Management of Pinyon-Juniper Woodlands at Kirtland Air Force Base: Pinyon Jay Summer and Winter Home Ranges and Habitat Use

2009 Final Report

Kristine Johnson, Matt Baumann, Cole Wolf, Teri Neville, and Jacqueline Smith
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Abstract

In 2009 we began a study of Pinyon Jays and their relationship to pinyon pines at Kirtland Air Force Base, NM. From March through December 2009 we surveyed for Pinyon Jays in appropriate habitat on KAFB. For all detections, we recorded the birds' locations, their behavior, and flock size and entered locations into Geographic Information System (GIS). The number of jays sighted ranged from 1-135. Mean flock size was 18.2. Only nine of 54 detections were of a lone individual. In August, we captured 18 birds and attached radio transmitters to three of them. We tracked the birds with radios several times per week through the end of December. We used the bearings of the radio signals to triangulate on the birds' locations and entered these points into a GIS. Using the detection points, we drew minimum convex polygons and performed fixed density kernel analyses to determine flock home ranges. The entire area in which we recorded jays covered 4819.46 ha. The north combined breeding and non-breeding season home range, which may comprise the home range of a single flock, covered 2101.15 ha. We mapped jay locations and assigned vegetation types to these polygons to determine habitat use. Jays used five main habitat types: Pinyon Woodland, Pinyon-juniper Woodland, Juniper-pinyon Woodland, Juniper Woodland, and Burned areas. They were found more often in pinyon-dominated habitats during the breeding season and more often in juniper-dominated habitats during the non-breeding season. They cached and retrieved caches in open areas with sparse vegetation. The primary caching area was situated on a south-facing slope that remained snow-free for most of the winter. A secondary caching area was located in a burned area, also open and relatively snow-free.

Introduction

Some of the largest, most intact stands of pinyon pine (*Pinus edulis*) and juniper (*Juniperus monosperma, J. scopulorum*) woodlands in the Southwest occur on military lands. Unlike private lands, which are subject to development, management for livestock, and fuelwood exploitation, woodlands on military installations have been managed relatively sustainably, particularly with respect to fire and biodiversity. Although fire has been found to play a role in structuring pinyon-juniper woodlands on New Mexico installations (Muldavin et al. 2003) and across the region (Baker and Shinneman 2004), fire is only one factor affecting the processes and patterns of this complex ecosystem. Birds, particularly Pinyon Jays (*Gymnorhinus cyanocephalus*), and insect pests play critical roles in the establishment and demise, respectively, of the woodlands.

Pinyon Jays serve as short- and long-distance seed dispersers for pinyon pines, and the pines in turn provide mast crops of pinyon seeds that insure Pinyon Jay population viability (Ligon 1978, Marzluff and Balda 1992). Adapted for carrying and caching millions of seeds in a few weeks, Pinyon Jays are the only seed disperser capable of re-planting an entire woodland decimated by fire, chaining, or insect pests. It has been suggested that an evolved keystone mutualism between the tree and the bird ensures their mutual, long-term sustainability (Ligon 1978, Lanner 1996).

The potential impacts of insects on pinyon-juniper ecosystems have become poignantly evident in recent years, with the drought-induced expansion of pinyon bark beetle (*Ips confusus*) impacts across the western United States. Surveys completed by the US Forest Service (USFS) in 2003 estimated that 770,000 ac of New Mexico's pinyon pine forests had been affected, killing 45,000,000 trees. Most significant losses occurred in the north central mountains, in Rio Arriba and Taos Counties, with notable mortality in Los Alamos, Sandoval, and Santa Fe Counties. In addition, wildfire and management for livestock grazing have recently destroyed significant areas of pinyon-juniper woodland in New Mexico and the Southwest. Global climate change is expected to bring increased temperatures and frequent drought, which will only exacerbate insect and wildfire impacts.

The pinyon pine's most important seed disperser may also be in trouble. Breeding bird surveys indicate that Pinyon Jay populations in New Mexico and across its range in the southwestern US have been declining significantly from 1966 to the present (Sauer et al. 2005). Due to population declines and concern over impacts to pinyon-juniper woodlands, New Mexico Partners in Flight ranks the Pinyon Jay as a Level 1 Species of Concern.

Pinyon pine mortality appears to be considerably lower at Kirtland Air Force Base (KAFB) than in some other areas of New Mexico, including at White Sands Missile Range (Johnson and Smith 2006, 2007), around Santa Fe, and as close as Tijeras Canyon (K. Johnson personal observations). As a relatively healthy, protected example of pinyon-juniper habitat, the pinyon-juniper woodland at KAFB represents an important laboratory

for understanding the dynamic interactions of pinyon pines, Pinyon Jays, and the impacts on both species that threaten to destabilize pinyon-juniper woodlands on several military installations in the southwestern US. In 2009, Natural Heritage New Mexico began a baseline study of Pinyon Jays at KAFB. The purposes of this study are to investigate the relationship of pinyon pines and Pinyon Jays in pinyon-juniper habitats at KAFB and to provide information for management of pinyon-juniper habitats on KAFB and other installations. The goals for year 1 were to:

- survey for Pinyon Jays at KAFB
- delineate flock home ranges
- find caching areas, and
- find nesting areas.

In the first field season, we conducted extensive surveys for Pinyon Jays, documented and mapped detections, located caching sites, and mapped summer and winter home ranges.

Methods

From March through December 2009, we surveyed for Pinyon Jays in pinyon-juniper habitats at KAFB. Initially we visited areas where Pinyon Jays had been reported by KAFB biologists, MAPS station operators, and DOE biologist Steve Cox. Once we had located several areas frequented by groups of jays, we focused our surveys on those sites. From 1-5 times weekly (except for the weeks of 26 April and 6 May, when we did not survey), we visited areas frequented by the birds and collected GPS points wherever we found jays. Some detections were in areas we could not access. For example, we could not enter the Live Firing Range, and we could not reach locations high on hills before the birds left the area. In those cases we placed location points on a mapping GPS unit.

On 16 June 2009 we erected an automatic koi feeder from Super Feeder (http://www.super-feeder.com/) at the Range Guzzler. After several weeks jays were not visiting the feeder regularly, and on 1 July we moved it to a site next to Coyote Springs Road (Figure 1). We set up a livestock watering tub near the koi feeder. On 9 June, we set up a standard (non-automatic) feeder near the MAPS station in the south part of the base. We later moved this feeder into the trees to encourage jays to visit it and added a water tub (Figure 1). All feeders were kept supplied with *P. edulis* seeds and water was kept in the tubs constantly, except when deer emptied them overnight or they dried on weekends. Water was supplied at both feeders.

After Pinyon Jays were regularly visiting, on 12 and 31 August 2009 we trapped jays near the Coyote Springs Road koi feeder. We used a 107 x 61 x 20 cm welded wire walk-in trap designed after a standard pigeon trap (Figure 2). The trap was baited with *P. edulis* seeds. Each captured bird was banded with a US Fish and Wildlife Service numbered aluminum band and a unique combination of three plastic color bands. We recorded the following data on each captured bird: age, sex, weight, culmen length, bill depth, tarsus, and wing chord. We attached tail-mounted, whip antenna radio transmitters (Holohil

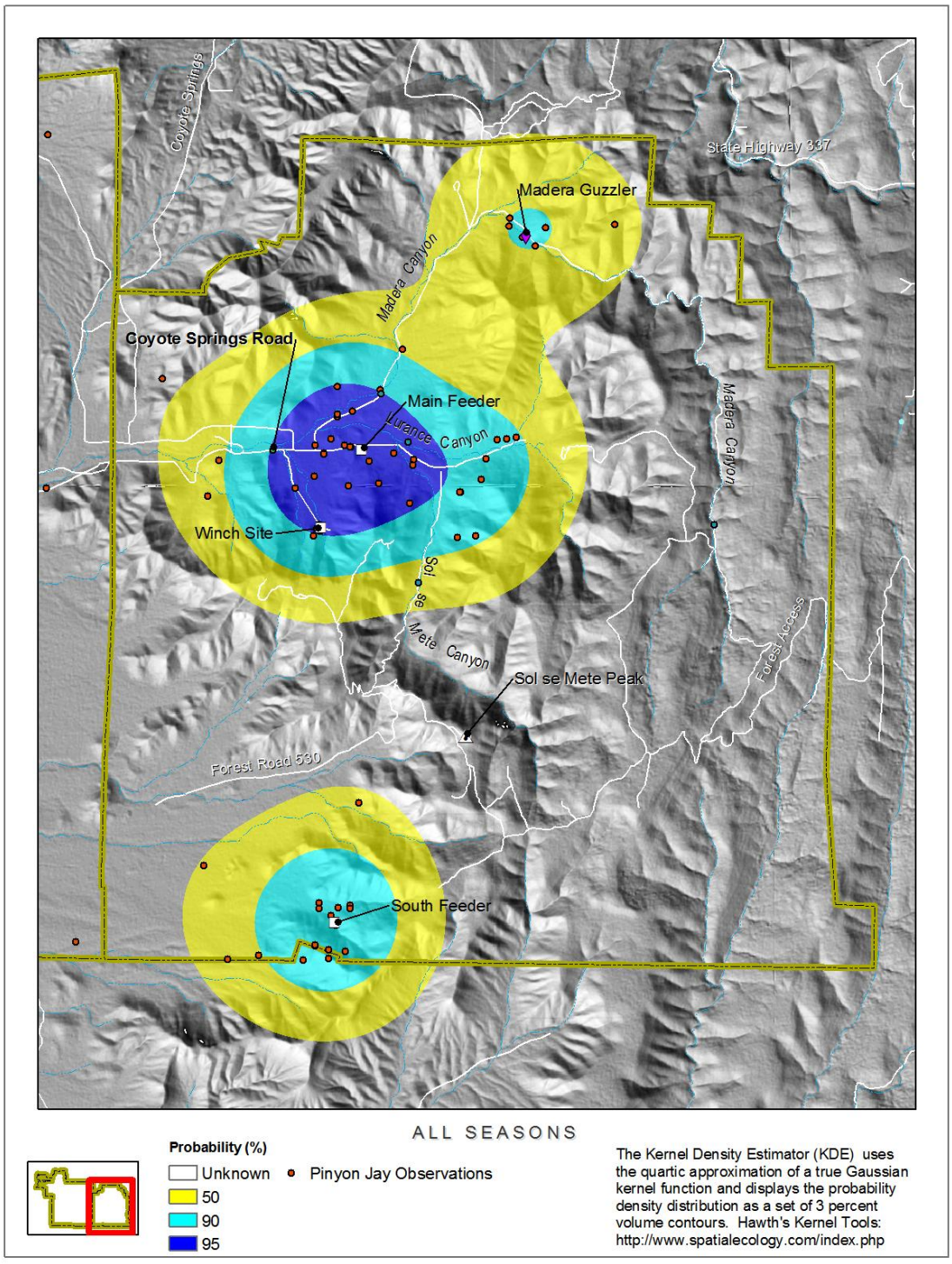

Figure 1. Fixed kernel density map, all seasons.

Figure 2. Pigeon trap and jays at water source.

Systems Ltd.) to three of the birds captured on 12 August. We tied each transmitter to the base of the two central rectrices with sturdy thread, and then glued the body of the transmitter to the top of the same two rectrices (Figure 3). All birds were released unharmed after processing.

Figure 3. Pinyon Jay with transmitter attached.

After transmitters had been attached to the birds, we used a TRX 1000S receiver from Wildlife Materials to listen for transmitter birds 1-4 times each week from mid-August through November and once each on two weeks in December. Each time we received a signal, we recorded our location when we heard the signal and took a compass bearing of the strongest signal. We then attempted to take a second GPS point and directional bearing from a different location, to triangulate on the bird's specific location. The success of obtaining a second set of data point depended on the jays' movements. GPS coordinates for all sightings of jays and all signal bearings were recorded in an Excel spreadsheet. Using GIS, we mapped the location where we were standing when we

received a signal from each bird. We then mapped the vector indicating the direction we heard the strongest radio signal. Where the vectors crossed on the map, we added a point to signify the approximate location of the bird. Each point was associated in the GIS with the following data for the observation: date, time elapsed between observations, weather, transmitter frequency, and general location on KAFB.

We combined all GPS coordinates of Pinyon Jay locations into a GIS layer. This included points derived from visual detection, audio detection of Pinyon Jays, or radio telemetry. We used only telemetry locations resulting from bearings taken 25 or fewer minutes apart, a total of eleven. We divided GPS point locations into breeding (1 March through 31 August), non-breeding (1 September to 28 February), and all (all points combined).

Because Pinyon Jays are highly social, we mapped and analyzed locations for the flock rather than for any single individual. Telemetry points were used to find an individual, but that individual was almost invariably with other jays. To determine home ranges, we first created minimum convex polygons (MCPs) for each season using Hawth's Analysis Tools for ArcGIS, tools developed to function in ArcGIS (Beyer 2004). The resulting MCPs showed the minimum area used by the flock in either the breeding or non-breeding season. Because the MCPs lack detail on probability of detection/use, we followed with a fixed kernel density analysis.

For the kernel analysis we used the Hawth's Tool, Fixed Kernel Density Estimator. Kernel analysis is a nonparametric statistical method for estimating probability densities from a set of points. When used to analyze home range data, kernel density methods describe the probability of finding an animal in any one place. The Fixed Kernel Density Estimator calculates a fixed kernel density estimate and produces contour lines representing the boundary of the area that contains a specified percent of the volume of a probability density distribution. A 95% volume contour, for example, typically contains 95% of the points used to generate the kernel density estimate. Kernel parameters were set as follows: scaling factor- 1000000, kernel- bivariate normal, single parameter smoothing factor (h)-1000, raster cell size-100, and percent volume contours- 50, 90, and 95.

To assess habitat use, in the map document we drew polygons around each GPS point where jays were seen or heard to indicate the area covered by the flock at that observation. Polygon boundaries were determined from our notes and from memory. In lieu of an accurate vegetation layer for the area frequented by the jays, remote sensing and GIS specialists visited the study site with us, identified the primary vegetation types in the main areas of Pinyon Jay activity, and recorded them on a field map showing aerial photography of the study area. We then added the vegetation polygons to a GIS layer. Jay activity polygons were then overlaid on the vegetation polygons to determine general vegetation types used by the jays. In addition, we consulted digital aerial photographs of the study area to assign vegetation types. Percent coverages of the vegetation classes were analyzed using ArcGIS.

Results

Banding

We captured and banded seven Pinyon Jays on 12 August and 11 more on 31 August, 10 after-hatch-year birds and eight hatch-year birds. The presence of hatch-year birds indicates that the jays at KAFB nested successfully in 2009.

One transmitter was detectable only until 23 October. This was well within the expected battery life of the transmitter, which suggests that the bird left the area. A second transmitter stopped moving on 11 November, which suggests that the bird died or the transmitter fell off. We were unable to triangulate on this transmitter, and we failed to find it. We continued to receive moving signals from the third transmitter until 28 December, when the battery presumably died. The third transmitter provided several flock locations through the fall and into the winter.

Location Data

We obtained 23 useful overlapping telemetry bearings that resulted in 11 point locations in the GIS. Ground surveys yielded an additional 86 point locations. The kernel density map for the entire 2009 study depicts the 50, 90, and 95% kernel density polygons for all Pinyon Jays detected in 2009 (Figure 1). This map provides a reasonably good prediction of where Pinyon Jays could be found at KAFB between March and December 2009.

Flock Size

We have 54 records of Pinyon Jays where we noted flock size, excluding observations at the feeder. For these 54, the mean number of birds was 18.2 (range 1-135). The majority of observations were of groups of birds. Only nine observations were of a single bird. Over half (29) of the observations were of groups of 6 or more individuals. For these larger groups, the mean group size was 31.7. On seven occasions we counted or estimated 50 or more birds in a flock. These observations occurred in June (n=4), July (n=2), and October (N=1). These data suggest that the breeding season flock in the north area has up to 135 members but that the flock typically breaks up into smaller groups for foraging, caching, etc.

Breeding

We heard fledglings begging near the south KAFB boundary in late May, and we detected jays in the area and received reports from other investigators indicating that they were present in that canyon until the end of August. Because the jays left the south area in August, it is unclear whether those birds comprise a separate flock or whether they joined the Madera Canyon area flock after the young fledged. We captured hatch-year birds near the koi feeder in August.

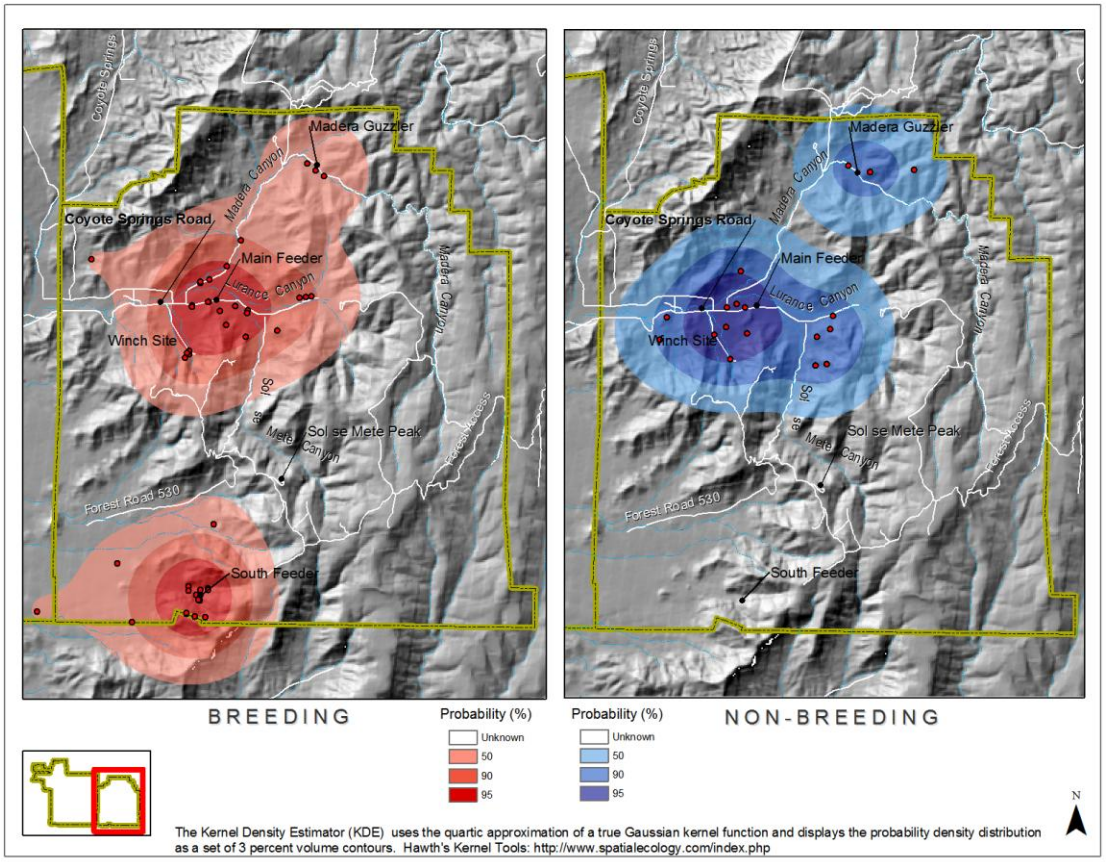

Figure 4. Fixed kernel density map, breeding and non-breeding seasons.

Home Ranges

Summer

In the north, Pinyon Jays frequented the north facing slopes of the Winch Site and Sol se Mete Canyon. Birds could readily be found in this relatively small area almost daily in July and August. Nesting was never confirmed because they had apparently finished breeding by the time our surveys began, but this area may be a traditional colony site. We regularly heard and saw begging from juvenile birds in this area and we banded 10 hatch-year birds at our feeder in August, between Winch Site and Sol Semete Canyon (Figure 4). The breeding season home range of this flock centered around the slopes of the Winch Site and Sol Se Mete, extending north to the caching area in juniper habitat inside the Live Firing Range. Another, smaller center of activity occurred on a hill to the northeast of the Burn Site (Figure 4).

Another flock of Pinyon Jays was readily found near the south MAPS station, near the southern boundary of KAFB. The birds were present at this location from May through late August (Figure 4). Pinyon Jays frequented a very steep, northwest-facing canyon south of the Receiver Site. Jays were regularly heard near the top of the canyon, in dense pinyon-juniper woodland. Rarely the jays would come down from the slopes into the

sparse juniper grassland, presumably to forage, cache, or retrieve caches. Several observers repeatedly heard and/or saw juveniles begging at this site, which suggests that this was another breeding colony location.

The MCP polygon including breeding and non-breeding areas north and south and everything in between covers 4819.46 ha in area. The north breeding MCP covers 1719.23 ha and the north non-breeding MCP covers 969.37 ha. The north MCP of both breeding and non-breeding, which includes considerable overlap of the two seasonal MCPs, covers 2101.15 ha. The breeding MCP in the south covers 348.73 ha.

Winter

Jays left the south area by the end of August. Although at least one radio was transmitting through 28 December, we never detected a radio signal or found the flock in the south area after August. Thus, the winter home range map is confined to the north area near the Winch Site and Sol se Mete Canyon (Figure 5).

Caching Areas

Only two activity polygons were clearly in caching areas. One, at the top of a hill near the Madera Canyon guzzler, was in a burned area. We observed birds in this area in early spring of 2009 apparently retrieving caches. These birds may have been retrieving seeds collected from the nearby woodland and cached in late 2008. We found several pinyon seedlings near the top of this hill, which was relatively free of trees and shrubs. The presence of seedlings on top of a hill suggests that avian seed dispersers cached there in previous years.

The main caching area, used in both breeding and non-breeding seasons, was an 18.2 ha area covered in juniper. This caching area was on a south-facing slope within the Live Firing Range. We frequently observed jays walking on the ground in this area, apparently caching and/or retrieving caches. Birds probably cached seeds from the feeder there, but they might have also had caches there from the cone crop in the fall of 2008. We observed jays in this area on nine occasions, once in August 2009 and eight times between September and December 2009. We noted that in January and February when deep snow was present on north-facing slopes, the caching area was free of snow. Soon after we put up the feeder in February 2010 jays began frequenting this caching area again.

Habitat Use

Polygons of Pinyon Jay activity covered 238.06 ha (Table 1, Figure 5). We classified the vegetation used by the jays into five main types. Pinyon is dense, high-elevation pinyon woodland. Pinyon-juniper is a woodland mixture of pinyon and juniper dominated by pinyon. Juniper-pinyon is also mixed woodland, dominated by juniper. Juniper is juniper with various grasses and shrubs. Burn refers to areas previously burned and now mainly covered in grass, with some standing pinyon and juniper.

The Pinyon Jays used all five habitat types in both breeding and non-breeding seasons. They were found in the pinyon-dominated vegetation types more often in the breeding

season than in the non-breeding season: Pinyon 16.96% vs. 9.42%; Pinyon-juniper 25.9% vs. 20.08%, respectively. Conversely, they were found in juniper-dominated types less often in the breeding than the non-breeding season: Juniper 32.44% vs. 34.26%; Juniper-pinyon 22.18% vs. 31.00%, respectively (Table 1).

	Breeding (ha)	%	Non-Breeding (ha)	%	Both Seasons (ha)	%	All (ha)	%
Burn	3.32	0.03	4.61	0.05			7.93	0.03
Juniper	42.86	0.32	30.06	0.34	18.20	1.00	91.12	0.38
Juniper-Pinyon	29.30	0.22	27.20	0.31			56.50	0.24
Pinyon	22.41	0.17	8.26	0.09			30.67	0.13
Pinyon-Juniper	34.22	0.26	17.62	0.20			51.84	0.22
TOTAL	132.11		87.76		18.20		238.06	

Table 1. Habitat types used by Pinyon Jays, breeding, non-breeding, and both seasons.

Discussion

Home Ranges

Pinyon Jay home ranges reported in the literature vary widely: 1600 ha (Balda 2002), 2300 ha (Marzluff and Balda 1992), 2890 ha (Ligon 1971), and 6400 ha (Balda 2002). Both the year-round range we found for the north flock (2101.15 ha) and the entire range including both breeding areas (4819.46 ha) fall within these ranges. Radio telemetry enabled us to collect a substantial number of point locations for the flock over four months, including points we would not have collected without the radios. However, on several occasions we were unable to locate any jays, even when we knew transmitters were functional. Our inability to find jays at these times could be due to the birds' mobility, their large home range, a tendency to wander out of their primary range, or the limitations of telemetry equipment in rough terrain. The areas of home ranges we computed in the GIS therefore may be conservative, particularly in winter when they are known to wander widely (Marzluff and Balda 1992). As we continue to band and radio tag more birds, we may be able to better assess home range boundaries and potential sources of error.

Breeding

We observed a substantial cone crop in the fall of 2008 before this study began and expected the jays to breed successfully in response to this food source. We spent the spring of 2009 locating Pinyon Jay flocks and mapping their home ranges. Nesting was complete before we found potential breeding colony sites, and we did not find any nests in 2009. The high proportion of hatch-year birds (10 of 18 or 56% of trapped birds) bears out our prediction of a successful breeding event in early 2009.

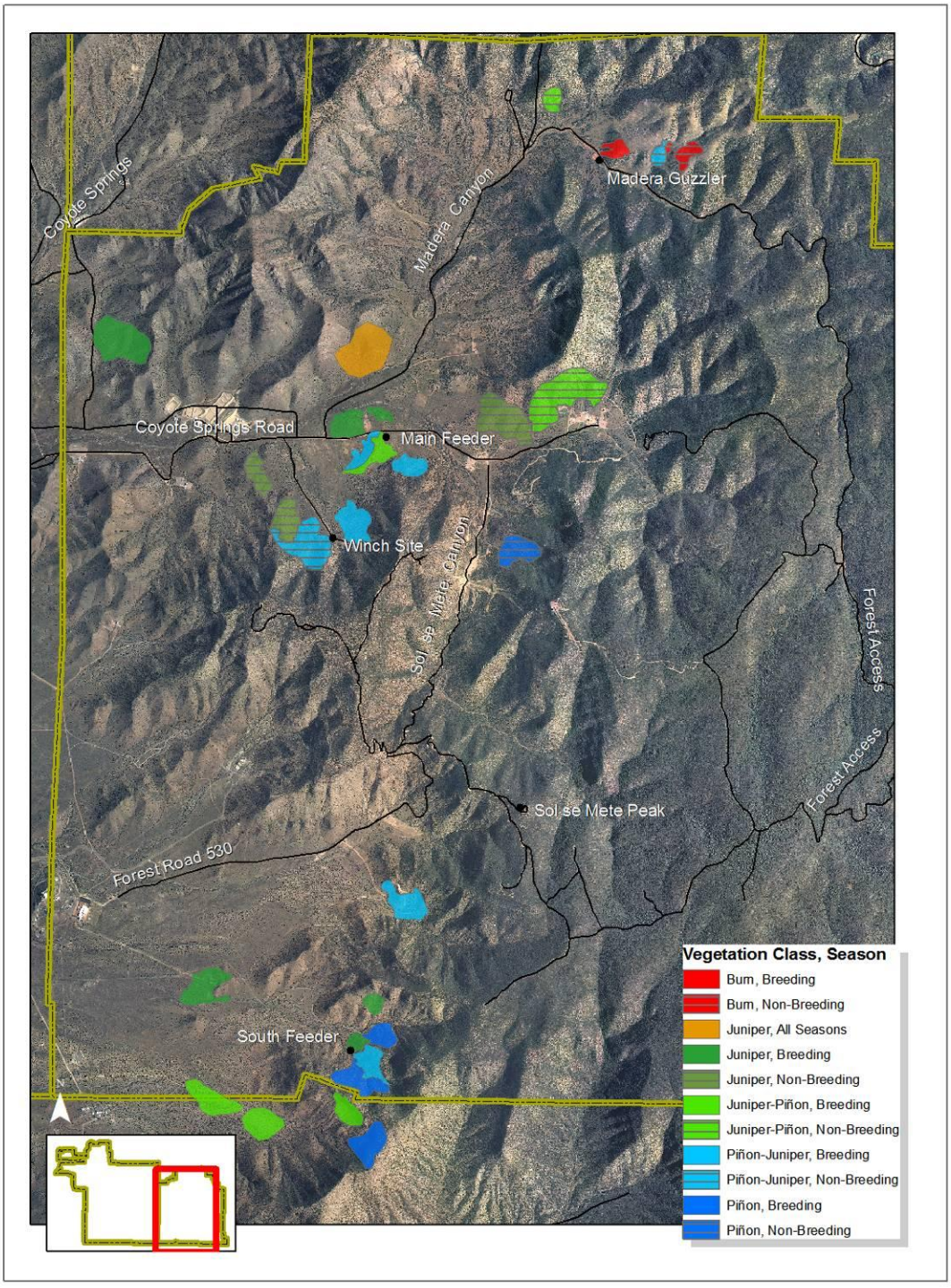

Figure 5. Vegetation types used by Pinyon Jays and season of use at KAFB.

In the first season of this project we have found Pinyon Jays in two main areas. The south area is likely a traditional nesting colony for some birds. Birds were only there during the breeding season, and we heard fledglings begging in late May. Pinyon Jays tend to be faithful to breeding colony sites, and we expect them to return to this area to breed. We will survey this area for breeding birds and nests in early spring of 2010.

Because jays have been faithful to the Madera Canyon-Winch-Burn area, we also expect that some birds may breed within this large home range. We will continue surveying this area for birds through the early spring and begin watching for courtship and nesting behavior in February and March. We activated a feeder in these two areas in early February and expect to trap jays and attach transmitters to several by early March, to help us find the breeding colony or colonies.

Caching

We have located two caching areas, both within the north area of the breeding home range. Both are areas with sparse vegetation, which is consistent with other descriptions of Pinyon Jay caching sites (Ligon 1978, Marzluff and Balda 1992, Balda 2002). The main site is located on south-facing slopes. This area was free of snow in January and February, when north-facing slopes and tree-covered areas were covered in snow up to a meter deep. Caching in open, south-facing areas allows the jays to find caches when deep snow is present elsewhere in the study area. Marzluff and Balda (1992) also report that caching sites are often snow-free in winter.

Wintering

Pinyon jay flocks move widely in winter. When we visited the north home range in December, January, and February, the birds were often nowhere to be seen. Out of seven visits to the study area during these months, we detected jays only twice. Although the difficulty in finding the birds in winter might suggest that they leave the area entirely, we believe the KAFB flock remains in the area. A large flock appeared at the feeder within six days of the feeder being set up in February, which indicates that they were not far from their home range.

Relationship of Pinyon Jays and Pinyon Pines

We detected Pinyon Jays at KAFB almost exclusively in pinyon-juniper woodland, juniper woodland, or juniper grassland habitats. We found them most often in pinyon-dominated vegetation types, particularly in the breeding season.

KAFB Pinyon Jays are providing the ecosystem services for which they are evolved. In late 2008 they apparently cached pinyon seeds from a mast crop and retrieved a portion of those caches in 2009. They also used the same caching area to cache seeds we supplied at the feeder. Notably, one of their caching sites is in a burned area at the top of a hill outside the possibility of seed rain. This demonstrates the importance of Pinyon Jays to the re-establishment of pinyon trees destroyed by fire at KAFB. They would likely provide this same service in areas within their home range where pinyon trees were destroyed by insects or drought.

At KAFB, the pinyon woodlands have not been impacted by drought and bark beetles as severely as some other areas of New Mexico. However, if the droughts predicted for the Southwest under climate change materialize, health and productivity of pinyon-juniper woodlands will suffer, and Pinyon Jay populations all over the Southwest will likely continue to decline. The importance of healthy Pinyon Jay populations to maintenance of pinyon-juniper woodlands at KAFB and elsewhere will likely only increase with climate change.

2010 Goals

In 2010 we plan to collect monitoring data that will contribute to understanding the relationship between tree size, tree health, stand structure, and cone production in pinyon-juniper habitats used by Pinyon Jays. Tasks in 2010 will be as follows:

1. survey both areas jays were using in 2009, to refine the home range maps,
2. find nesting colonies,
3. establish permanent monitoring transects within flock home ranges to determine pinyon pine stand structure and monitor pinyon pine health and cone production, and
4. Using GIS, refine maps of foraging and caching areas, if pinyon trees produce a cone crop.

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