



Bird Community Monitoring for Grand Canyon National Park

2007 Summary Report

Natural Resource Data Series NPS/SCPN/NRDS—2010/099



ON THE COVER
Western Tanager (*Piranga ludoviciana*)
Photo courtesy of U.S. Fish and Wildlife Service

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This project was conducted under a Colorado Plateau Cooperative Ecosystems Study Unit agreement with the Southern Colorado Plateau Network (SCPN). The corresponding author and project manager for this project is Jennifer Holmes (Jennifer.Holmes@nau.edu). Other contributions were made by the SCPN staff. The 2007 field crew consisted of Kylan Frye and Sarah Brown.

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1 Introduction and Background

The National Park Service Inventory and Monitoring Program was designed to determine the current status and monitor long-term trends in the condition of park natural resources, providing park managers with a strong scientific foundation for making decisions and working with other agencies and the public for the protection of park ecosystems. The goal of bird community monitoring is to provide status and trends data on bird communities in several predominant habitats where integrated upland or riparian vegetation monitoring is also occurring.

For Grand Canyon National Park (GRCA), Southern Colorado Plateau Network (SCPN) and park staff selected mixed-conifer forest as an important ecosystem for vegetation and bird community monitoring. Occurring at elevations above 2500 m, mixed-conifer forest occupied approximately 17,600 hectares on the North Rim of GRCA in the year 2000. Since then, large, stand-replacing fires (fig. 1) have reduced the amount of mature mixed-conifer forest.

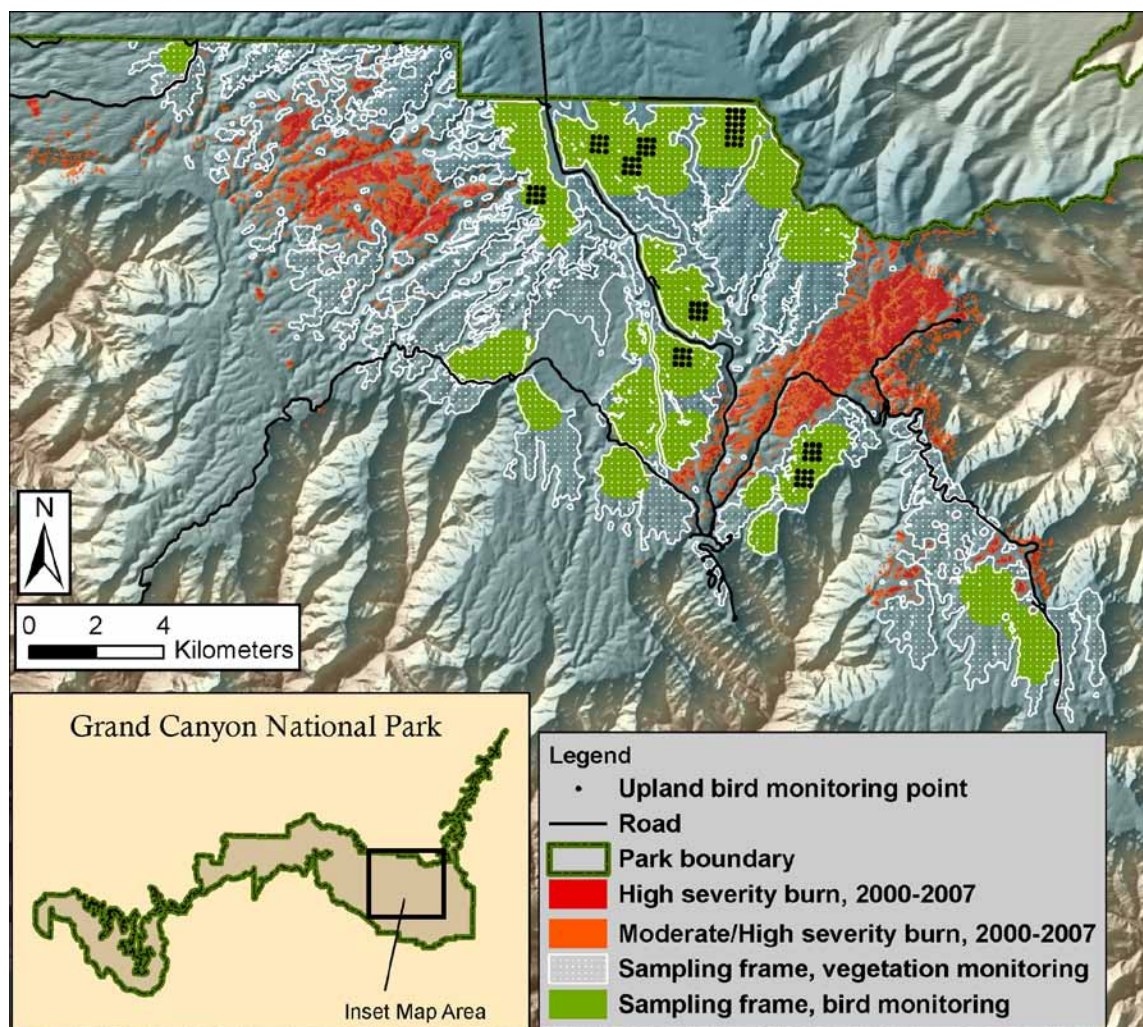


Figure 1. Bird monitoring sampling frame of mixed-conifer habitat at Grand Canyon National Park, with the 10 clusters of 9 bird and habitat sampling plots and upland vegetation monitoring sampling frame. Extent of large, stand-replacing fires is indicated in red and orange.

This system is represented by a few extensive areas on the Colorado Plateau, but climate change and altered fire regimes threaten its integrity.

In 2007, through a Colorado Plateau Cooperative Ecosystems Study Unit agreement with SCPN, we began monitoring the upland bird community of the target mixed-conifer habitat in GRCA. In this report, we document monitoring activities in the 2007 field season and summarize the data that were collected.

2 Methods

2.1 Sampling Frame

A sampling frame is the area within which we randomly locate our monitoring sites, and hence, the area to which statistical inferences can be made based on monitoring data. The sampling frames for vegetation and bird community monitoring at GRCA were derived from the maps of two ecological sites developed by the US Natural Resources Conservation Service (NRCS): Loamy Hills Cold and Loamy Hills ecological sites (See Appendix A of DeCoster et al., in review). Ecological sites are landscape divisions with characteristic soils, hydrology, plant communities, and disturbance regimes and responses, and are based on soil survey data (Butler et al. 2003). The Loamy Hills Cold and Loamy Hills ecological sites are high elevation areas with mixed-conifer and spruce-fir forests.

We merged the two ecological sites into one, henceforth referred to as mixed-conifer habitat. To complete the bird community monitoring sampling frame, we modified the map of the sampling frame using Geographical Information System (GIS) technology to remove

- areas that were not within the target habitat (roads, buildings, and infrastructure, and elevations below 2500 m)
- areas that were expected to differ substantially from the norm for the target habitat, such as areas that have experienced fire of moderate to high burn severity and mechanically treated areas, because these areas would have increased ecological variation, making it more difficult to detect trends
- areas too small to fit an entire cluster of 9 points spaced 250 m apart within the target habitat
- areas with slopes $\geq 30\%$ to prevent erosion from occurring as a result of the field work

When monitoring in large target habitats, such as GRCA mixed-conifer forest, we employ a cluster sampling method in which bird sample points are clustered around a primary sampling unit so that a cluster of points can be sampled in a single morning. Primary sampling units are selected in a probabilistic manner from a grid of uniformly-spaced points using the Generalized Random-Tessellation Stratified (GRTS) design (Stevens and Olsen 2004). For GRCA, park staff first reviewed all of the sampling points and rejected those points that landed in the proximity of archeological sites. Next, the bird monitoring crew evaluated the accessibility of each cluster and rejected clusters that were inaccessible. Sites were deemed inaccessible if they were greater than two hours of traveling time (by car and foot) from the park's main entrance. The bird monitoring crew then assessed each sampling point within the selected clusters to ensure that (1) it fell within the target habitat, (2) had a slope of less than 30%, and (3) did not contain a major disturbance. Any points that did not meet these criteria were rejected. Ten clusters were selected for monitoring (fig. 1) and 20 clusters were rejected. No points within clusters were rejected.

2.2 Field Methods

Bird sampling occurred at permanent sampling points, or Variable Circular Plot (VCP) point count

stations within clusters in mixed-conifer habitat at GRCA (fig. 1). A total of ten clusters, each containing 9 sampling points, were sampled. Habitat sampling was conducted for a subset of these points. We conducted bird sampling during three survey periods (table 1). A brief description of the field methods we employed is provided here. A more detailed description can be found in Holmes et al. (2009).

Table 1. Survey periods and sampling effort for bird community monitoring at Grand Canyon National Park (GRCA). Dates for VCP point counts conducted at GRCA in 2007, and the number of points sampled.

Survey period	Dates (2007)	Number of clusters	Number of VCP point counts
1	5/30 – 6/2	8	72
2	6/16 – 6/20	10	90
3	7/10 – 7/15	10	90

At each sampling point, we conducted a VCP point count, noting all birds seen or heard during an 8-minute sampling period, regardless of the distance from the observer. We recorded the species, method of detection, gender (if known), and distance from the sampling point to the individual bird. Distances were measured to the nearest meter using a laser range finder. During a single morning, approximately nine VCP point counts each were conducted by two technicians surveying separate clusters of sampling points.

Habitat sampling was conducted on a 50-m-radius macroplot centered on a sampling point within a cluster, and in four subplots within the macroplot. First we estimated and recorded the area occupied by vegetation types and other land-use types in the macroplot. Then we recorded foliar vegetation cover by functional group (e.g. forbs, shrubs), canopy closure, and tree and snag density and basal area for the four subplots. Basal area was measured using a DBH tape, and canopy closure was measured using a spherical densiometer. Ocular estimates of foliar cover were made using a modified Braun-Blanquet cover class scale.

2.3 Data Summary

2.3.1 Variable Circular Plot Point Count Data

The following data were summarized for the target habitat (mixed-conifer forest) at GRCA. The sample unit for bird data is the cluster (which contains 9 VCP sampling points).

- *Observed species richness* (i.e., unadjusted for detectability) is the number of species detected within a given area and specified time.
- *Mean number of individuals detected* for each species is reported as the average number of individuals detected per 8-minute VCP point count. To calculate mean number of individuals detected for each species, the data for a given cluster are averaged across the three survey periods, and a mean number of individuals detected and standard deviation are calculated. Then the cluster means are used to calculate the mean number of individuals detected and associated standard deviation for the target habitat. Detectability-based density estimates are not reported here, but they will be derived for multi-year trend reports.
- *Mean frequency* is the proportion of plots “occupied” by each species. To calculate species

frequency, we first calculated the proportion of plots occupied in each cluster. For example, if a hermit thrush was detected on six of the nine plots in a cluster, during any or all of the three visits to that plot, the proportion of plots occupied in that cluster is 0.67 (67%). We then calculate the mean proportion of plots occupied across the ten clusters for the target habitat.

2.3.2 Habitat Data

Habitat data will be used with bird sampling data to examine bird habitat relationships. For GRCA, habitat data were collected within a circular 0.8 ha macroplot which contained four subplots and was centered on each bird sampling point. Data were summarized at three levels: the macroplot, the cluster, and the target habitat. The means and standard deviations for the cluster were calculated from the macroplot data. The means and standard deviations for the target habitat were calculated from the cluster data.

- *Vegetation cover types.* For GRCA, we classified six vegetation types as shown in Table 2. For each vegetation type, we calculated
 - mean percent cover by calculating the mean cover per cluster for each vegetation type (using the cover class midpoints), and then calculating the mean of the cluster means to determine the mean and standard deviation for the target habitat.
 - frequency by reporting the number of macroplots where a specific cover type had been recorded as a proportion of the total number of macroplots
- *Foliar cover of functional groups.* The mean foliar cover for each functional group was calculated for the macroplot (using the cover class midpoints), then for the cluster. The mean and standard deviation were then calculated for the target habitat.
- *Tree and snag density.* Density was calculated as stems/ha for each species and size class, and for all species within a size class. Mean density was calculated for the macroplot, then for the cluster, and finally a mean species density and standard deviation were calculated for the target habitat.
- *Tree and snag basal area.* Basal area was calculated as m²/ha for each species and size class using the midpoints of the size class as the diameter at breast height (dbh). Mean basal area was calculated for the macroplot, then for the cluster, and finally a mean species basal area and standard deviation were calculated for the target habitat.

Table 2. Vegetation cover types in mixed-conifer habitat at Grand Canyon National Park.

Vegetation type	Description
Mixed-Conifer Forest (target habitat)	Dominated by various combinations of ponderosa pine (<i>Pinus ponderosa</i>), Douglas fir (<i>Pseudotsuga menziesii</i>), white fir (<i>Abies concolor</i>), blue spruce (<i>Picea pungens</i>), southwestern white pine (<i>Pinus strobiformis</i>), aspen (<i>Populus tremuloides</i>) and sometimes other species. Typically consists of a topographically determined heterogeneous mosaic of patches.
Aspen Grove	Dominated by aspen. Typically, aspen stands occur in areas relatively recently impacted by disturbance that removed the tree canopy.
Ponderosa Pine Forest	Dominated by ponderosa pine, occupies the lowest elevation of the montane zone. Often contains elements of the Pinyon-Juniper Woodland type.
Montane Grassland	Includes small stands (meadows) and larger stands (parks). Scattered in valley bottoms and on dry, steep, south-facing slopes in the montane zone.
Spruce-Fir Forest	Characterized by Engelmann spruce (<i>Picea engelmannii</i>) and subalpine fir (<i>Abies lasiocarpa</i>).
Burned Mixed-Conifer	Burned areas with little or no canopy cover from live conifer trees.

3 Results

3.1 Summary of Bird Community Data

In 2007, we conducted a total of 252 VCP point counts in mixed-conifer habitat at GRCA (table 1). We were unable to sample at two clusters during the first survey period, because we were still field-checking sampling points during this pilot year. During the 2007 surveys, we detected 4,882 individuals of 41 species (table 3). The most commonly detected species was the yellow-rumped warbler—detections of this species comprised 17.18 % of the total number of individuals detected.

Table 3. Bird species and number detected during VCP point counts in mixed-conifer habitat at Grand Canyon National Park (GRCA). Data are from VCP point counts conducted at GRCA in 2007. Species are listed in descending order of the total number of individuals detected.

Common name	Scientific name	Total number of detections	Proportion of all detections (%)
Yellow-rumped warbler	<i>Dendroica coronada</i>	839	17.18
Hermit thrush	<i>Catharus guttatus</i>	408	8.35
Warbling vireo	<i>Vireo gilvus</i>	399	8.17
Violet-Green swallow	<i>Tachycineta thalassina</i>	340	6.96
Western tanager	<i>Piranga ludoviciana</i>	316	6.47
Mountain chickadee	<i>Poecile gambeli</i>	304	6.22
Ruby-crowned kinglet	<i>Regulus calendula</i>	291	5.96
Northern flicker	<i>Colaptes auratus</i>	290	5.94
Dark-eyed junco	<i>Junco hyemalis</i>	273	5.59
House wren	<i>Troglodytes aedon</i>	218	4.46
Red-breasted nuthatch	<i>Sitta canadensis</i>	191	3.91
Chipping sparrow	<i>Spizella passerina</i>	174	3.56
Western wood-pewee	<i>Contopus sordidulus</i>	170	3.48
Pine siskin	<i>Carduelis pinus</i>	118	2.42
Hairy woodpecker	<i>Picoides villosus</i>	89	1.82
Williamson's sapsucker	<i>Sphyrapicus thyroideus</i>	87	1.78
Brown creeper	<i>Certhia americana</i>	62	1.27
Steller's jay	<i>Cyanocitta stelleri</i>	50	1.02
Red-naped Sapsucker	<i>Sphyrapicus nuchalis</i>	37	0.76
Dusky flycatcher	<i>Empidonax oberholseri</i>	36	0.74
Black-headed grosbeak	<i>Pheucticus melanocephalus</i>	35	0.72
Pygmy nuthatch	<i>Sitta pygmaea</i>	34	0.70
Cassin's finch	<i>Carpodacus cassinii</i>	22	0.45
Broad-tailed hummingbird	<i>Selasphorus platycercus</i>	15	0.31
American robin	<i>Turdus migratorius</i>	13	0.27
Black-chinned hummingbird	<i>Archilochus alexandri</i>	13	0.27
Olive-sided flycatcher	<i>Contopus cooperi</i>	11	0.23
White-throated swift	<i>Aeronautes saxatalis</i>	10	0.20
Cordilleran flycatcher	<i>Empidonax occidentalis</i>	8	0.16

Table 3. Bird species and number detected during VCP point counts in mixed-conifer habitat at Grand Canyon National Park *continued*.

Common name	Scientific name	Total number of detections	Proportion of all detections (%)
Clark's nutcracker	<i>Nucifraga columbiana</i>	5	0.10
Common raven	<i>Corvus corax</i>	5	0.10
Mourning dove	<i>Zenaida macroura</i>	4	0.08
Plumbeous vireo	<i>Vireo plumbeus</i>	4	0.08
House finch	<i>Carpodacus mexicanus</i>	3	0.06
White-breasted nuthatch	<i>Sitta carolinensis</i>	3	0.06
Mountain bluebird	<i>Sialia currocoides</i>	2	0.04
Cooper's hawk	<i>Accipiter cooperii</i>	1	0.02
Northern goshawk	<i>Accipiter gentilis</i>	1	0.02
Rufous hummingbird	<i>Selasphorus rufus</i>	1	0.02
Western bluebird	<i>Sialia mexicana</i>	1	0.02
Wild turkey	<i>Meleagris gallopavo</i>	1	0.02

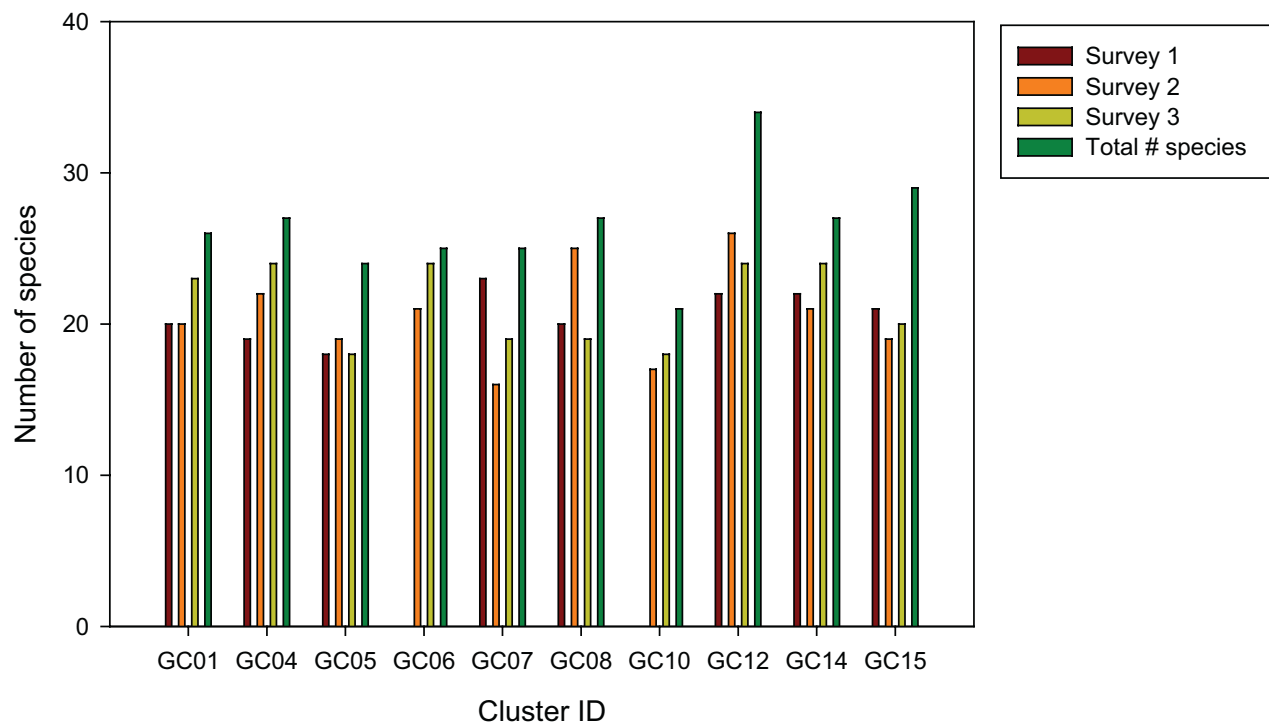


Figure 2. Number of bird species detected in mixed-conifer habitat at Grand Canyon National Park (GRCA). The number of species detected at each cluster, during each of three survey periods, and the total number of species detected at each cluster in GRCA mixed-conifer habitat in 2007.

The number of species detected at each cluster, during each of three survey periods, and the total number of species detected at each cluster in 2007 are shown in Figure 2. No clear pattern emerged for the number of species detected per survey period. Two clusters had the highest number of species detected during the first survey period; three clusters during the second survey period; and five clus-

ters had the highest number during the third survey. The total number of species detected at a cluster was always higher than the number of species in any given survey period, indicating that some unique species were detected during specific survey periods. The mean observed (i.e., unadjusted for detectability) bird species richness per cluster, across all three surveys, was 20.77 (n=10, SD=2.00).

The mean number of individuals detected per species during a VCP point count, and the mean frequency of plots with detections (averaged across the frequency for each sampling cluster), for each species detected in GRCA mixed-conifer habitat are presented in Table 4. The yellow-rumped warbler had the highest mean number of individuals, with an average of 3.35 individuals detected during an eight-minute point count. Yellow-rumped warblers were also found at almost every plot (97.78%). The Williamson's sapsucker had a relatively low abundance (0.35 individuals/point count), but was fairly widely distributed, detected on an average of 61.11% of the plots in a cluster (table 4).

Table 4. Mean number of individuals detected per VCP point count, mean frequency of occupied plots, and proportions of clusters occupied in mixed-conifer habitat in Grand Canyon National Park (GRCA). Mean number of individuals detected per VCP point count (averaged across sampling clusters), mean frequency (%) of occupied plots per cluster, averaged across 10 clusters, and proportion (%) of clusters occupied in mixed-conifer habitat at GRCA in 2007.

Species	Mean # of individuals	SD	Mean frequency occupied plots (%)	% Clusters occupied
Yellow-rumped warbler	3.35	0.89	97.78	100.00
Hermit thrush	1.64	0.43	100.00	100.00
Warbling vireo	1.55	0.58	96.67	100.00
Violet-green swallow	1.30	0.97	66.67	90.00
Western tanager	1.28	0.39	95.56	100.00
Mountain chickadee	1.24	0.45	96.67	100.00
Northern flicker	1.17	0.23	100.00	100.00
Ruby-crowned kinglet	1.16	0.39	95.56	100.00
Dark-eyed junco	1.11	0.72	91.11	100.00
House wren	0.88	0.40	77.78	100.00
Red-breasted nuthatch	0.76	0.34	87.78	100.00
Chipping sparrow	0.71	0.26	83.33	100.00
Western wood-pewee	0.67	0.36	76.67	100.00
Pine siskin	0.46	0.38	53.33	100.00
Hairy woodpecker	0.35	0.14	61.11	100.00
Williamson's sapsucker	0.35	0.19	61.11	100.00
Brown creeper	0.25	0.19	38.89	80.00
Steller's jay	0.20	0.18	34.44	90.00
Red-naped sapsucker	0.15	0.14	30.00	100.00
Black-headed grosbeak	0.14	0.11	28.89	90.00
Dusky flycatcher	0.14	0.13	33.33	90.00
Pygmy nuthatch	0.13	0.16	24.44	70.00
Cassin's finch	0.08	0.11	15.56	60.00

Table 4. Mean number of individuals detected per VCP point count, mean frequency of occupied plots, and proportion (%) of clusters occupied in mixed-conifer habitat in Grand Canyon National Park, 2007, *continued*.

Species	Mean # of individuals	SD	Mean frequency occupied plots (%)	% Clusters occupied
Broad-tailed hummingbird	0.06	0.07	15.56	50.00
American robin	0.05	0.06	13.33	50.00
Black-chinned hummingbird	0.05	0.06	14.44	50.00
Olive-sided flycatcher	0.04	0.09	8.89	20.00
White-throated swift	0.04	0.08	7.78	40.00
Cordilleran flycatcher	0.03	0.05	7.78	40.00
Clark's nutcracker	0.02	0.03	4.44	30.00
Common raven	0.02	0.02	5.56	50.00
House finch	0.01	0.02	3.33	30.00
Mountain bluebird	0.01	0.02	2.22	10.00
Mourning dove	0.01	0.04	4.44	20.00
Plumbeous vireo	0.01	0.03	4.44	30.00
White-breasted nuthatch	0.01	0.04	3.33	10.00
Cooper's hawk	0.00	0.01	1.11	10.00
Northern goshawk	0.00	0.01	1.11	10.00
Rufous hummingbird	0.00	0.01	1.11	10.00
Western bluebird	0.00	0.01	1.11	10.00
Wild turkey	0.00	0.01	1.11	10.00

3.2 Summary of Bird Habitat Data

We found five vegetation types in the macroplots (0.8 ha circular plots centered on each bird sampling point) in the GRCA sampling area: Mixed-Conifer Forest, Aspen Grove, Ponderosa Pine Forest, Montane Grassland and Burned Mixed Conifer (table 5). When we calculated the mean percent cover for each vegetation type, Mixed-Conifer Forest, the target habitat for this study, was the most common vegetation cover type (table 5), accounting for, on average, 70.31% of the overall vegetative cover of the macroplots. The average canopy closure is 20.89% (SD=7.13).

The understory of the mixed-conifer habitat at GRCA is mainly comprised of small trees, perennial grasses, and forbs (table 6). There is considerable variation in the amount of total foliar cover, and the amount of foliar cover each functional group contributes to a particular plot (as reflected in the standard deviations; SD). For example, the amount of total foliar cover ranges from 5.00% to 33.75%, and forb cover ranges from 0.22% to 15.25%.

The abundance of trees is expressed in terms of density—the number of stems per hectare and basal area, by species and size class. Table 7 and Figure 3 illustrate density of trees by species and size class. Eight tree species were recorded on the sampling plots. In general, the standard deviations are high; this may be, in part, due to the reduced sampling conducted in this, the pilot year.

Sapling densities provide insight into the structure and dynamics of the forest. Aspen (see Table 7 for common names of tree species) dominated the sapling class—trees less than 15 cm dbh. Sapling

Engelmann spruce, white fir, and subalpine fir were also fairly common. The size structure of the three most common species (fig. 3) shows a typical decline in tree density with increasing tree diameter.

Table 5. Mean cover of vegetation types, standard deviation (SD), and range; and mean frequency per cluster in target mixed-conifer habitat in Grand Canyon National Park, 2007.

Vegetation type	Cover (%)	SD	Range	Frequency (%)
Mixed-Conifer Forest	70.31	9.88	62.22-87.50	98.89
Aspen Grove	16.15	13.98	3.00-38.61	97.78
Ponderosa Pine Forest	1.89	4.15	0.00-11.94	4.44
Burned Mixed Conifer	3.33	10.54	0.00-33.33	4.44
Montane Grassland	0.97	2.79	0.00-8.89	3.33

Table 6. Foliar cover of functional groups in target mixed-conifer habitat in Grand Canyon National Park in 2007.

Functional groups	Foliar cover (%)		
	Mean foliar cover	SD	Range
Total foliar cover	18.95	(10.18)	5.00-33.75
Perennial grasses, graminoids	4.47	(3.79)	0.63-10.72
Annual grasses	0.59	(1.55)	0.00-4.41
Forbs	4.39	(4.58)	0.22-15.25
Shrubs*	1.71	(1.73)	0.00-5.31
Understory trees (< 1.4m height)	5.91	(3.88)	1.81-10.88
Standing dead herbaceous	0.01	(0.03)	0.00-0.08
Standing dead woody	0.51	(0.83)	0.00-2.31

*Note: In 2007, this only included shrubs < 0.5 m tall.

Table 7. Density of trees by species and size class in mixed-conifer habitat in Grand Canyon National Park, 2007. Density (number of stems/ha) is provided for saplings (<15 cm dbh), and overstory trees 15-23 cm dbh, 23-38 cm dbh, and >38 cm dbh. Common names are provided for each tree species.

Species	Common name	< 15 cm	15-23 cm	23-38 cm	>38 cm	Total overstory
<i>Abies concolor</i>	White fir	208.12	19.45	8.44	0.48	28.37
<i>Abies lasiocarpa</i>	Subalpine fir	133.40	30.77	15.60	0.56	46.94
<i>Picea engelmannii</i>	Engelmann spruce	287.47	55.79	51.93	5.73	113.45
<i>Picea pungens</i>	Colorado spruce	0.99	0.39	-	-	0.39
<i>Pinus edulis</i>	Pinyon pine	2.65	0.09	-	-	0.09
<i>Pinus ponderosa</i>	Ponderosa pine	4.42	7.47	19.73	18.37	45.57
<i>Populus tremuloides</i>	Aspen	705.37	79.11	54.18	1.80	135.09
<i>Pseudotsuga menziesii</i>	Douglas fir	11.05	10.65	4.74	0.56	15.95
All species		1353.48	203.71	154.63	27.50	385.85

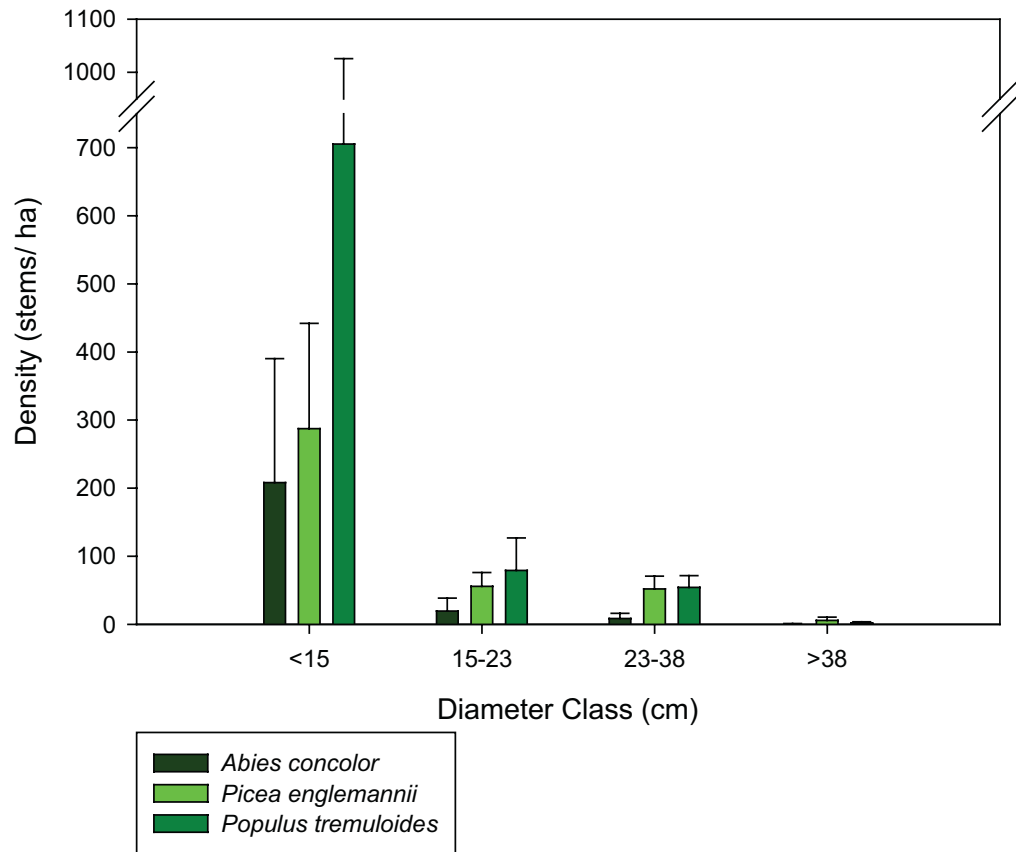


Figure 3. Size structure of sapling and overstory trees in mixed-conifer habitat in Grand Canyon National Park (GRCA), 2007. Mean density (number of stems/ha) of *Abies concolor*, *Picea engelmannii* and *Populus tremuloides*, the three most common trees in GRCA mixed-conifer habitat, by species and size class, including saplings (<15 cm dbh), and overstory trees 15-23 cm dbh, 23-38 cm dbh, and >38 cm dbh. Error bars represent one standard deviation.

Table 8. Basal area of trees by species and size class in mixed-conifer habitat in Grand Canyon National Park, 2007. Basal area (m²/ha) are provided for saplings (<15 cm dbh), and overstory trees 15-23 cm dbh, 23-38 cm dbh, and >38 cm dbh.

Species	< 15 cm	15-23 cm	23-38 cm	>38 cm	Total overstory
<i>Abies concolor</i>	0.92	0.55	0.62	0.08	1.25
<i>Abies lasiocarpa</i>	0.59	0.86	1.13	0.09	2.10
<i>Picea engelmannii</i>	1.27	1.54	3.79	0.93	6.31
<i>Picea pungens</i>	0.00	0.01	-	-	0.01
<i>Pinus edulis</i>	0.01	0.00	-	-	-
<i>Pinus ponderosa</i>	0.02	0.21	1.42	2.93	4.64
<i>Populus tremuloides</i>	3.12	2.22	3.96	0.29	6.49
<i>Pseudotsuga menziesii</i>	0.05	0.30	0.35	0.09	0.74
All species	5.98	5.78	11.30	4.47	21.55

Table 9. Density and basal area of snags by species and size class in mixed-conifer habitat in Grand Canyon National Park, 2007. Density (stems/ha) and basal area (m²/ha) are provided for small snags (<15 cm dbh), and overstory snags (≥15 cm dbh).

Species	Density (stems/ha)		Basal area (m ² /ha)	
	< 15 cm	≥15 cm	< 15 cm	≥15 cm
<i>Abies concolor</i>	7.21	2.53	0.03	0.23
<i>Abies lasiocarpa</i>	8.83	10.88	0.04	0.99
<i>Picea engelmannii</i>	29.71	19.13	0.13	1.74
<i>Pinus ponderosa</i>	1.36	6.66	0.01	0.61
<i>Populus tremuloides</i>	11.77	21.01	0.05	1.91
<i>Pseudotsuga menziesii</i>	0.19	0.58	0.00	0.05
Unknown species	43.44	32.74	0.19	2.97
All snags	103.95	93.55	0.45	8.49

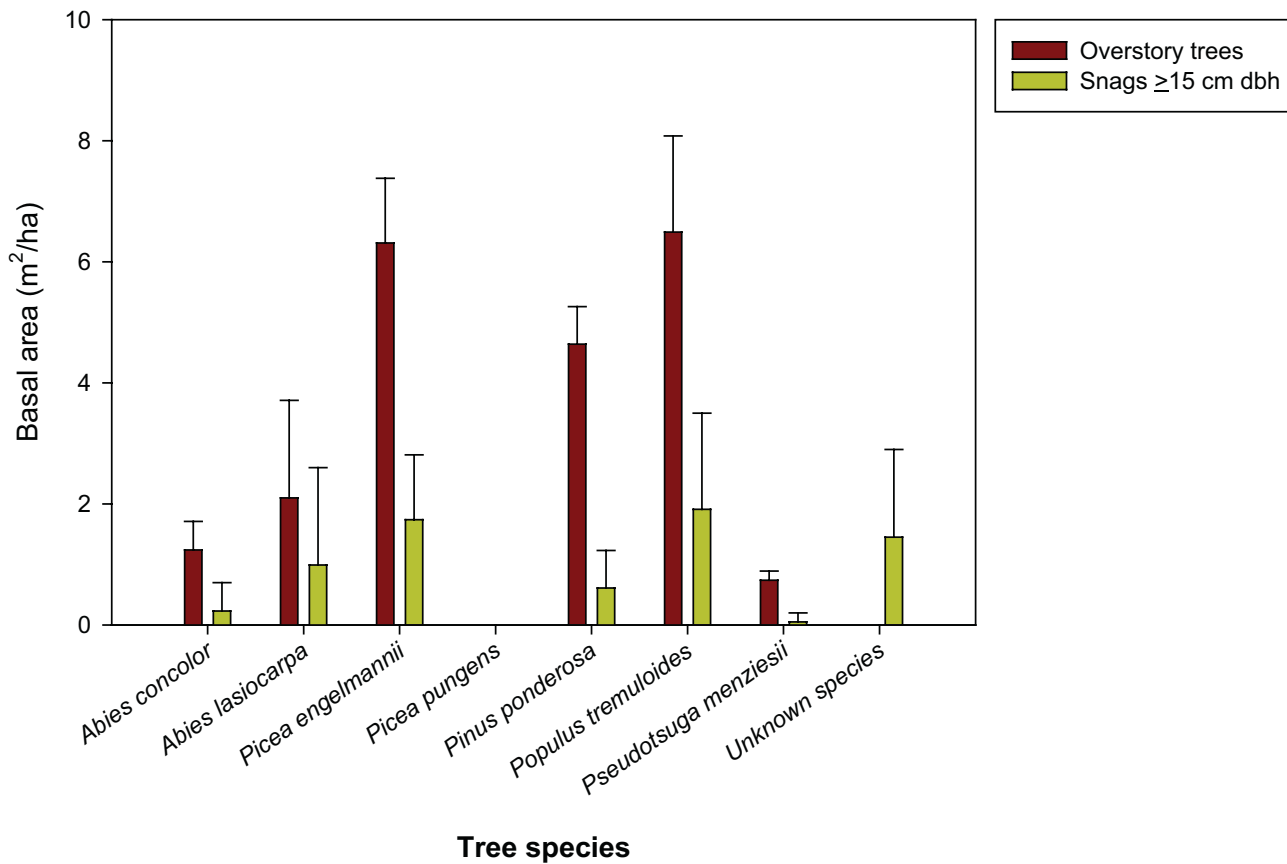


Figure 4. Basal area of overstory trees and snags by species in mixed-conifer habitat in Grand Canyon National Park, 2007. Overstory trees and snags are ≥15 cm dbh. Error bars represent one standard deviation.

Trees with a dbh of 23 to 38 cm contributed the most to basal area (table 8). Aspen had the greatest basal area in every size class except the largest. Ponderosa pine had the greatest basal area among the largest trees (> 38 cm dbh). In the total overstory, aspen and Engelmann spruce had the greatest basal area, followed by ponderosa pine (fig. 4).

The abundance of snags is expressed in terms of density—the number of stems per hectare—and basal area, by species and size class (table 9). We were often unable to identify the species of snag and these snags had the highest density in each size class. Snags of aspen and Engelmann spruce had the greatest basal area (fig. 4). The most common larger snag was aspen, followed by Englemann spruce.

4 Discussion

These data represent the first year baseline sampling for the mixed-conifer bird community at GRCA. The mixed-conifer habitat at GRCA has a variable density of trees typical of mixed-conifer forests, and the bird community is comprised of species typically found in the region's mixed-conifer forests. Yellow-rumped warbler was the most commonly detected species, comprising more than 17% of the total detections. Typically found in conifer and aspen forest in Arizona (Corman and Wise-Gervais 2005), they were detected on almost every plot (98%).

In all, 14 species had over 100 detections, providing a baseline from which to track changes in bird density over time. Many of the species are closely associated with mixed-conifer forests, and their distribution may be affected by climate change over time. For example, the hermit thrush is one of the most widely distributed migratory birds in North America (Jones and Donovan 1996). In Arizona, it is most often found in mixed-coniferous forests and its populations in Arizona represent the southern part of their breeding range. If climate change affects the distribution of mixed-conifer forests, it may also affect the distribution of the hermit thrush. Climate change may also affect fire risk, and the hermit thrush may be sensitive to fire. Eight years after a fire in the Sierra Nevada there were no hermit thrushes recorded breeding in the burn area (Bock and Lynch 1970).

Williamson's sapsucker is fairly common in the mixed-conifer habitat of GRCA (87 detections). Partners in Flight's North American Landbird Conservation Plan (Rich et al. 2004) lists the Williamson's sapsucker on its watchlist of species of national conservation concern. It has a disjunct breeding range, confined to mountainous regions of western North America (Corman and Wise-Gervais 2005). It is thought to inhabit areas with large snags, patches of snags, and areas of high snag density (Dobbs et al. 1997). Monitoring can provide information about changes in the abundance and distribution of the sapsucker, as well as changes in snag density and distribution.

During our pilot work in mixed-conifer forest in GRCA, we were unable to complete sampling during the scheduled field season using the pilot habitat sampling methods. This has prompted us to modify our sampling techniques. We are currently developing more time-efficient methods.

Our long-range plan is to conduct VCP point counts every three years to track changes in bird species abundance, distribution, and habitat metrics over time. Each year's data will be compared to the previously collected data to analyze changes through time in bird species abundance, occurrence, and density (for species with adequate sample size). More thorough trend analyses will be conducted once sufficient data have been collected.

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