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Legacy Bird Species at Risk Monitoring in and around Camp Navajo and the Naval Observatory Flagstaff Station, AZ

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Introduction

Two Department of Defense (DoD) installations, Camp Navajo Army Depot and Naval Observatory Flagstaff Station (NOFS) are located approximately 10 miles west of Flagstaff, Arizona. Arizona ponderosa pine forests are described as having a 2-20 year fire frequency prior to European settlement, facilitating a grass-herbaceous understory beneath a mosaic of widely-spaced mature trees (Covington and Moore 1994, Covington et al. 1997, Moore et al. 1999). This landscape has changed markedly since the mid 19th century due to a convergence of complex stressors such as overgrazing, timber harvest, drought, and fire suppression (Allen et al. 2002, Moore et al. 2004). Currently, most Arizona pine forests are overstocked with dense thickets of smaller trees and high accumulations of forest litter, posing a high risk of catastrophic wildfire (Moore et al. 2004). High intensity wildfire at Camp Navajo or NOFS could destroy forest cover necessary for realistic training, could negatively affect the sustainability of training ranges and could damage high value mission-essential equipment. As such, both Camp Navajo and NOFS have recently initiated plans to reduce the risk of wildfire at their facilities by restoring their forests through a combination of thinning and burning, thereby ensuring the uninterrupted completion of mission-critical activities.

Camp Navajo and NOFS have also joined a partnership with the US Fish and Wildlife Service (USFWS), US Forest Service (USFS), Arizona State Lands Department (ASLD) and Arizona Game and Fish Department (AZGFD) to monitor species recognized by the Arizona Partners in Flight (PIF) as a conservation priority including the Cordilleran flycatcher (*Empidonax occidentalis*) and the Olive-sided flycatcher (*Contopus cooperi*) (Latta et al. 1999). The primary goal of the partnership is to work proactively to conserve these species and prevent federal listing, thereby facilitating agency missions. However, because forest restoration activities have begun to be widely implemented only recently, the effect of forest thinning on these species remains unclear. This study focused on determining the effects of forest thinning on these sensitive species as to inform proper management to prevent further listing of wildlife

residing on DOD properties. We provide management recommendations to guide the conservation efforts for these priority bird species within the project area, while preserving the military mission for both Camp Navajo and NOFS.

The objectives of this study were to:

1. Survey for the presence of Cordilleran and olive-sided flycatchers in treated ponderosa pine forests representative of fire-managed forests around Flagstaff, Arizona;
2. Record all other detectable bird species during surveys, and;
3. Make recommendations for the management of DOD forest lands for conservation of these priority bird species in lieu of federal listing

Study Area

Members of the cooperative partnership agreed it was important to evaluate the effects of forest thinning on relatively "simple" forests with relatively small trees, few snags, and not to include potentially confounding factors such as tree species other than ponderosa pine or stands with recent fire. Early vegetative structural stage (VSS) forests seem to be the most common in the local landscape and forest thinning conducted to minimize the risk of high intensity wildfire in such stands could have the greatest effect on priority bird conservation species. We consulted with the U.S. Forest Service (USFS) to identify “simple” ponderosa pine forests that were most representative of the northern Arizona landscape. We based our selection on the following criteria:

1. Distance between study sites was greater than 2,000 meters.
2. Greater than 2 years post thinning.
3. Stands in VSS class 3 and 4 with greater than 60% of the trees within 9-12” diameter at breast height (DBH) and less than 6 ponderosa pines greater than 24” DBH per acre.
4. Tree species basal area greater than 95% ponderosa pine (for trees greater than 5” DBH).

5. Snags greater than 16” DBH should comprise less than 0.5 per acre.
6. No prescribed wildfire within 5 years.
7. Minimum stand size of 160 acres.
8. Distance to any water source greater than 200 meters from survey locations.

Using these criteria, we identified four study plots within forest restoration treatments in the Coconino National Forest: 1) Along forest road 518; 2) forest road 506 north of the A1 Exit on Interstate 40; 3) State forest lands adjacent to NOFS, and; 4) along Woody Mountain Road (Figure 1). All Legacy plots were dominated by the ponderosa pine association of the montane coniferous forest community (Brown 1994), and contained virtually no Gambel oak (*Quercus gambelli*). The elevation ranges from 7,100-7,500 feet. Cold winters and warm summers characterize the Flagstaff regional climate with most precipitation occurring as snowfall from December through March. Monsoon rainfall provides additional moisture from mid-July through September. Average annual precipitation is 22.91 inches (58.2 cm) with the annual snowfall averaging 100 inches (254 cm).

Methods

Avian Point Counts

We conducted avian surveys using a systematic sampling approach of multiple point count stations along linear transects following methods described in Buckland et al. (2001). Individual stations were located (± 10 m) using Universal Transverse Mercator (UTM; NAD 83) coordinates and a Global Positioning System (GPS) receiver. Point counts were conducted to detect birds during the 2008 and 2009 breeding seasons (May – July) and were surveyed within 3 hours of sunrise by a single observer to maximize detection and reduce observer bias. At each point count station the observer remained silent for one minute prior to beginning the survey to prevent bias resulting from disturbance to birds. The observer then began the survey and recorded all birds seen or heard for the next 5 minutes. Distances to individuals were measured with a rangefinder when possible and auditory detections were estimated using

distance categories (25-50m, 50-75m, 75-100m, 100-150m, 150-200m, and >200m). Each point count station was visited three times over the course of the summer (once per month in May, June and July).

Diversity and Richness

We calculated species richness and diversity for each study plot, as well as for the entire study area using the following equations:

Margalef's Index Species Richness Index

$D_{MG} = (S-1)/\ln N$ $SR = S + N_1 / (2 * N_2)$

where,

S= number of species

N= number of individuals, and N_1=number of species recorded only once,

ln=natural log N_2=number of species recorded at least twice

Habitat Assessment

We used the variable radius plot (VRP) method to sample forest structure around each point count station. We used a 10 basal-area factor sighting gauge to "sight in" all trees (live and dead) all trees around each station. The diameter at breast height (DBH) of each sighted in tree was measured and tallied by species. We classified each tree into one of five vegetative structural stage (VSS) classes. We counted the number of shrubs and shrub species within a 15m radius around each survey station. We measured percent canopy cover using a spherical densitometer 10m from each station at each cardinal direction (i.e. 4 measurements/survey point), and calculated mean canopy cover for each plot.

Results

2008 Avian Surveys

We detected a total of 35 species comprised of 1,148 individuals across the 49-point count stations established within the study area (Table 1). We recorded 533 individuals of 26 species near Forest Road 518, and 376 individuals of 31 species near Forest Road 506. We detected 176 individuals of 26 species during surveys conducted near Woody Mountain Road and 61 individuals of 25 species at NOFS. Neither the Cordilleran flycatcher nor the Olive-sided flycatcher were detected at any Legacy plot in 2008. The Margalef's diversity indices were 3.98, 5.06, 4.84 and 5.84 for Forest Road 518, Forest Road 506, Woody Mountain and NOFS plots, respectively (Table 3). Species richness values were 0.68, 0.65, 0.68 and 0.89 for Forest Road 518, Forest Road 506, Woody Mountain and NOFS plots, respectively (Table 3). Combining all 4 plots yielded a Margalef's value of 4.83 and a Species Richness value of 0.59 for the 2008 surveys.

2009 Avian Surveys

A total of 41 species were detected comprised of 1,451 individuals across the same 49 point-count stations established within the study area in 2008. We detected 758 individuals of 32 species near Forest Road 518, and 518 individuals of 32 species during near Forest Road 506. We detected 161 individuals of 21 species near Woody Mountain Road, and 80 individuals of 18 species at NOFS. Two (total) Cordilleran flycatchers were detected during 2009 Legacy surveys on 5/18/2009 and 6/15/2009 at survey points located within the Forest Road 518 region (Figure 2). Olive-sided flycatchers were not detected on any Legacy survey plots in 2008 or 2009, however, a single incidental detection occurred shortly after a survey was completed on 5/16/2009 in the northwest region of Forest Road 518 (Figure 2). The Margalef's diversity indices were 4.68, 5.14, 4.72 and 3.88 for Forest Road 518, Forest Road 506, Woody Mountain and NOFS plots, respectively (Table 4). Species Richness values were 0.69, 0.73, 0.89 and 0.7 for Forest

Road 518, Forest Road 506, Woody Mountain and NOFS plots, respectively (Table 4). Combining all 4 sites yielded a Margalef's value of 5.5 and a Species Richness value of 0.61 for the 2009 surveys.

Habitat Assessment

Overall, the Forest Road 506 survey plot had the highest basal area, followed by forest road 518, NOFS, and Woody Mountain plots (Table 5). The only tree species within VRPs was ponderosa pine, and most measured trees fell within VSS classes 2 and 3 (Table 5). The Forest Road 506 survey plot also had the highest basal area of snags and the highest percent canopy cover (Table 5). We found the highest density of understory shrubs at Woody Mountain and NOFS plots (Table 5).

Discussion

No Cordilleran flycatchers were detected on any Legacy plots in 2008 and only two were detected in 2009. The May 2009 detection was a well-viewed silent individual and was most likely a migrant. The June Cordilleran flycatcher detection was of a singing male indicating a possible breeding event, although this could also have been a transient individual, as it was not detected again in a subsequent survey. Olive-sided flycatchers were not detected on any Legacy survey plots in 2008 or 2009, with a single exception of an incidental detection in 2009.

Based on these results, it appears that the Cordilleran flycatcher and the Olive-sided flycatcher are either absent or exist in low densities during the breeding season in ponderosa pine forests surveyed in our study. Cordilleran flycatchers were regularly detected in 2008 and 2009 on nearby Camp Navajo in ponderosa pine forest that included a heavy Gambel oak component accompanied by a dense understory consisting of New Mexican locust (*Robinia neomexicana*), oak saplings, and herbaceous annuals (Frary and Blackman 2008, S.T. Blackman unpublished data). Pine-oak forests on Camp Navajo also had higher overall avian diversity and richness than we found in our study (Frary and Blackman

2008, S.T. Blackman unpublished data). These results are similar to Rosenstock (1998) who recorded significantly higher richness and diversity of species in pine-oak versus pine only stands in northern Arizona. This includes the Cordilleran flycatcher, which was twice as likely to occupy ponderosa pine stands that included an oak component (Rosenstock 1998). The same study, however, suggested that olive-sided flycatchers regularly occurred in pine-only stands, although we observed only a single individual during an incidental encounter. This is likely due to olive-sided flycatcher's selection of coniferous forests with large trees and snags (Altman and Sallabanks 2000), which were scarce in our study area (Table 5).

The lack of consistent detections of either priority species may indicate that at present, the young, recently thinned forests, representative of many restoration sites in northern Arizona, represent low-quality habitat for these species. However, over time post-thinning changes in forest structure may result in improved habitat for both the Cordilleran and olive-sided flycatcher. For example, mechanical thinning of ponderosa pine forests has been shown to be conducive to oak regeneration and recruitment (Okonburi 1999). This would likely make conditions more favorable for a higher diversity of avian species, including the Cordilleran flycatcher. The creation of forest gaps through mechanical thinning should also allow for increased use by Olive-sided flycatchers (Altman and Sallabanks 2000). Furthermore, the focus of restoration treatments on the removal of smaller trees reduces overall resource competition and encourages growth of larger, older trees. Over time, the increased prevalence of large trees and eventually large snags will further improve conditions for the olive-sided flycatcher (Cheskey 1987).

Additional Partners in Flight (PIF) priority species that occur in ponderosa pine woodlands include: band-tailed pigeon, red-faced warbler, gray flycatcher, purple martin and black-throated gray warbler (Latta et al. 1999). Of these potentially occurring species, two purple martins were detected during 2009 Legacy surveys on near FR 506 and several gray flycatchers were additionally observed (Tables 1 and 2). Also notable was the detection of a singing

greater pewee on 5/19/2009 within the Forest Road 506 region. The greater pewee is a Mexican species that breeds in the sky island forests and rarely strays above the Mogollon Rim (Corman and Wise-Gervais 2005).

Management Recommendations

Over the next decade, forest restoration treatments will continue with the goal of simultaneously reducing wildfire threats and enhancing ecological health. We recommend the following steps be taken to help prevent the listing of DoD Species At Risk, inform management of forest songbirds and their habitat, and manage habitat while reducing the risk of wildfire to achievement of DoD missions:

1. Restoration treatments may improve conditions for the olive-sided and Cordilleran flycatcher over time (i.e. 80-100+ years) by encouraging oak recruitment, creating forest gaps, and contributing to the prevalence of large-diameter pines and eventually large snags. However, until empirical evidence documents use of restored stands by these species, refugia sites need to be identified and excluded from treatment to mitigate habitat loss.
2. We agree with other avian research conducted in ponderosa pine forests (e.g., Brawn and Balda 1988, Rosenstock 1998, Wightman and Germaine 2006) that Gambel oak is vital to many breeding bird species. Thus, removal of existing Gambel oak should be avoided during future forest treatments. Practices that encourage Gambel oak generation such as providing cover through strategic placement of slash, exclusion of grazing, and manual seeding of thinned areas should be considered following forest treatment (Abella 2008).
3. Forest treatment prescriptions should exclude removal of snags and large-diameter pines to maintain olive-sided flycatcher foraging perches.
4. Restrict forest treatments to non-breeding season to reduce localized impacts to breeding birds.

5. Continue annual monitoring of songbird response to forest thinning on Legacy plots. Long-term studies (> 15 years) are needed to adequately assess avian response to management actions, as responses are typically diverse, dynamic, and often exhibit a significant lag after management action (Purcell et al. 2005).

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Table 1. Species list and total detections of birds observed during the summer of 2008 on Legacy Plots west of Flagstaff, Arizona.

Common Name	Species	Total Detections[a]
Acorn Woodpecker	*Melanerpes formicivorus*	2
American Kestrel	*Falco sparverius*	1
American Robin	*Turdus migratorius*	28
Black-headed Grosbeak	*Pheucticus melanocephalus*	2
Broad-tailed Hummingbird	*Selasphorus platycercus*	6
Brown Creeper	*Certhia americana*	2
Brown-headed Cowbird	*Molothrus ater*	23
Chipping Sparrow	*Spizella passerina*	8
Common Raven	*Corvus corax*	24
Cooper's Hawk	*Accipiter cooperii*	1
Dark-eyed Junco	*Junco hyemalis*	97
Grace's Warbler	*Dendroica graciae*	29
Gray Flycatcher	*Empidonax wrightii*	14
Great-horned owl	*Bubo virginianus*	2
Hairy Woodpecker	*Picoides villosus*	25
House Finch	*Carpodacus mexicanus*	3
House Wren	*Troglodytes aedon*	1
Lesser Goldfinch	*Carduelis psaltria*	16
Mountain Chickadee	*Parus gambeli*	64
Mourning Dove	*Zenaida macroura*	14
Northern Flicker	*Colaptes auratus*	27
Pine Siskin	*Carduelis pinus*	16
Olive Warbler	*Peucedramus taeniatus*	5
Plumbeous Vireo	*Vireo solitarius*	60
Pygmy Nuthatch	*Sitta pygmaea*	177
Red Crossbill	*Loxia curvirostra*	109
Red-tailed Hawk	*Buteo jamaicensis*	2
Steller's Jay	*Cyanocitta stelleri*	39
Violet-green swallow	*Tachycineta thalassina*	68
Western Bluebird	*Sialia mexicana*	118
Western Tanager	*Piranga ludoviciana*	10
Wild Turkey	*Meleagris gallopavo*	1
Western wood-pewee	*Contopus sordidulus*	57
White-breasted Nuthatch	*Sitta carolinensis*	62
Yellow-rumped Warbler	*Dendroica coronata*	35

Table 2. Species list and total detections of birds observed during the summer of 2009 on west of Flagstaff, Arizona.

Common Name	Species	Total Detections[a]
Acorn Woodpecker	*Melanerpes formicivorus*	4
American Kestrel	*Falco sparverius*	3
American Crow	*Corvus brachyrhynchos*	3
American Robin	*Turdus migratorius*	52
Black-headed Grosbeak	*Pheucticus melanocephalus*	4
Broad-tailed Hummingbird	*Selasphorus platycercus*	15
Brown Creeper	*Certhia americana*	5
Brown-headed Cowbird	*Molothrus ater*	20
Chipping Sparrow	*Spizella passerina*	9
Common Nighthawk	*Chordeiles minor*	3
Common Raven	*Corvus corax*	13
Cordilleran Flycatcher	*Empidonax occidentalis*	2
Dark-eyed Junco	*Junco hyemalis*	105
Grace's Warbler	*Dendroica graciae*	42
Gray Flycatcher	*Empidonax wrightii*	2
Greater Pewee	*Contopus pertinax*	1
Great-horned Owl	*Bubo virginianus*	1
Hairy Woodpecker	*Picoides villosus*	28
Hermit Thrush	*Catharus guttatus*	2
House Finch	*Carpodacus mexicanus*	3
House Wren	*Troglodytes aedon*	1
Lazuli Bunting	*Passerina amoena*	1
Lesser Goldfinch	*Carduelis psaltria*	25
Mountain Chickadee	*Parus gambeli*	64
Mourning Dove	*Zenaida macroura*	14
Northern Flicker	*Colaptes auratus*	50
Pine Siskin	*Carduelis pinus*	58
Olive-sided Flycatcher	*Contopus cooperi*	1 - Incidental
Olive Warbler	*Peucedramus taeniatus*	11
Pinyon Jay	*Gymnorhinus cyanocephalus*	3
Plumbeous Vireo	*Vireo solitarius*	69
Purple Martin	*Progne subis*	2
Pygmy Nuthatch	*Sitta pygmaea*	206
Red Crossbill	*Loxia curvirostra*	109
Steller's Jay	*Cyanocitta stelleri*	24
Violet-green swallow	*Tachycineta thalassina*	56
Warbling Vireo	*Vireo gilvus*	2
Western Bluebird	*Sialia mexicana*	205
Western Tanager	*Piranga ludoviciana*	6
Western wood-pewee	*Contopus sordidulus*	108
White-breasted Nuthatch	*Sitta carolinensis*	80
Yellow-rumped Warbler	*Dendroica coronata*	40

Table 3. Margalef's Index and Species Richness Index values for 4 Legacy sites surveyed during the 2008 breeding season west of Flagstaff, Arizona.

Site	Total Species	Total Individuals	Margalef's Index	Species Richness
FR 518	26	533	3.98	0.68
FR 506	31	376	5.06	0.65
Woody Mtn.	26	176	4.84	0.68
Navy	25	61	5.84	0.89

Table 4. Margalef's Index and Species Richness Index values for 4 Legacy sites surveyed during the 2009 breeding season Legacy Plots west of Flagstaff, Arizona.

Site	Total Species	Total Individuals	Margalef's Index	Species Richness
FR 518	32	758	4.68	0.69
FR 506	32	416	5.14	0.73
Woody Mtn.	25	161	4.72	0.89
Navy	18	80	3.88	0.7

Table 5. Summary of vegetation characteristics measured for each Legacy survey plot. All trees recorded were ponderosa pine (*Pinus ponderosa*).

Site	Basal Area Live (ft^2/acre)	Basal Area Snag (ft^2/acre)	% Canopy Cover ($\bar{X}$)	Number of Shrubs ($\bar{X}$)	Number of Shrub Species ($\bar{X}$)	Basal area (ft^2/ per acre) by VSS Class					
							Class 1 (<12.4 cm dbh)	Class 2 (12.5-30.2 cm dbh)	Class 3 (30.3-45.5 cm dbh)	Class 4 (45.6-61.0 cm dbh)	Class 5 (>61.0 cm dbh)
FR 518	81.6	2.0	43.4	0	0	Live	0	40.8	35.2	4.40	1.20
						Snag	0	1.20	0	0.80	0
FR 506	108.5	6.2	60.4	0	0	Live	5.38	45.4	48.5	8.46	0.77
						Snag	0.77	4.62	0.77	0	0
Woody Mtn.	45.7	1.3	32.4	6	1	Live	0	4.29	14.3	21.4	5.71
						Snag	0	0	0	0	1.43
NOFS	46.7	0	26.4	5	1	Live	0	33.3	3.33	3.33	6.67
						Snag	0	0	0	0	0

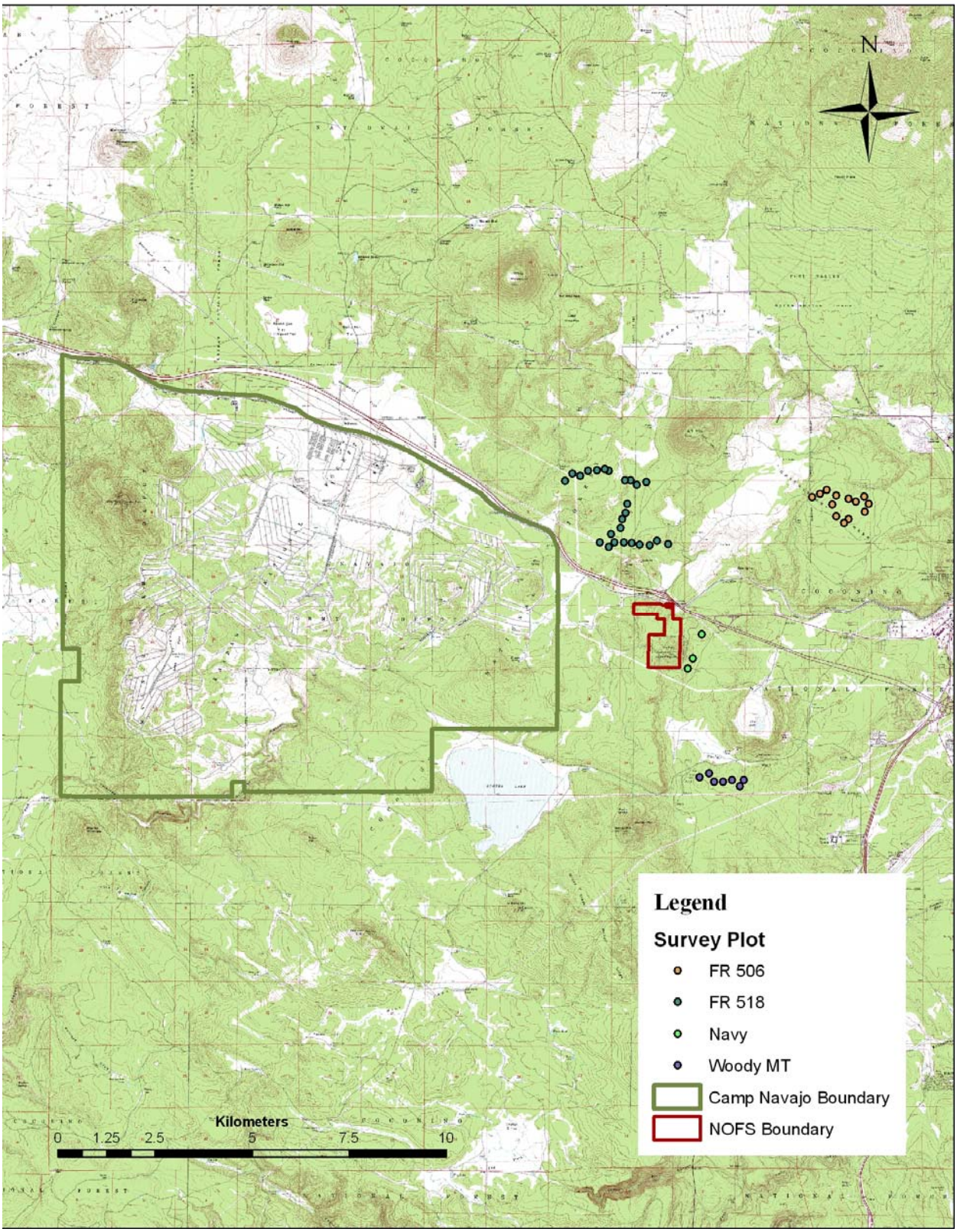

Figure 1. Legacy bird plot survey locations west of Flagstaff, Arizona.

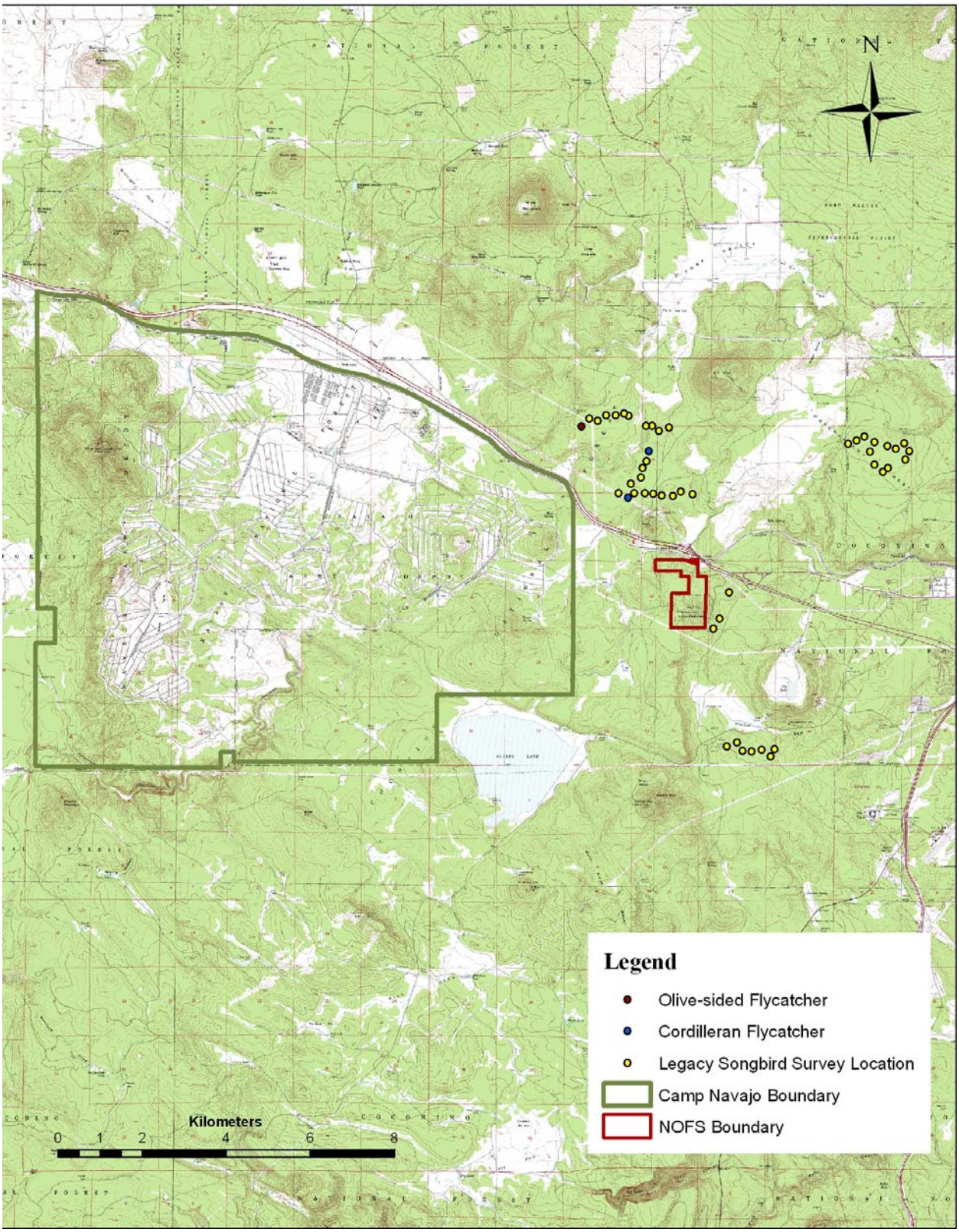

Figure 2. Locations of priority species detected in 2009. Cordilleran Flycatcher observations occurred at Legacy point count stations, the Olive-sided Flycatcher observation occurred incidentally near the FR518 plot.

Appendix 1

Bird Survey Form

Arizona Game and Fish Dept.

Location / ID #__________ Start Time:__________End Time:__________Date:___________

Cloud:__________ Temp (Start/End):__________ PPT:__________ Wind:_____________

Comments:____

POINT	TIME	SPECIES	A / V	COUNT	DISTANCE	CONDITION

Aural Distance Intervals (in Meters): 5-10, 10-25, 25-50, 50-100, 100-200, 200+

Appendix 2

Legacy Birds Vegetation Data Sheet

Date:_____ Observers:_____
Plot:_____

Canopy Cover N _____S_____E_____W_____

Observations within a 15-m radius plot center:
# of shrub species_____ #of ind. shrubs_____
(>12 in height) * >250 put in increments of 50 (i.e. 250-300, 300-350)

Variable radius plot (10 BAF):

Total number in each DBH (cm) classes: *(Tally as L, D)

Species	<12.4	12.5-30.2	30.3-45.5	45.6-61.0	>61.0	
						Total
Total Count Live Trees						
Total Count Conifer						
Total Count Hardwood						
Total Count Snags						

Basal Area: Live _____ Snag_____ (basal area = stem count x BAF)