Relationship of Pinyon Jays and Pinyon Pines at

North Oscura Peak, White Sands Missile Range

2006 Draft Report

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NHNM Publication No. 07-GTR-311

14 February 2007

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Introduction

After two-and-a-half years of studying the pinyon-juniper woodland and pinyon jays at North Oscura Peak (NOP), perhaps our strongest impression is that of change. Vigor ranks of the pinyon trees change between years, cone crops vary from year to year, trees die. Pinyon jays are present some times of the year and absent others; we do not know where they go when they leave. Nesting varies temporally and spatially; nesting effort and success are inconstant.

And yet, some changes are at least sometimes predictable. The pinyon jays have returned to the top of NOP in the spring for three years running. They bred in 2005 and 2006. In 2004 we did not observe breeding activity but suspect that they bred that year as well. The flock has left the top of NOP during the winter for three years, and we have no evidence that they remain in their breeding home range. Where they go and how they survive the winter is a mystery. Although we have not observed a large mast crop, at least some trees have produced seeds in the fall of all three years. For three years, where there were ripening pinyon cones, there we found the NOP flock.

Thus we see a classic keystone mutualism in operation at NOP. The trees provide the birds with seeds, albeit so far not enough for them to survive an entire winter at NOP; perhaps enough to assist breeding the following spring. The birds perform without fail their duty for the trees. Near every pinyon seed is cached before the flock departs for the winter.

Aside from documenting the functional relationship between the trees and the jays, our interest is in the health and viability of the system that rests upon this mutualism. Is the stand structure of the woods productive enough to sustain its long-distance seed disperser? Are the jays numerous and reliably-present enough to provide adequate ecosystem services for the woodland? If not, what are the signs of failure on the part of either? And finally, can management of the woodlands improve upon the natural dynamics? Answers to these basic questions may not be attainable any time soon. Our aim in continuing this study is to at least provide foundation knowledge to inform management decisions.

Methods

Tree Data

We collected vegetation data on 26, 29, and 30 July 2006, on six existing transects (Johnson and Smith 2006). Transects contained 11 (one transect), 12 (four transects) or 13 (one transects) points each. Using the point-centered quarter method, we collected data from the nearest tree over 1 m tall, in each quarter at each point on each transect, 288 trees in all. Points were approximately 50 m apart and situated at the same GPS coordinates used for each point in 2004 and 2005. Due to GPS inaccuracy, some points were not exactly at the same spot as in previous years, but we recognized many as being in the same place. Tree selection likewise varied among years. In 2006, we flagged the northernmost tree at each point, to facilitate collecting data on the same trees in subsequent years.

For each tree, we recorded any symptoms of disease (needle loss or discoloration, needle scale, popcorn sap, etc.). Vigor was assigned a ranking from 1-5 (1-dead/defoliated, 2- majority of needles lost or brown, 3- half or more of needles present and green, 4- few needles brown or lost, 5- vigorous). Standing approximately 5m from the uphill side of the tree, we counted the number of cones within a binocular field, using the same binoculars for all counts. Counts were made for three fields in each tree, from areas of the tree containing the most cones. We averaged the three field counts for each tree to produce an index of cone production. We performed statistical analyses using Minitab 13 and plotted pinyon jay and cone locations using ArcGIS.

Capturing and Banding

We set up two standard glass and wood seed feeders (Figure 1) on 8 August 2006, along the road between the barracks and the top of NOP. With help from Stan Sessions, feeders were filled with pinyon seeds about three times each week until we removed them on 30 October 2006.

On 1 and 8 September, we captured jays in a modified Australian crow trap (Figure 1) set near one of the feeders and baited with pinyon seed. We removed birds from the trap, placed them in closed cardboard boxes, and took them to a truck parked near the trap for processing. We took the following data on each bird: age, sex, weight, tarsus, wing, and culmen. Each bird was banded with a US Fish and Wildlife Service numbered aluminum band and a unique combination of three color bands. Although it is not possible to unequivocally determine the sex of HY (hatch-year) pinyon jays (Pyle 1997), for our information we attempted to assign sex using a combination of weight, tarsus, and culmen, as we have done for adult and SY (second-year) pinyon jays. (Because they were not definite, sexes of HY birds were not reported to the Bird Banding Lab.) Birds were released within site of the trap after processing.

We visited the study site once every week or two from August through October, noted flock size, and took GPS coordinates of harvesting sites. We attempted to find caching sites. After we were unable to find jays at NOP, we stopped visiting the study site for the winter.

Figure 1. Pinyon feeder and modified Australian crow trap used to capture pinyon jays in 2006.

Results

Pinyon Jays

Population Monitoring

We now have pinyon jay count data for NOP from August 2004 through October 2006. The data include observations from Stan Sessions and Horacio Perez, who were working at NOP for most of that period. Numbers appear to peak in August, drop to zero when the flock leaves for the winter, rise when breeding adults return in the spring, and peak again in late summer after nesting and immigration from other flocks (Figure 2). Re-sightings of color banded birds allow for flock identification.

The flock apparently left the area on 21 September 2004, 20 October 2005, and between 6 and 26 October 2006. Because we did not visit NOP in November 2006, December

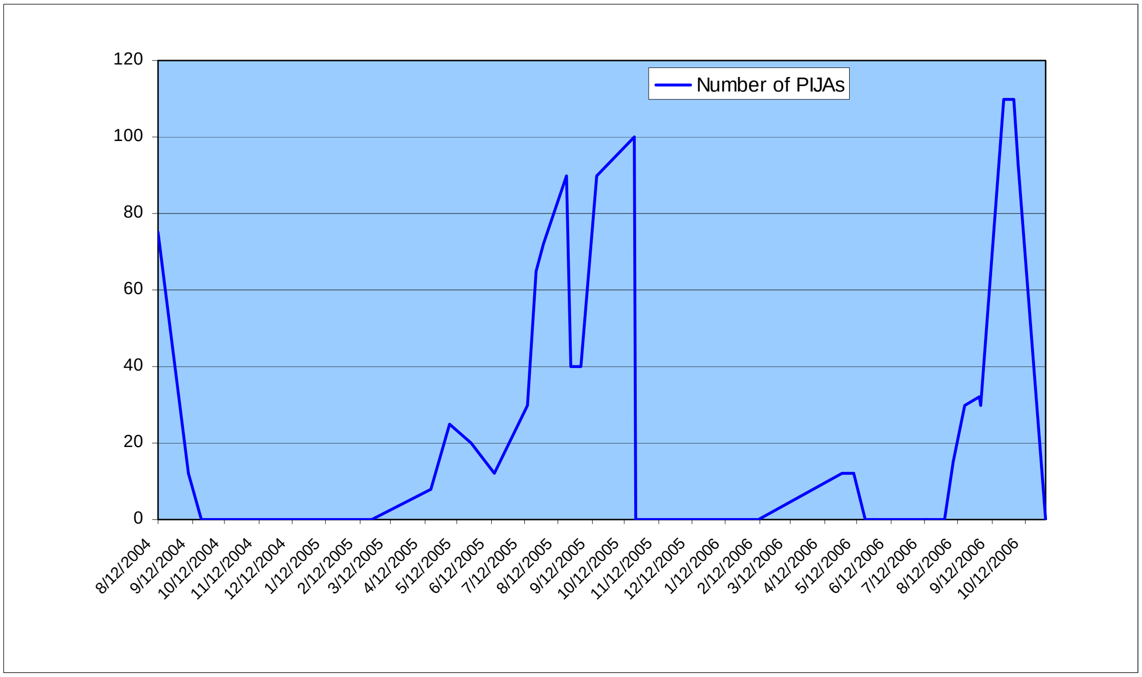

Figure 2. Pinyon jay counts at NOP study site, 2004-2006.

2006, or January 2007, it is possible that the birds were in the area during the winter of 2006-2007; however, they were not present on 30 October, and Horacio Perez reported not seeing the flock this winter.

They were first observed on 18 April 2005 and 28 April 2006. However, we believe they arrived in March 2006 to nest because we detected one non-flying fledgling on 8 May 2006. In 2006, the flock apparently left the area between 8 and 19 May and was not observed again until 7 August. We found no pinyon jays on 19 May, 26 May, 14 July, 26 July, 29 July, or 30 July 2006. NOP workers were present during that time and did not report seeing pinyon jays. Stan Sessions observed the birds in the area again on 7 August.

The flock apparently had a limited breeding event in 2006. We expected the birds to breed in May as in 2005 and, due to limited funding, we did not visit the site between 10 February and 28 April 2006. On 8 May the jays appeared to be feeding young, and we found one non-flying fledgling. Thus, we believe the birds returned in March to breed, finished breeding by early May, and left the area in early to mid-May. Further evidence that the flock bred is provided by our banding data. Six of 19 birds we captured were HY birds (see 2006 Banding, below). They were found in the same flock as previously-banded adult members of the NOP flock.

The flock nested at different sites in 2005 and 2006 (Figure 3). The 2006 site was south of and not overlapping the 2005 site. Both sites are at the top of NOP and at the highest elevation within in the flock's home range.

2006 Banding

We trapped and banded 14 pinyon jays on 1 September 2006 and five more on 8 September, a total of 19. Six (32%) of the 19 birds captured in 2006 were HY birds; the rest were AHY (after hatch year, including second year or after second year) birds. We did not attach radio transmitters to any birds in 2006, due to funding limitations. Three birds were recaptures from 2005. One of the three recaptured birds had a transmitter in 2005, but the transmitter had fallen off, as anticipated.

Harvesting and Caching

Probably due to the relatively large seed crop in 2006, outside birds apparently joined the NOP flock in August and continued to cache near NOP into October. Although the breeding flock was small, in September and October we counted the largest groups of pinyon jays ever at NOP, at least 110 birds. It is unlikely that we saw all the birds at one time, so actual numbers were probably higher. Birds harvested cones from 18 August until they left the last week of October. The cone crop was especially large on top of NOP near the road and the traditional breeding colony site, which gave us the opportunity to observe the flock harvesting cones on several occasions. We attempted to follow birds to caching locations, but in most cases we were only able to record the general direction they flew to cache. The flock is quite wary and often leaves an area when we arrive; thus, it is surprisingly difficult to obtain exact caching locations.

Based on flight patterns of caching birds and detections of the flock in cone-free areas, we identified probable caching sites in all three years. Birds cached in different areas each year (Figure 3). We hypothesize three areas for 2006. It is possible that the birds using cache site 2006-3 were not from the resident flock. One observer saw two flocks of around 100 birds at two different sites that day, but we cannot know for certain whether she saw two different flocks or one flock that changed caching sites.

Trees

Cone Production

Our tree transects confirm that the cone crop was larger in 2006 than in 2004 and 2005 (Figure 4). An ANOVA comparing the mean number of cones per point in the three years revealed that cone production differed significantly among the three years (Table 1). Multiple comparisons showed that the mean number of cones per point was significantly greater in 2006 (7.073) than in 2005 (1.491) and 2004 (1.203). Cone number in 2004 was not significantly different from that of 2005.

The average number of cones per point was significantly correlated with the average height of trees per point ($r=0.29$, $P=0.011$) and nearly significantly correlated with mean root crown per point ($r=0.23$, $P=0.054$). There was no apparent relationship between tree density on transects and cone production (Table 2).

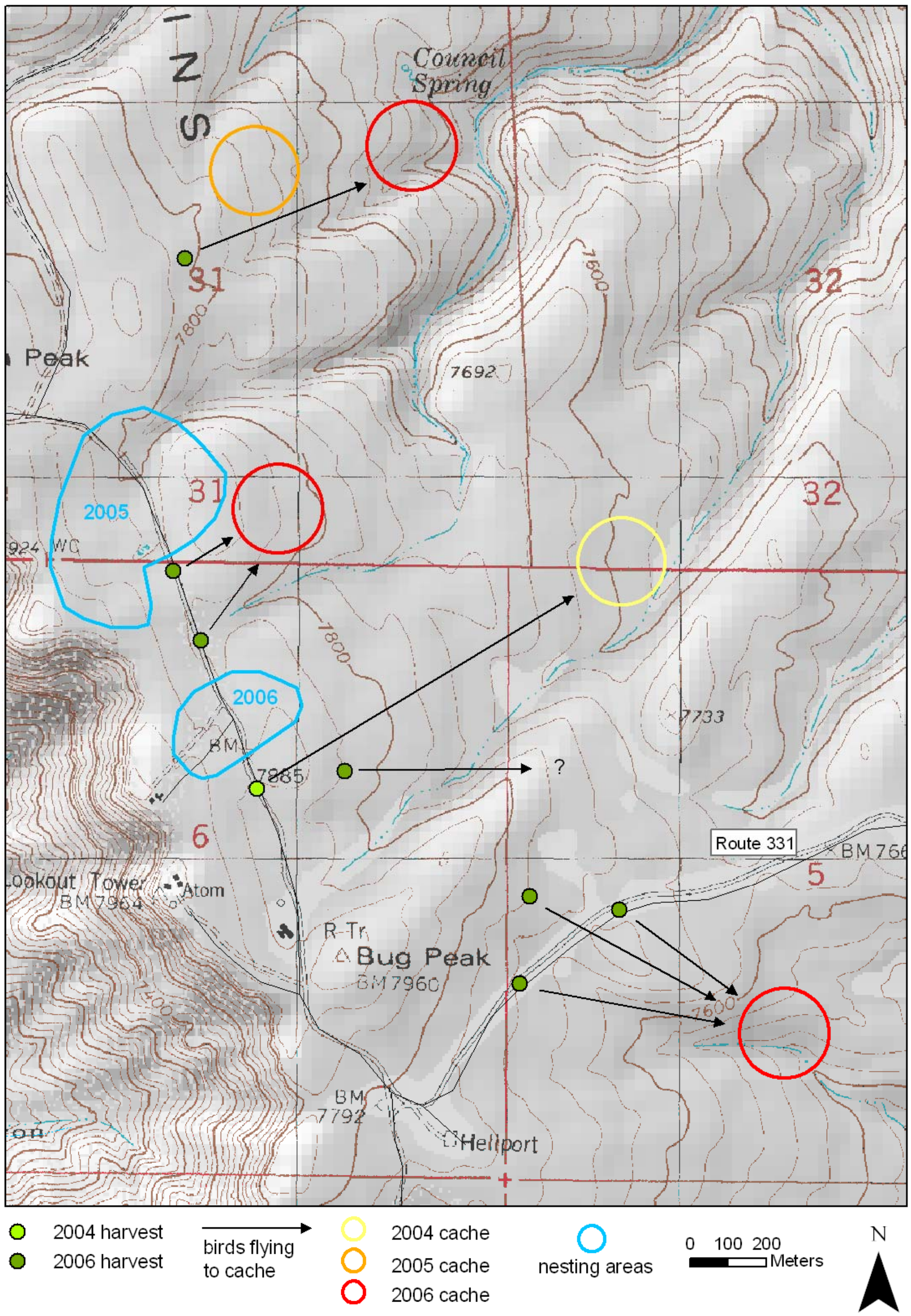

Figure 3. Harvest sites, probable cache areas, and nesting sites at NOP, 2004-2006.

Source	DF	SS	MS	F	P
Year	2	1563.3	781.6	31.02	0.000
Error	206	5190.4	25.2		
Total	208	6753.7			
Level	**N**	**Mean**	**StDev**		
2004	62	1.203	2.904		
2005	73	1.491	2.325		
2006	74	7.073	7.663		

Table 1. ANOVA of mean cones per point versus year.

Transect	2004 Tree Density	Mean Cones	Mean Vigor
0	2.38	5.94	3.73
2	2.62	6	3.91
5	3.8	8.17	3.48
7	13.26	3.82	3.76
8	16.72	6.69	3.15
9	14.03	11.07	3.2

Table 2. Relationship of mean tree density to mean cones and mean vigor per transect, 2006.

Source	DF	SS	MS	F	P
Year	2	18.836	9.418	25.31	0.000
Error	206	76.655	0.372		
Total	208	95.491			
Level	**N**	**Mean**	**StDev**		
2004	62	4.284	0.698		
2005	73	3.796	0.596		
2006	74	3.543	0.542		

Table 3. ANOVA of mean vigor per point versus year.

Vigor

An ANOVA comparing the average vigor per point among years was also significant (Table 3). In multiple comparisons, mean 2004 vigor (4.284) was significantly higher than 2005 vigor (3.796), which was in turn significantly higher than 2006 vigor (3.543).

Average vigor per point was highly correlated among years (2004-2005: $r=0.612$; 2004-2006: $r=0.630$; 2005-2006: $r=0.618$; all $P<0.001$). The number of dead trees on all transects was seven in 2004, 10 in 2005, and 13 in 2006. Allowing for the lower number of points in 2004 (transect 9 was added in 2005) gives 8.26 for an adjusted number of dead trees in 2004. For five of the six transects, vigor in 2006 was apparently related to tree density on the transect - transects with more densely packed trees had lower vigor (Table 2). The exception was transect 7, which was dense but had relatively high vigor. The other two dense transects had the lowest vigor rankings of all six transects.

Figure 4. Pinyon tree with abundant ripe cones, NOP study site, 2006.

Discussion

Pinyon Jays

Population Monitoring

After about 2.5 years of monitoring the NOP pinyon jay flock, a pattern of residency is becoming apparent. Birds have been present in May 2004, 2005, and 2006. In 2004 and 2005, the flock stayed all summer and left the area in the fall, returning the next spring. In 2006, the flock also left in late May, returned in August to harvest pinyon seeds, and left for the winter. Flock size fluctuates markedly through the year, with peaks in

September and October, just before the flock leaves for the winter, and lows in the spring before breeding. The low spring counts can be attributed mainly to over-winter mortality and dispersal. In addition, spring counts probably detect only a fraction of the birds present, because females are incubating and males make foraging trips in small groups.

Six (32%) of the 19 birds captured in 2006 were HY birds, compared with 14 of 16 (87.5%) captured in 2005. The relatively small proportion of HY birds in 2006 suggests that the breeding event this year was relatively small. In 2005, based on the numbers and locations of males flying in and out of the nesting colony and the numbers of fledglings observed, we estimated that about 18 pairs of pinyon jays bred and produced about two fledglings per pair (Johnson and Smith 2006). We made fewer observations of breeding birds in 2006, but we estimated that only 12 pairs were present on 8 May. Some of these were apparently nesting, but we do not have an accurate count of breeding birds for 2006.

If as many as 12 pairs nested in 2006, flock size at the end of May should have been no larger than 50, but we counted over 100 birds when they birds returned in late September and early October. We suggest that birds from one or more nearby flocks joined the NOP flock to exploit the relatively abundant cones at NOP. We have observed pinyon jays at Red Rio Bombing Range, Hardin Ranch (Johnson and Smith 2006), and the US 380 gate, any of which would be an easy flight for a pinyon jay. It is somewhat surprising that the NOP flock leaves its cached seeds during the winter. Perhaps the number of seeds has so far been too small to sustain the flock over the entire winter. Given that more seeds were cached in 2006, we expect the flock to return and breed early in 2007.

We have not banded enough birds to allow an accurate estimate of survivorship. In 2006 we captured three individuals banded in 2005 and sighted at least two more, counting conservatively when all three color bands were not visible. These data indicate that we observed at least 36% of the 14 birds banded in 2005. Some individuals could have dispersed, and we likely missed detecting others that were present in 2006; thus, 2005-2006 winter mortality must have been at most 63% and could have been considerably lower. This estimate is within the range of juvenile survivorship (mean=41.3%, range 23.2%-65.9%) reported over an 11-year period (Marzluff and Balda 1992). It is encouraging that one of the five birds fitted with radios in 2005 was present at the study site in 2006 and that the radio had fallen off, as we intended.

Caching

When pinyon jays are leaving a harvesting area to cache, their throats are visibly distended and they fly with their heads tilted back. These cues, along with timing of in- and out-flights, indicate the timing and direction of caching trips. However, although it is clear when birds are caching, it is not so easy to follow them to caching sites and observe caching. Pinyon jays are strong fliers and in a minute can traverse canyons that would require hours by a person on foot. When we do come upon caching birds, they usually stop caching, alarm call, and leave the area. This wariness has no doubt been exacerbated by capturing and banding. We have identified hypothetical cache sites, based on finding the flock in an area during the caching period and the direction they repeatedly fly while caching; however, these sites may be inexact. Our goal is to continue trying to understand caching behavior and characterize caching sites. We hope for a large mast crop to facilitate further study of caching behavior.

Trees

Cone Production

In 2005, cone production was influenced primarily by tree density and tree maturity, as indicated by root crown diameter and, to a lesser extent, by tree height. In 2006, tree height and cone production were positively correlated. The correlation between root crown diameter and cone production was positive and nearly significant, suggesting that mature trees again produced more cones in 2006. This result is consistent with literature (Gillihan 2006).

In contrast to 2005 results, in 2006 there was no apparent pattern of cone production with tree density on transects. We suggest that in a year of poor cone production, only the least crowded, most stressed trees can produce cones, whereas under better conditions, trees in denser stands can also produce cones.

Mature pinyon trees are clearly important for pinyon jay survival and reproduction, and any management actions should conserve these most productive trees. In addition, data from 2005 suggest that, at NOP in poor pinyon years, pinyon trees at densities above 13 trees/m^2 are likely to produce fewer seeds than trees at less than 5 trees/m^2. However, 2006 data show that trees in denser stands can also be productive in better years. Over time, mast-year production by numerous trees in dense stands should be weighed against more frequent, smaller crops from fewer trees. Pinyon jay life history studies suggest that the birds are adapted to occasional, huge mast crops rather than more frequent, smaller crops (Ligon 1978, Marzluff and Balda 1992).

Vigor

Vigor was higher in 2004 than in 2005 and higher in 2005 than in 2006. We attempted to reduce subjectivity by having the same person rank vigor each year and reviewing our vigor definitions several times while ranking vigor. However, vigor ranks are nevertheless subjective and could vary systematically from year to year. Per point vigor scores were highly correlated among years, which also might suggest consistent changes in our rankings among years. On our ranking scale, a "1" signifies a dead tree. The rank of 1 is therefore much less subjective than other ranks- the tree appears dead. Comparisons among years show the fewest dead trees in 2004, more in 2005, and the highest number in 2006. This pattern is consistent with decreased vigor scores over the three years and gives us more confidence in the consistency of our vigor ranks.

In 2004 and 2005, trees on dense transects were less vigorous than trees on sparse transects. Vigor measures were lower in 2006 than in either 2004 or 2005, but vigor was still generally related to tree density, except for transect 7, which was the sparsest of the three dense transects and also had high vigor scores. Keeping in mind the potential for observer-based variation in vigor ranks, data from all three years suggest that tree health may be better on sparser transects. Again, our data apply only under conditions observed between 2004 and 2006 and assuming high densities are defined as above 13 trees/m^2 and low densities as below 4 trees/m^2.

Viability of NOP Pinyon Jays and Pinyon-Juniper Woodland

The NOP flock has its home range on the southern edge of the pinyon jay distribution (Marzluff and Balda 1992). In addition, the pinyon-juniper woodlands on the Oscuras comprise a higher-elevation habitat island surrounded by lower-elevation grasslands and shrublands. Juniper savannah occurs in lower elevations to the east, desert grasslands below the cliffs to the west, and the desert grasslands of the Tularosa Valley to the south. The area of the Oscuras is small relative to nearby sky island ranges where pinyon-juniper occurs (e.g., Sacramento, Magdalena, and San Mateo Mts.). Due to their small size, isolation, and location at the edge of the pinyon jay range, the Oscuras would not be expected to harbor large numbers of pinyon jays. For the last two years, the breeding population at NOP has been quite small, on the order of 12-20 breeding pairs. The small size of the NOP flock makes it vulnerable to extirpation, particularly given that it tends to leave NOP each year to winter elsewhere. This suggests that conditions are marginal at NOP and the woodlands have not typically produced enough pinyon to sustain even a small flock for an entire winter. Wandering in search of food may be more risky than staying in place, especially with plentiful caches. Pinyon jay mortality has been shown to be lower in winter than during the breeding season (Marzluff and Balda 1992), but the flock in that study does not typically wander each winter. In combination, mortality, poor reproduction in the absence of large cone crops, and dispersal by young birds probably act to limit the size of the NOP flock.

Although the breeding flock is small, the area apparently attracts pinyon jays from nearby areas when cones are present. In both 2005 and 2006, the number of birds on NOP swelled to 100 or more birds during September and October. By late October, the cones had been harvested and the birds left the area. As long as birds come from surrounding areas, there may be enough jays to disperse seeds from producing trees. However, the most reliable source of seed dispersers will always be resident birds. The loss of the small NOP flock could not be good for the persistence of the woodland.

Dead pinyon trees are common on the road to our study site, but at the nesting colony, the numbers of dead trees are limited to small patches. Pinyon mortality that has affected other areas of New Mexico has so far been confined to lower elevations of the Oscuras and small patches on top. At the 2005 nesting site, several trees have died. We have also observed patches of dead trees in doghair stands on dry, east- and south-facing slopes (see also 2004 photos of Jim Peak in Johnson and Smith 2006). A wet summer of 2006 and a wet 2006-20007 winter may have contributed to forestall pinyon mortality at NOP for the time being.

The patchily-distributed pinyon mortality on NOP appears to constitute a natural, self-thinning process. Historical fire frequencies in the Oscuras were probably on the order of 30-100 years, with 12% turnover of the woodlands per century as a result of stand-replacing fires (Muldavin et al. 2003). Given this relatively long fire interval, natural mortality induced by drought, insects, or pathogens might significantly influence stand structure. Caching behavior of pinyon jays is also an important factor. In planning for woodland management, the desire for productive stand structures should be considered in light of the woodland's dynamic nature and inherent tendencies toward self-thinning.

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