Bird Response to Timber Harvest in a Mixed Conifer Forest in Arizona

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Abstract

A mixed conifer forest in eastern Arizona was harvested by a combination of group and individual tree selection. Some small patches ranging in size from 1/2 to 3 acres were clearcut. Total bird numbers were slightly lower after timber cutting, but the number of species observed increased from 28 to 35. Analysis of bird species by nesting and feeding guilds showed no significant differences in numbers before and after cutting for any of the guilds.

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Management Implications

Timber harvesting in southwestern mixed conifer forests should not adversely affect bird density or species diversity, provided removals are less than 30% to 40% of the stand basal area. This study, at Thomas Creek in eastern Arizona, evaluated changes in a bird population before and after an operational timber harvest designed to benefit several resources. Bird population changes were also compared with an uncut stand. The silvicultural prescription for the virgin, uneven-aged forest called for group selection on south-facing slopes and for individual tree selection with patch clearcutting on the north-facing slopes. Patches were from 0.5 to 3.0 acres. The harvest removed from 24% to 34% of the total stand basal area, and from 28% to 37% of the overstory basal area. Sixty-eight acres were in patchcuts and in openings created by the group selection. A net volume of 3.4 million board feet was harvested.

The harvest resulted in only minor changes in bird populations. Bird numbers decreased slightly (12%) but the number of species increased from 28 to 35. House wrens,[3] American robins, and pine siskins were new additions to the area's bird population. There were no significant differences in bird numbers when analyzed by nesting and feeding guilds. The ruby-crowned kinglet was the only major species to show a significant decrease.

A previous study by Szaro and Balda (1979) in a ponderosa pine forest showed that moderate harvesting by either strip shelterwood or by a silvicultural improvement cut did not adversely affect the bird population. In contrast, heavy overstory reductions by clearcutting or heavy thinning (82% reduction in basal area) in ponderosa pine (Szaro and Balda 1979), or by diameter-limit cutting in mixed conifers (Franzreb 1977), did reduce bird densities and, often, species diversity.

There are still other harvesting prescriptions sufficiently different from the Thomas Creek cut or from those reported in the literature that should be studied before a predictive model for bird management in mixed conifer forests can be developed.

Introduction

Birds are an important forest resource because of their ecological role and recreational value. Logging practices alter habitat conditions and may affect species composition and densities. Bird populations appear to respond differently, depending on the amount and distribution of trees removed. Szaro and Balda (1979) found species diversity and density decreased on a clearcut plot of ponderosa pine and density decreased on a severely thinned plot, whereas bird numbers increased where timber reductions were less drastic. Franzreb (1977) found that bird density decreased when the basal area of a southwestern mixed conifer stand was reduced 84%, although number of species increased slightly.

Southwestern mixed conifer forests occupy about 2-1/2 million acres of high-elevation lands in Arizona and New Mexico (Jones 1974). The forests usually grow above 8,000 feet, except on protected north slopes and canyon bottoms, where they occur down to 6,000 feet. The mixed conifer forest is a highly diversified type, with a wide mixture of stand structures and with up to eight tree species. The type is an important avian habitat with as many as 53 species of birds (Franzreb 1977).

Timber harvesting practices in the Southwest are designed primarily for timber production; however, water yield improvement is possible. Rich and Thompson (1974) indicated that increases in water yield are positively related to the percentage of the watershed that is cleared. Periodic harvests of trees in small groups and clearcuts are compatible with recommended silvicultural methods for mixed conifers (Alexander 1974) and provide successional stages of regeneration for use by a variety of wildlife. The timber harvest on the Thomas Creek watershed was an attempt to develop a silvicultural prescription that would benefit timber management, wildlife, water yield, and aesthetics. This report summarizes the response of nongame birds to the timber harvest.

Study Area

The Thomas Creek watersheds are located in eastern Arizona on the Apache-Sitgreaves National Forests, about 15 miles south of Alpine. Objectives of the Thomas Creek investigation were to design and evaluate a multiresource management program for the southwestern

[3]*Scientific names of trees and birds are listed in Appendix I.*

mixed conifer forest type (Brown 1976). Two watersheds (South Fork and North Fork) were instrumented with weirs to measure water yields and sediment. Timber was harvested from the South Fork watershed, whereas the North Fork watershed was uncut and maintained as a control (fig. 1).

Some important watershed characteristics are:

Characteristic	South Fork	North Fork
Size (acres)		
South-facing slope	311	327
North-facing slope	251	140
Elevation (ft)	8,350-9,150	8,350-9,250
Slope, average (%)	22	27

Soils on both watersheds are generally sandy loams derived from basalt parent material.

Annual precipitation, measured near the South Fork weir, averaged 29.2 inches from 1964 through 1980. About 55% fell from October through May mainly as snow. During the summer (May to August), the mean daily maximum temperature was 72° F; the mean daily minimum was 42° F, and the daily mean temperature was 57° F.

Both watersheds originally supported a virgin, uneven-aged mixed conifer forest (fig. 2) consisting primarily of eight tree species: Engelmann spruce, blue spruce, Douglas-fir, white fir, corkbark fir, ponderosa pine, southwestern white pine, and quaking aspen. Gambel oak is an important minor species. The usual stand consists of a mosaic of groups and patches of varying sizes and species composition. Thomas Creek has not had a major fire in over 90 years. Douglas-fir is the most common species on the watersheds, whereas ponderosa pine is the most commercially valuable (tables 1 and 2). North Fork has numerous young ponderosa pine thickets, which accounts for the relatively high density of trees (table 2). The open, mature ponderosa pine overstory on the south-facing slopes above the North Fork weir contributes to the lower average basal area for that unit.

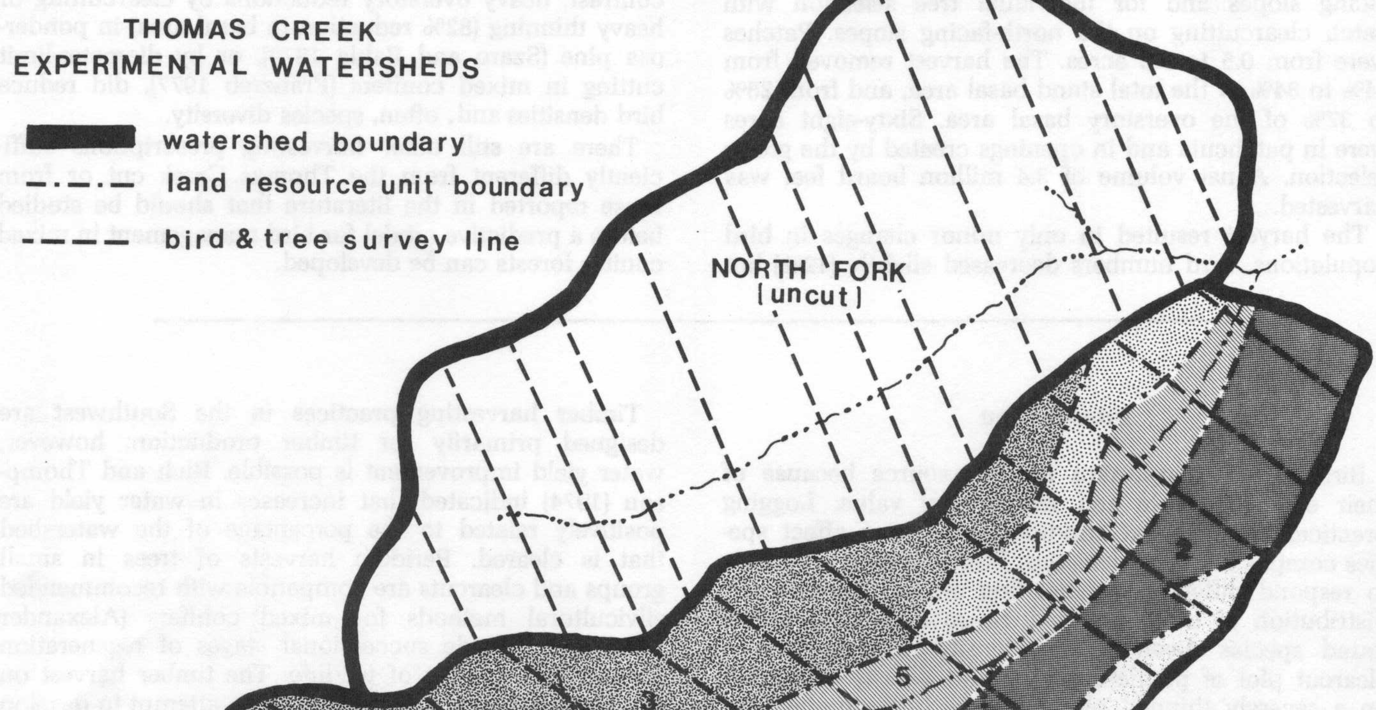

Figure 1.—A multiple-random start design was used to establish the inventory lines and points on North and South Fork of Thomas Creek. South Fork was divided into 6 land response units for evaluating treatment alternatives.

The Prescription

Management activities to be evaluated on South Fork were a combination of silvicultural practices designed to consider wildlife, water, and timber resources. South Fork watershed was divided into six land response units (LRU). The silvicultural prescription for LRU 5 was individual tree selection; for units 1 and 3, group selection designed to reduce the basal area by 30%; and for units 2 and 4, clearcut patches with individual tree selection away from the clearcuts (fig. 1). However, units 1, 2 and the downstream half of unit 5 were not harvested because of the locally steep slopes.

The Harvest

Timber harvesting began in May 1978 and continued intermittently through January 1979. A net volume of 3.4 million board feet was harvested. This included some volume that was salvaged from trees which blew down in fall 1978.

In group selection unit 3, the cutting operation created 41 small openings about 0.5 acre or larger. Total area opened was about 35 acres. Thirty-three acres were patchcut in unit 4, creating 25 openings (fig. 3). The average patch clearcut was about 1.3 acres although they varied from 0.5 acre to about 3.2 acres.

Slash was lopped in all areas except fuelbreaks and along watercourses. Larger material (greater than 8 inches diameter inside bark) was skidded to designated landings. Slash was machine piled with a 330-foot wide fuelbreak which ran along the perimeter of the harvest area and in a 200-foot fuelbreak along the logging roads. It was hand piled along the channel. Slash was piled in the cleared patches that were within fuelbreak zones. Piles were constructed in July 1979 and burned in October 1980.

Figure 2.—Both watersheds supported a dense, multi-storied mixed conifer forest before harvest.

Figure 3.—Looking into a small patch-cut from the single-tree selection area on a north-facing slope.

Methods

Vegetation Measurements

Forest vegetation was measured in 1974, before treatment, and in 1979 after harvesting was completed. All forest stand data were collected at permanent timber inventory points using standard point sampling techniques based on a 25 basal area factor (BAF) angle gage. Points were established according to a multiple-random start design. A total of 128 points, located at 264-foot intervals, were established on the 14 South Fork lines. However, because the steep areas were not harvested, measurements were concentrated on 59 points on the south-facing slope and 35 points on the north-facing slope. Samples were collected at 119 points on the 12 North Fork lines (fig. 1).

Stand values, in terms of average number of trees per acre and average basal area (square feet) per acre, were calculated using standard point sampling procedures (Husch et al. 1972). To show the vegetation available to birds, the 1979 data reflects changes caused by growth of trees measured in 1974 and surviving to 1979, natural mortality and harvesting, and new trees which were initially measured during the 1979 survey.

Changes in stand composition were analyzed by chi-square tests for significance ($\alpha = 0.05$). Diameter distributions were analyzed by transformed linear regressions (Husch et al. 1972) and covariance analyses.

Bird Densities

Birds were censused on the watersheds in spring and early summer 1974 and 1975 before any timber was cut. Posttreatment surveys were conducted in 1979-1980. Censuses were conducted along established timber in-

Table 1.—Pre- and posttreatment stand characteristics for the treated portion of South Fork of Thomas Creek Watershed

	Trees (No./acre)[a]				Basal area (ft²/acre)[b]			
	North exposure		South exposure		North exposure		South exposure	
	Before harvest	After harvest	Before harvest	After harvest	Before harvest	After harvest	Before harvest	After harvest
Aspen	45	38	49	44	21	18	19	17
Ponderosa pine	79	75	18	11	24	16	34	18
White fir	76	36	37	86	46	25	37	29
Corkbark fir	17	18	2	5	7	7	2	2
S.W. white pine	110	46	38	44	15	8	23	20
Douglas-fir	105	84	134	168	65	39	67	51
Blue spruce	13	10	5	7	13	9	3	3
Engelmann spruce	32	67	11	10	19	17	9	8
Total	477	374	294	375	210	139	194	148

[a]*One acre = 0.4047 hectare.*
[b]*One square foot per acre = 0.2296 square meters per hectare.*

Table 2.—Stand characteristics for (untreated) North Fork of Thomas Creek Watershed by exposure in 1974 before treatment on South Fork

	Trees (No./acre)[a]		Basal area (ft²/acre)[b]	
	North exposure	South exposure	North exposure	South exposure
Aspen	71	16	28	4
Ponderosa pine	1	166	3	65
White fir	233	86	63	22
Corkbark fir	68	2	18	1
S.W. white pine	7	71	6	19
Douglas-fir	79	277	52	50
Blue spruce	4	0	2	2
Engelmann spruce	172	2	36	2
Other	0	84	0	4
Total	635	704	209	166

[a]*One acre = 0.4047 hectare.*
[b]*One square foot per acre = 0.2296 square meters per hectare.*

ventory transect lines, which ran perpendicular to the drainage in each watershed. The South Fork transect lines totaled 4.6 miles and the North Fork lines were 4.2 miles. Censuses began at sunrise and continued for 3.5 hours. Three days were required to census all transect lines on each watershed. Two censuses were made on each watershed each year. For each bird observed we recorded bird species, location, sex (if possible), activity, distance from survey line, and the tree species being used by the bird. We estimated bird numbers by first calculating the mean observation distance from the transect for each species. This was assumed to be one-half of the effective distance censused (Amman and Baldwin 1960). Bird numbers were then determined by using two times the mean observation distance times transect length to determine the area censused. Differences in numbers of birds between drainages before and after timber harvest were tested for significance ($\alpha = 0.05$) by a two-factor repeated measures analysis of variance by species and by feeding and nesting guilds. A diversity profile for birds was prepared following Patil and Taillie (1979). Differences in numbers of birds by exposure were tested by a "t" test ($\alpha = 0.05$).

Results

Vegetation

Before harvest, basal area differences between the two slopes of South Fork were minor (table 1), but there were differences in the species distribution of trees. On North Fork (table 2), the proportion of trees and basal area per acre were different between the two slopes for most species.

Diameter distributions for the total stand were different between the north- and south-facing slopes of South Fork because of the proportionately larger number of overstory trees (d.b.h. < 7.0 inches) on the south-facing slopes (39%). A comparison of south-facing slopes between watersheds also showed differences because of the proportions of overstory trees. Only 14% of the trees on the south-facing unit of North Fork were < 7.0 inches d.b.h. Comparisons of the two slopes on North Fork, and between the north-facing slopes of the two watersheds, showed no differences in d.b.h. of trees.

Timber harvest on South Fork resulted in a 22% reduction in the total number of trees per acre on the north-facing slope (table 1) and a 34% reduction in basal area per acre. The south-facing slope showed a 28% increase in number of trees, reflecting increased growth of smaller trees, particularly white fir. Basal area on this slope decreased by about 24%. The harvest had a greater effect on the overstory component of the stand. The total reductions in number of overstory trees per acre were 12% for the south-facing slope and 30% for the north-facing slope. Basal area reductions were 28% and 37%, respectively. Most of the changes were the result of timber harvest, although some trees died later of natural causes and were left in the woods.

Harvesting did not affect relative basal area composition within either area. Relative overstory composition within units did not change because of treatment. Comparisons between slopes showed relatively more Douglas-fir and white fir on the south slope and more Engelmann spruce, corkbark fir, and ponderosa pine on the north slope. Diameter distributions for both areas of South Fork changed significantly after harvest, as expected (fig 4).

Stand changes on North Fork during the study period were minor, reflecting growth and natural mortality, which mainly occurred in overmature ponderosa pine and aspen.

Figure 4.—Large, overmature trees have been harvested from this section of the south-facing slope on the group selection method area.

Bird Densities

Bird numbers varied considerably between years in the untreated area as well as the treated area (table 3). Bird estimates were lower by 12% on South Fork after treatment compared to a 3% reduction on North Fork, but the number of species increased from 28 to 35. Bird species observed on the uncut North Fork dropped from 29 to 27. Species found on South Fork after harvest, but not present before, included the house wren, (which made use of the slash piles left after harvest), American robin, and pine siskin. The bird diversity profile indicated that the uncut North Fork had a higher bird diversity than South Fork before timber harvest, but that diversity on South Fork was greater after timber harvest.

Twenty-two species were tested individually for significant changes in density levels before and after timber harvesting. Only densities of ruby-crowned kinglets were found to have changed significantly ($P = 0.05$). The difference was significant because of a large increase in kinglets on the uncut North Fork and a slight decrease on the harvested drainage.

Birds also were separated into foraging and nesting guilds (table 4) and tested for changes in numbers after treatment. No significant change was found for any of the guilds.

Total bird populations were not different by slope, but several birds favored either north or south exposures (table 3). Northern flickers, white-breasted nuthatches, red-faced warblers, and western tanagers were significantly more numerous on south-facing slopes, whereas ruby-crowned kinglets were more numerous on north-facing slopes.

Frequency of tree use by birds was compared with tree species composition. Birds were observed in aspen and Douglas-fir trees significantly more than if use were random. True firs (white and corkbark) were used less than would be expected.

Tree use by those birds with significantly higher densities on north and south exposures was compared in an effort to determine if tree species availability could explain preferences for exposure. Ruby-crowned kinglets, the only species with significantly higher density on north-facing slopes, used spruce, Douglas-fir, and white pine more than if use were random; ponderosa pine and the true firs were used less. Those birds more abundant on south slopes also utilized the true firs less than would be expected, but the use of Douglas-fir and ponderosa pine was greater. The difference in bird density by exposure probably cannot be explained by tree species composition.

Probably the only truly tree-specific bird was the warbling vireo. Aspen was used significantly more than would be expected by warbling vireos, whereas all other tree species except white pine were used significantly less.

Discussion

The silvicultural prescription for the timber harvest on South Fork watershed of Thomas Creek was designed

Table 3.—Estimated number of birds/100 ac on Thomas Creek Watershed in Arizona

Species	Densities by watershed: South Fork, Before harvest 1974-75	South Fork, After harvest 1979-80	North Fork (uncut) 1974-75	North Fork (uncut) 1979-80	Densities by exposure: South Fork, Mean 1974-1975 N.	South Fork, Mean 1974-1975 S.	South Fork, Mean 1979-1980 N.	South Fork, Mean 1979-1980 S.	North Fork, Mean 1974-1975 N.	North Fork, Mean 1974-1975 S.	North Fork, Mean 1979-1980 N.	North Fork, Mean 1979-1980 S.
Williamson's sapsucker	4	2	5	4	3	6	1	3	7	4	7	2
Hairy woodpecker	10	3	6	5	15	4	2	3	0	8	0	7
Northern flicker	6	6	8	10	6	6	3	9	5	8	6	12*
Western flycatcher	21	11	12	8	13	25	14	9	10	13	28	0
Violet green swallow	2	9	0	12	0	3	5	12	0	0	5	15
Steller's jay	13	8	9	9	23	4	6	9	4	11	15	7
Mountain chickadee	49	40	34	15	55	50	39	42	47	28	18	14
Red-breasted nuthatch	4	10	3	2	6	4	3	15	7	2	3	2
White-breasted nuthatch	2	2	1	4	0	4	1	2	0	2	0	5*
Pygmy nuthatch	1	<1	9	6	0	2	<1	0	0	13	0	8
Brown creeper	20	8	19	16	12	27	0	11	13	22	38	8
House wren	0	17	0	2	0	0	22	13	0	0	0	2
Golden-crowned kinglet	17	4	19	<1	28	8	4	3	30	3	0	<1
Ruby-crowned kinglet	47	41	39	73	36	54	48	36	84	11	146	42*
Hermit thrush	23	10	16	12	29	19	10	12	12	18	5	15
American robin	0	5	0	0	0	0	2	2	0	0	0	0
Warbling vireo	22	20	16	12	13	30	18	21	15	17	21	8
Orange-crowned warbler	1	0	5	0	2	0	0	0	18	0	0	0
Yellow rumped warbler	60	62	57	85	48	70	28	90	56	59	89	83
Red-faced warbler	14	17	26	33	18	11	9	28	17	29	0	46*
Western tanager	10	9	14	2	0	19	3	13	0	20	0	3*
Dark-eyed junco	17	8	23	12	15	18	6	10	25	23	2	16
Pine siskin	0	11	11	3	0	0	11	10	13	11	0	3
Other birds[1]	0	1	3	1	0	0	1	0	0	4	0	0
Total birds	343	304	335	326	322	364	236	353	363	306	383	298

[1] *A complete list of birds observed on the study area is in the Appendix.*
* *Indicates significant differences (α = 0.05) between north and south exposures.*

Table 4.—Estimated number of birds/100 ac. by guild on Thomas Creek

Guilds	South Fork: Before harvest 1974-75	South Fork: After harvest 1979-80	North Fork (uncut): 1974-75	North Fork (uncut): 1979-80
Foraging guilds				
Pickers & gleaners	260	249	263	263
Ground feeders	46	29	47	34
Hammerers & tearers	14	6	13	9
Aerial feeders	23	20	12	20
Nesting guilds				
Cavities & depressions	119	109	99	84
Foliage nesters	184	177	197	218
Ground nesters	40	18	39	24

to benefit a variety of resources—timber, wildlife, and water. Although more than 3.4 million board feet were harvested, overall stand changes were not drastic. Total basal area on the north-facing slopes was reduced 34% where timber was cut in patches and by individual tree selection, and 24% on the south-facing slopes where the cutting was done by group selection. Reductions in overstory basal area were slightly higher. Trees per acre decreased on the north-facing slope by 22% but increased on the south-facing slope as a large number of new trees grew into larger size classes. Relative species basal area composition did not change within units.

Logging resulted in minor short-term changes in bird populations. Total estimated numbers dropped by 12%, but the number of species increased from 28 to 35. House wrens, absent before logging, used the resulting slash piles after timber cutting. Only the ruby-crowned kinglet was significantly less abundant after timber harvest.

In an adjacent mixed conifer watershed on Willow Creek, Franzreb (1977) found a significantly higher density of birds in an unlogged area compared with an area that was logged according to a diameter-limit prescription, which removed about 84% of the original basal area. In the cut area, aspen made up over 54% of the residual basal area. Ten species of birds, including American kestrel, yellow-bellied sapsucker, olive-sided flycatcher, house wren, and American robin increased, and 13 species, including western flycatcher, mountain chickadee, and ruby-crowned kinglet, decreased. The trends for house wren, American robin, and ruby-crowned kinglet are consistent with our findings on Thomas Creek.

We conclude that a moderate timber harvesting operation that removes about 30% of the basal area of a stand, whether designed for multi-resource benefits or primarily for timber production, will not adversely affect bird populations. More severe reductions in basal area, such as the overstory removal on Willow Creek, may reduce the total number of birds (Franzreb 1977).

The relationship we found between bird populations and the severity of timber cutting in a mixed conifer forest tends to be consistent with results in southwestern ponderosa pine (Szaro and Balda 1979). Bird population densities decreased significantly when ponderosa pine was clearcut or heavily thinned (from 120 to 22 square feet per acre). In comparison to an untreated control, they found that bird populations increased, as did species diversity and richness, where less severe, irregular strip shelterwood or improvement cuttings were applied. Diversity and richness did not decrease on their heavily thinned plot. Total ponderosa pine and Gambel oak basal area can be reduced by between 15% and 50% in strips or blocks or by 30% in uniform thinning, without adversely influencing bird populations (Szaro and Balda 1979).

For the welfare of nongame birds, Szaro and Balda (1979) recommend that no more than 45% of trees over 9 inches d.b.h. be removed, leaving a minimum of 32 trees per acre, and that certain densities of smaller trees also be maintained. Snags and overmature trees should be left for cavity-nesting birds.

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Appendix I

Common and scientific names of birds and trees found on the study area

	Bird Species
Turkey vulture	*Cathartes aura*
Sharp-shinned hawk	*Accipiter striatus*
Cooper's hawk	*A. cooperii*
Northern goshawk	*A. gentilis*
Red-tailed hawk	*Buteo jamaicensis*
American kestrel	*Falco sparverius*
Blue grouse	*Dendragapus obscurus*
Wild turkey	*Meleagris gallopavo merriami*
Band-tailed pigeon	*Columba fasciata*
Mourning dove	*Zenaida macroura*
Broad-tailed hummingbird	*Selasphorus platycercus*
Yellow-bellied sapsucker	*Sphyrapicus varius*
Williamson's sapsucker	*S. thyroideus*
Downy woodpecker	*Picoides pubescens*
Hairy woodpecker	*P. villosus*
Three-toed woodpecker	*P. tridactylus*
Northern flicker	*Colaptes auratus*
Olive-sided flycatcher	*Contopus borealis*
Western wood peewee	*C. sordidulus*
Western flycatcher	*Empidonax difficilis*
Purple martin	*Progne subis*
Violet-green swallow	*Tachycineta thalassina*
Steller's jay	*Cyanocitta stelleri*
Clark's nutcracker	*Nucifraga columbiana*
American crow	*Corvus brachyrhynchos*
Common raven	*C. corax*
Black-capped chickadee	*Parus atricapillus*
Mountain chickadee	*P. gambeli*
Red-breasted nuthatch	*Sitta canadensis*
White-breasted nuthatch	*S. carolinensis*
Pygmy nuthatch	*S. pygmaea*
Brown creeper	*Certhia familiaris*
House wren	*Troglodytes aedon*
Golden-crowned kinglet	*Regulus satrapa*
Ruby-crowned kinglet	*R. calendula*
Townsend's solitaire	*Myadestes townsendi*
Swainson's thrush	*Catharus ustulatus*
Hermit thrush	*C. guttatus*
American robin	*Turdus migratorius*
Solitary vireo	*Vireo solitarius*
Warbling vireo	*V. gilvus*
Orange-crowned warbler	*Vermivora celata*
Yellow-rumped warbler	*Dendroica coronata*
Red-faced warbler	*Cardellina rubrifrons*
Olive warbler	*Peucedramus taeniatus*
Western tanager	*Piranga ludoviciana*
Black-headed grosbeak	*Pheucticus melanocephalus*
Dark-eyed junco	*Junco hyemalis*
Pine grosbeak	*Pinicola enucleator*
Red crossbill	*Loxia curvirostra*
Pine siskin	*Cardeulis pinus*

	Tree Species
Engelmann spruce	*Picea engelmannii* Parry ex Engelm.
Blue spruce	*P. pungens* Engelm.
Rocky Mountain Douglas-fir	*Pseudotsuga menziesii* var. *glauca* (Beissn.) Franco
Rocky Mountain white fir	*Abies concolor* (Gord. and Glend.) Lindl. ex Hildebr.
Corkbark fir	*A. lasiocarpa* var. *arizonica* (Merriam) Lemm.
Rocky Mountain ponderosa pine	*Pinus ponderosa* Dougl. ex Laws.
Southwestern white pine	*P. strobiformis* Engelm.
Quaking aspen	*Populus tremuloides* Michx.
Gambel oak	*Quercus gambelii* Nutt.

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Keywords: Wildlife habitat, timber harvesting, clearcutting, wildlife populations

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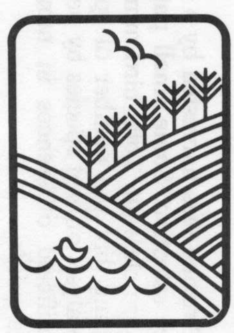
U.S. Department of Agriculture
Forest Service

Rocky Mountain Forest and Range Experiment Station

Rocky Mountains

Southwest



Great Plains

The Rocky Mountain Station is one of eight regional experiment stations, plus the Forest Products Laboratory and the Washington Office Staff, that make up the Forest Service research organization.

RESEARCH FOCUS

Research programs at the Rocky Mountain Station are coordinated with area universities and with other institutions. Many studies are conducted on a cooperative basis to accelerate solutions to problems involving range, water, wildlife and fish habitat, human and community development, timber, recreation, protection, and multiresource evaluation.

RESEARCH LOCATIONS

Research Work Units of the Rocky Mountain Station are operated in cooperation with universities in the following cities:

Albuquerque, New Mexico
Flagstaff, Arizona
Fort Collins, Colorado*
Laramie, Wyoming
Lincoln, Nebraska
Rapid City, South Dakota
Tempe, Arizona

*Station Headquarters: 240 W. Prospect St., Fort Collins, CO 80526