

Kaibab National Forest Landbird Surveys



2005 MIGRATORY BIRD BREEDING SEASON



**July
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Introduction

Under the 1976 National Forest Management Act (NFMA), the Forest Service is directed to “provide for diversity of plant and animal communities ... in order to meet overall multiple-use objectives.” This entails managing habitat in a manner that will support at least a minimum number of individuals, ensuring that the habitat is well distributed, and that reproductive individuals can interact with others on a given National Forest. The NFMA planning regulations under which the Forest Service operates [36 CFR 219.19 (a)(6), 1982] states that "Population trends of management indicator species [MIS] will be monitored and relationships to habitat changes determined." The Planning Regulations and the Forest Service Manual (FSM 2620 and 2621) describe how to select MIS and what groups of species to include. One category is “ecological indicators,” or those species in which measurable change indicates trends in abundance of other species or in conditions of specific biological communities. There is also specific direction concerning use of best available information and commercial and scientific data in the 1982 NFMA implementing regulations [36 CFR 219.12(d)] and the NEPA implementing regulations [40 CFR 1502.24].

Methodologies for determining population status vary by species. This report represents efforts by the Kaibab National Forest (KNF) to document and monitor selected MIS ecological indicators and forest-wide songbird species. The long-term goal is to provide input for informed decision-making by line officers with respect to potential management-induced habitat changes and the impact of those changes on the wildlife resource.

Kaibab National Forest Management Indicator Species

Eighteen MIS were selected for planning purposes in the KNF Forest Plan (1987; Record of Decision, 1988) (Table 1). The same MIS list was brought forward in subsequent Plan amendments.

Table 1. Management indicator species of the Kaibab National Forest and the vegetation characteristics they were chosen to represent.

<u>Management Indicator Species</u>	<u>Vegetation Characteristics</u>
1. Aquatic macroinvertebrates	Riparian
Birds	
2. Cinnamon teal	Late-seral wetlands
3. Goshawk	Late-seral ponderosa pine
4. Hairy woodpecker	Snags in ponderosa pine, mixed conifer and spruce-fir
5. Lincoln's sparrow	Late-seral, high elevation (>7,000') riparian
6. Lucy's warbler	Late-seral, low elevation (<7,000') riparian
7. Juniper titmouse	Late-seral pinyon-juniper, and snags in pinyon-juniper
8. Pygmy nuthatch	Late-seral ponderosa pine
9. Spotted owl	Late-seral mixed conifer and spruce-fir
10. Turkey	Late-seral ponderosa pine
11. Red-naped sapsucker	Late-seral aspen and snags in aspen
12. Yellow-breasted chat	Late-seral, low elevation (<7,000') riparian
Mammals	
13. Elk	Early-seral ponderosa pine, mixed conifer, spruce-fir
14. Mule deer	Early-seral aspen and pinyon-juniper
15. Pronghorn antelope	Early- and late-seral grassland
16. Red squirrel	Late-seral mixed conifer and spruce-fir
17. Tassel-eared squirrel	Early-seral ponderosa pine
Plants	
18. Arizona bugbane	No representative habitat was associated with this species

Several groups of species were not targeted by the landbird survey effort reported here. Several of the KNF MIS are riparian dependent, yet the KNF is perhaps the driest forest in the National Forest System. Although ephemeral wetlands occur on the Forest, their quantity and distribution

are directly related to seasonal precipitation patterns. The lack of perennial streams makes riparian habitat essentially non-existent. At the landscape scale, the KNF has only scattered pockets and patches, and sometimes only individual plants, which qualify as wetland or riparian habitat. There is not sufficient habitat consistently available to maintain adequate numbers and distributions of reproductively capable individuals to support vertebrate *populations* of riparian-dependent MIS. Therefore, the monitoring effort reported here did not specifically target cinnamon teal, Lucy's warbler, yellow-breasted chat, or Lincoln's sparrow. A separate monitoring effort was continued in our wetland and lake habitats that follows a different protocol (internal documentation, Kaibab National Forest, 2005). However, all bird detections were recorded during our landbird surveys, i.e., no effort was made to exclude any avian species. Raptors and other secretive species are not well suited for these methods, but Mexican spotted owls and goshawks are also monitored separately. Although game species are monitored by the Arizona Game and Fish Department, wild turkey detections were included in our surveys.

The efforts reported here were principally designed and adapted to address the remaining land bird MIS. Because of the opportunity offered by our survey methods, we added a component to include tassel-eared and red squirrels. This survey method also allows us to build a list of all migratory birds breeding on the KNF.

Methods

We conducted point-transect surveys using distance sampling, following Buckland et al. (1993) and Leukering et al. (2000). Point-transects is an effective survey method for monitoring multiple species while emphasizing focal species, e.g., MIS. Observers recorded all bird

detections on the point counts, but only recorded MIS detections along transects between point counts. Point-transect methods are effective for obtaining species density estimates in a variety of habitat types (Rosenstock et al 2001). Transect surveys targeted the following MIS: pygmy nuthatches, hairy woodpeckers, juniper titmice, and red-naped sapsuckers.

Survey Design

The overall objective for 2005 was to test how well this methodology worked in our landscapes given our inherent budgetary and logistic restraints. Funding allowed for 4 weeks time for 4 surveyors, including 2 weeks of bird identification training conducted on the KNF (Biome Ecological and Biological Research, Flagstaff, AZ). The remaining 2 weeks time had potential to complete up to 40 days of actual bird survey-effort. Using stand inventory data, we stratified the KNF into 6 habitat classifications: ponderosa pine, mixed-conifer, woodland/grassland, montane grassland, aspen, and wetland/water-associated cover types. All survey stands were randomly selected within the designated habitat stratifications. A 250 m buffer along habitat boundaries was excluded during the selection process to avoid areas influenced by neighboring habitats. Maintenance level 1 and 2 roads (closed roads and roads open for use for high-clearance vehicles) are ubiquitous on the Forest and were considered part of the available habitat. Maintenance level 3-5 roads were buffered 250 m along either side to avoid potential road influences.

We subjectively assigned our target of 40 transects among cover types with an emphasis on ponderosa pine and mixed-conifer forests (Table 2). The emphasis was based in part on the predominance of these habitats, especially ponderosa pine, and because most of our forest

management occurs in these 2 cover types (i.e., our goal was to use MIS as indicators of management). Wetland/water cover types were dropped from this effort, as described above. Aspen and woodland/grassland were considered pilot efforts designed as much to test the protocol as to actually collect data in these cover-types.

Table 2. Total area (acres) of each habitat coverage type by ranger district and across the Kaibab National Forest.

Habitat Cover Type	Area			
	Williams	Tusayan	North Kaibab	Forest-wide
Aspen	958	0	21,996	22,953
Mixed-conifer	4,297	0	52,748	57,044
Montane Grassland	27,265	80	7,302	34,647
Ponderosa Pine	225,741	71,705	190,373	487,819
Woodland/Grassland	271,620	235,652	271,599	778,871
Total	530,979	309,379	544,102	1,384,460

We developed the following habitat stratification:

PONDEROSA PINE: All ponderosa pine stands were included without regard to the presence or absence of oak. Gambel’s oak presence was documented in the field to potentially allow better resolution in assessing habitat types in the future. Twenty transects were assigned within ponderosa pine.

MIXED-CONIFER: Mixed-conifer includes Douglas-fir, white fir, blue spruce, limber pine, Englemann spruce, corkbark fir, and spruce-fir. Fourteen transects were assigned within this cover type.

WOODLAND-GRASSLAND: Because we did not have *a priori* information to determine when pinyon-juniper woodland becomes savannah, or when savannah becomes grassland, habitat within this ecocline was lumped into 1 category. Two transects were planned to test how well birds and habitat could be identified, distances

measured, and whether we could further segregate this cover-type. During the course of the field effort, a 3rd stand was added to the sample.

MONTANE GRASSLAND: Grasslands above the pinyon-juniper elevations were designated “montane.” Montane grasslands typically occur as linear features and were not wide enough to allow buffering stand edges by 250 m. Although this violated the policy of distancing transects from neighboring cover types, we felt the addition of this habitat variability within the general forest matrix warranted assessing the influence of montane grassland resources on resident bird communities. Two transects were designated in montane grasslands.

ASPEN: Aspen frequently occurs as isolated patches or relatively linear stands, neither of which is large enough to allow 250 m edge buffers. Although this too violated the policy of distancing transects from neighboring stands, we again felt the addition of this habitat structure within the general forest matrix warranted assessing the influence of aspen on resident bird communities. Two transects were assigned in aspen.

Transects were only initiated from level 2 roads and actual starting points began 50 m from the road edge to avoid additional biases. Based on stand maps, compass bearings were identified that defined the broadest arc (i.e., degrees) from which a transect bearing that would remain within stand boundaries for at least 10 survey points (2,500 m) could be selected. Actual transect bearings were then randomly selected from within this range of compass degrees. Surveyors followed the selected compass bearing while conducting transect surveys for 250 m after which a point-count was completed before continuing along the next 250 m component of the transect. Surveyors followed this protocol unless an obstacle was encountered, e.g., stand boundary, Forest boundary, cliff, etc. If this occurred, surveyors randomly turned left or right and followed a new bearing $\geq 90^\circ$ away from the original line to avoid double counting birds.

Survey Implementation

Stand number, observer, date, district, habitat type, line azimuth and total line length was recorded for each survey. Temperature (°F), wind speed (using the Beaufort scale), and UTM

coordinates (using handheld GPS units) were recorded at the start and stop of each transect. Surveys were conducted from 15 minutes after sunrise until 1000 hour between 24 May and 25 June, 2005; surveys were delayed or canceled when wind velocities exceeded 10 mph. These parameters follow established protocol for northern Arizona (C.L. Chambers, School of Forestry, Northern Arizona University, personal communications, May, 2005; S.S. Rosenstock, Research Branch, Arizona Game and Fish Department, personal communications, May 2005).

We followed the recommendations of Rosenstock et al (2001) for both point and transect surveys. Observers waited quietly for 2 minutes at each point before beginning a 5-minute survey. During each 5-minute point-count survey we recorded: survey start and stop time; all bird species; method of detection (visual, call, song, drum, flyover); sex or age when possible; distance from point-center measured with laser range finders; flock size where applicable; UTM coordinates; percent slope; and visual or auditory squirrel detections. Habitat descriptions included presence or absence of Gambel's oak within the ponderosa pine habitat and a relative sense of tree density within the woodland/grassland cover type.

Between point-count stations, observers walked 250-m transects focusing only on MIS. Data recorded for transect surveys included: all MIS detections; species; sex or age when possible; perpendicular distance from line transects measured with laser range finders; time of detection; method of detection (visual, call, song, drum, flyover); flock size where applicable; and visual or auditory squirrel detections. Perpendicular distance from transects is required for analysis and was either directly measured or calculated based on the sight angle recorded in the field (perpendicular distance (x) was calculated using with the equation: $x = r \sin(\theta)$ where $r =$

sighting distance from the transect and θ is the sight angle measured from the transect line, also recorded in the field). Nearly all perpendicular distances were directly measured in the field.

We attempted to meet each of the assumptions identified by Rosenstock et al (2001).

After completion of each bird survey, routes were then back-tracked and 10 m-wide strip transect surveys (5 m on either side of the transect line) were conducted to record occurrence of squirrel sign. Squirrel sign included groups of pinecone cores, scale piles, branch cuttings, peeled twigs, and middens.

Data Analysis

Under this design, transects are not a fixed length. Instead, survey effort, i.e., total transect length, was maximized until 1000 hours. Data were aggregated by habitat stratification.

Point-transect data was analyzed using program DISTANCE, following model selection guidelines from Buckland et al. (1993). All known juvenile and female birds were omitted from density analysis. According to Buckland et al. (1993), reliable density estimates by species requires a sample size (n_0) of 60-80 individual detections per habitat-type. A minimum sample size of $n \geq 35$ is recommended by Buckland et al. (2004) for a statistically rigorous analysis of detection probabilities, which allows for an evaluation of sampling effectiveness by species. For non-MIS birds, we calculated: minimum total line length (L), or points needed (k) to meet the recommended target coefficients of variation (cv) using sample size calculations for line transects (Equation 1.1) and point counts (Equation 1.2) provided by Buckland et al. (1993) and

the upper limit for “monitoring” described by Leukering et al. (2000). Our estimate of the dispersion parameter b was taken from recommendations by Buckland et al. (1993).

Equation 1.1.
$$L = \left(\frac{b}{(cv_t(\hat{D}))^2} \right) \cdot \left(\frac{L_0}{n_0} \right)$$

Equation 1.2.
$$k = \left(\frac{b}{(cv(\hat{D}))^2} \right) \cdot \left(\frac{k_0}{n_0} \right)$$

Total line length and number of points is determined by the desired precision ($cv(\hat{D})$) for the study and the expected encounter rate (n_0/L_0 for lines and n_0/k_0 for points) determined by the data. A 3% / year decline can be detected within 12 years for those species with coefficients of variation (CV) < 0.50 at the current effort-level; a 3% / year decline can be detected within 30 years for species with CVs between 0.5 and 1.00 (Leukering et. al 2000). The CV quantifies scatter in the data and is a way to represent the statistical precision of our estimates. Statistical significance of $p = 0.1$ and power of 0.8 apply to both trend estimates assuming current survey efforts and methods are continued annually (Leukering et. al 2000). Changes in populations may be detected over time for species with low relative abundance or low encounter rates (i.e., species with CVs > 1.00), however, these trends will have low statistical power. We calculated CVs for each songbird species detected on the point-count surveys. These calculations are useful in refining study design and monitoring objectives for individual species in future years.

Results

MIS species

We surveyed 36 transects in 5 different habitat coverage types across the KNF. Wind velocities prevented surveys from being completed on 4 different mornings. We detected all 4 target avian MIS (pygmy nuthatches, hairy woodpeckers, juniper titmice, and red-naped sapsuckers) and wild turkeys (MIS/game species). Sample size allowed calculations of the probability of detection for pygmy nuthatches, hairy woodpeckers, and juniper titmice (Table 3, Appendices 2-3). Robust density estimates ($n \geq 60$ and $CV < 0.50$) were developed for pygmy nuthatches in ponderosa pine (Table 3, Appendix 1).

Sample sizes did not meet the recommended 60-80 detections necessary for rigorous density estimates for hairy woodpeckers ($n = 37$) or juniper titmice ($n = 24$). Sample sizes for hairy woodpeckers exceeded the minimum of $n \geq 35$ recommended by Buckland et al. (2004) for a statistically rigorous analysis of detection probabilities. CV values were well below the recommended 0.50 threshold for both species (Appendix 2). Detection functions show high probabilities of detections at close distances (i.e., “shoulders” on the first distance bars), meeting one of the essential assumptions that all birds at point-center and along transects are detected (Rosenstock et al. 2001; Appendix 1). The results compare well with other monitoring efforts using the same methodology in ponderosa pine habitat (Table 3). The CV was low for juniper titmice but the detection function was skewed, indicating results are not robust and should be interpreted with caution (Table 3, Appendix 1). However, detections in woodland/grassland habitat were relatively high ($n = 24$) given the low sample size ($K = 3$ transects). The results were encouraging in terms of future survey potential with increased sampling effort. Two other avian MIS, red-naped sapsuckers and wild turkeys, were detected during the 2-week sampling

effort. However, total detections for both species were too low for calculating detection probabilities or density estimates (Appendices 2-3).

Table 3. Summary of detections for avian MIS during line-transect surveys on the Kaibab National Forest, Arizona, summer 2005. *n* = number of detections; *K* = number of total transects; CV (%) = coefficient of variation for distance.

Species	Habitat Type	District	<i>n</i>	<i>K</i>	Area (ac)	Birds/ac	CV
Hairy Woodpecker	Ponderosa Pine	Kaibab NF	37	17	487,819	<0.01	0.19
		San Juan NF ²	14	10	n/a	0.08	0.34
		Black Hills NF ³	45	30	n/a	n/a	0.26
		Colorado ⁴	30	16	n/a	0.13	
Pygmy Nuthatch	Ponderosa Pine	Kaibab NF	122	17	487,819	0.25	0.09
		Colorado ⁴	114	24	n/a	1.08	0.22
Juniper Titmouse	Woodland-Grassland Pinyon-Juniper	South Zone ¹	24	3	778,871	0.09	0.52
		Colorado ⁴	44	17	n/a	0.35	0.25

¹South Zone of the Kaibab National Forest equals the Williams and Tusayan Ranger Districts.

² Estimates from surveys conducted in the HD Mountains by Ecosphere Environmental Services, summer 2002.

³ Estimates from forestwide surveys conducted by the Rocky Mountain Bird Observatory, summer 2005.

⁴Estimates from state-wide surveys conducted by the Rocky Mountain Bird Observatory, summer 2005.

Forest-wide songbird species

We detected 1,914 birds of 66 species (Appendices 4-7). Point count data provided good results (CV of ≤ 0.50) on 29 bird species and fair results (CV of 0.51-1.00) on 40 additional species (Appendices 5). Although annual variation may adjust the results, we can expect to monitor around 49 species (74% of total species) with fair to good precision given the current survey effort (20 species were detected in more than 1 habitat-type, resulting in CVs of both ≤ 0.5 and ≤ 1.0).

Species differences were detected between ranger districts within the ponderosa pine cover type (Appendices 4, 6, and 7). One year of data does not allow differentiating between differences associated with the landscape and those due to the limited sample effort. In ponderosa pine habitat, the Williams Ranger District had the highest species richness and species abundance, but also had the highest survey effort (Table 4). However, the Tusayan district had the fewest transects but the highest relative abundance (8.0 birds/point) in ponderosa pine. Gambel's oak was present on all ponderosa pine transects surveyed on the southern ranger districts (K = 13), but was absent from all surveys on the North Kaibab Ranger District (K = 4; Table 5).

Table 4. Summary of point-transect surveys for all birds on the Kaibab National Forest, Arizona, 2005.

District	Habitat Type	Total Transects	Total Points	Line Length (km)	Species Richness	Species Abundance	Relative Abundance (birds/point)
Williams	Ponderosa Pine	10	111	29.80	48	674	6.1
	Mixed-Conifer	4	22	5.00	28	145	6.6
	Woodland-Grassland	2	22	5.00	28	145	6.6
Tusayan	Ponderosa Pine	3	43	10.50	32	344	8.0
	Woodland-Grassland	1	13	3.25	20	58	4.5
North Kaibab	Ponderosa Pine	4	33	8.25	28	182	5.5
	Mixed-Conifer	6	33	8.25	28	182	5.5
	Montane Grassland ^a	4	15	2.50	19 ^b	64 ^b	4.3
	Aspen	2	17	4.28	20	77	4.5

^aHabitat patch width ranged from 50-200 m.

^bMost species detected during surveys were along habitat edges or within neighboring habitat coverage types.

Species with CVs > 1.00 cannot be adequately monitored within defined habitat-types under the current survey effort. Some species are likely to have low detection probabilities even with increased survey effort due to naturally low population numbers, scattered distributions, secretive habits, and species that may be occupying secondary habitat on the KNF. Knowledge of species ecology is required when interpreting results.

Table 5. Summary of oak presences/absence on ponderosa pine and mixed-conifer point-transect surveys on the Kaibab National Forest, AZ, summer 2005.

Habitat	District	Transects With Oak	% Transects	Points with Oak	% Points
Mixed-conifer	Williams	3	75	13	59
	North Kaibab	0	0	0	0
Ponderosa Pine	Williams	10	100	66	59
	Tusayan	3	100	27	63
	North Kaibab	0	0	0	0

Squirrel Surveys

All 36 transects were surveyed for squirrels. Eighteen squirrels were seen or heard during bird surveys on 12 transects, including 2 detections along the forest edge while surveying montane grassland (Table 6). No visual or auditory detections of squirrels were made after 0815. A total of 464 instances of squirrel sign was encountered on 21 transects (Table 7). The majority of sign (71%) was detected in ponderosa pine forests. Gambel's oak was present on 12 of 13 ponderosa pine transects and on 2 of 3 mixed-conifer transects containing squirrel sign on the South Zone (67% of total transects with squirrel sign). Gambel's oak was not present on transects with squirrel sign in ponderosa pine ($n = 2$) or mixed-conifer ($n = 2$) on the North Kaibab District.

Table 6. Squirrel detections during bird line transect and point count surveys on the Kaibab National Forest, Arizona, 2005. Detections were either visual (V) or auditory (A).

District	Habitat	Number of stands	Number of squirrels	Species	How?
North Kaibab	Montane Grassland ¹	2	2	Tassel-eared	V
	Ponderosa pine	1	1	Tassel-eared	V
Tusayan	Ponderosa pine	1	2	Tassel-eared	V
Williams	Mixed-conifer	1	1	Tassel-eared	V
	Ponderosa pine	6	9	Tassel-eared	V, A
	Mixed-conifer	1	3	Red	V, A

¹ Squirrels were detected on the habitat edge.

One incident of new branch clippings was recorded in aspen on the North Kaibab. No field sign was detected in woodland/grassland or montane grassland habitat.

Branch clippings were by far the most common squirrel sign across all habitats (94% of the sign). Fifty-seven percent of transects surveyed for squirrels were on the Williams District, but this effort accounted for 79% of the total branch clippings (Table 7). Twenty-two of 25 cone cores/scale piles (88%) and all middens (2 of 2) were detected on the North Kaibab District. An old midden was located in ponderosa pine and a new midden was detected in mixed-conifer habitat. Five of 15 transects completed on the North Kaibab had squirrel sign. This effort accounted for 28% of the squirrel sign encountered forest wide. Twelve of 16 transects surveyed on the Williams District had evidence of squirrels and 75% of the forest wide squirrel sign was recorded on the Williams District. Although effort (transects) and detections (field sign) appear correlated, transect length was not equal and has yet to be quantified for the squirrel surveys.

Four of 5 transects had evidence of squirrel use on the Tusayan District, accounting for 4% of the total sign observed.

Table 7. Squirrel sign by sign type, district, and habitat type detected during strip transect surveys on the Kaibab National Forest, Arizona, 2005. Transects lengths were variable, depending on site conditions.

Area	Transects	Cones		Clippings		Middens		All Sign
	<i>N</i>	Old	New	Old	New	Old	New	
Williams	12	2	0	258	89	0	0	349
Tusayan	4	1	0	17	1	0	0	19
North Kaibab	5	18	4	3	69	1	1	96
Forest-wide	21	21	4	278	159	1	1	464
Mixed Conifer	5	3	0	13	26	0	1	43
Ponderosa Pine	15	18	4	265	129	1	0	417
Aspen	1	0	0	0	4	0	0	4

Discussion

The differences in species richness in ponderosa pine between the 3 Ranger Districts may be due to physical differences on the landscape or may simply be due to sample effort. More of the randomly selected ponderosa pine stands occurred on the Williams District and weather further eroded efforts on the North Kaibab District. However, the differences in species abundance, nearly 2-fold between the North Kaibab and Tusayan and almost 4-fold between the North Kaibab and Williams, may be related to distribution of Gambel's oak. Gambel's oak was present on all transects and 60% of the individual point counts in ponderosa pine habitat on the South Zone. Although present on the Kaibab Plateau, Gambel's oak was absent from all the stands (83 points in forested habitat) surveyed on the North Kaibab District.

Species richness and relative abundance were similar between the Williams and Tusayan Districts within woodland-grassland habitat; no woodland-grassland stands were selected on the North Kaibab. However, habitat structure varied considerably between each of the 3 transects sampled in woodland habitat. Twenty-one species were detected within this habitat-type, but only 11 species were common to both Districts (Appendix 7). Woodland-grassland habitat on surveyed on the Tusayan District was dominated by a mix of dense pinyon pine and juniper trees with scattered openings dominated by sagebrush. Surveys on the Williams District were characterized by open juniper woodlands with both pinyon pine and sagebrush absent. Woodland-grassland surveys on the Tusayan District recorded forest species such as hairy woodpeckers, white-breasted and pygmy nuthatches, plumbeous vireos, dusky flycatchers, and mountain chickadees. Species associated with more open habitat, such as mourning dove, Gambel's quail, lesser nighthawk, western kingbird, and lark sparrow were detected on the Williams District.

Montane grasslands on the North Kaibab District were linear, narrow (50 – 200 m wide), and most birds were detected along habitat edges or within adjacent forest habitat. Few birds (14 of 64 birds) were actually detected within the grassland. Montane grasslands appeared to be used primarily for foraging. Vegetation in the pastures surveyed in 2005 was short and did not appear to offer quality nesting habitat. Sightings of elk are very rare on the Kaibab Plateau and have not been reported in the last couple of years. Elk are either not present or, at most, limited to less than 20 animals (Ron Sieg, personnel communications, Regional Supervisor, Region II, Arizona Game and Fish Department). The pastures surveyed were not grazed by cattle in 2004 or 2005;

cattle were removed from the allotment more than 2 months early in 2003. Although the surveys occurred early in the growing season for the Kaibab Plateau, they reflect habitat conditions available to birds during the nesting season. The lack of nesting cover may have been a result of previous drought conditions, despite the wet winter of 2004/2005.

Species on the Partners in Flight (PIF) 2005 North American Landbird Conservation Plan Watch List include Grace's warbler, red-faced warbler, Virginia's warbler, Lucy's warbler, pinyon jay, and band-tailed pigeons (Rich et al. 2005). All but Lucy's warbler, a KNF MIS, were detected by this survey effort (Table 8). Grace's warbler, pinyon jay, and band-tailed pigeons are listed due to significant population declines and potential threats to their primary habitat (Rich et al. 2005). The U.S. Fish and Wildlife Service Birds of Conservation Concern Report (BCR) also lists Grace's warbler, Virginia's warbler, and pinyon jay, but additionally includes black-throated gray warblers and Williamson's sapsuckers (USFWS 2002). Listing factors include restricted distributions and low population numbers. Our survey efforts recorded good monitoring results ($CV \leq 0.5$) for 4 of 7 species and fair results ($CV \leq 1.0$) for 2 of the remaining species occurring on the KNF (Table 8). Only Williamson's sapsuckers, a KNF MIS, had poor monitoring results.

Red-faced warblers are considered wetland associates by the PIF plan, but we detected the species in mixed-conifer forest types. All red-faced warblers were detected on the South Kaibab where mixed-conifer sites were generally associated with steep slopes bordering drainages. These drainages typically support woody shrubs, including New Mexico locust, rose, Gambel's oak, raspberry, and Rocky Mountain maple. Shrubs are typically sparse to absent in the general forest matrix.

Table 8. Overlap between Partners in Flight (PIF) Watch List, U.S. Fish and Wildlife Service Birds of Conservation Concern Report (BCR), and birds detected on the Kaibab National Forest (KNF), Arizona, summer, 2005.

PIF	BCR	KNF CV values¹ (habitat)
Grace's warbler	Grace's warbler	0.17 (PP)
Virginia's warbler	Virginia's warbler	0.42 (PP)
pinyon jay	pinyon jay	0.61 (PP)
Lucy's warbler	-----	NA
Red-faced warbler	-----	0.50 (MC)
Band-tailed pigeons	-----	1.00 (MC)
-----	black-throated gray warblers	0.50 (WG)
-----	Williamson's sapsuckers	1.73 (MC)

¹PP = ponderosa pine, MC = mixed-conifer, WG = woodland/grassland.

MIS Species

Our initial efforts resulted in robust estimates for pygmy nuthatches. The CV for juniper titmice and hairy woodpeckers was < 0.05, but the number of detections was below the minimum levels necessary for statistically meaningful abundance estimates. The model estimates an additional 2 transects (2500 m each) in woodland-grassland habitat and 6 transects in ponderosa pine would provide the ability to detect a 3% change in the respective populations within 12 years with statistical significance of $p = 0.1$ and power of 0.8. Given that the effort expended in woodland/grassland habitat was intended to inform us on what is required to survey these habitats, the juniper titmouse results were very encouraging in terms of MIS monitoring. The mixed results for hairy woodpeckers may result from their naturally patchy and ephemeral distribution, which generally mirrors availability and distribution of snag patches. Fire behavior

on the forest may be a more important determinant of survey success for hairy woodpeckers than survey effort.

Model results indicate that our methodology is not likely to successfully monitor red-naped sapsuckers or wild turkeys. Red-naped sapsuckers are MIS for aspen habitat. We had a single red-naped sapsucker detection in mixed-conifer habitat. Although we expended a limited effort (2 transects) in aspen habitat, program DISTANCE estimates 72 more transects would be required to attain robust estimates. The secretive and largely ground-dwelling behaviors of wild turkey likely indicate this survey method is not suited to tracking their numbers. However, all results are preliminary and future efforts should better illuminate interpretation of these data and eventually allow trend estimates.

It is important to realize the limitations of this survey technique. We selected it to help us monitor MIS avian ecological indicators, but this is not an effective technique for monitoring raptors or elusive species (e.g., wild turkeys). There is no nest success/reproductive element associated with these survey results, therefore we cannot make conclusions relative to basic elements of population health such as correlating population trends with source or sink habitats. Positive abundance trends may have negative ecological ramifications for sink populations. In addition, our habitat data is quantified at coarse scales. Although this methodology addresses our needs for monitoring population trends, recognition of survey limitations will be important for future data interpretation.

Squirrels

Two different species of squirrels occur on the KNF. There is some overlap in habitat use, but tassel-eared squirrels tend to use ponderosa pine and red squirrels tend to use mixed-conifer habitat. Most clippings were on South Kaibab and likely associated with tassel-eared squirrels.

Dodd et.al. (1998) used a similar range of field sign in their study of tassel-eared squirrels in ponderosa pine habitat. Based on over 56,000 trap days and 2,542 squirrel captures, they found a significant relationship between feeding sign and squirrel densities. They also recorded a preponderance of twig clippings, but found including other forms of feeding sign reduced Type II errors, making squirrel sign a much more sensitive index for squirrel densities, even outperforming track station counts (Dodd et. al. 1998). Dodd et. al. (1998) included truffle excavations, which we are not recording. However, truffles primarily served as a winter food while clippings were a key spring food (Dodd et. al. 1998). The timing of our surveys likely reduces the importance of tracking truffle excavations, but increases the usefulness of tracking twig clippings. Because of the work of Dodd et. al. (1998) comparing live-trapping, track plates, and feeding sign, we feel continuing the squirrel component of our landbird surveys can establish an index for tracking trends in squirrel populations.

Literature Cited

- Buckland, S. T., D. R. Anderson, K. P. Burnham, and J. L. Laake. 1993. Distance sampling: estimating abundance of biological populations. Chapman and Hall, New York, New York, USA.
- Dodd, N.L., S.S. Rosenstock, C.R. Miller, and R.E. Schweinsburg. 1998. Tassel-eared squirrel population dynamics in Arizona: index techniques and relationships to habitat condition. Arizona Game and Fish Technical Report 27. Phoenix, Arizona.
- Leukering, T. , M. F. Carter, A. Panjabi, D. Faulkner, and R. Levad. 2000. Monitoring Colorado's Birds: The Plan for Count-based Monitoring. Unpubl. Document, Rocky Mountain Bird Observatory, Brighton, CO. 21 pp.
- Rich, T. D., C. J. Beardmore, H. Berlanga, P. J. Blancher, M. S. W. Bradstreet, G. S. Butcher, D. W. Demarest, E. H. Dunn, W. C. Hunter, E. E. Iñigo-Elias, J. A. Kennedy, A. M. Martell, A. O. Panjabi, D. N. Pashley, K. V. Rosenberg, C. M. Rustay, J. S. Wendt, T. C. Will. 2004. Partners in Flight North American Landbird Conservation Plan. Cornell Lab of Ornithology. Ithaca, NY. Partners in Flight website accessed on April 19, 2006 @ http://www.partnersinflight.org/cont_plan/ (VERSION: March 2005).
- Rosenstock, S. S., D. R. Anderson, K. M. Giesen, T. Leukering, and M. F. Carter. 2002. Landbird counting techniques: current practices and an alternative. *Auk* 119:46-53.
- U.S. Fish and Wildlife Service. 2002. Birds of conservation concern 2002. Division of Migratory Bird Management, Arlington, Virginia. 99 pp. [Online version accessed on April 19, 2006 @ <<http://migratorybirds.fws.gov/reports/bcc2002.pdf>>]

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July 31, 2006

Appendix 1 – Figure 1. Detection function for pygmy nuthatches from forest-wide line transect surveys on the Kaibab National Forest, Arizona, summer 2005. $P = 0.68$ for model fit, as determined by a χ^2 Goodness of Fit test; detection Probability = 0.53.

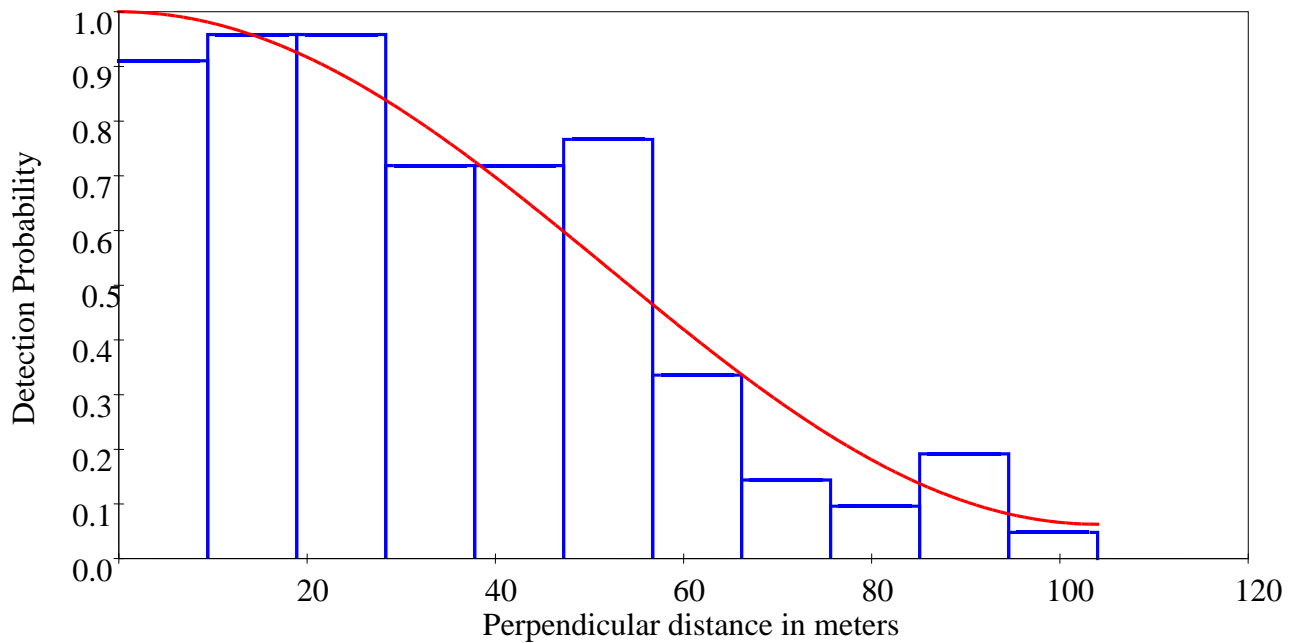


Figure 2. Detection function for pygmy nuthatches during line transect surveys on the South Kaibab districts of the Kaibab National Forest, Arizona, summer 2005. $P = 0.92$, as determined by a χ^2 Goodness of Fit test; detection probability = 0.53.

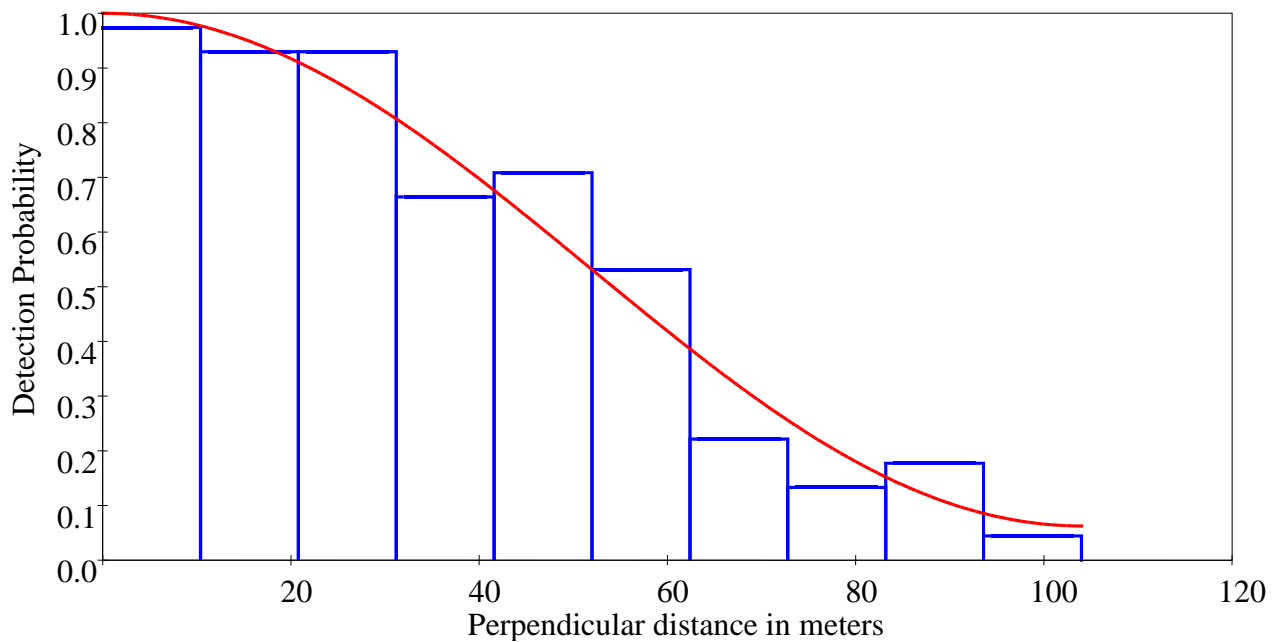


Figure 3. Detection function for hairy woodpeckers from forest-wide line transect surveys on the Kaibab National Forest, Arizona, summer 2005. $P = 0.88$ as determined by a χ^2 Goodness of Fit test; detection probability = 0.58.

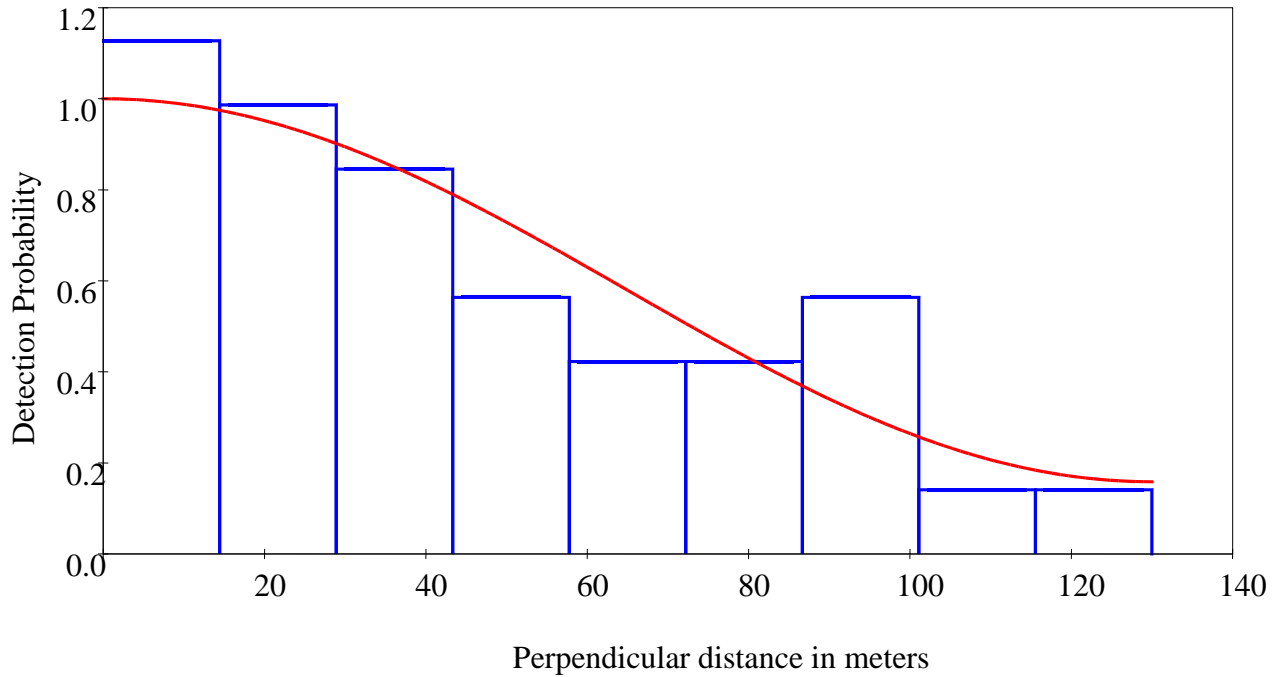


Figure 4. Detection function for hairy woodpeckers from line transect surveys on the South Kaibab ranger districts, Kaibab National Forest, Arizona, summer 2005. $P = 0.64$, as determined by a χ^2 Goodness of Fit test, detection probability = 0.56.

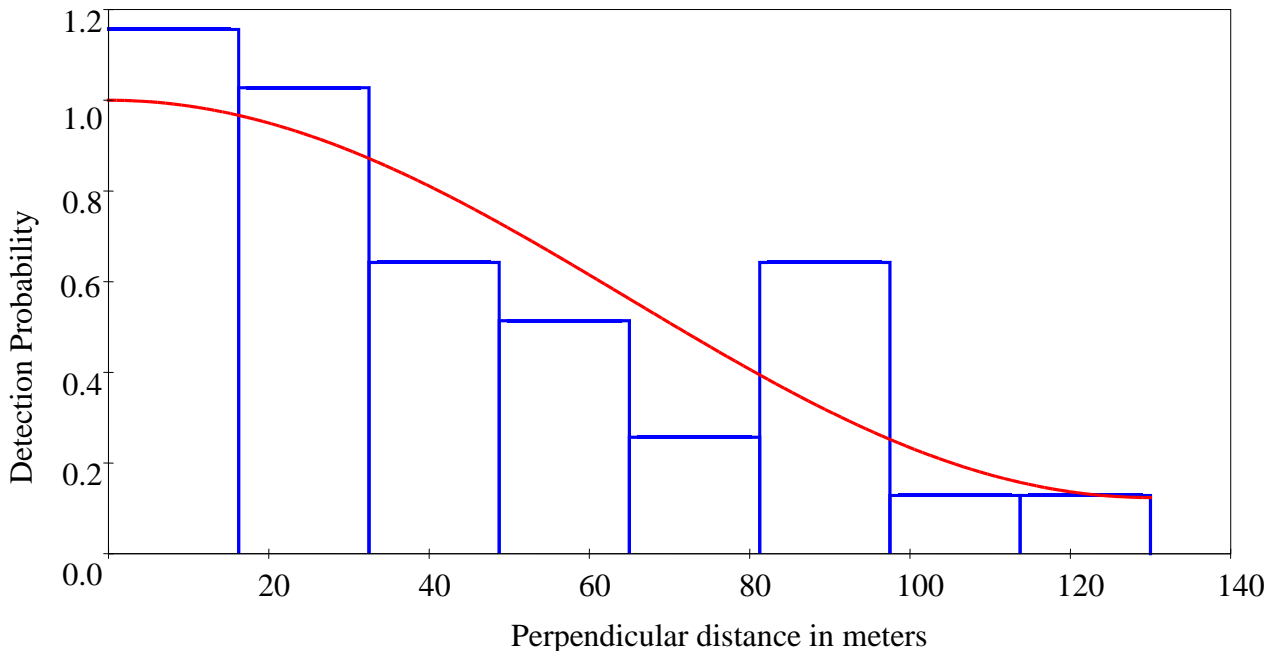
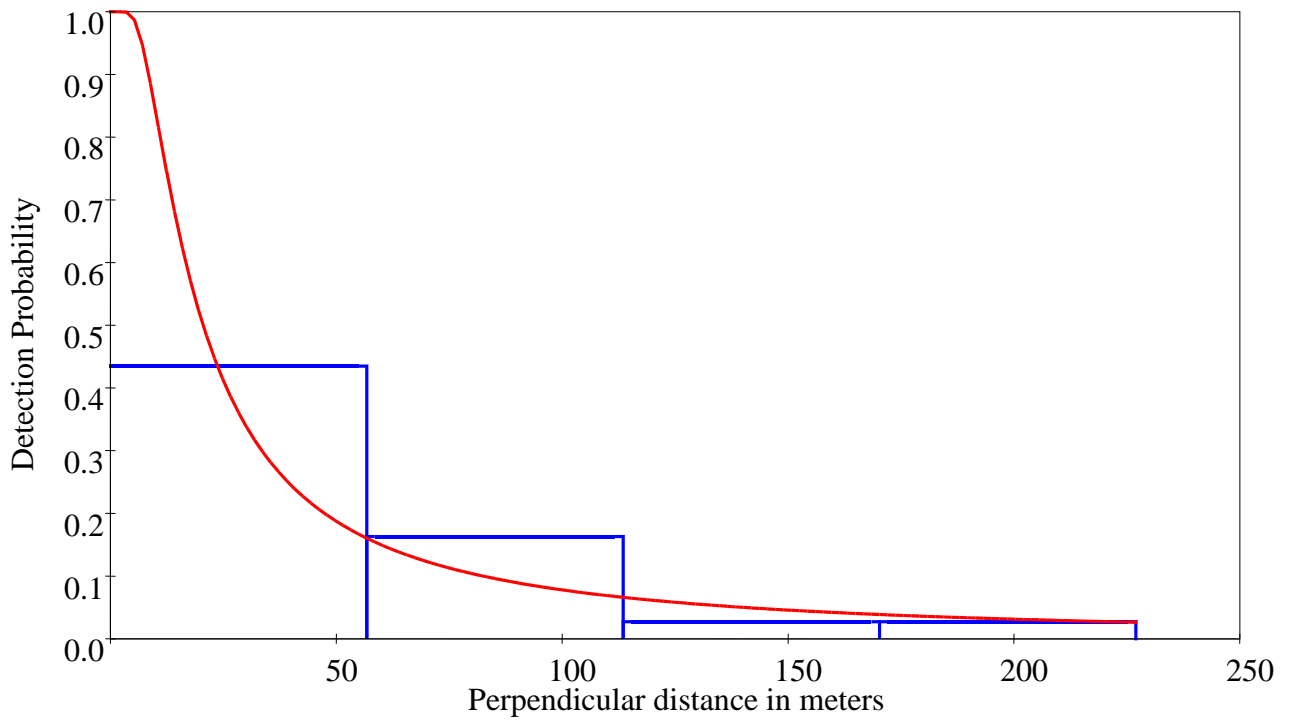


Figure 5. Detection function for juniper titmice from forest-wide line transect surveys on the Kaibab National Forest, Arizona, summer 2005. $P = 0.17$, as determined by a χ^2 Goodness of Fit test; detection probability = 0.16.



Appendix 2. Forest-wide summary of MIS species detected during line transect surveys on the Kaibab National Forest, Arizona, summer 2005. Minimum CV, total line length, and number of transects required to detect a 3% /year decline within 12 years with statistical significance of $p = 0.1$ and power of 0.8 are included for comparison to current efforts.

Species	Habitat	Detections	Line Length (m)	Current CV	Minimum CV	Minimum length (m)	Transects of 2500 m
Forest-wide							
Hairy Woodpecker	Ponderosa Pine	37	48550	0.28	na	15746	6
	Mixed-conifer	6	13534	0.71	0.5	27068	11
	Woodland /Grassland	1	8980	1.73	0.5	107760	43
Pygmy Nuthatch	Ponderosa Pine	122	48550	0.16	n/a	4775	2
	Mixed-conifer	4	13534	0.87	0.5	40602	16
	Woodland /Grassland	1	8980	1.73	0.5	107760	43
Juniper Titmouse	Woodland /Grassland	24	8980	0.35	n/a	4490	2
Red-naped Sapsucker	Aspen	1	4282	1.73	0.5	51384	21
Wild Turkey	Ponderosa Pine	3	48550	1.00	0.5	194200	78

Appendix 3. Summary by area of MIS species detected during line transect surveys on the Kaibab National Forest, Arizona, summer 2005. Minimum CV, total line length, and number of transects required to detect a 3% /year decline within 12 years with statistical significance of $p = 0.1$ and power of 0.8 are included for comparison to current efforts.

Species	Habitat		Detections	Transects	Line Length (m)	Current CV	Minimum CV	Minimum length (m)	Transects of 2500 m
Hairy Woodpecker	Ponderosa Pine	South Kaibab	35	14	40300	0.29	n/a	13817	6
		North Kaibab	2	3	8250	1.22	0.5	49500	20
	Mixed-conifer	South Kaibab	3	4	5000	1.00	0.5	20000	8
		North Kaibab	3	6	8534	1.00	0.5	34136	14
	Woodland-grassland	South Kaibab	1	1	3250	1.73	0.5	39000	16
		North Kaibab	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Pygmy Nuthatch	Ponderosa Pine	South Kaibab	120	14	40300	0.16	n/a	4030	2
		North Kaibab	2	3	8250	1.22	0.5	49500	20
	Mixed-conifer	South Kaibab	4	4	5000	0.87	0.5	15000	6
		North Kaibab	0	6	8534	n/a	n/a	n/a	n/a
	Woodland-grassland	South Kaibab	1	1	3250	1.73	0.5	39000	16
		North Kaibab	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Juniper Titmouse	Woodland-grassland	South Kaibab	24	3	8980	0.35	n/a	4490	2
		North Kaibab	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Red-naped Sapsucker	Aspen	South Kaibab	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		North Kaibab	1	2	4282	1.73	0.5	51384	21
Wild Turkey	Ponderosa Pine	South Kaibab	2	10	29800	1.22	0.5	178800	72
		North Kaibab	1	3	8250	1.73	0.5	99000	40

Appendix 4. Summary by Ranger District of MIS species detected during line transect surveys on the Kaibab National Forest, Arizona, summer 2005. Minimum CV, total line length, and number of transects required to detect a 3% /year decline within 12 years with statistical significance of $p = 0.1$ and power of 0.8 are included for comparison to current efforts.

Species	Habitat		Detections	Transects	Line Length (m)	Current CV	Minimum CV	Minimum length (m)	Transects of 2500 m
Hairy Woodpecker	Ponderosa Pine	Williams	18	10	29800	0.41	n/a	n/a	n/a
		Tusayan	17	4	10500	0.42	n/a	n/a	n/a
		North Kaibab	2	3	8250	1.22	0.5	49500	20
	Mixed-conifer	Williams	3	4	5000	1.00	0.5	20000	8
		Tusayan	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		North Kaibab	3	6	8534	1.00	0.5	34136	14
	Woodland-grassland	Williams	0	2	5730	n/a	n/a	n/a	n/a
Tusayan		1	1	3250	1.73	0.5	39000	16	
North Kaibab		n/a	n/a	n/a	n/a	n/a	n/a	n/a	
Pygmy Nuthatch	Ponderosa Pine	Williams	61	10	29800	0.22	n/a	n/a	n/a
		Tusayan	59	4	10500	0.23	n/a	n/a	n/a
		North Kaibab	2	3	8250	1.22	0.5	49500	20
	Mixed-conifer	Williams	4	4	5000	0.87	0.5	15000	6
		Tusayan	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		North Kaibab	0	6	8534	n/a	n/a	n/a	n/a
	Woodland-grassland	Williams	0	2	5730	n/a	n/a	n/a	n/a
Tusayan		1	1	3250	1.73	0.5	39000	16	
North Kaibab		n/a	n/a	n/a	n/a	n/a	n/a	n/a	
Juniper Titmouse	Woodland-grassland	Williams	16	2	5730	0.43	n/a	n/a	n/a
		Tusayan	8	1	3250	0.61	0.5	4875	2
		North Kaibab	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Red-naped Sapsucker	Aspen	Williams	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		Tusayan	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		North Kaibab	1	2	4282	1.73	0.5	51384	21
Wild Turkey	Ponderosa Pine	Williams	2	10	29800	1.22	0.5	178800	72
		Tusayan	n/a	n/a	n/a	n/a	n/a	n/a	n/a
		North Kaibab	1	3	8250	1.73	0.5	99000	40

Appendix 5. Forest-wide summary of bird species detected by habitat type during point-transect surveys on the Kaibab National Forest, Arizona, summer 2005. Minimum CV, total points, and number of transects (10 points each) required to detect a 3% /year decline within 12 years with statistical significance of $p = 0.1$ and power of 0.8 are included for comparison to current efforts.

Species with a current CV < 0.5 in which annual monitoring efforts will detect a 3%/year decline within 12 years with statistical significance of $p = 0.1$ and power of 0.8

Species with a current CV < 1.00 in which annual monitoring efforts will detect a 3%/year decline within 30 years with statistical significance of $p = 0.1$ and power of 0.8

Species with a current CV > 1.00. Current monitoring protocol is inadequate to detect a 3%/year declines within 30 years with statistical significance of $p = 0.1$ and power of 0.8

Habitat	Species	Detections	Points Surveyed	Current CV	Minimum CV	Min Pts Needed	Line of 10 pts
Aspen	Warbling Vireo	18	17	0.41	n/a	n/a	n/a
	Grace's Warbler	14	17	0.46	n/a	n/a	n/a
	Hermit Thrush	7	17	0.65	0.5	29	3
	Dark-eyed Junco	4	17	0.87	0.5	51	5
	Mountain Chickadee	4	17	0.87	0.5	51	5
	American Robin	4	17	0.87	0.5	51	5
	Chipping Sparrow	3	17	1.00	0.5	68	7
	House Wren	3	17	1.00	0.5	68	7
	Northern Flicker	3	17	1.00	0.5	68	7
	Ruby-crowned Kinglet	3	17	1.00	0.5	68	7
	Western Tanager	2	17	1.22	0.5	102	10
	Audubon's Warbler	2	17	1.22	0.5	102	10
	Pine Siskin	2	17	1.22	0.5	102	10
	Common Raven	2	17	1.22	0.5	102	10
	Hairy Woodpecker	1	17	1.73	0.5	204	20
	Western Bluebird	1	17	1.73	0.5	204	20
	White-breasted Nuthatch	1	17	1.73	0.5	204	20
	Stellar's Jay	1	17	1.73	0.5	204	20
	Pygmy Nuthatch	1	17	1.73	0.5	204	20
	Virginia's Warbler	1	17	1.73	0.5	204	20

Habitat	Species	Detections	Points Surveyed	Current CV	Minimum CV	Min Pts Needed	Line of 10 pts
Mixed-conifer	Audubon's Warbler	56	60	0.23	n/a	n/a	n/a
	Warbling Vireo	41	60	0.27	n/a	n/a	n/a
	Hermit Thrush	40	60	0.27	n/a	n/a	n/a
	Pine Siskin	32	60	0.31	n/a	n/a	n/a
	Western Tanager	28	60	0.33	n/a	n/a	n/a
	Ruby-crowned Kinglet	27	60	0.33	n/a	n/a	n/a
	Chipping Sparrow	17	60	0.42	n/a	n/a	n/a
	Dark-eyed Junco	15	60	0.45	n/a	n/a	n/a
	Red-breasted Nuthatch	15	60	0.45	n/a	n/a	n/a
	Grace's Warbler	14	60	0.46	n/a	n/a	n/a
	Red-faced Warbler	12	60	0.50	n/a	n/a	n/a
	Stellar's Jay	12	60	0.50	n/a	n/a	n/a
	Black-headed Grosbeak	10	60	0.55	0.5	72	7
	House Wren	10	60	0.55	0.5	72	7
	Mountain Chickadee	10	60	0.55	0.5	72	7
	Northern Flicker	9	60	0.58	0.5	80	8
	American Robin	8	60	0.61	0.5	90	9
	Brown Creeper	8	60	0.61	0.5	90	9
	Virginia's Warbler	8	60	0.61	0.5	90	9
	Cordilleran Flycatcher	7	60	0.65	0.5	103	10
	White-breasted Nuthatch	7	60	0.65	0.5	103	10
	Pygmy Nuthatch	6	60	0.71	0.5	120	12
	Hairy Woodpecker	5	60	0.77	0.5	144	14
	Red Crossbill	4	60	0.87	0.5	180	18
	Western-wood Pewee	4	60	0.87	0.5	180	18
	Band-tailed Pigeon	3	60	1.00	0.5	240	24
	Common Raven	2	60	1.22	0.5	360	36
	Evening Grosbeak	2	60	1.22	0.5	360	36
	Townsend's Solitaire	2	60	1.22	0.5	360	36
	Broad-tailed Hummingbird	1	60	1.73	0.5	720	72
	Cactus Wren	1	60	1.73	0.5	720	72
	Downy Woodpecker	1	60	1.73	0.5	720	72
Red-naped Sapsucker	1	60	1.73	0.5	720	72	

Habitat	Species	Detections	Points Surveyed	Current CV	Minimum CV	Min Pts Needed	Line of 10 pts
Mixed-conifer (con't)	Spotted Towhee	1	60	1.73	0.5	720	72
	Williamson's Sapsucker	1	60	1.73	0.5	720	72
Montane grassland	Chipping Sparrow	13	15	0.48	n/a	n/a	n/a
	Violet-green Swallow	7	15	0.65	0.5	26	3
	Mountain Chickadee	5	15	0.77	0.5	36	4
	Warbling Vireo	5	15	0.77	0.5	36	4
	Dark-eyed Junco	5	15	0.77	0.5	36	4
	Western Tanager	4	15	0.87	0.5	45	5
	Western-wood Pewee	4	15	0.87	0.5	45	5
	Audubon's Warbler	4	15	0.87	0.5	45	5
	Brewer's Blackbird	3	15	1.00	0.5	60	6
	Hermit Thrush	2	15	1.22	0.5	90	9
	Pygmy Nuthatch	2	15	1.22	0.5	90	9
	Broad-tailed Hummingbird	2	15	1.22	0.5	90	9
	White-breasted Nuthatch	2	15	1.22	0.5	90	9
	Mountain Bluebird	1	15	1.73	0.5	180	18
	Northern Flicker	1	15	1.73	0.5	180	18
	Plumbeous Vireo	1	15	1.73	0.5	180	18
	American Robin	1	15	1.73	0.5	180	18
Western Bluebird	1	15	1.73	0.5	180	18	
House Wren	1	15	1.73	0.5	180	18	
Ponderosa Pine	Dark-eyed Junco	105	187	0.17	n/a	n/a	n/a
	Grace's Warbler	100	187	0.17	n/a	n/a	n/a
	Pygmy Nuthatch	98	187	0.17	n/a	n/a	n/a
	Mountain Chickadee	77	187	0.20	n/a	n/a	n/a
	Audubon's Warbler	75	187	0.20	n/a	n/a	n/a
	Western Tanager	75	187	0.20	n/a	n/a	n/a
	Western-wood Pewee	70	187	0.21	n/a	n/a	n/a
	White-breasted Nuthatch	50	187	0.24	n/a	n/a	n/a
	American Robin	49	187	0.25	n/a	n/a	n/a

Habitat	Species	Detections	Points Surveyed	Current CV	Minimum CV	Min Pts Needed	Line of 10 pts
Ponderosa Pine (con't)	Chipping Sparrow	49	187	0.25	n/a	n/a	n/a
	Plumbeous Vireo	42	187	0.27	n/a	n/a	n/a
	Western Bluebird	41	187	0.27	n/a	n/a	n/a
	Stellar's Jay	38	187	0.28	n/a	n/a	n/a
	Northern Flicker	36	187	0.29	n/a	n/a	n/a
	Hairy Woodpecker	23	187	0.36	n/a	n/a	n/a
	Black-headed Grosbeak	21	187	0.38	n/a	n/a	n/a
	Hermit Thrush	21	187	0.38	n/a	n/a	n/a
	Violet-green Swallow	19	187	0.40	n/a	n/a	n/a
	Warbling Vireo	18	187	0.41	n/a	n/a	n/a
	Virginia's Warbler	17	187	0.42	n/a	n/a	n/a
	Ash-throated Flycatcher	16	187	0.43	n/a	n/a	n/a
	Pine Siskin	15	187	0.45	n/a	n/a	n/a
	Common Raven	13	187	0.48	n/a	n/a	n/a
	Ruby-crowned Kinglet	11	187	0.52	0.5	204	20
	Brown-headed Cowbird	10	187	0.55	0.5	224	22
	Broad-tailed Hummingbird	10	187	0.55	0.5	224	22
	House Wren	9	187	0.58	0.5	249	25
	Dusky Flycatcher	8	187	0.61	0.5	281	28
	Gray Flycatcher	8	187	0.61	0.5	281	28
	Pinyon Jay	8	187	0.61	0.5	281	28
	Mountain Bluebird	7	187	0.65	0.5	321	32
	Brown Creeper	6	187	0.71	0.5	374	37
	Black-throated Gray Warbler	6	187	0.71	0.5	374	37
	Red Crossbill	6	187	0.71	0.5	374	37
	Townsend's Solitaire	6	187	0.71	0.5	374	37
	Lesser Goldfinch	5	187	0.77	0.5	449	45
	Acorn Woodpecker	4	187	0.87	0.5	561	56
	Cordilleran Flycatcher	4	187	0.87	0.5	561	56
	Cassin's Finch	3	187	1.00	0.5	748	75
	Red-faced Warbler	3	187	1.00	0.5	748	75
	Scrub Jay	3	187	1.00	0.5	748	75
	Red-winged Blackbird	2	187	1.22	0.5	1122	112

Habitat	Species	Detections	Points Surveyed	Current CV	Minimum CV	Min Pts Needed	Line of 10 pts
Ponderosa Pine (con't)	Williamson's Sapsucker	2	187	1.22	0.5	1122	112
	Band-tailed Pigeon	1	187	1.73	0.5	2244	224
	Bushtit	1	187	1.73	0.5	2244	224
	Great Blue Heron	1	187	1.73	0.5	2244	224
	Hammond's Flycatcher	1	187	1.73	0.5	2244	224
	House Finch	1	187	1.73	0.5	2244	224
	Juniper Titmouse	1	187	1.73	0.5	2244	224
	Mourning Dove	1	187	1.73	0.5	2244	224
	Red-breasted Nuthatch	1	187	1.73	0.5	2244	224
	Spotted Towhee	1	187	1.73	0.5	2244	224
	Western Meadowlark	1	187	1.73	0.5	2244	224
	Wild Turkey	1	187	1.73	0.5	2244	224
Woodland- grassland	Chipping Sparrow	25	35	0.35	n/a	n/a	n/a
	Ash-throated Flycatcher	20	35	0.39	n/a	n/a	n/a
	Gray Flycatcher	14	35	0.46	n/a	n/a	n/a
	Juniper Titmouse	13	35	0.48	n/a	n/a	n/a
	Black-throated Gray Warbler	12	35	0.50	n/a	n/a	n/a
	Lark Sparrow	12	35	0.50	n/a	n/a	n/a
	Spotted Towhee	7	35	0.65	0.5	60	6
	Bewick's Wren	7	35	0.65	0.5	60	6
	Common Raven	6	35	0.71	0.5	70	7
	Pinyon Jay	5	35	0.77	0.5	84	8
	Bushtit	3	35	1.00	0.5	140	14
	Mountain Chickadee	3	35	1.00	0.5	140	14
	Black-headed Grosbeak	3	35	1.00	0.5	140	14
	Scrub Jay	2	35	1.22	0.5	210	21
	Western Tanager	2	35	1.22	0.5	210	21
	Lesser Nighthawk	2	35	1.22	0.5	210	21
	Vesper Sparrow	2	35	1.22	0.5	210	21
House Finch	2	35	1.22	0.5	210	21	
Mourning Dove	2	35	1.22	0.5	210	21	

Habitat	Species	Detections	Points Surveyed	Current CV	Minimum CV	Min Pts Needed	Line of 10 pts
Woodland-grassland (con't)	Western Kingbird	1	35	1.73	0.5	420	42
	White-breasted Nuthatch	1	35	1.73	0.5	420	42
	Warbling Vireo	1	35	1.73	0.5	420	42
	Brown-headed Cowbird	1	35	1.73	0.5	420	42
	Plumbeous Vireo	1	35	1.73	0.5	420	42
	Dusky Flycatcher	1	35	1.73	0.5	420	42
	Gambel's Quail	1	35	1.73	0.5	420	42
	Blue-gray Gnatcatcher	1	35	1.73	0.5	420	42
	Western-wood Pewee	1	35	1.73	0.5	420	42
	Hairy Woodpecker	1	35	1.73	0.5	420	42
Pygmy Nuthatch	1	35	1.73	0.5	420	42	

Appendix 6. Bird species detections by habitat type during line-transect surveys for the Ranger Districts of the Kaibab National Forest occurring north and south of the Grand Canyon, Arizona, summer 2005. Minimum CV, total points, and number of transects (10 points each) required to detect a 3% /year decline within 12 years with statistical significance of $p = 0.1$ and power of 0.8 are included for comparison to current efforts.

Species with a current CV < 0.5 in which annual monitoring efforts will detect a 3%/year decline within 12 years with statistical significance of $p = 0.1$ and power of 0.8

Species with a current CV < 1.00 in which annual monitoring efforts will detect a 3%/year decline within 30 years with statistical significance of $p = 0.1$ and power of 0.8

Species with a current CV > 1.00. Current monitoring protocol is inadequate to detect a 3%/year declines within 30 years with statistical significance of $p = 0.1$ and power of 0.8

District	Habitat	Species	Detections	Points	Current CV	Minimum CV	Min Pts Needed	Line of 10 pts
South Kaibab	Mixed-conifer	Hermit Thrush	17	22	0.42	0.5	16	2
		Audubon's Warbler	16	22	0.43	0.5	17	2
		Red-faced Warbler	12	22	0.50	0.5	22	2
		Red-breasted Nuthatch	12	22	0.50	0.5	22	2
		House Wren	7	22	0.65	0.5	38	4
		Cordilleran Flycatcher	7	22	0.65	0.5	38	4
		Brown Creeper	7	22	0.65	0.5	38	4
		Black-headed Grosbeak	7	22	0.65	0.5	38	4
		Stellar's Jay	7	22	0.65	0.5	38	4
		Virginia's Warbler	5	22	0.77	0.5	53	5
		Pygmy Nuthatch	5	22	0.77	0.5	53	5
		White-breasted Nuthatch	5	22	0.77	0.5	53	5
		Mountain Chickadee	5	22	0.77	0.5	53	5
		Warbling Vireo	4	22	0.87	0.5	66	7
		Hairy Woodpecker	4	22	0.87	0.5	66	7
		Red Crossbill	4	22	0.87	0.5	66	7
		Pine Siskin	3	22	1.00	0.5	88	9
		Dark-eyed Junco	3	22	1.00	0.5	88	9
		Band-tailed Pigeon	3	22	1.00	0.5	88	9
		Grace's Warbler	2	22	1.22	0.5	132	13

District	Habitat	Species	Detections	Points	Current CV	Minimum CV	Min Pts Needed	Line of 10 pts
South Kaibab (con't)	Mixed-conifer (con't)	Western Tanager	2	22	1.22	0.5	132	13
		American Robin	2	22	1.22	0.5	132	13
		Ruby-crowned Kinglet	1	22	1.73	0.5	264	26
		Spotted Towhee	1	22	1.73	0.5	264	26
		Townsend's Soletaire	1	22	1.73	0.5	264	26
		Cactus Wren	1	22	1.73	0.5	264	26
		Broad-tailed Hummingbird	1	22	1.73	0.5	264	26
		Northern Flicker	1	22	1.73	0.5	264	26
Ponderosa Pine		Dark-eyed Junco	95	154	0.18	n/a	n/a	n/a
		Pygmy Nuthatch	87	154	0.19	n/a	n/a	n/a
		Grace's Warbler	72	154	0.20	n/a	n/a	n/a
		Mountain Chickadee	71	154	0.21	n/a	n/a	n/a
		Western-wood Pewee	61	154	0.22	n/a	n/a	n/a
		Western Tanager	61	154	0.22	n/a	n/a	n/a
		Audubon's Warbler	53	154	0.24	n/a	n/a	n/a
		American Robin	47	154	0.25	n/a	n/a	n/a
		White-breasted Nuthatch	44	154	0.26	n/a	n/a	n/a
		Chipping Sparrow	43	154	0.26	n/a	n/a	n/a
		Western Bluebird	40	154	0.27	n/a	n/a	n/a
		Plumbeous Vireo	39	154	0.28	n/a	n/a	n/a
		Stellar's Jay	33	154	0.30	n/a	n/a	n/a
		Northern Flicker	31	154	0.31	n/a	n/a	n/a
		Hairy Woodpecker	23	154	0.36	n/a	n/a	n/a
		Black-headed Grosbeak	20	154	0.39	n/a	n/a	n/a
		Violet-green Swallow	18	154	0.41	n/a	n/a	n/a
		Ash-throated Flycatcher	16	154	0.43	n/a	n/a	n/a
		Hermit Flycatcher	13	154	0.48	n/a	n/a	n/a
		Common Raven	13	154	0.48	n/a	n/a	n/a
		Pine Siskin	13	154	0.48	n/a	n/a	n/a
Virginia's Warbler	12	154	0.50	n/a	n/a	n/a		
Brown-headed Cowbird	10	154	0.55	0.5	185	18		

District	Habitat	Species	Detections	Points	Current CV	Minimum CV	Min Pts Needed	Line of 10 pts
South Kaibab (con't)	Ponderosa Pine (con't)	Broad-tailed Hummingbird	10	154	0.55	0.5	185	18
		Dusky Flycatcher	8	154	0.61	0.5	231	23
		Gray Flycatcher	8	154	0.61	0.5	231	23
		Pinyon Jay	8	154	0.61	0.5	231	23
		Mountain Bluebird	7	154	0.65	0.5	264	26
		Red Crossbill	6	154	0.71	0.5	308	31
		Black-throated Gray Warbler	6	154	0.71	0.5	308	31
		House Wren	6	154	0.71	0.5	308	31
		Brown Creeper	6	154	0.71	0.5	308	31
		Townsend's Solitaire	5	154	0.77	0.5	370	37
		Lesser Goldfinch	5	154	0.77	0.5	370	37
		Acorn Woodpecker	4	154	0.87	0.5	462	46
		Cordilleran Flycatcher	4	154	0.87	0.5	462	46
		Warbling Vireo	3	154	1.00	0.5	616	62
		Scrub Jay	3	154	1.00	0.5	616	62
		Red-faced Warbler	3	154	1.00	0.5	616	62
		Red-winged Blackbird	2	154	1.22	0.5	924	92
		Western Meadowlark	1	154	1.73	0.5	1848	185
		Juniper Titmouse	1	154	1.73	0.5	1848	185
		Great Blue Heron	1	154	1.73	0.5	1848	185
		Band-tailed Pigeon	1	154	1.73	0.5	1848	185
		Wild Turkey	1	154	1.73	0.5	1848	185
		House Finch	1	154	1.73	0.5	1848	185
		Mourning Dove	1	154	1.73	0.5	1848	185
		Bushtit	1	154	1.73	0.5	1848	185
		Cassin's Finch	1	154	1.73	0.5	1848	185
			Woodland-grassland	Chipping Sparrow	25	35	0.35	n/a
Ash-throated Flycatcher	20			35	0.39	n/a	n/a	n/a
Gray Flycatcher	14			35	0.46	n/a	n/a	n/a
Juniper Titmouse	13			35	0.48	n/a	n/a	n/a

District	Habitat	Species	Detections	Points	Current CV	Minimum CV	Min Pts Needed	Line of 10 pts
South Kaibab (con't)	Woodland-grassland (con't)	Black-throated Gray Warbler	12	35	0.50	n/a	n/a	n/a
		Lark Sparrow	12	35	0.50	n/a	n/a	n/a
		Spotted Towhee	7	35	0.65	0.5	60	6
		Bewick's Wren	7	35	0.65	0.5	60	6
		Common Raven	6	35	0.71	0.5	70	7
		Pinyon Jay	5	35	0.77	0.5	84	8
		Bushtit	3	35	1.00	0.5	140	14
		Mountain Chickadee	3	35	1.00	0.5	140	14
		Black-headed Grosbeak	3	35	1.00	0.5	140	14
		Scrub Jay	2	35	1.22	0.5	210	21
		Western Tanager	2	35	1.22	0.5	210	21
		Lesser Nighthawk	2	35	1.22	0.5	210	21
		Vesper Sparrow	2	35	1.22	0.5	210	21
		House Finch	2	35	1.22	0.5	210	21
		Mourning Dove	2	35	1.22	0.5	210	21
		Western Kingbird	1	35	1.73	0.5	420	42
		White-breasted Nuthatch	1	35	1.73	0.5	420	42
		Warbling Vireo	1	35	1.73	0.5	420	42
		Brown-headed Cowbird	1	35	1.73	0.5	420	42
		Plumbeous Vireo	1	35	1.73	0.5	420	42
		Dusky Flycatcher	1	35	1.73	0.5	420	42
		Gambel's Quail	1	35	1.73	0.5	420	42
		Blue-gray Gnatcatcher	1	35	1.73	0.5	420	42
		Western-wood Pewee	1	35	1.73	0.5	420	42
		Hairy Woodpecker	1	35	1.73	0.5	420	42
		Pygmy Nuthatch	1	35	1.73	0.5	420	42
		North Kaibab	Aspen	Warbling Vireo	18	17	0.41	n/a
Grace's Warbler	14			17	0.46	n/a	n/a	n/a
Hermit Thrush	7			17	0.65	0.5	29	3
Dark-eyed Junco	4			17	0.87	0.5	51	5

District	Habitat	Species	Detections	Points	Current CV	Minimum CV	Min Pts Needed	Line of 10 pts		
North Kaibab (con't)	Aspen (con't)	Mountain Chickadee	4	17	0.87	0.5	51	5		
		American Robin	4	17	0.87	0.5	51	5		
		Chipping Sparrow	3	17	1.00	0.5	68	7		
		House Wren	3	17	1.00	0.5	68	7		
		Northern Flicker	3	17	1.00	0.5	68	7		
		Ruby-crowned Kinglet	3	17	1.00	0.5	68	7		
		Western Tanager	2	17	1.22	0.5	102	10		
		Audubon's Warbler	2	17	1.22	0.5	102	10		
		Pine Siskin	2	17	1.22	0.5	102	10		
		Common Raven	2	17	1.22	0.5	102	10		
		Hairy Woodpecker	1	17	1.73	0.5	204	20		
		Western Bluebird	1	17	1.73	0.5	204	20		
		White-breasted Nuthatch	1	17	1.73	0.5	204	20		
		Stellar's Jay	1	17	1.73	0.5	204	20		
		Pygmy Nuthatch	1	17	1.73	0.5	204	20		
		Virginia's Warbler	1	17	1.73	0.5	204	20		
		Mixed-conifer		Audubon's Warbler	40	38	0.27	n/a	n/a	n/a
				Warbling Vireo	37	38	0.28	n/a	n/a	n/a
				Pine Siskin	29	38	0.32	n/a	n/a	n/a
				Western Tanager	26	38	0.34	n/a	n/a	n/a
Ruby-crowned Kinglet	26			38	0.34	n/a	n/a	n/a		
Hermit Thrush	23			38	0.36	n/a	n/a	n/a		
Chipping Sparrow	17			38	0.42	n/a	n/a	n/a		
Dark-eyed Junco	12			38	0.50	n/a	n/a	n/a		
Grace's Warbler	12			38	0.50	n/a	n/a	n/a		
Northern Flicker	8			38	0.61	0.5	57	6		
American Robin	6			38	0.71	0.5	76	8		
Mountain Chickadee	5			38	0.77	0.5	91	9		
Stellar's Jay	5			38	0.77	0.5	91	9		
Western-wood Pewee	4			38	0.87	0.5	114	11		
Red-breasted Nuthatch	3			38	1.00	0.5	152	15		

District	Habitat	Species	Detections	Points	Current CV	Minimum CV	Min Pts Needed	Line of 10 pts
North Kaibab (con't)	Mixed-conifer (con't)	Virginia's Warbler	3	38	1.00	0.5	152	15
		Black-headed Grosbeak	3	38	1.00	0.5	152	15
		House Wren	3	38	1.00	0.5	152	15
		White-breasted Nuthatch	2	38	1.22	0.5	228	23
		Common Raven	2	38	1.22	0.5	228	23
		Evening Grosbeak	2	38	1.22	0.5	228	23
		Downy Woodpecker	1	38	1.73	0.5	456	46
		Townsend's Soletaire	1	38	1.73	0.5	456	46
		Red-naped Sapsucker	1	38	1.73	0.5	456	46
		Brown Creeper	1	38	1.73	0.5	456	46
		Pygmy Nuthatch	1	38	1.73	0.5	456	46
		Hairy Woodpecker	1	38	1.73	0.5	456	46
		Williamson's Sapsucker	1	38	1.73	0.5	456	46
			Montane grassland	Chipping Sparrow	13	15	0.48	n/a
Violet-green Swallow	7			15	0.65	0.5	26	3
Mountain Chickadee	5			15	0.77	0.5	36	4
Warbling Vireo	5			15	0.77	0.5	36	4
Dark-eyed Junco	5			15	0.77	0.5	36	4
Western Tanager	4			15	0.87	0.5	45	5
Western-wood Pewee	4			15	0.87	0.5	45	5
Audubon's Warbler	4			15	0.87	0.5	45	5
Brewer's Blackbird	3			15	1.00	0.5	60	6
Hermit Thrush	2			15	1.22	0.5	90	9
Pygmy Nuthatch	2			15	1.22	0.5	90	9
Broad-tailed Hummingbird	2			15	1.22	0.5	90	9
White-breasted Nuthatch	2			15	1.22	0.5	90	9
Mountain Bluebird	1			15	1.73	0.5	180	18
Northern Flicker	1			15	1.73	0.5	180	18
Plumbeous Vireo	1			15	1.73	0.5	180	18
American Robin	1			15	1.73	0.5	180	18
Western Bluebird	1	15	1.73	0.5	180	18		

District	Habitat	Species	Detections	Points	Current CV	Minimum CV	Min Pts Needed	Line of 10 pts
North Kaibab (con't)	Montane grassland (con't)	House Wren	1	15	1.73	0.5	180	18
	Ponderosa Pine	Grace's Warbler	28	32	0.33	n/a	n/a	n/a
		Audubon's Warbler	22	32	0.37	n/a	n/a	n/a
		Warbling Vireo	15	32	0.45	n/a	n/a	n/a
		Western Tanager	14	32	0.46	n/a	n/a	n/a
		Pygmy Nuthatch	11	32	0.52	0.5	35	3
		Ruby-crowned Kinglet	11	32	0.52	0.5	35	3
		Dark-eyed Junco	10	32	0.55	0.5	38	4
		Western-wood Pewee	9	32	0.58	0.5	43	4
		Hermit Thrush	8	32	0.61	0.5	48	5
		Chipping Sparrow	6	32	0.71	0.5	64	6
		Mountain Chickadee	6	32	0.71	0.5	64	6
		White-breasted Nuthatch	6	32	0.71	0.5	64	6
		Virginia's Warbler	5	32	0.77	0.5	77	8
		Northern Flicker	5	32	0.77	0.5	77	8
		Stellar's Jay	5	32	0.77	0.5	77	8
		Plumbeous Vireo	3	32	1.00	0.5	128	13
		House Wren	3	32	1.00	0.5	128	13
		Pine Siskin	2	32	1.22	0.5	192	19
		Cassin's Finch	2	32	1.22	0.5	192	19
		American Robin	2	32	1.22	0.5	192	19
		Williamson's Sapsucker	2	32	1.22	0.5	192	19
		Red-breasted Nuthatch	1	32	1.73	0.5	384	38
		Spotted Towhee	1	32	1.73	0.5	384	38
		Townsend's Soletaire	1	32	1.73	0.5	384	38
		Violet-green Swallow	1	32	1.73	0.5	384	38
		Black-headed Grosbeak	1	32	1.73	0.5	384	38
	Western Bluebird	1	32	1.73	0.5	384	38	
	Hammond's Flycatcher	1	32	1.73	0.5	384	38	

Appendix 7. Summary by bird species detected by habitat type during line-transect surveys by Ranger District, Kaibab National Forest, Arizona, summer 2005. Minimum CV, total points, and number of transects (10 points each) required to detect a 3% /year decline within 12 years with statistical significance of $p = 0.1$ and power of 0.8 are included for comparison to current efforts.

Species with a current CV < 0.5 in which annual monitoring efforts will detect a 3%/year decline within 12 years with statistical significance of $p = 0.1$ and power of 0.8

Species with a current CV < 1.00 in which annual monitoring efforts will detect a 3%/year decline within 30 years with statistical significance of $p = 0.1$ and power of 0.8

Species with a current CV > 1.00. Current monitoring protocol is inadequate to detect a 3%/year declines within 30 years with statistical significance of $p = 0.1$ and power of 0.8

District	Habitat	Species	Detections	Points	Current CV	Minimum CV	Min Pts Needed	Line of 10 pts
Williams	Mixed-conifer	Hermit Thrush	17	22	0.42	n/a	n/a	n/a
		Audubon's Warbler	16	22	0.43	n/a	n/a	n/a
		Red-faced Warbler	12	22	0.50	n/a	n/a	n/a
		Red-breasted Nuthatch	12	22	0.50	n/a	n/a	n/a
		House Wren	7	22	0.65	0.5	38	4
		Cordilleran Flycatcher	7	22	0.65	0.5	38	4
		Brown Creeper	7	22	0.65	0.5	38	4
		Black-headed Grosbeak	7	22	0.65	0.5	38	4
		Stellar's Jay	7	22	0.65	0.5	38	4
		Virginia's Warbler	5	22	0.77	0.5	53	5
		Pygmy Nuthatch	5	22	0.77	0.5	53	5
		White-breasted Nuthatch	5	22	0.77	0.5	53	5
		Mountain Chickadee	5	22	0.77	0.5	53	5
		Warbling Vireo	4	22	0.87	0.5	66	7
		Hairy Woodpecker	4	22	0.87	0.5	66	7
		Red Crossbill	4	22	0.87	0.5	66	7
		Pine Siskin	3	22	1.00	0.5	88	9
		Dark-eyed Junco	3	22	1.00	0.5	88	9
		Band-tailed Pigeon	3	22	1.00	0.5	88	9
		Grace's Warbler	2	22	1.22	0.5	132	13

District	Habitat	Species	Detections	Points	Current CV	Minimum CV	Min Pts Needed	Line of 10 pts
Williams (con't)	Mixed-conifer (con't)	Western Tanager	2	22	1.22	0.5	132	13
		American Robin	2	22	1.22	0.5	132	13
		Ruby-crowned Kinglet	1	22	1.73	0.5	264	26
		Spotted Towhee	1	22	1.73	0.5	264	26
		Townsend's Soletaire	1	22	1.73	0.5	264	26
		Cactus Wren	1	22	1.73	0.5	264	26
		Broad-tailed Hummingbird	1	22	1.73	0.5	264	26
		Northern Flicker	1	22	1.73	0.5	264	26
Ponderosa Pine		Dark-eyed Junco	64	110	0.22	n/a	n/a	n/a
		Western-wood Pewee	49	110	0.25	n/a	n/a	n/a
		Audubon's Warbler	45	110	0.26	n/a	n/a	n/a
		Pygmy Nuthatch	41	110	0.27	n/a	n/a	n/a
		Western Tanager	39	110	0.28	n/a	n/a	n/a
		White-breasted Nuthatch	35	110	0.29	n/a	n/a	n/a
		Grace's Warbler	35	110	0.29	n/a	n/a	n/a
		American Robin	34	110	0.30	n/a	n/a	n/a
		Chipping Sparrow	33	110	0.30	n/a	n/a	n/a
		Mountain Chickadee	32	110	0.31	n/a	n/a	n/a
		Western Bluebird	30	110	0.32	n/a	n/a	n/a
		Stellar's Jay	25	110	0.35	n/a	n/a	n/a
		Northern Flicker	24	110	0.35	n/a	n/a	n/a
		Plumbeous Vireo	24	110	0.35	n/a	n/a	n/a
		Pine Siskin	12	110	0.50	n/a	n/a	n/a
		Virginia's Warbler	12	110	0.50	n/a	n/a	n/a
		Hairy Woodpecker	12	110	0.50	n/a	n/a	n/a
		Common Raven	12	110	0.50	n/a	n/a	n/a
		Black-headed Grosbeak	12	110	0.50	n/a	n/a	n/a
		Brown-headed Cowbird	10	110	0.55	0.5	132	13
		Broad-tailed Hummingbird	9	110	0.58	0.5	147	15
		Dusky Flycatcher	8	110	0.61	0.5	165	17
		Hermit Thrush	7	110	0.65	0.5	189	19

District	Habitat	Species	Detections	Points	Current CV	Minimum CV	Min Pts Needed	Line of 10 pts
Williams (con't)	Ponderosa Pine (con't)	Mountain Bluebird	7	110	0.65	0.5	189	19
		House Wren	6	110	0.71	0.5	220	22
		Violet-green Swallow	6	110	0.71	0.5	220	22
		Red Crossbill	5	110	0.77	0.5	264	26
		Black-throated Gray Warbler	5	110	0.77	0.5	264	26
		Brown Creeper	5	110	0.77	0.5	264	26
		Townsend's Soletaire	4	110	0.87	0.5	330	33
		Lesser Goldfinch	4	110	0.87	0.5	330	33
		Red-faced Warbler	3	110	1.00	0.5	440	44
		Warbling Vireo	3	110	1.00	0.5	440	44
		Cordilleran Flycatcher	3	110	1.00	0.5	440	44
		Ash-throated Flycatcher	3	110	1.00	0.5	440	44
		Red-winged Blackbird	2	110	1.22	0.5	660	66
		Acorn Woodpecker	2	110	1.22	0.5	660	66
		Scrub Jay	2	110	1.22	0.5	660	66
		Wild Turkey	1	110	1.73	0.5	1320	132
		Band-tailed Pigeon	1	110	1.73	0.5	1320	132
		Western Meadowlark	1	110	1.73	0.5	1320	132
		Cassin's Finch	1	110	1.73	0.5	1320	132
		Great Blue Heron	1	110	1.73	0.5	1320	132
		Gray Flycatcher	1	110	1.73	0.5	1320	132
		House Finch	1	110	1.73	0.5	1320	132
		Juniper Titmouse	1	110	1.73	0.5	1320	132
		Mourning Dove	1	110	1.73	0.5	1320	132
		Bushtit	1	110	1.73	0.5	1320	132
			Woodland-grassland	Chipping Sparrow	20	22	0.39	n/a
Ash-throated Flycatcher	13			22	0.48	n/a	n/a	n/a
Lark Sparrow	12			22	0.50	n/a	n/a	n/a
Juniper Titmouse	10			22	0.55	0.5	26	3
Bewick's Wren	7			22	0.65	0.5	38	4

District	Habitat	Species	Detections	Points	Current CV	Minimum CV	Min Pts Needed	Line of 10 pts
Williams (con't)	Woodland-grassland (con't)	Spotted Towhee	6	22	0.71	0.5	44	4
		Common Raven	4	22	0.87	0.5	66	7
		Gray Flycatcher	3	22	1.00	0.5	88	9
		Black-headed Grosbeak	3	22	1.00	0.5	88	9
		Bushtit	2	22	1.22	0.5	132	13
		Black-throated Gray Warbler	2	22	1.22	0.5	132	13
		House Finch	2	22	1.22	0.5	132	13
		Lesser Nighthawk	2	22	1.22	0.5	132	13
		Mourning Dove	2	22	1.22	0.5	132	13
		Scrub Jay	2	22	1.22	0.5	132	13
		Western-wood Pewee	1	22	1.73	0.5	264	26
		Western Kingbird	1	22	1.73	0.5	264	26
		Pinyon Jay	1	22	1.73	0.5	264	26
		Gambel's Quail	1	22	1.73	0.5	264	26
		Western Tanager	1	22	1.73	0.5	264	26
		Tusayan	Ponderosa Pine	Pygmy Nuthatch	46	43	0.26	n/a
Mountain Chickadee	39			43	0.28	n/a	n/a	n/a
Grace's Warbler	37			43	0.28	n/a	n/a	n/a
Dark-eyed Junco	31			43	0.31	n/a	n/a	n/a
Western Tanager	22			43	0.37	n/a	n/a	n/a
Plumbeous Vireo	15			43	0.45	n/a	n/a	n/a
American Robin	13			43	0.48	n/a	n/a	n/a
Ash-throated Flycatcher	13			43	0.48	n/a	n/a	n/a
Violet-green Swallow	12			43	0.50	n/a	n/a	n/a
Western-wood Pewee	12			43	0.50	n/a	n/a	n/a
Hairy Woodpecker	11			43	0.52	0.5	47	5
Western Bluebird	10			43	0.55	0.5	52	5
Chipping Sparrow	10			43	0.55	0.5	52	5
White-breasted Nuthatch	9			43	0.58	0.5	57	6
Stellar's Jay	8			43	0.61	0.5	65	6

District	Habitat	Species	Detections	Points	Current CV	Minimum CV	Min Pts Needed	Line of 10 pts		
Tusayan (con't)	Ponderosa Pine (con't)	Audubon's Warbler	8	43	0.61	0.5	65	6		
		Pinyon Jay	8	43	0.61	0.5	65	6		
		Black-headed Grosbeak	8	43	0.61	0.5	65	6		
		Northern Flicker	7	43	0.65	0.5	74	7		
		Gray Flycatcher	7	43	0.65	0.5	74	7		
		Hermit Thrush	6	43	0.71	0.5	86	9		
		Acorn Woodpecker	2	43	1.22	0.5	258	26		
		Pine Siskin	1	43	1.73	0.5	516	52		
		Broad-tailed Hummingbird	1	43	1.73	0.5	516	52		
		Common Raven	1	43	1.73	0.5	516	52		
		Black-throated Gray Warbler	1	43	1.73	0.5	516	52		
		Lesser Goldfinch	1	43	1.73	0.5	516	52		
		Cordilleran Flycatcher	1	43	1.73	0.5	516	52		
		Brown Creeper	1	43	1.73	0.5	516	52		
		Townsend's Soletaire	1	43	1.73	0.5	516	52		
		Scrub Jay	1	43	1.73	0.5	516	52		
		Red Crossbill	1	43	1.73	0.5	516	52		
		Woodland-grassland		Gray Flycatcher	11	13	0.52	0.5	14	1
				Black-throated Gray Warbler	10	13	0.55	0.5	16	2
				Ash-throated Flycatcher	7	13	0.65	0.5	22	2
				Chipping Sparrow	5	13	0.77	0.5	31	3
				Pinyon Jay	4	13	0.87	0.5	39	4
				Juniper Titmouse	3	13	1.00	0.5	52	5
Mountain Chickadee	3			13	1.00	0.5	52	5		
Vesper Sparrow	2			13	1.22	0.5	78	8		
Common Raven	2			13	1.22	0.5	78	8		
Blue-gray Gnatcatcher	1			13	1.73	0.5	156	16		
Western Tanager	1			13	1.73	0.5	156	16		
White-breasted Nuthatch	1			13	1.73	0.5	156	16		

District	Habitat	Species	Detections	Points	Current CV	Minimum CV	Min Pts Needed	Line of 10 pts
Tusayan (con't)	Woodland-grassland (con't)	Warbling Vireo	1	13	1.73	0.5	156	16
		Hairy Woodpecker	1	13	1.73	0.5	156	16
		Pygmy Nuthatch	1	13	1.73	0.5	156	16
		Dusky Flycatcher	1	13	1.73	0.5	156	16
		Plumbeous Vireo	1	13	1.73	0.5	156	16
		Brown-headed Cowbird	1	13	1.73	0.5	156	16
		Bushtit	1	13	1.73	0.5	156	16
		Spotted Towhee	1	13	1.73	0.5	156	16
North Kaibab	Aspen	Warbling Vireo	18	17	0.41	n/a	n/a	n/a
		Grace's Warbler	14	17	0.46	n/a	n/a	n/a
		Hermit Thrush	7	17	0.65	0.5	29	3
		Dark-eyed Junco	4	17	0.87	0.5	51	5
		Mountain Chickadee	4	17	0.87	0.5	51	5
		American Robin	4	17	0.87	0.5	51	5
		Chipping Sparrow	3	17	1.00	0.5	68	7
		House Wren	3	17	1.00	0.5	68	7
		Northern Flicker	3	17	1.00	0.5	68	7
		Ruby-crowned Kinglet	3	17	1.00	0.5	68	7
		Western Tanager	2	17	1.22	0.5	102	10
		Audubon's Warbler	2	17	1.22	0.5	102	10
		Pine Siskin	2	17	1.22	0.5	102	10
		Common Raven	2	17	1.22	0.5	102	10
	Hairy Woodpecker	1	17	1.73	0.5	204	20	
	Western Bluebird	1	17	1.73	0.5	204	20	
	White-breasted Nuthatch	1	17	1.73	0.5	204	20	
	Stellar's Jay	1	17	1.73	0.5	204	20	
	Pygmy Nuthatch	1	17	1.73	0.5	204	20	
	Virginia's Warbler	1	17	1.73	0.5	204	20	
	Mixed-conifer	Audubon's Warbler	40	38	0.27	n/a	n/a	n/a
		Warbling Vireo	37	38	0.28	n/a	n/a	n/a

District	Habitat	Species	Detections	Points	Current CV	Minimum CV	Min Pts Needed	Line of 10 pts		
North Kaibab (con't)	Mixed-conifer (con't)	Pine Siskin	29	38	0.32	n/a	n/a	n/a		
		Western Tanager	26	38	0.34	n/a	n/a	n/a		
		Ruby-crowned Kinglet	26	38	0.34	n/a	n/a	n/a		
		Hermit Thrush	23	38	0.36	n/a	n/a	n/a		
		Chipping Sparrow	17	38	0.42	n/a	n/a	n/a		
		Dark-eyed Junco	12	38	0.50	n/a	n/a	n/a		
		Grace's Warbler	12	38	0.50	n/a	n/a	n/a		
		Northern Flicker	8	38	0.61	0.5	57	6		
		American Robin	6	38	0.71	0.5	76	8		
		Mountain Chickadee	5	38	0.77	0.5	91	9		
		Stellar's Jay	5	38	0.77	0.5	91	9		
		Western-wood Pewee	4	38	0.87	0.5	114	11		
		Red-breasted Nuthatch	3	38	1.00	0.5	152	15		
		Virginia's Warbler	3	38	1.00	0.5	152	15		
		Black-headed Grosbeak	3	38	1.00	0.5	152	15		
		House Wren	3	38	1.00	0.5	152	15		
		White-breasted Nuthatch	2	38	1.22	0.5	228	23		
		Common Raven	2	38	1.22	0.5	228	23		
		Evening Grosbeak	2	38	1.22	0.5	228	23		
		Downy Woodpecker	1	38	1.73	0.5	456	46		
		Townsend's Soletaire	1	38	1.73	0.5	456	46		
		Red-naped Sapsucker	1	38	1.73	0.5	456	46		
		Brown Creeper	1	38	1.73	0.5	456	46		
		Pygmy Nuthatch	1	38	1.73	0.5	456	46		
		Hairy Woodpecker	1	38	1.73	0.5	456	46		
		Williamson's Sapsucker	1	38	1.73	0.5	456	46		
			Montane grassland	Chipping Sparrow	13	15	0.48	n/a	n/a	n/a
				Violet-green Swallow	7	15	0.65	0.5	26	3
				Mountain Chickadee	5	15	0.77	0.5	36	4
				Warbling Vireo	5	15	0.77	0.5	36	4
				Dark-eyed Junco	5	15	0.77	0.5	36	4

District	Habitat	Species	Detections	Points	Current CV	Minimum CV	Min Pts Needed	Line of 10 pts
North Kaibab (con't)	Montane grassland (con't)	Western Tanager	4	15	0.87	0.5	45	5
		Western-wood Pewee	4	15	0.87	0.5	45	5
		Audubon's Warbler	4	15	0.87	0.5	45	5
		Brewer's Blackbird	3	15	1.00	0.5	60	6
		Hermit Thrush	2	15	1.22	0.5	90	9
		Pygmy Nuthatch	2	15	1.22	0.5	90	9
		Broad-tailed Hummingbird	2	15	1.22	0.5	90	9
		White-breasted Nuthatch	2	15	1.22	0.5	90	9
		Mountain Bluebird	1	15	1.73	0.5	180	18
		Northern Flicker	1	15	1.73	0.5	180	18
		Plumbeous Vireo	1	15	1.73	0.5	180	18
		American Robin	1	15	1.73	0.5	180	18
		Western Bluebird	1	15	1.73	0.5	180	18
		House Wren	1	15	1.73	0.5	180	18
			Ponderosa Pine	Grace's Warbler	28	32	0.33	n/a
Audubon's Warbler	22			32	0.37	n/a	n/a	n/a
Warbling Vireo	15			32	0.45	n/a	n/a	n/a
Western Tanager	14			32	0.46	n/a	n/a	n/a
Pygmy Nuthatch	11			32	0.52	0.5	35	3
Ruby-crowned Kinglet	11			32	0.52	0.5	35	3
Dark-eyed Junco	10			32	0.55	0.5	38	4
Western-wood Pewee	9			32	0.58	0.5	43	4
Hermit Thrush	8			32	0.61	0.5	48	5
Chipping Sparrow	6			32	0.71	0.5	64	6
Mountain Chickadee	6			32	0.71	0.5	64	6
White-breasted Nuthatch	6			32	0.71	0.5	64	6
Virginia's Warbler	5			32	0.77	0.5	77	8
Northern Flicker	5			32	0.77	0.5	77	8
Stellar's Jay	5			32	0.77	0.5	77	8
Plumbeous Vireo	3			32	1.00	0.5	128	13
House Wren	3			32	1.00	0.5	128	13

District	Habitat	Species	Detections	Points	Current CV	Minimum CV	Min Pts Needed	Line of 10 pts
North Kaibab (con't)	Ponderosa Pine (con't)	Pine Siskin	2	32	1.22	0.5	192	19
		Cassin's Finch	2	32	1.22	0.5	192	19
		American Robin	2	32	1.22	0.5	192	19
		Williamson's Sapsucker	2	32	1.22	0.5	192	19
		Red-breasted Nuthatch	1	32	1.73	0.5	384	38
		Spotted Towhee	1	32	1.73	0.5	384	38
		Townsend's Soletaire	1	32	1.73	0.5	384	38
		Violet-green Swallow	1	32	1.73	0.5	384	38
		Black-headed Grosbeak	1	32	1.73	0.5	384	38
		Western Bluebird	1	32	1.73	0.5	384	38
		Hammond's Flycatcher	1	32	1.73	0.5	384	38