to insect abundance. Lower thermal conditions in the unthinned areas may provide more

favorable conditions and counteract increased food levels. More research is needed to study these confounding factors.

The last explanation for our unpredicted results is that we observed small patches of open forest within the unthinned study area. It is possible that these areas could provide similar habitat that would minimize difference between the two study areas.

Even though we did not observe any significant differences in diversity or richness in any of the groups looked at, the data does show some anecdotal differences:

1) While the results were not significant, migrant and cavity nester richness and diversity were opposite of our expectations. For migrants, we expected to see higher diversity and richness in the more "natural", thinned study area but our data showed the opposite. In regards to cavity nesters, some past studies (Caton 1996, Hitchcox 1996) have indicated that forest thinning can have a negative impact. However, we saw higher richness and diversity of cavity nesters in the thinned area. While many hypotheses could be put forward to explain these observations, we feel that the small differences are more likely the result of a small sample size and the difficultly/unpredictability of recording birds in forest habitats (see below).
2) Both areas contained a relatively large number of species not recorded in the other study area (7 in the thinned areas vs. 6 in the unthinned area) (Table 3). We looked at these species to try to find some common denominator that might indicate an impact from the management (e.g. more aerial feeders in the thinned area) but none could be found. These 13 species display a wide range of feeding techniques, life history strategies, etc. However, most were seen in low numbers indicating again that a small sample size and unpredictability of observation could have played a significant role.
3) Several species seen in both areas did display a large difference in abundance between the two areas (Tables 4-6). In particular, Chipping sparrows, American robins and Dark-eyed juncos were much more abundant in the thinned area. The differences are large enough that they do not appear to be the result of sampling error or bias. According to the species descriptions of these birds, all are commonly found feeding on the ground in open areas such as lawns or grassy areas (Middleton 1998, Nolan 2002, Sallabanks 1999). The expansive open, grassy areas found in the thinned areas provide excellent habitat for the type of feeding utilized by these birds and thus forest thinning does appear to have a positive impact on these species.

As discussed above, several sources of error most likely influenced the results of this study. First, due to the time constraints placed on us by the timing of migration (i.e. conducting fieldwork after migration begins but before the breeding season), our sample size was quite small. We were only able to conduct four days in the field over one migration season. This small sample size could have easily led to bias in our data. Second, while the general timing of bird migration is fairly predictable, the exact timing of movements is influenced by a variety of factors (e.g. weather, temperature, wind direction, etc.) and is thus hard to predict. With only four days in the field, we could have easily missed many migrating birds that passed through our study areas.

Next, differences in the terrain/habitat of the study areas most likely influenced the birds that were recorded. By design, our study areas were different. While our ability to detect vocalizing birds was similar in both study area, detecting non-vocalizing birds was much more difficult in the unthinned area. Allowing birds to acclimatize to the recorders' presence, remaining silent and having fairly long observation periods hopefully helped decrease this bias but some birds were almost certainly missed. As mentioned before, the two areas were different by design and therefore differences in detecting non-vocalizing birds are simply an unfortunate bias of this type of study.

Lastly, though we did our best to ensure all observers were able to adequately identify the bird seen in this study, observer bias most likely contributed some error to this study. In order to decrease this source of error, teams alternated study areas each week. However, as mentioned above, bird movements are often unpredictable and thus observer bias was almost certainly a source of error.

Despite the sources of error inherent to this type of research, we feel that this study is a good first step in quantifying the effects of forest thinning on bird communities as a whole and migrating species in particular. At this time, it appears that the forest management used thus far has had little impact, either positive or negative, on the birds of the Heil Ranch. However, in order to decrease the sources of error mentioned above, we feel it is important to make this a long-term study. Multiple observations over a number of years will greatly increase the accuracy of this study and yield more information on the forest management practices used by Boulder County and its impact our county's bird communities.

Budget:

Expense	Cost
Garmin eTrex Legend GPS	$250.00
Garmin Topo United States 2008	$100.00
Flagging	$3.00

Gas	$77.00
Literature download fees	$20.00
Total	$450.00

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