Tassel-eared squirrel foraging patterns and projected effects of ecological restoration treatments at Mt. Trumbull, Arizona

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ABSTRACT

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Tassel-eared squirrels (*Sciurus aberti*) are an important component of southwestern ponderosa pine (*Pinus ponderosa*) ecosystems. Tassel-eared squirrel habitat has been altered by the interruption of the natural fire regime, which maintained low tree densities and diverse stand structures prior to Euro-American settlement. Although ecological restoration efforts seeking to restore presettlement conditions through mechanical thinning and prescribed fire are currently underway in many areas of the Southwest, the effects of restoration treatments on tassel-eared squirrels are unknown. We selected three experimental blocks at Mt. Trumbull, Arizona, to represent a continuum of stand types prior to ecological restoration. The locations of all tassel-eared squirrel feed trees were mapped in a total of 27 hectares. Data collected on each feed tree included tree status (leave or take), dbh, number of clipped needle clusters, number of peeled cone cores, number of fungi digs, relative abundance of old clipped clusters, tree damage, and the presettlement status of the tree. We determined the characteristics and spatial pattern of feed trees under current conditions at Mt. Trumbull and predicted changes due to restoration treatments using the marked status of trees. The current prescription resulted in low percentages of the trees

currently used for foraging on inner bark being marked for retention in the three treatment units surveyed. Trees selected by squirrels for foraging on ovulate cones were retained at higher percentages. More random spatial distribution and larger average sizes of retained feed trees are predicted. We predict corresponding reductions in squirrel populations, larger home range sizes, and increased seasonal movements. We developed two possible modifications of the current prescription to mitigate impacts on squirrel foraging habitat. The individual tree approach is predicted to significantly reduce impacts on forage availability while having little impact on structural objectives of current prescriptions. It is uncertain, however, whether the available forage will be fully utilized. The patch approach is predicted to have greater benefits for squirrels and is considered a more reliable approach to mitigating impacts. Implementing the patch approach, however, would require fundamental changes in current objectives and marking guidelines--a cost which may outweigh the anticipated benefits.

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PREFACE

This thesis is presented in journal format. Chapters two and three are intended to stand alone as manuscripts which have been prepared for submission to the journal Restoration Ecology. This format results in minor redundancy between chapters. Chapter one is provided to give additional background through a comprehensive literature review, and also serves as a cohesive overview of the issues addressed by the research presented in this thesis. All literature citations have been consolidated and placed in a single literature cited section at the end of the thesis. Appendices present additional data and methodological details.

CHAPTER 1

INTRODUCTION

The tassel-eared squirrel and its habitat

Tassel-eared squirrels (*Sciurus aberti*) are an important component in southwestern ponderosa pine (*Pinus ponderosa*) ecosystems. These squirrels disperse the spores of hypogeous fungi (Maser et al. 1978), increase nutrient cycling through their feeding habits (Skinner and Klemmedson 1978; Allred and Gaud 1994a), may exert a selective pressure on ponderosa pine genetics (Soderquest 1987; Hall 1981; Linhart 1989; Linhart et al. 1989; Snyder 1993), and are an important prey species for northern goshawks (*Accipiter gentilis atricapillus*) and other predators in these ecosystems (Farentinos 1972; Hall 1981; Reynolds et al. 1992).

The ponderosa pine ecosystems which this species inhabits north of the United States-Mexico border have changed dramatically within approximately the last 130 years, resulting in atypical habitat conditions when viewed from an evolutionary perspective. Prior to Euro-American settlement, southwestern ponderosa pine ecosystems were characterized by a frequent, low-intensity fire regime which kept the tree densities very low (Cooper 1960). Trees occurred in a clumped arrangement, typically surrounded by open bunchgrass communities. When Euro-Americans began to settle in southwestern ponderosa pine ecosystems in the early 1870's the natural fire regime was disrupted, resulting in widespread alterations of ecosystem structure and function. Fire exclusion was initiated primarily due to livestock grazing which reduced fine fuels, and was later perpetuated through active fire suppression efforts. Today the forests are much denser, often with continuous canopy cover and smaller average tree diameters (Covington and Moore 1994a). It is not known how these postsettlement habitat changes may have altered the habitat relationships of the tassel-eared squirrel in ponderosa pine ecosystems. Covington and Moore (1994b) postulated that postsettlement changes in forest structure probably favor closed-forest species, such as tassel-eared squirrels and porcupine, to the detriment of open-habitat species, such as pronghorn and grasshoppers. Hall (1981), in contrast, thought that fire exclusion may lower habitat quality for tassel-eared squirrels. Hall (1981) suggested that the evolutionary habitat of squirrels (open forests) would probably be more favorable habitat than today's altered forests. A clear explanation of why such forests would be more favorable is somewhat lacking. Hall (1981) does note, however, the invasion of more shade-tolerant species into the understory of pine forests where fire exclusion has occurred. A shift in species composition could indeed have negative implications for squirrel habitat.

While Ratcliff et al. (1975), Patton (1977), and Ffolliott and Patton (1978) all reported increasing squirrel density with increasing ponderosa pine basal area, Patton (1977, 1984) noted that the basal area should be comprised of uneven-aged groups of trees, including large, over-mature cone producers to provide high quality squirrel habitat. States et al. (1988) also stressed the importance of clumped trees of different sizes which provide different forage and cover resources for squirrels. In many areas stands are becoming increasingly homogenous, with competition from younger trees increasing mortality rates among the larger trees (Covington et al. 1997), possibly due to a competitive advantage in obtaining soil moisture (Oliver and Larson 1996). It is therefore unclear what the future may hold for tassel-eared squirrel habitat in the absence of forest restoration, despite increasing tree densities and basal area.

Ecological restoration

Currently there is a great deal of interest in restoring southwestern ponderosa pine ecosystems to conditions that resemble those thought to have occurred prior to Euro-American settlement (Covington et al. 1997). Restoration treatments, which typically include a combination of mechanical thinning and prescribed fire, provide an opportunity to compare how tassel-eared squirrels use two distinctly different stand structural conditions (i.e., habitats). Pre-treatment structures represent current (post-settlement) habitat conditions, while post-treatment (restored) structures are designed to develop habitat conditions which likely existed for thousands of years prior to Euro-American settlement.

Feed trees

Forage availability has been shown to be a potentially limiting factor in sciurid populations (e.g., Sullivan et al. 1983). Tassel-eared squirrels are selective herbivores, confining most of their foraging to particular "feed trees," and selective herbivores may be more sensitive to reductions in forage availability than less specialized species. (e.g., Johns 1997). Feed trees have been shown to be chemically distinct from non-feed trees by some researchers (Farentinos et al. 1981; Zhang and States 1991; Snyder 1992), and are important as a primary source of forage during winter and other periods when more desirable foods are unavailable (Goldman 1928; Keith 1965; Stephenson 1975; Hall 1981; Allred et al. 1994). This importance is accentuated by the lack of food caching by these squirrels (Golightly and Ohmart 1978). It is possible that the availability of sufficient numbers of appropriate feed trees may play an important role in tassel-eared squirrel fitness and survival.

There are numerous studies which describe the characteristics of trees selected by squirrels for foraging on inner bark (Goldman 1928; Bailey 1931; Pearson 1950; Keith 1965; Reynolds 1965; Hall 1967; Patton and Green 1970; Farentinos 1972; Stephenson 1974, 1975; Pederson et al. 1976; Ffolliott and Patton 1978; Capretta and Farentinos 1979; Thomas 1979; Capretta et al. 1980; Farentinos et al. 1981; Hall 1981; Pederson and Welch 1985; Soderquist 1987; States et al. 1988; Linhart et al. 1989; Austin 1990; Zhang and States 1991; Snyder 1992, 1993; Allred and Gaud 1994a, 1994b). These studies yielded consensus on some characteristics, such as average size of feed trees, while showing large variation in other characteristics, such as the frequency of feed tree occurrence in forest stands and fidelity to feed trees on an annual basis.

Linhart et al. (1989) reported that feed trees are approximately 10 % of trees in stands along the Front Range in Colorado, while Soderquist (1987) reported up to 68% of ponderosa pine at Mt. Trumbull, AZ, were feed trees, and States et al. (1988)

reported up to 67% of trees in stands near Flagstaff, AZ were used as feed trees. Part of this variation may be explained by annual variation in the squirrels' dependence on inner bark as a food source (Keith 1965; Hall 1981; States et al. 1988; Allred et al. 1994), and on varying definitions for classification as a feed tree. The high estimates of feed tree occurrence given by Soderquist (1987) and States et al. (1988) were based on a very liberal definition for a feed tree--any evidence of use, even a single clip.

Ffolliott and Patton (1978) reported that only 2% of the feed trees examined were used in each of four years examined, although heavily used trees were typically revisited after a 2 or 3 year rest period. States et al. (1988) reported that 23% of feed trees were used in each of three years studied. While noting some annual variation, Larson and Schubert (1970) stated that in their 10 year study "repeated clipping of the same tree year after year was the rule." Soderquist (1987) also reported data which suggest consistent use of moderate to heavily used feed trees (>22 clipped needle clusters) for many consecutive years. Hall (1981) found that feed trees were 3 times more likely to be used in a subsequent year than non-feed trees, and reported a 90% fidelity rate among feed trees for a 3 year period analyzed. Interestingly, Snyder (1993), reported that none of the 90 trees designated as non-feed trees in his study were ever used by squirrels in the four years examined. It appears that while tassel-eared squirrels rotate use of feed trees, they do so within a somewhat limited set of acceptable trees, as suggested by Ffolliott and Patton (1978) and States et al. (1988). Hall (1981) suggested two scales of rotating use, at both the individual tree level and the stand level. Among feed trees, moderately and heavily used trees appear to be used more predictably over the years than lightly used trees (Ffolliott and Patton 1978).

Chemical characteristics of trees selected for foraging on inner bark have been investigated by several researchers (Pederson et al. 1976; Capretta and Farentinos 1979; Thomas 1979; Farentinos et al. 1981; Hall 1981; Pederson and Welch 1985; Zhang and States 1991; Snyder 1992). A chemical basis for selection was suspected prior to actual research to identify such a link (Keith 1965; Hall 1967). Results of chemical analyses have varied by researcher. Perhaps the most thorough and convincing study (Snyder 1992) found that selected trees had lower oleoresin flow rates, lower concentrations of some monoterpenes, lower iron and mercury concentrations, higher sodium concentrations, and higher nonstructural carbohydrate concentrations. Hoffmeister (1986) stated that inner bark becomes less nutritious as trees age, and Keith (1965) also suggested this may be the case; however, no evidence for these claims was provided. States et al. (1988) found that some of the most heavily used feed trees were the older yellow pines on their study sites.

Tassel-eared squirrels also appear to select particular trees for feeding on immature ovulate cones, however, investigations of cone-feeding tree characteristics have been more limited (Larson and Schubert 1970; Pederson et al. 1976; Hall 1981). Immature ponderosa pine cones are an important and nutritious late-summer food source that may have major influences on squirrel fitness and population levels (Hall

1981). I will distinguish between feed trees utilized for foraging on inner bark and ovulate cones by referring to them as twig and cone trees, respectively.

Impact of Restoration

Few studies have investigated the impact of timber harvesting on squirrel populations directly (Patton et al. 1985; Pederson et al. 1987), and none have addressed the impact of restoring presettlement stand structures. As noted earlier, Ratcliff et al. (1975) and Ffolliott and Patton (1978) found that higher squirrel densities are associated with greater basal area of ponderosa pine, and restoration treatments dramatically reduce basal area (Covington et al. 1997). Patton et al. (1985) and Pederson et al. (1987) found decreased squirrel activity following timber harvesting. It is not clear whether the availability of appropriate feed trees may limit squirrel populations, or if other factors such as cover, nesting habitat, or the availability of other food sources, are more important. For example, Patton (1975) and Hall (1981) emphasized the importance of connecting canopies around nest trees, while States (1985) noted the association of fungi heavily utilized by squirrels (Stephenson 1975) with high canopy cover blackjack ponderosa pine stands.

While the impact of tree removal is unknown, it is reasonable to assume that the loss of feed trees may have a significant impact. Even feed trees not removed may become less suitable if isolated or exposed by openings in the canopy. States et al. (1988) suggested that isolated yellow pine received less use than those surrounded by other trees--and such isolation is more likely to occur following restoration treatments.

The nutritional value of inner bark is low (Patton 1974), and extended dependence on this food source is believed to result in reduced fitness and increased mortality (Keith 1965; Stephenson and Brown 1980). Thus, inner bark is at most a subsistence food resource, and when utilized exclusively may be little more than a starvation resource. Since feed trees may be nutritionally superior to non-feed trees (Snyder 1992), the availability of sufficient numbers of appropriate trees could influence squirrel fitness and survival, particularly during years with persistent snow cover (Stephenson and Brown 1980). The role of persistent snow cover in squirrel mortality could be accentuated by reduced interception of snow following restoration treatments. It is therefore possible that a deliberate effort to retain feed trees, particularly twig trees, may be necessary to mitigate impacts on tassel-eared squirrels in restored areas.

Previous studies have indicated that most twig trees are medium-sized trees averaging approximately 30 to 50 cm diameter at breast height or dbh (Patton and Green 1970; Ffolliott and Patton 1978; Pederson et al. 1976; Snyder 1992; Allred and Gaud 1994b). Trees in this size class are frequent in today's forests, and are removed in large numbers by restoration treatments which reduce the unnaturally high frequency of trees which became established in the last century (Pearson 1950; Covington and Moore 1994a). Previous researchers have found that squirrels select against very small trees (less than about 10-20 cm dbh), however, it has not been clearly demonstrated in previous research if all trees above this minimum threshold size are equally suitable, or if there is a disproportionate selection for trees in the 30-50 cm diameter class (Patton and Green 1970; Ffolliott and Patton 1978; Pederson et al. 1976; Snyder 1992, Allred and Gaud 1994b). Ffolliott and Patton (1978) found that the characteristics of feed trees were the same regardless of various prior silvicultural treatments. Hall (1981), however, observed that higher percentages of ponderosa pine were used as feed trees in areas where they were less abundant at higher elevations in the mixed conifer zone, possibly indicating less selectivity when ponderosa pine are scarce.

It is unclear precisely how feed trees are distributed on the landscape, either before or after timber harvesting, although States et al. (1988) and Linhart (1989) reported that feed trees tend to be clumped at small scales (a few trees to a few acres), possibly due to genetic relatedness or local squirrel population levels. Hall (1981) described "hot spots" which occurred in different locations at different times during his 14 year study in Grand Canyon National Park. Ecological restoration treatments seeking to restore the clumped nature of presettlement forests will result in cutting some small clumps of trees while retaining at least portions of other clumps. How the spatial distribution of feed trees and trees selected for retention during restoration treatments correspond has not been investigated. Determining how squirrel foraging patterns change with respect to tree characteristics and spatial distribution following restoration treatments will provide insights into how these treatments will affect squirrel populations, as well as providing clues about how current habitat use may differ from that which occurred prior to human induced changes in ecosystem characteristics.

CHAPTER 2

Projected effects of ecological restoration on tassel-eared squirrel feed tree characteristics and availability

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Abstract

Sciurus aberti (tassel-eared squirrels) are an important component of southwestern *Pinus ponderosa* (ponderosa pine) ecosystems which may be adversely affected by ecological restoration treatments. We characterized two types of feed trees used by this species on experimental blocks of the Mt. Trumbull Ecological Restoration Project in northwestern Arizona. Most trees used by squirrels for foraging on inner bark of twigs (twig trees) were in the 30 to 50 cm diameter class as reported in other studies. Unlike other researchers, however, we discovered that this selection tended to be proportional to the availability of trees 31 cm dbh or greater. Selection for trees in smaller size classes was less than expected based on availability. Trees selected for foraging on immature ovulate cones (cone trees) were larger, with 78% having greater than 40 cm dbh. Because restoration treatments will remove a large proportion of small feed trees, but a smaller proportion of large feed trees, the average diameter for feed trees may increase following restoration. Currently used twig trees will be reduced by treatments by up to 71%, and cone trees by up to 50%. We predicted decreases in squirrel numbers and increases in home range sizes and seasonal movements following treatments.

Key words: *Sciurus aberti kaibabensis, Pinus ponderosa*, forage availability, feed trees, habitat selection

Introduction:

Ecological restoration treatments are increasingly considered in many southwestern *Pinus ponderosa* (ponderosa pine) forests (Covington et al. 1997). Restoration treatments seek to restore ecosystem structure and function which existed prior to disturbance of the natural fire regime by Euro-American settlers, hereafter "presettlement" (Covington et al. 1997). These treatments may have negative impacts on wildlife species such as *Sciurus aberti* (the tassel-eared squirrel). Tassel-eared squirrels are considered vulnerable due to their selection for high ponderosa pine basal area (Ratcliff et al. 1975; Patton 1977; Ffolliott and Patton 1978) and interlocking canopies (Patton 1975, 1977, 1984; Hall 1981; Snyder and Linhart 1994). Restoration treatments dramatically reduce ponderosa pine basal area (e.g., Covington et al. 1997) and create numerous breaks in the canopy cover, simulating conditions which existed in presettlement forests (Covington and Moore 1994a).

Tassel-eared squirrels are a species of particular interest due to their unique dependence on ponderosa pine (Keith 1965), and their ecological roles in dispersing fungal spores (Maser et al. 1978), in nutrient cycling (Skinner and Klemmedson 1978; Allred and Gaud 1994a), as a selective pressure on ponderosa pine genetics (Hall 1981; Soderquist 1987; Linhart 1989; Linhart et al. 1989; Snyder 1993), and as an important link in the food web (Farentinos 1972; Hall 1981; Reynolds et al. 1992).

One important and highly visible element of tassel-eared squirrel habitat is the use of particular "feed trees" for most of their winter foraging on the inner bark of pine twigs, and most of their summer foraging on immature ovulate pine cones (Keith 1965; Stephenson 1975; Hall 1981). The impacts of restoration treatments on these habitat elements may provide important indications of the overall impacts of treatments on squirrel populations. Comparing the characteristics of feed tree use patterns under current conditions with those projected following treatment may also provide insights into changes in squirrel habitat use from pre-settlement times to the present.

Tassel-eared Squirrel Feed Trees

Numerous studies have investigated the characteristics of trees selected by tassel-eared squirrels for foraging on inner bark of pine twigs (e.g., Keith 1965; Patton and Green 1970; Stephenson 1975; Ffolliott and Patton 1978; Hall 1981; States et al. 1988; Snyder 1992), while few have given much attention to trees selected for foraging on immature ovulate cones (Larson and Schubert 1970; Pederson et al. 1976; Hall 1981). Much of the focus on feed trees used for foraging on inner bark has been on the chemical characteristics of those trees (Pederson et al. 1976; Capretta and Farentinos 1979; Thomas 1979; Farentinos et al. 1981; Hall 1981; Pederson and Welch 1985; Zhang and States 1991; Snyder 1992). Although there is much agreement on the size of typical feed trees (Patton and Green 1970; Pederson et al. 1976; Ffolliott and Patton 1978; Snyder 1992; Allred and Gaud 1994b), there is a lack of agreement on the pattern of squirrel use from one year to the next--although all authors acknowledge some variation in feed tree use on an annual basis. Ffolliott and Patton (1978) and States et al. (1988) indicated relatively low levels of fidelity to particular feed trees, although their calculations include all trees used, even if only one clip had been counted. Larson and Schubert (1970), Hall (1981), and Snyder (1992) reported much higher levels of squirrel fidelity to feed trees, particularly heavily used feed trees.

Study Site:

The Mt. Trumbull Resource Conservation Area is located in the Uinkaret and Sawmill Mountains of northwestern Arizona, approximately 85 kilometers southwest of Fredonia, AZ. Elevation for ponderosa pine ranges from approximately 1,980 m to 2,447 m, and the area contains a total of approximately 4,000 ha of ponderosa pine forest. This island of ponderosa pine is isolated by lower-elevation vegetation on all sides. The forest has been characterized as an ecotonal pine forest (Soderquist 1987), with ponderosa pine occurring at atypically low elevations. The dry climate of Mt. Trumbull is influenced by proximity to the Great Basin, and there is a noticeable mixing of lower elevation species (e.g., *Artemesia tridentata*) with plants more typical of the ponderosa pine zone. *Sciurus aberti kaibabensis* (Kaibab squirrel), a subspecies of tassel-eared squirrel, was introduced to Mt. Trumbull in 1972 from the Kaibab Plateau approximately 48 kilometers to the east (Hall 1981). Prior to that time there were no tree squirrels at Mt. Trumbull, possibly due to a prehistoric extinction related to isolation effects. All tassel-eared squirrels in the Southwest are behaviorally and physiologically very similar (Hoffmeister and Diersing 1978; Hoffmeister 1986; Hall 1981), and would be expected to exhibit similar responses to habitat alterations.

Three previously designated experimental blocks ranging in size from approximately 40 ha to 100 ha were selected for this study. Although the blocks were untreated, the treatment half of each block had been marked for individual tree retention during the treatment. The marking guidelines were based on a prescription which retained all trees of presettlement status, and from 1.5 to 3 replacement trees (depending on size) in locations where evidence of presettlement trees (stumps, logs) was observed. Blocks were separated by approximately 2 km, and represent a continuum of elevations, stand densities, and soil conditions. The selected blocks had previously been designated as experimental blocks 1, 3, and 5, and will be referred to as such using notation such as EB-1T for experimental block 1, treatment unit. Table 2.1 provides detailed information concerning the characteristics of each block.

Methods:

Data Collection

Within each treatment and control unit of each block (except EB-1C) a central 5.4 ha portion was mapped between May and August of 1998 for the exact location of all tassel-eared squirrel feed trees. Feed trees were distinguished as twig and cone trees depending on the type of foraging use they received. Twig trees were defined as those with 10 or more clipped needle clusters from the previous year (trees typically had 10 or more clips if they had any), and cone trees as those with 20 or more peeled ovulate cone cores from the previous year (if trees had more than 5 cone cores they typically had 20+). Reported levels of use found in the literature (Keith 1965; Ffolliott and Patton 1978; Allred and Gaud 1994b) were also considered in making these determinations.

Distinct color changes which occur with time (Brown 1984) were used to determine if feeding evidence was greater or less than one year old. Position of feeding evidence under the canopy, slope angle, prevailing wind direction, and evidence of clipping in the canopy were all considered when assigning feeding evidence to a particular tree. In most cases we feel the evidence was unambiguous; however, difficult judgement calls were noted for particular trees in dense clumps. The total number of clips in the areas was systematically counted or in some cases estimated, although exact locations of trees providing fewer than 10 clips were not mapped and detailed data for those trees were not collected. Data collected for each mapped tree included: number of clipped needle clusters, number of peeled twigs, number of peeled cone cores, number of fungi digs, dbh, dominance, aspect, damage (due to squirrel use or other causes), tree status (leave or take), relative abundance of feeding evidence >1 year old, and distance and azimuth to one of the permanent rebar stakes placed at 60 m intervals on the grid. Mapping was conducted using graph paper and a 20 m x 20 m grid system marked on the sites using wire flags or forestry flagging. Results from spatial analyses based on these maps are reported elsewhere (chapter 3).

Statistical Analysis

The chi-square goodness-of-fit test was used to test for selection of twig trees by size class among trees 31 cm dbh or greater. The diameter distribution of available trees was obtained from data collected by the Northern Arizona University Ecology Lab (pers. comm. Amy Waltz). Observed values were the actual number of twig trees in each size class, and expected values were obtained by multiplying the proportion of live pine ≥ 31 cm dbh in each size class by the total number of twig trees ≥ 31 cm dbh. Ten-centimeter size classes were used unless expected values were less than one, in which case size classes were combined (after Cochran 1954).

Predicting Treatment Effects

For the purpose of making predictions from this study we assumed that the feed trees used at moderately high levels in 1997-1998 represented a large percentage of the suitable feed trees on the study sites into the near future. While this assumption is open to debate, we provide evidence to support the assumption, and also provide a means to test its validity. We used feed trees marked for retention as a means of predicting available feed trees following treatments.

Results:

Twig tree characteristics

When all five mapped units were combined, twig trees on our study sites had a median dbh of 36.0 cm, with a range from 16.1 to 114.3 cm. Seventy percent of all twig trees had a dbh between 25 and 50 cm. We found that use by size class was roughly proportional to availability when looking at trees larger than 31.0 cm (Figure 2.1), but selection of trees in smaller size classes was less than expected based on availability. Fifty percent of the total number of clips counted in the units came from just 21% of the twig trees. Twig trees as a group represented from 4.9 to 14.2% of the ponderosa pine greater than 20 cm dbh, which is approximately the minimum threshold size for use by squirrels. Eighty-four percent of twig trees showed evidence of at least two consecutive years of previous use as a twig tree. Clips from non twig trees (<10 clips) accounted for 12.9% of the total number of clips on the sites. Table 2.2 provides the characteristics of twig trees by unit. The number of clipped needle clusters was not correlated with the diameter of twig trees (Figure 2.4).

Twig trees that remain after restoration treatments are applied will have a somewhat larger median size. We do not anticipate that the number of clips per tree will increase. Table 2.2 describes projected characteristics of retained twig trees, using leave trees in treatment units as a forecasting method.

Cone Tree Characteristics

Cone trees had a median dbh of 52.8 cm, and 86% of cone trees had diameters greater than 40 cm. Cone trees as a group represented from 0.13 to 3.7% of the ponderosa pine in the stand greater than 20 cm. Since cone and twig trees had inherently different and somewhat arbitrary definitions, it is difficult to say based on these data that cone trees are necessarily less common than twig trees, however, based on our definitions that is the case. A chi-square analysis of cone tree selection by size class was not attempted due to the small sample sizes of cone trees. Table 2.3 provides characteristics of cone trees by unit. There was very little correlation between the number of cone cores and the diameter of cone trees (Figure 2.5).

It appears that cone tree characteristics will also be somewhat affected by restoration treatments, however, these effects are less striking than those for twig trees

(Table 2.3).

Twig Tree Retention

We projected the impact of restoration treatments on the number of twig trees in each unit (Figure 2.2). We made these projections by removing from the data set all twig trees in the treatment units which were not marked for retention. Other suitable trees in the units will probably begin to receive use following treatment. However, it is also likely that alterations in stand structure will reduce the attractiveness of some of the retained twig trees due to increased exposure to predators. If currently unused but suitable trees in the stands are reduced at similar levels as the current twig trees, it seems highly probable that twig tree availability will be substantially reduced by restoration treatments.

Cone Tree Retention

It appears that impacts on the availability of cone trees (Figure 2.3) will be less severe than the impacts on twig trees. This difference is probably related to the larger average size of cone trees, making them more likely to be retained under the current restoration prescription. It should be noted, however, that sample sizes for cone trees are small (Table 2.3).

Discussion:

Restricted food availability has been shown to be a limiting factor in some sciurid populations (Sullivan et al. 1983). Food availability is most restricted for tassel-eared squirrels during the winter, and winter mortality is a major factor in tassel-eared squirrel population fluctuations (Keith 1965; Stephenson and Brown 1980; Hall 1981). Almost exclusive dependence on inner bark for food during periods when snow cover is >10 cm has been shown to be a period of particularly high squirrel mortality, and may limit the range of tassel-eared squirrels (Stephenson and Brown 1980). Since Patton (1974) showed that pine twigs have low food value, and Snyder (1992) provided evidence suggesting that the selected feed trees have higher nutritional value, the availability of appropriate feed trees may be a crucial factor in squirrel survival during winters with prolonged snow cover. Ovulate cones are a favored food source during the summer and autumn, and may be one of the most important elements in the diet of squirrels contributing to weight gain and maintenance of good health (Keith 1965; Hall 1981). Reductions in the availability of trees selected for foraging on cones and inner bark, therefore, have important implications for squirrel populations. Our projections indicate that twig trees may be substantially reduced by restoration treatments, while cone trees will be less affected. These projections suggest that summer foraging habitat may be less affected than winter foraging habitat. Increased seasonal movements of squirrels may result if restored areas continue to receive use during summer and fall, but are less suitable during winter months. Larger home range sizes may also result if squirrels compensate for reduced forage availability by increasing their range of activity, as reported by Farentinos (1972) and Patton et al. (1985).

Changes in the characteristics of feed trees following restoration may provide clues to the changes which have occurred in squirrel foraging patterns since Euro-

Table 2.1 - Description of study units at Mt. Trumbull, AZ.

		Unit Characteristics		
Unit	Location	Elevation	Ponderosa pine/ha	Description
EB-1T	36°22'00"N, 113°10'00"W	2023-2036 m	477.5	Young lava flow with open forest dominated by presettlement pine and brush species.
EB-3C	36°21'00"N, 113°12'00"W	2255-2316 m	507.5	Open forest of predominantly large postsettlement pine on cinder soil, patches of small locust in understory
EB-3T	36°21'00"N, 113°11'30"W	2218-2292 m	620.0	Similar to EB-3C, but also with small openings of exclusively sagebrush and locust
EB-5C	36°22'50"N, 113°12'50"W	2023-2060 m	882.5	Dense patches of mid-sized postsettlement pine, patches of oak, and abundant pinyon/juniper
EB-5T	36°22'30"N, 113°12'50"W	2048-2121 m	1671.3	Dense small to mid-sized pine, understory of small oak

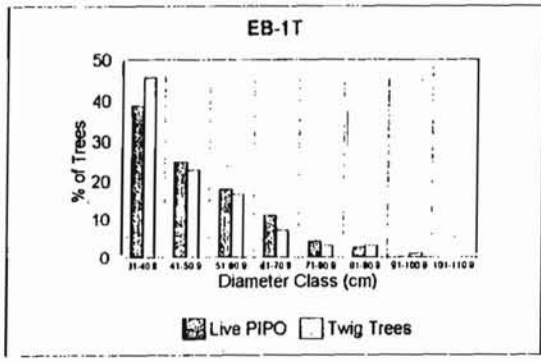
Table 2.2 - Tassel-eared squirrel twig tree characteristics at Mt. Trumbull, AZ. Characteristics of twig trees marked for retention (leave trees) were used to predict effects of restoration treatments.

Twig Tree Characteristics

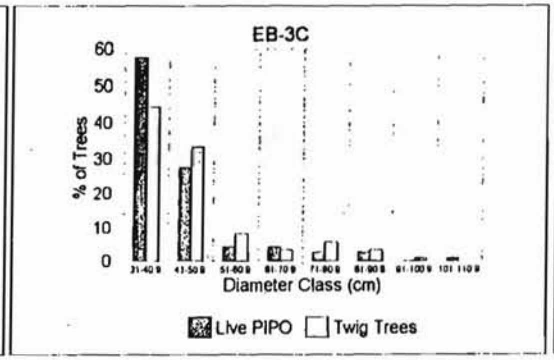
Unit	n	Median dbh	dbh range	Median clips	clip range
EB-1T	123	38.1 cm	18.5 - 93.5 cm	22.0	10 - 130
Leave trees	68	47.2 cm	26.2 - 93.5 cm	23.0	10 - 130
EB-3C	142	40.2 cm	21.0 - 96.1 cm	25.0	10 - 306
EB-3T	166	38.9 cm	20.4 - 114.3 cm	23.0	10 - 269
Leave trees	48	52.4 cm	31.2 - 114.3 cm	23.5	11 - 136
EB-5C	79	28.2 cm	16.1 - 60.4 cm	23.5	10 - 166
EB-5T	107	27.3 cm	16.8 - 95.9 cm	23.5	10 - 396
Leave trees	36	32.3 cm	21.0 - 95.9 cm	24.0	10 - 396

Table 2.3 - Tassel-eared squirrel cone tree characteristics at Mt. Trumbull, AZ. Leave trees were used to predict possible effects of restoration treatments.

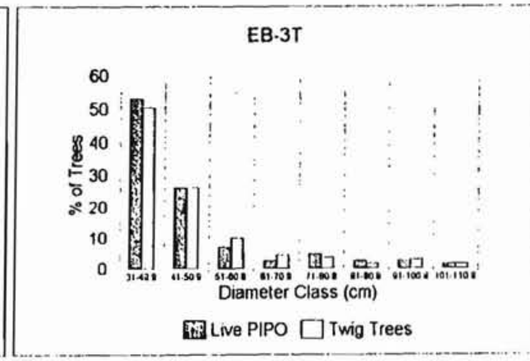
			Cone Tree Characteristics		
Unit	n	Median dbh	dbh range	Median cores	core range
EB-1T	32	53.9 cm	23.2 - 81.3 cm	56.0	23 - 374
Leave trees	26	56.5 cm	35.9 - 81.3 cm	60.0	23 - 374
EB-3C	41	51.6 cm	34.3 - 104.8 cm	53.5	21 - 415
EB-3T	20	49.7 cm	35.9 - 96.1 cm	58.0	20 - 280
Leave trees	10	65.3 cm	43.0 - 96.1 cm	75.5	20 - 280
EB-5C	2	66.8 cm	57.0 - 76.5 cm	28.0	24 - 32
EB-5T	7	54.0 cm	35.7 - 84.6 cm	33.0	20 - 44
Leave trees	*6*	56.8 cm	48.6 - 84.6 cm	28	20 - 44



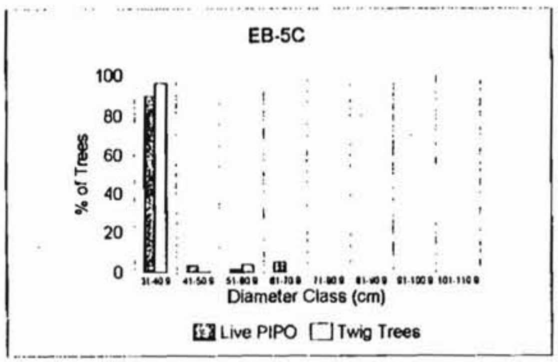
Chi-Square = 3.5265, df = 5, P = 0.9965



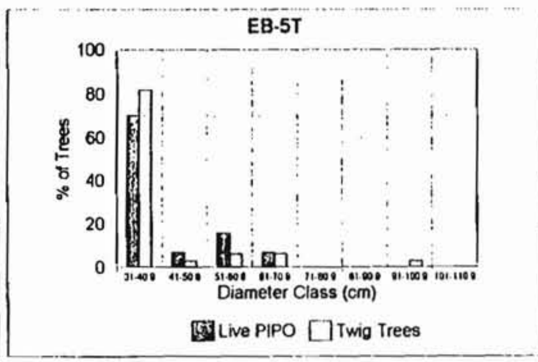
Chi-Square = 14.7058, df = 6, P = 0.022



Chi-Square = 4.9897, df = 7, P = 0.6612



Chi-Square = 3.0872, df = 3, P = 0.3784



Chi-Square = 3.7434, df = 3, P = 0.2905

Figure 2.1 - Selection of tassel-eared squirrel twig trees by diameter class at Mt. Trumbull, AZ. Differences in degrees of freedom are due to lumping of size classes when expected values are <1 (after Cochran 1954). In each size class, the first bar shows the percentage of live ponderosa pine 31 cm dbh or larger which occur in that diameter class. The second bar shows the percentage of twig trees 31 cm dbh or greater which occur in that diameter class.

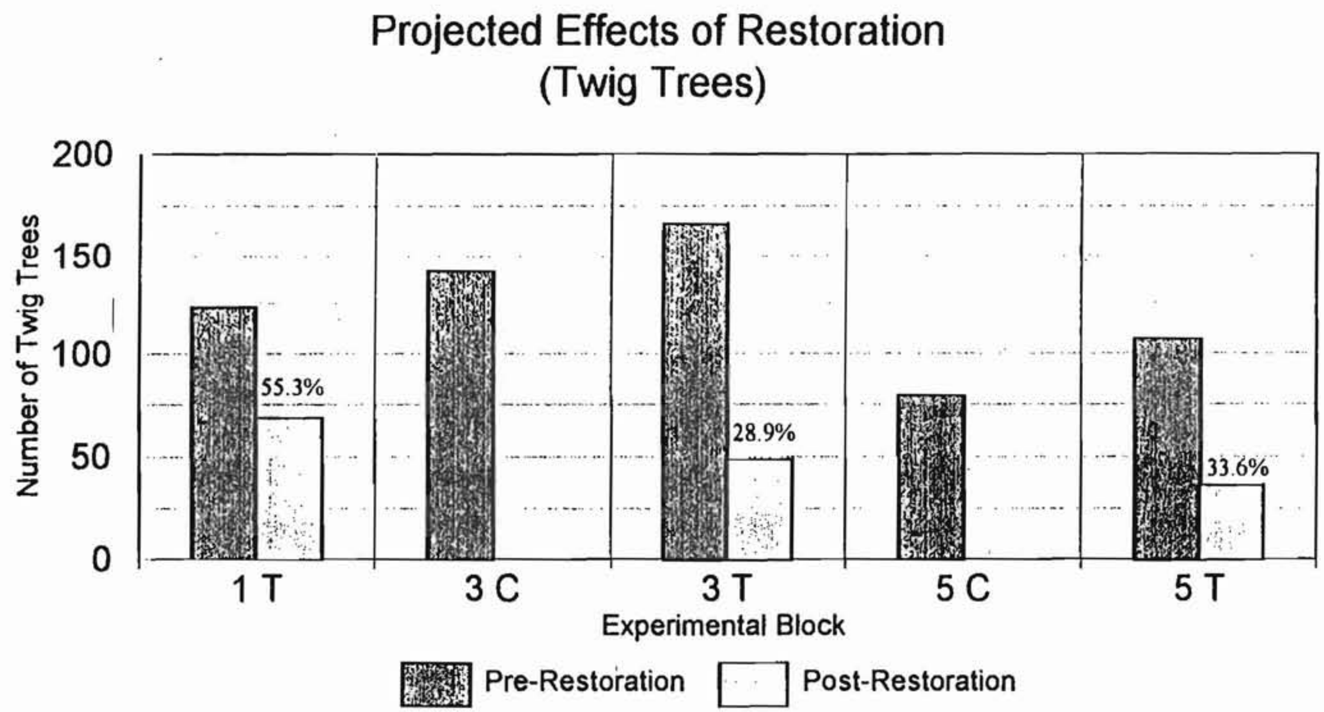


Figure 2.2 - Projected retention of tassel-eared squirrel twig trees during ecological restoration treatments at Mt. Trumbull, AZ.

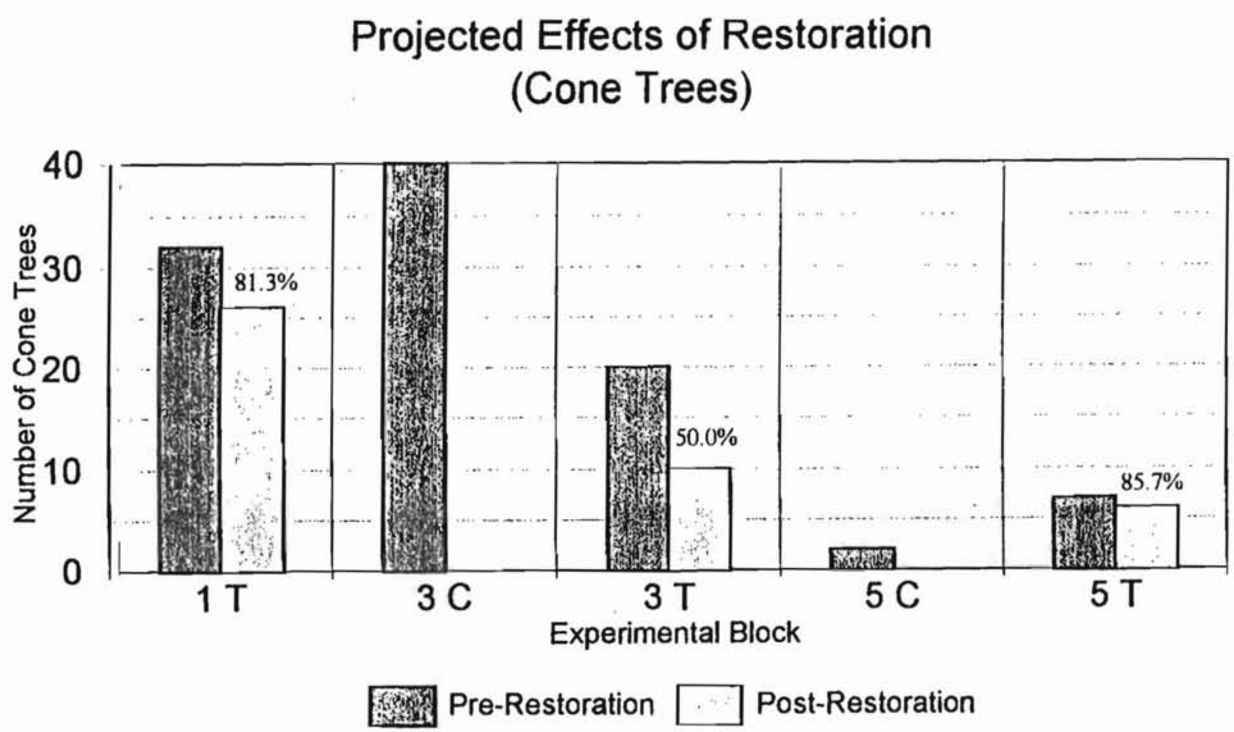


Figure 2.3 - Projected retention of tassel-eared squirrel cone trees during ecological restoration treatments at Mt. Trumbull, AZ.

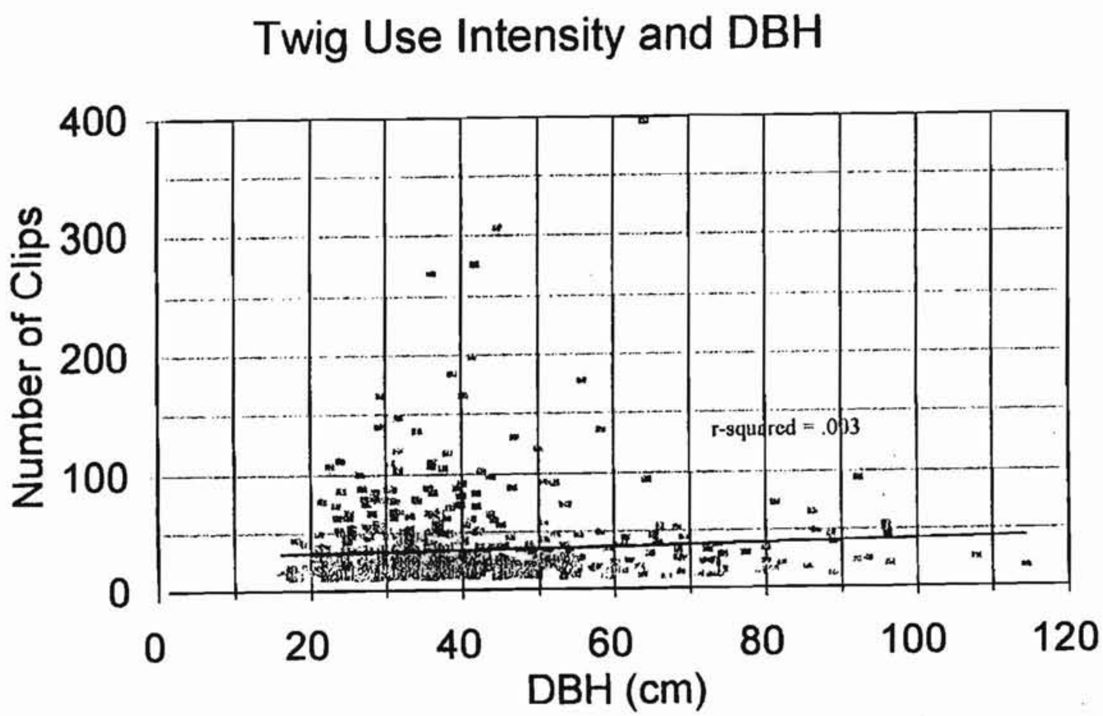


Figure 2.4 - Relationship between dbh (cm) and the number of clipped needle clusters from tassel-eared squirrel twig trees at Mt. Trumbull, AZ.

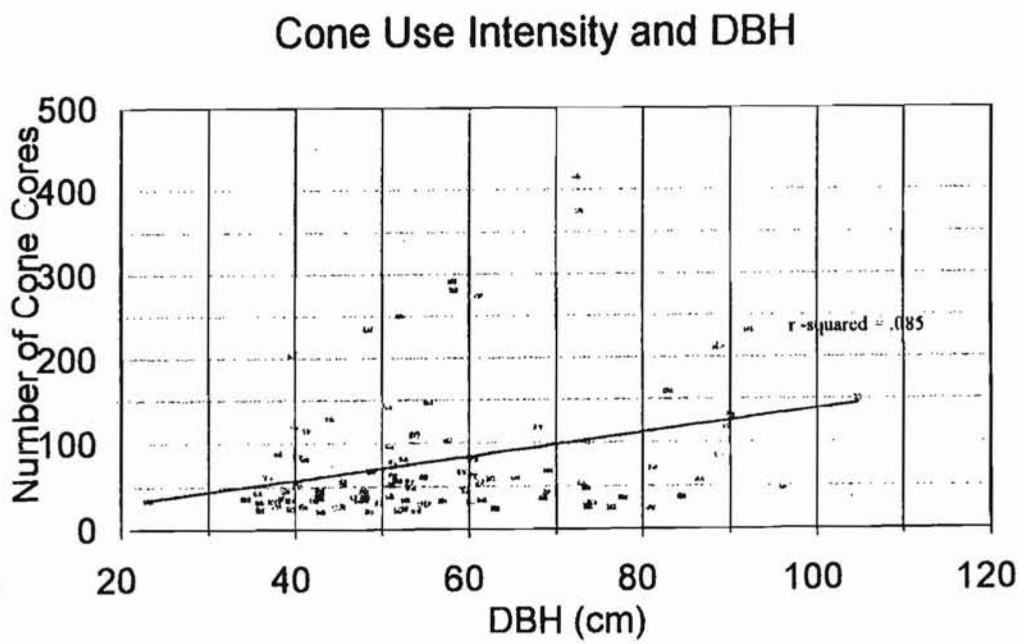


Figure 2.5 - Relationship between the dbh (cm) of each cone tree and the number of cones harvested by tassel-eared squirrels at Mt. Trumbull, AZ.

CHAPTER 3

Spatial patterns of tassel-eared squirrel foraging habitat and proposed modifications of restoration prescriptions for *Pinus ponderosa* forests

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Running title: Squirrel foraging patterns and pine restoration

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Abstract

Tassel-eared squirrels depend on *Pinus ponderosa* (ponderosa pine) for survival, and depend particularly on individual trees known as feed trees for much of their foraging activity. We mapped exact locations of tassel-eared squirrel feed trees on five, 5.4 ha units of the Mt. Trumbull Ecosystem Restoration Project in northwestern Arizona. Spatial patterns of this important habitat element were analyzed using Ripley's K(t), K12(t), and Moran's I Coefficient. Trees used for foraging on inner bark were clumped at scales ranging from 5 to 120 meters. It is projected that restoration treatments will result in a more random distribution of selected trees. Trees receiving similar levels of squirrel use were not clumped with each other, and trees utilized for inner bark foraging and cone harvesting were not associated with one another. Two modified prescriptions to mitigate impacts on tassel-eared squirrels are proposed. An individual tree approach would have little impact on restoration objectives, however, the effectiveness of this approach for mitigating impacts on squirrels is uncertain. The patch approach appears more promising as an effective method to mitigate impacts on squirrel habitat, but requires significant alterations of current restoration objectives and marking guidelines.

Key words: *Sciurus aberti kaibabensis, Pinus ponderosa*, habitat selection, spatial analysis, Ripley's K functions, mitigating impacts, modified prescriptions

Introduction:

Sciurus aberti (tassel-eared squirrels) live exclusively in *Pinus ponderosa* (ponderosa pine) forests of the southwestern United States and northern Mexico (McKee 1941). The dependence of tassel-eared squirrels on ponderosa pine, and the important ecological roles squirrels play in these forests, have been described previously (e.g., Goldman 1928; Keith 1965; Hall 1981; Brown 1984; Allred and Gaud 1994a). Ponderosa pine forests of the Southwest have undergone significant changes in approximately the last 130 years following interruption of the frequent, low intensity fire regime by Euro-American settlement (Cooper 1960). Livestock grazing and active fire suppression efforts have led to a dramatic increase in tree densities and associated loss of the formerly open, park-like forest structure (Covington and Moore 1994a). Currently there are ecological restoration efforts underway in several areas of the Southwest which seek to restore presettlement reference conditions through mechanical thinning and prescribed fire (Covington et al. 1997).

Because tassel-eared squirrels are associated with areas of high ponderosa pine basal area (Ratcliff et al. 1975; Patton 1977; Ffolliott and Patton 1978), restoration treatments may reduce the quality of tassel-eared squirrel habitat. Restoration treatments will directly remove some of the feed trees where the squirrels do much of their foraging.

Feed trees are an important habitat element for tassel-eared squirrels during the critical winter months when other favored food resources are unavailable (Keith 1965;

Stephenson and Brown 1980; Hall 1981). Tassel-eared squirrels do not cache food (Golightly and Ohmart 1978) and do not hibernate, making it necessary to forage for food daily. Despite their extensive use of inner bark from pine twigs, this food source is of relatively limited nutritional value (Patton 1974) compared to preferred, high-value food items such as pine seeds. Previous research indicates that the particular feed trees selected by the squirrels may have a nutritional and energetic advantage to the squirrels due to their chemical characteristics (Snyder 1992) and possibly the ease with which the bark can be peeled (Pederson and Welch 1985). The availability of suitable trees which make foraging more efficient could, therefore, be an important factor influencing squirrel survivorship. The distribution of feed trees has been casually described as clumped (Hall 1981; States et al. 1988; Linhart 1989), but has never been formally analyzed. Particular trees are also selected as sites for much of the immature ovulate cone harvesting which occurs in summer and autumn, but these trees have received limited research attention (Larson and Schubert 1970; Hall 1981). Trees utilized for inner bark and cone harvesting will be referred to as twig and cone trees respectively.

In order to protect an important habitat element it is necessary to understand how that element is spatially distributed, and in particular to understand that distribution at a scale which is applicable to the scale of management activities. Ecological restoration treatments in southwestern ponderosa pine forests are currently being marked at the individual tree level, making the scale of interest one fine enough to detect individual tree locations. If feed trees are distributed in a non-random way, that distribution may be important for squirrel foraging behavior, and should be considered when attempting to mitigate impacts on foraging habitat.

Study Site:

Our research was conducted on the Mt. Trumbull Resource Conservation Area administered by the Bureau of Land Management. The area is located in northwestern Arizona approximately 85 km southwest of Fredonia, AZ. Operational-scale restoration treatments began in the area in 1996, and three planned but untreated experimental blocks were selected for this study. A detailed description of the study sites has been provided previously (chapter 2).

Methods:

Data collection

We mapped exact locations of all tassel-eared squirrel feed trees in a central 5.4 ha portion of both the control and treatment half of each of the three blocks, with the exception of the control half of experimental block 1 (EB-1C). This resulted in a total of 5 units and 27 mapped hectares. Entire blocks were not mapped due to time constraints. We designated feed trees as twig trees if they had 10 or more clipped needle clusters from the previous year, and cone trees if they had 20 or more peeled cone cores from the previous year. Trees that did not meet one or both of these definitions were not mapped (see chapter 2 for further explanation). Distinct color changes which occur with time (Brown 1984) allowed feeding evidence to be aged as greater or less than one year old. We established grid cells 20 meters on a side across the entire mapped area using compass, tape measure, and wire flags or forestry flagging. We mapped locations of trees within grid cells using graph paper. Data was collected for each mapped tree, and has been reported previously (chapter 2). Tree locations were later digitized using ArcInfo software for use with a computerized map of the study area.

Statistical Analysis

Ripley's K functions and Moran's I coefficient were used to describe spatial patterns of feed trees in the study units at Mt. Trumbull. The K(t) function is a univariate analysis used to characterize the distribution of a set of points as random, clumped, or uniform (Ripley 1977), and was used to determine if feed trees occur in clumps. The K12(t) function is a bivariate analysis used to describe two sets of points as being independent, positively, or negatively associated (Lotwick and Silverman 1983). This function was used to test if twig and cone trees occur together. Moran's I coefficient is used to describe the distribution of a variable associated with a set of points (Upton and Fingleton 1985), and was used to see if feed trees receiving a high level of use (measured by number of clips) are clumped. We used software developed by Duncan (1990) to perform the analyses. Using these statistical tools distributions can be described at scales up to one-half the width of the plot. For each distance class, the observed K(t) is compared to a 95% confidence envelope obtained by computing K(t) for 19 sets of randomly-selected points (Monte Carlo simulations), with the number of points in each set equal to the number of feed trees in the analysis. A

minimum population size of 20 or more trees was set as a requirement for analysis, after Fulé and Covington (1998).

Alternative restoration prescriptions designed to mitigate impacts on tassel-eared squirrel foraging habitat were developed using current patterns of squirrel use as an indicator of individual tree potential as a feed tree. Although individual feed tree use may vary from year to year, several studies indicate that previous use is a good predictor of future use as a feed tree (Larson and Schubert 1970; Hall 1981; Soderquist 1987; Snyder 1992). We found evidence of at least two consecutive years of previous use for 84% of the feed trees mapped on our study sites. For the purposes of this exercise, we made the assumption that future use would be the same as use recorded for the year 1997-1998. We then projected the effects of restoration treatments by removing from the data set all mapped trees which were not marked for retention (for additional details, see chapter 2). Various modifications of the current prescription were examined by adding back take trees as appropriate based on the criteria of the proposed modified prescriptions. We were not able to predict how treatments might impact the level of use received by retained trees in the future, and thus assumed use on an individual tree level would remain constant.

Results:

Spatial Analysis

Twig trees tended to be clumped at spatial scales ranging from 5 to 120 meters, the maximum distance at which clumping could be detected in our units (Table 3.1).

Within each unit twig trees were clumped in all 5 meter distance classes from 5 to 40 meters, with clumping inconsistent across units at distances greater than 40 meters. Following simulated treatments, some clumping of retained twig trees was still evident, however, this pattern was less consistent than it had been previously (Table 3.1)

The clumping pattern of cone trees varied by unit, possibly due to small sample sizes. Sample sizes were so small for two units that analysis was not attempted (Table 3.1). The clumping pattern observed in EB-3C, the unit with the largest sample size for cone trees, suggests that cone trees may indeed exhibit significant clumping patterns. Because a larger proportion of cone trees than twig trees are retained in restoration treatments (see chapter 2), mitigation efforts for cone trees may not be as important as those directed at twig trees. Due to the varied results of spatial analyses (likely due to small sample sizes), and less of a sense of urgency, we did not attempt to incorporate cone trees into the modified prescriptions.

While collecting data in the field it appeared that twig trees receiving similar levels of use were clumped; however, using Moran's I coefficient the clumping was not consistently shown to be statistically significant in any units or in any particular distance classes. These results imply that particular clumps of feed trees are no more likely to contain especially heavily used twig trees than other clumps of twig trees.

Twig trees and cone trees also appeared to be positively associated with one another based on casual observations in the field. Using the K12(t) function this was not shown to be consistently statistically significant, however (Table 3.2). It should be noted again that small sample sizes of cone trees prevented analysis in two units, and may have influenced analysis in the other units. If these results are supported by further investigation, they may indicate that separate approaches will be necessary to mitigate impacts on cone and twig trees, if necessary.

Modified Restoration Prescriptions

Two approaches for mitigating impacts of treatments on tassel-eared squirrels were considered. Figure 3.1 graphically depicts the concept behind the individual tree approach to modifying current prescriptions. Under this approach the intent is to save the most heavily used twig trees in order to preserve the greatest amount of foraging habitat with the least amount of impact on stand structural objectives of the current prescription. Although the approach of identifying the 'best' twig trees on an operational scale (depicted in Figure 3.1) is not a practical approach (because it would require mapping and tagging all twig trees and then a second marking effort), similar results could be obtained using squirrel use-levels as a criteria (Figure 3.2). Such an approach could easily be implemented through minor modifications of current marking guidelines, either through substituting qualifying feed trees for non-feed trees currently marked, or by adding qualifying trees to those currently marked for retention. We found that the additional retention of approximately 2-4 heavily used twig trees per hectare could theoretically reduce impacts on inner bark foraging by 50% or more (Figure 3.2).

The second approach to mitigating impacts is based on the results of the spatial analyses which show that twig trees tend to be clumped, suggesting that perhaps modified prescriptions should also seek to clump retained twig trees. This patch approach is likely to have further benefits for squirrels if entire clumps of trees--feed and associated non-feed trees--are retained to provide additional cover, nesting, and foraging habitat. Previous research has indicated that tassel-eared squirrels typically select dense clumps of trees with interlocking canopies for nest locations (Patton 1975), possibly to allow a more concealed approach to the nest through the canopy (Hall 1981). Protection from aerial predators such as *Accipiter gentilis atricapillus* (northern goshawk), perhaps the primary predator of tassel-eared squirrels (Farentinos 1972; Hall 1981; Reynolds et al. 1992), during foraging would likely be enhanced in dense patches of trees. Retaining such clumps may have energetic benefits for squirrels which would not have to travel as far between trees, particularly during periods of powdery snowcover which make ground travel difficult or impossible for squirrels (Hall 1981). Fungi utilized heavily by squirrels have also been associated with closed canopy forests (States 1985), suggesting that an additional food resource would also be benefitted by retaining dense clumps of trees.

Using unit EB-1T as an example (Figure 3.3), it would be relatively easy to designate clumps of twig trees approximately 25 meters across for retention in the treatment. Since spatial analyses showed that heavily used trees are not clumped, and therefore patches can be considered somewhat equal in value, it would not be necessary to make two passes using this approach. In the case of EB-1T, three such patches of approximately 25 m diameter could be used to retain a similar number of additional feed trees as the individual tree approach when using 30 clips per tree as the criteria for retention (Figure 3.2, 3.3). The potential amount of forage retained, however, may vary because the feed trees retained are not exclusively heavily used trees as those in the individual tree approach. As an alternative to complete exclusion from treatment, designated clumps could receive reduced levels of thinning, or only minor thinning of understory vegetation. At essentially any level of additional twig tree retention, impacts on structural objectives of current prescriptions will be greater under the patch approach than the individual tree approach. This is results from the large number of additional trees retained in even a single clump if non-feed trees (not shown in figure 3.3) are included.

Discussion:

The consistently clumped pattern of distribution for tassel-eared squirrel twig trees in 5 units at Mt. Trumbull prior to restoration suggests that squirrel foraging habitat should be viewed as a mosaic of patches, despite virtually continuous canopy cover of pine on the sites. Whether these patches are the result of genetic relatedness of clumps of trees (Linhart 1989), or due to some other factor influencing squirrel activity is not known. Regardless of the cause of clumping, it is easy to hypothesize benefits to squirrels if such clumps of trees are intentionally retained--including increased cover, nesting, and foraging habitat. Modifying current restoration prescriptions to preserve dense patches containing known twig trees would be relatively easy, although the most effective size of patches is not known, and in practice would depend on the extent to which modifications are acceptable to decision makers. Since trees receiving particular use levels do not appear to be clumped, it would not matter in theory which clumps were designated for retention, and since tassel-eared squirrels are not territorial (Brown 1984) spacing should not be particularly important. The research upon which the current prescription is based does not indicate, however, that such patches existed under presettlement reference conditions (pers. comm. Peter Z. Fulé, Research Assistant Professor, Northern Arizona University, 1999), which must be seriously considered in view of the stated objective for the treatments to restore those reference conditions. In the small areas currently designated for restoration treatments, such major alterations to the current marking guidelines may not be warranted for the protection of a currently wide-spread and abundant species.

An alternative to retaining patches would be to retain individual, heavily-used twig trees regardless of their location or proximity to other trees. In terms of current usage, this approach could cut impacts on forage availability by half, while the number of additional trees retained (approximately 2-4 per hectare) would have only minor impacts on structural objectives of the current prescription (pers. comm. Peter Z. Fulé, Research Assistant Professor, Northern Arizona University, 1999). This approach, however, seems less certain to mitigate impacts on squirrels. Previous research has indicated that squirrel habitat use declines following timber harvesting (Patton et al.

1985; Pederson et al. 1987). Retained twig trees may not receive the same levels of use following the reduction in surrounding tree densities, thus limiting the effectiveness of this approach. Alternatively, when twig trees become more scarce following treatment they may be used more heavily. Hall (1981) noted that where pine were scarce within mixed conifer forests they seemed to be used in higher percentages than where they were abundant.

It is also important to consider the possible impacts on forest genetics if feed trees are intentionally retained at higher levels. Shifts in gene frequencies and associated tree characteristics could alter vulnerability to other herbivores, insects, pathogens, and fire. It is not known how the suggested modifications of the current prescription might influence such factors.

Decision makers will ultimately have to determine how tassel-eared squirrel habitat requirements fit into the larger picture of ecological restoration in southwestern ponderosa pine forests. We have provided two possible approaches to mitigating impacts on squirrels. The predicted benefits of these modifications of the current prescription should be viewed as testable hypothesis based on imperfect assumptions. As with any management decision, tradeoffs must be made when choosing between available options. We suggest monitoring squirrel populations in restored areas, and then experimenting with modified prescriptions if reductions in squirrel numbers or other species of wildlife are deemed to be unacceptable.

Table 3.1 - K(t) spatial analysis of tassel-eared squirrel feed trees at Mt. Trumbull, AZ (C = clumped, Blank = random, NA = not available due to plot size or sample size). Alpha = 0.05

			K(t) Spatial Analysis - Distance (t) in meters										
Unit	Group	n	5	10	15	20	25	30	35	40	45	50	55
EB-1T	Twig Trees	123	C	C	C	C	C	C	C	C	C	C	C
	Retained Twig Trees	68		C	C	C	C	C	C	C	C	C	C
	Cone Trees	32						C			C	C	C
EB-3C	Twig Trees	142	C	C	C	C	C	C	C	C	C	C	C
	Cone Trees	41	C	C	C	C	C	C	C	C	C	C	C
EB-3T	Twig Trees	166	C	C	C	C	C	C	C	C	C	C	C
	Retained Twig Trees	48		C	C	C	C	C		C	C		
	Cone Trees	20											
EB-5C	Twig Trees	81	C	C	C	C	C	C	C	C	C	C	
	Cone Trees	2	NA (Sample size too small for analysis)										
EB-5T	Twig Trees	107	C	C	C	C	C	C	C	C			
	Retained Twig Trees	36						C	C				
	Cone Trees	7	NA (Sample size too small for analysis)										

Table 3.1 continued - K(t) spatial analysis of tassel-eared squirrel feed trees (C = clumped, Blank = random, NA = not available due to plot size or sample size). Alpha = 0.05

		K(t) Spatial Analysis - Distance (t) in meters												
Unit	Group	60	65	70	75	80	85	90	95	100	105	110	115	120
EB-1T	Twig Trees	C	C	C	C	C	C	C	NA	NA	NA	NA	NA	NA
	Retained Twig Trees	C	C	C	C	C	C	C	NA	NA	NA	NA	NA	NA
	Cone Trees	C	C	C	C	C	C	C	NA	NA	NA	NA	NA	NA
EB-3C	Twig Trees	C	C	C	C	C	C	C	NA	NA	NA	NA	NA	NA
	Cone Trees	C	C	C	C	C	C	C	NA	NA	NA	NA	NA	NA
EB-3T	Twig Trees	C	C	C	C	C	C	C	C	C	C	C	C	C
	Retained Twig Trees		C											
	Cone Trees													
EB-5C	Twig Trees			C	C	C	C	C	NA	NA	NA	NA	NA	NA
	Cone Trees	NA (Sample Size too small for analysis)												
EB-5T	Twig Trees								NA	NA	NA	NA	NA	NA
	Retained Twig Trees			C	C	C	C	C	NA	NA	NA	NA	NA	NA
	Cone Trees	NA (Sample Size too small for analysis)												

Table 3.2 - K12(t) spatial analysis of tassel-eared squirrel cone and twig tree association at Mt. Trumbull, AZ (P = positively associated, Blank = independent, NA = not available due to plot size or sample size). Alpha = 0.05

Unit	K12(t) Spatial Analysis - Cone and Twig Tree Association														
	Distance (t) in meters														
	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75
EB-1T			P	P											
EB-3C															
EB-3T	P														
EB-5C	NA (Sample size for cone trees too small for analysis)														
EB-5T	NA (Sample size for cone trees too small for analysis)														

Table 3.2 continued - K12(t) spatial analysis of cone and twig tree association (P = positively associated, Blank = independent, NA = not available due to plot size or sample size). Alpha = 0.05

K12(t) Spatial Analysis - Cone and Twig Tree Association

	Distance (t) in meters								
Unit	80	85	90	95	100	105	110	115	120
EB-1T				NA	NA	NA	NA	NA	NA
EB-3C				NA	NA	NA	NA	NA	NA
EB-3T									
EB-5C	NA (Sample size for cone trees too small for analysis)								
EB-5T	NA (Sample size for cone trees too small for analysis)								

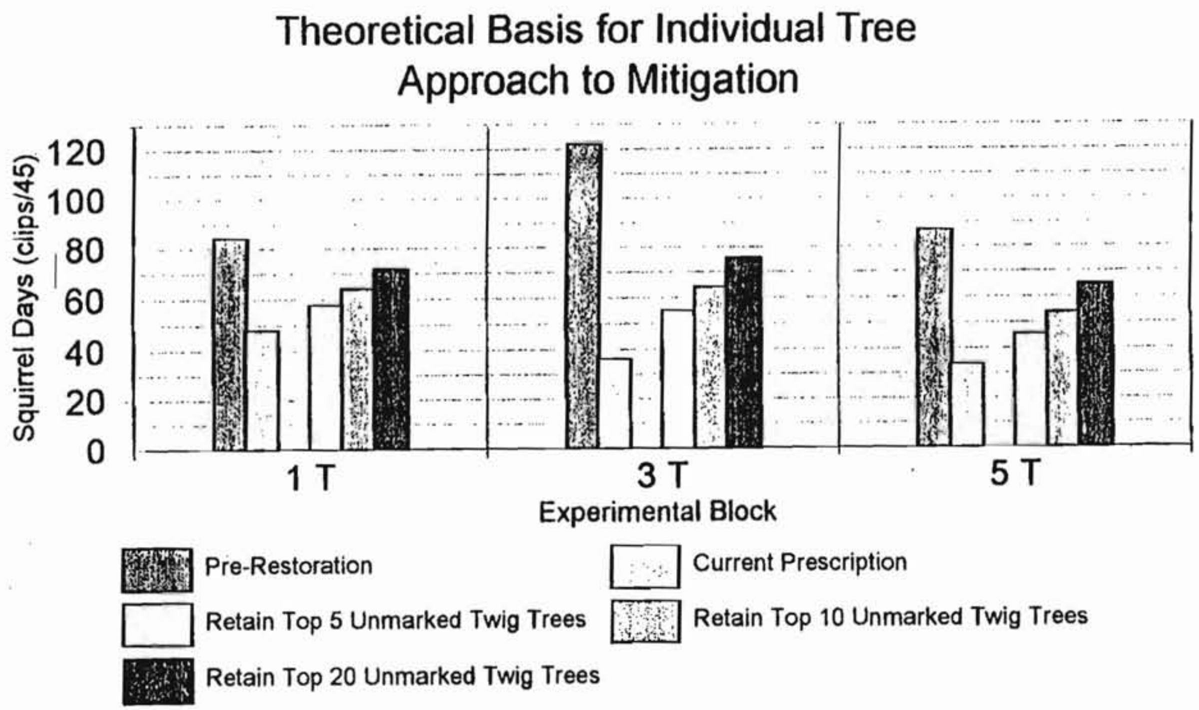

Figure 3.1 - Projected effects of mitigation efforts if various numbers of the most heavily used twig trees are retained. This concept is the basis for the individual tree approach to mitigating treatment effects on tassel-eared squirrel twig trees at Mt. Trumbull, AZ.

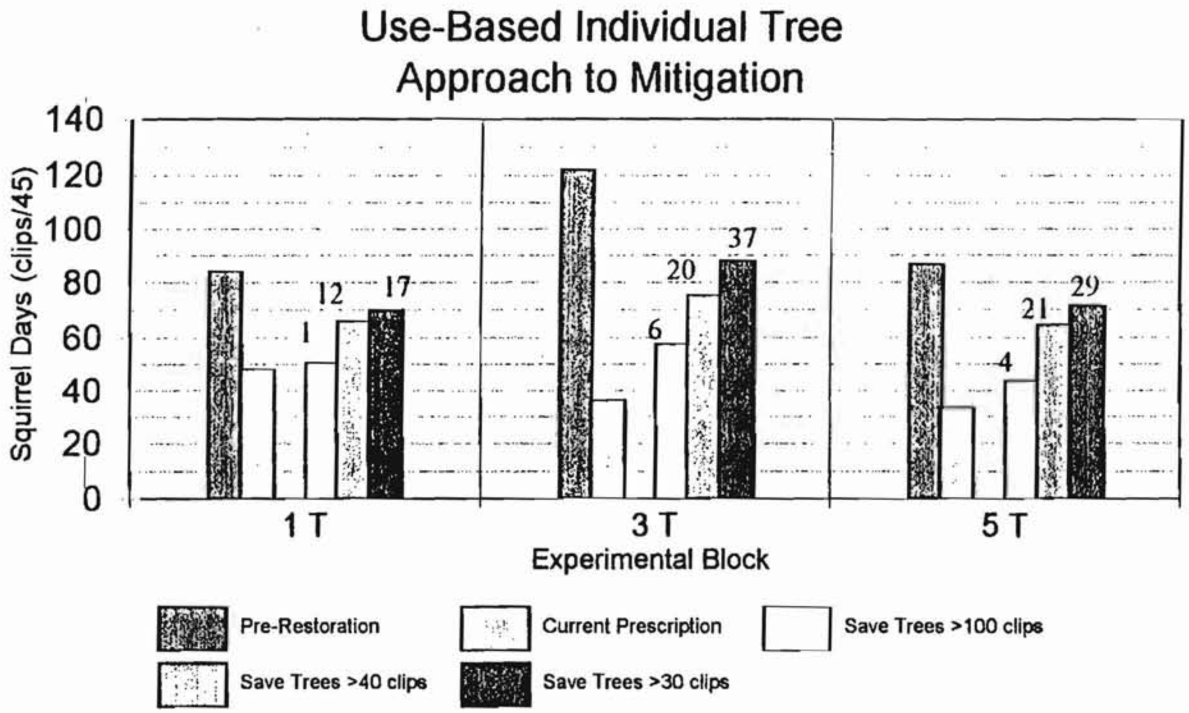

Figure 3.2 - Projected effects of individual tree approach to mitigation using use-level (number of clips) as criteria for retention at Mt. Trumbull, AZ. Note similarity of results to those in figure 3.1. Numbers above bars indicate number of additional tress in each 5.4 ha unit which would be marked for retention under the specified criteria.

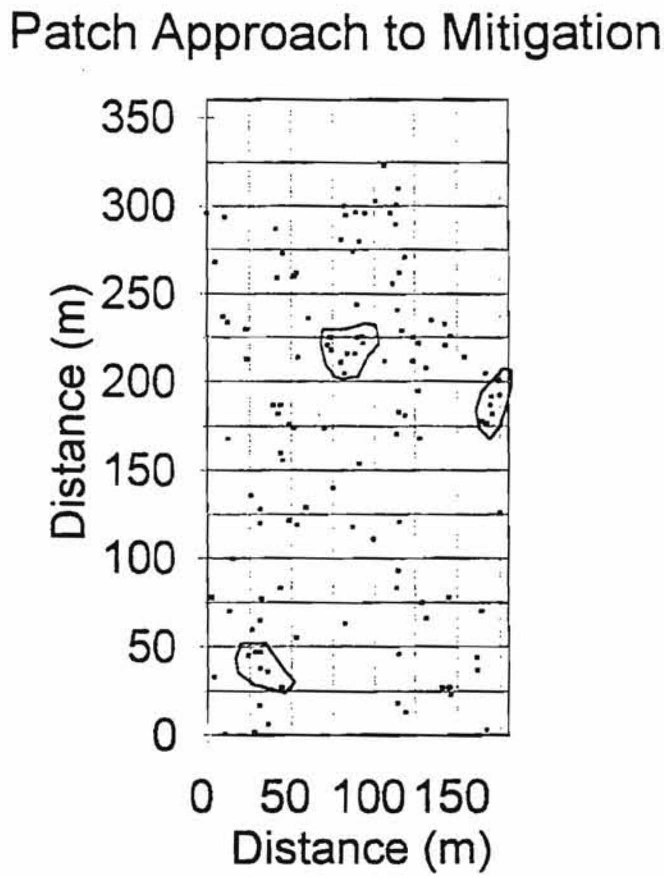

Figure 3.3 - Depiction of possible application of patch approach to mitigating impacts of ecological restoration treatments on tassel-eared squirrel twig trees at Mt. Trumbull, AZ.

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APPENDIX A

Tree Data

Explanation:

Study units are designated at the top of each page, and tree numbers correspond with numbered locations on maps (Appendix D). Location descriptions use rebar numbering systems as shown on maps in Appendix D, not as numbered on NAU Ecology Lab maps.

Data Codes:

Twig/Cone/Nest:
T = twig tree (≥10 clips)
C = cone tree (≥20 cores)
N = nest tree

Dominance:
D = dominant
C = codominant
I = intermediate

Yellow pine:
Y = yellow pine (all sides of trunk)
N = not yellow pine

Leave tree:
Y = leave tree
N = take tree

1 pace = approx. 5 feet

Damage:
M = mild squirrel damage
MMO = mild-moderate sq. d.
MO = moderate sq. d.
MOH = moderate - heavy sq. d.
H = heavy sq. d.
HS = heavy - severe sq. d.
S = severe sq. d.
SE = severe-extreme sq. d.
E = extreme sq. d.
FT = forked trunk
BD = bole damage
PD = portions dead
DT = dead top
MT = misshapen trunk
L or LT = lightning

Old Clips:
N = none
F = few
M = many

EB-1T

Tree No.	Date	Twig/Cone/Nest	Clips	Cores	Twigs	Digs	DBH (cm)
1	7-24-98	T, C	73	108	10	0	53.7
2	7-24-98	T	24	16	5	1	44.1
3	7-24-98	T	77	2	37	0	30.9
4	7-24-98	T	10	0	5	0	36.0
5	7-24-98	T	21	0	6	1	82.1
6	7-24-98	T, C	13	33	6	2	23.2
7	7-24-98	T, C	35	66	22	9	59.2
8	7-24-98	T	24	15	1	0	93.5
9	7-24-98	T	23	2	9	2	27.6
10	7-24-98	T	22	2	11	0	36.0
11	7-24-98	T	30	2	14	0	33.5
12	7-24-98	T, C	93	38	34	0	50.9
13	7-24-98	T, C	19	102	1	0	57.6
14	7-24-98	T	58	3	7	1	36.7
15	7-24-98	T	25	1	3	0	36.7
16	7-24-98	T	63	8	17	0	25.0
17	7-24-98	T	13	0	8	0	24.3
18	7-24-98	T	15	0	4	0	24.6
19	7-24-98	T	34	10	7	0	36.1
20	7-24-98	T	53	2	23	5	68.3
21	7-24-98	T	58	0	36	0	28.8
22	7-24-98	T	30	5	22	0	29.7
23	7-24-98	T	45	1	9	1	33.1
24	7-24-98	T, C	13	33	5	4	47.4
25	7-24-98	T	46	1	22	0	27.8
26	7-24-98	T	15	1	6	0	36.7
27	7-24-98	T	18	2	3	1	30.4
28	7-24-98	T	10	3	2	1	28.0
29	7-24-98	T	24	16	2	0	73.4
30	7-24-98	T	23	4	9	0	46.9
31	7-24-98	T	73	14	16	0	39.7
32	7-25-98	T	11	4	1	0	32.0
33	7-25-98	T	16	3	5	0	42.3
34	7-25-98	T	12	5	2	0	37.6
35	7-25-98	T, C	16	23	0	2	81.0

EB-1T

Tree No.	Date	Twig/Cone/Nest	Clips	Cores	Twigs	Digs	DBH (cm)
67	7-26-98	T	105	4	40	5	37.5
68	7-26-98	T, C, N	73	70	9	1	81.3
69	7-26-98	T	40	6	15	0	65.8
70	7-26-98	T, C	11	374	2	0	72.8
71	7-26-98	T	53	9	17	0	29.4
72	7-26-98	T	14	2	0	0	28.9
73	7-26-98	T	15	1	7	1	18.5
74	7-26-98	C	9	31	0	0	35.9
75	7-27-98	T, C	14	42	3	0	68.9
76	7-27-98	T	16	1	2	0	32.0
77	7-27-98	T, C	29	26	1	0	40.9
78	7-27-98	C	4	88	0	0	38.1
79	7-27-98	T, C	13	27	1	0	37.8
80	7-27-98	T, C	17	62	0	0	60.4
81	7-27-98	T	22	4	1	1	44.0
82	7-27-98	T	32	2	5	0	36.9
83	7-27-98	C	6	31	2	0	60.2
84	7-27-98	T	10	10	3	1	44.4
85	7-27-98	T, C	18	28	2	1	54.7
86	7-27-98	T, C	16	29	0	1	74.2
87	7-27-98	T	11	5	2	1	49.2
88	7-27-98	T	15	1	6	1	41.3
89	7-27-98	T	15	1	7	0	26.0
90	7-27-98	T	19	2	6	1	57.7
91	7-27-98	T, C	17	80	1	0	60.6
92	7-27-98	T	29	0	8	0	44.8
93	7-27-98	T	29	0	8	3	36.5
94	7-27-98	T	39	2	9	0	36.7
95	7-27-98	T	24	1	6	0	34.8
96	7-27-98	T	11	1	3	2	44.5

EB-1T

Tree No.	Date	Twig/Cone/Nest	Clips	Cores	Twigs	Digs	DBH (cm)
97	7-27-98	T, C	25	81	0	0	52.6
98	7-27-98	T, C	52	61	12	0	36.9
99	7-27-98	T	16	1	5	0	32.2
100	7-27-98	T	10	3	2	0	30.1
101	7-27-98	T, C	33	110	1	0	54.0
102	7-27-98	T, C	34	78	1	0	51.4
103	7-27-98	T	24	18	6	2	51.8
104	7-28-98	T, C	12	34	1	0	48.0
105	7-28-98	T	13	13	2	0	29.9
106	7-28-98	T	16	0	5	1	38.5
107	7-28-98	T	15	0	4	0	26.2
108	7-28-98	T	28	0	6	3	30.3
109	7-28-98	T	18	9	5	0	31.9
110	7-28-98	T	21	11	3	0	43.0
111	7-28-98	T, C	47	29	6	0	55.3
112	7-28-98	T	40	0	10	0	36.2
113	7-28-98	T	11	0	4	0	49.7
114	7-28-98	T	12	10	2	0	63.8
115	7-28-98	T	32	0	3	0	29.4
116	7-28-98	T	13	2	2	0	28.5
117	7-28-98	T	24	9	7	0	32.1
118	7-28-98	T	19	3	4	0	37.2
119	7-28-98	T	10	0	4	0	36.2
120	7-28-98	T	11	3	1	0	58.8
121	7-28-98	T	23	1	6	0	41.7
122	7-29-98	T	15	3	2	0	33.0
123	7-29-98	T	62	8	5	0	37.9
124	7-29-98	C	9	117	0	0	67.9
125	7-29-98	T	15	1	5	0	39.6
126	7-29-98	T	16	0	3	1	31.8
127	7-29-98	T	21	1	6	0	28.3
128	7-29-98	T	16	0	2	0	25.9
129	7-29-98	T	15	1	3	0	26.8
130	7-29-98	T	81	2	36	4	39.9

EB-1T

Tree No.	Dominance	Yellow pine	Leave tree	Damage	Old clips	Aspect
1	D	N	Y	M	N	NONE
2	C	N	N	MMO	F	NONE
3	I	N	N	MO	F	NONE
4	C	N	N	H	M	NONE
5	D	Y	Y	MOH	M	NONE
6	I	N	N	M	F	NONE
7	C	Y	Y	MO	M	NONE
8	C	Y	Y	M, PD	M	NONE
9	C	N	N	H	M	NONE
10	D	N	N	M	M	NONE
11	C	N	N	MOH	M	NONE
12	C	N	N	MO	M	N
13	D	Y	Y	MMO	F	N
14	C	N	N	H	M	NE
15	C	N	N	MO	F	NE
16	I	N	N	MOH, MT	F	NONE
17	C	N	N	M	N	NONE
18	C	N	N	M	N	NONE
19	C	N	N	MMO	F	S
20	C	Y	Y	H	M	NONE
21	C	N	N	S	M	NONE
22	C	N	N	MOH	F	NONE
23	C	N	N	SE	M	NONE
24	C	N	Y	M	F	NONE
25	I	N	N	H	M	NONE
26	C	N	Y	M, FT	M	NONE
27	C	N	Y	M	F	NONE
28	C	N	N	MMO	M	NONE
29	D	Y	Y	MMO	F	NONE
30	C	N	Y	M	N	NONE
31	C	Y	Y	MOH	F	NONE
32	I	N	N	MOH	M	N
33	C	N	N	MO	N	NONE
34	C	N	Y	MO	F	NONE
35	D	Y	Y	MO	F	NONE

EB-1T

Tree No.	Dominance	Yellow pine	Leave tree	Damage	Old clips	Aspect
36	C	N	Y	MMO	F	NONE
37	C	N	N	MO	M	NONE
38	C	N	Y	MOH	M	NONE
39	C	N	N	MO	N	NONE
40	C	N	Y	MO	F	NONE
41	C	N	N	MMO	M	NONE
42	I	N	N	MMO	F	NONE
43	D	Y	Y	MMO, MT	M	NONE
44	I	N	N	M	N	NONE
45	D	N	N	MO	N	NONE
46	D	N	Y	MOH	F	NONE
47	C	N	N	MOH	M	NONE
48	C	N	N	MO	F	NONE
49	D	N	N	H	F	NONE
50	C	N	Y	H	M	NONE
51	C	Y	Y	NONE	N	E
52	C	N	Y	MO	F	NONE
53	C	N	Y	H	M	NONE
54	C	N	Y	M	F	NONE
55	C	N	Y	M	N	NONE
56	D	Y	Y	M	F	NONE
57	C	N	N	MOH	F	NONE
58	C	N	Y	MO	M	NONE
59	C	N	N	MOH	N	NONE
60	C	N	Y	M	F	NONE
61	C	N	N	MOH	M	NONE
62	C	N	Y	MOH	M	NONE
63	D	N	Y	MOH	M	NONE
64	D	Y	Y	M, FT	M	NONE
65	C	N	N	H, FT	M	NONE
66	C	N	Y	MMO	F	S

EB-1T

Tree No.	Dominance	Yellow pine	Leave tree	Damage	Old clips	Aspect
67	C	N	Y	MMO	M	S
68	C	Y	Y	M	F	N
69	C	Y	Y	M, FT	F	NONE
70	D	Y	Y	M, FT	F	NONE
71	C	N	Y	MO	F	NONE
72	C	N	Y	MMO	F	NONE
73	I	N	N	MMO	F	S
74	D	N	Y	MMO	F	NONE
75	D	Y	Y	M	F	NONE
76	C	N	N	MO	F	NE
77	D	N	N	M	N	NONE
78	C	N	Y	M	N	SE
79	C	N	N	M	N	SE
80	D	Y	Y	M	F	NONE
81	C	N	Y	M	N	N
82	C	N	Y	M	F	N
83	D	N	Y	M	F	S
84	D	N	Y	H	M	NONE
85	D	N	Y	M	F	NONE
86	C	Y	Y	M	M	NONE
87	C	N	Y	MMO	F	NW
88	D	N	N	MO	M	NONE
89	I	N	N	H	M	NONE
90	D	N	Y	M	F	NE
91	D	Y	Y	M	F	E
92	D	N	Y	MOH	M	NONE
93	C	N	N	S	M	NE
94	C	N	N	MMO	F	NONE
95	C	N	N	M, FT	M	NONE
96	C	N	N	M	F	S

EB-1T

Tree No.	Dominance	Yellow pine	Leave tree	Damage	Old clips	Aspect
97	D	N	Y	MO	F	NONE
98	C	N	N	MO	M	NW
99	D	N	N	MOH	M	S
100	C	N	N	MMO	F	S
101	D	Y	Y	MMO	N	NONE
102	C	Y	Y	M	M	NONE
103	D	N	Y	M	F	NONE
104	D	N	Y	MO	F	NONE
105	C	N	Y	MO	M	NONE
106	C	N	Y	MMO	M	NONE
107	C	N	Y	H	M	NONE
108	D	N	Y	SE	M	NONE
109	C	N	Y	MMO	M	N
110	C	N	Y	M	F	NONE
111	C	N	Y	H	M	NONE
112	D	N	Y	SE	M	NONE
113	C	N	Y	NE	F	NE
114	D	Y	Y	M	N	NONE
115	C	N	Y	MMO	M	NONE
116	C	N	Y	MMO	F	NONE
117	C	N	Y	MOH	F	NONE
118	D	N	Y	M	M	NE
119	C	N	N	M	M	NONE
120	D	Y	Y	M	M	NONE
121	C	N	Y	MOH, FT	M	NONE
122	C	N	N	M	M	NONE
123	D	N	Y	MMO	M	NONE
124	D	Y	Y	M	F	NONE
125	C	N	N	M,FT,PD	M	NONE
126	C	N	N	M, FT	F	N
127	C	N	N	MO, FT	F	N
128	C	N	N	M	F	N
129	C	N	N	H, FT	M	NONE
130	D	N	N	HS	M	NONE

EB-1T

Tree No.	Location	Comments
1	98 deg., 8 paces to #8	Some overlap possible, cone cores difficult to age after rain. Young yellow pine.
2	116 deg., 7 ½ paces to #8	Young yellow pine
3	109 deg., 11 ½ paces to #8	Damage not as bad as would be expected on a small tree with so many clips, but fairly isolated, little question about source.
4	318 deg., 25 paces to #5	Heavy past use
5	294 deg., 18 paces to #5	Scraggly crown
6	299 deg., 9 paces to #5	Two trees joined near base, most clips seem to be from N. one, attributed all sign to it.
7	282 deg., 6 ½ paces to #5	Plot tree #3. Many old digs too, possibly some not squirrel digs--old burrows, etc. Six fresh green clips not included in total.
8	194 deg., 21 paces to #5	Dead top
9	178 deg., 38 paces to #5	Many old clips, some clips from adjacent trees possible.
10	193 deg., 38 paces to #5	
11	56 deg., 14 ½ paces to #6	
12	33 deg., 19 paces to #6	
13	138 deg., 16 paces to #7	
14	171 deg., 15 paces to #7	Didn't count what appear to be nest clips from a nearby tree.
15	162 deg., 14 paces to #7	Didn't count what appear to be nest clips.
16	176 deg., 23 paces to #8	Tree is wrapped around another, straighter tree. Pretty sure sign coming from this tree though.
17	227 deg., 2 paces to #15	Plot tree #1.
18	160 deg., 3 paces to #15	Plot tree #35.
19	31 deg., 23 ½ paces to #16	
20	324 deg., 32 paces to #7	Surrounding YP's may contribute some clips, especially one to SE which is very scragly and possibly dying of unknown cause.
21	320 deg., 26 paces to #7	
22	312 deg., 26 ½ paces to #7	
23	321 deg., 22 paces to #7	
24	306 deg., 27 paces to #7	
25	48 deg., 21 ½ paces to #16	
26	50 deg., 22 paces to #16	
27	50 deg., 20 ½ paces to #16	
28	322 deg., 18 ½ paces to #7	Very many old clips.
29	312 deg., 18 paces to #7	Smaller YP to S. may also have a few clips.
30	319 deg., 2 ½ paces to #7	Plot tree #9
31	3 deg., 8 ½ paces to #16	
32	268 deg., 23 paces to #7	
33	125 deg., 2 ½ paces to #16	Plot tree #3
34	166 deg., 11 ½ paces to #16	
35	179 deg., 17 paces to #16	Possibly some overlap. Large search area, may have missed some twigs, cores.

EB-1T

Tree No.	Location	Comments
36	0 deg., 16 ½ paces to #17	Didn't count what appear to be nest clips, nest tree. Young yellow pine.
37	25 deg., 7 paces to #17	
38	62 deg., 4 ½ paces to #17	Plot tree #8
39	97 deg., 2 paces to #17	Plot tree #11
40	104 deg., 11 paces to #17	
41	86 deg., 16 paces to #17	
42	274 deg., 19 paces to #6	Tree 42 is partially under canopy of tree 43, and isn't very damaged, but assigned sign based on distinct clumping around it.
43	280 deg., 16 paces to #6	
44	269 deg., 16 paces to #6	See note for tree 42, a few clips from adjacent tree to W.
45	310 deg., 17 pacest to #6	
46	312 deg., 23 paces to #6	Young yellow pine, very scragly top
47	58 deg., 23 ½ paces to #17	Open crown
48	156 deg., 19 paces to #17	Plot tree #14 (EM plot?). Some clips from adj. tree, possible overlap on one side.
49	174 deg., 7 paces to #17	Plot tree #12 (EM plot?). Nest on south side, didn't count nest clips or several green clips. Nest is in denser foliage below the heavy clip damage near top.
50	144 deg., 2 feet to #14	Some twigs difficult to age, didn't count several that looked old.
51	261 deg., 15 paces to #14	Some cone cores could be from rock squirrels. Mostly late season cores. Somewhat open, scragly top.
52	176 deg., 5 paces to #21	Plot tree #1. Clips very faded and difficult to spot in yellow needle cast, but still clearly last years.
53	74 deg., 6 ½ paces to #20	Plot tree #21
54	68 deg., 6 paces to #20	Plot tree #20. Mostly feeding clips, but didn't count the few nest clips, nest on S. side.
55	92 deg., 10 paces to #20	Young yellow pine
56	110 deg., 4 paces to #20	Plot tree #22. Overlap possible, large search area.
57	134 deg., 6 paces to #20	Plot tree #23. Overlap possible for trees 57, 58, and 59.
58	160 deg., 8 paces to #20	
59	178 deg., 8 paces to #20	
60	120 deg., 11 paces to #20	Young yellow pine.
61	170 deg., 13 paces to #20	Trees 61 and 62 overlap some.
62	167 deg., 20 paces to #20	Heavier use in past probably.
63	42 deg., 18 paces to #19	Almost all clips on N. side of tree
64	291 deg., 20 paces to #16	
65	286 deg., 13 paces to #16	Some clips may be from adj. tree to N. (almost joined at base).
66	296 deg., 21 paces to #16	

Tree No.	Location	Comments
67	305 deg., 21 paces to #16	
68	348 deg., 11 paces to #16	Nest on W. side, didn't count obvious nest clips, including 2 green nest clips. Most clips very hard to see, lots of needle cast exactly the same color, large search area. Flat top.
69	352 deg., 14 paces to #16	Clips difficult to see.
70	357 deg., 24 paces to #16	Two green clips. Many small burrows around base. Somewhat scragly crown.
71	205 deg., 16 ½ paces to #15	Two green clips and one fresh cone core not counted. Potentially more than 9 cores, several appear to be from tree #70, mostly on that side.
72	193 deg., 10 paces to #15	
73	326 deg., 12 paces to #15	
74	326 deg., 9 ½ paces to #15	Several fresh cores, not counted. Narrow crown.
75	262 deg., 18 paces to #10	Four green clips as well. Watched & photographed 2 Kaibab squirrels feeding on pine cones in this tree at the same time.
76	170 deg., 16 paces to #13	
77	2 deg., 18 ½ paces to #14	
78	47 deg., 10 paces to #14	
79	62 deg., 9 ½ paces to #14	
80	87 deg., 21 paces to #14	Large search area, clips widely scattered. Also one fresh clip and a few fresh cone cores.
81	180 deg., 7 ½ paces to #9	Plot tree #37. Two green clips. Some clips attributed to "some clips" category downhill may be from this tree. Large search area, probably more twigs not found. Flat top.
82	225 deg., 18 paces to #9	
83	12 deg., 17 paces to #15	Young yellow pine. May be additional sign hidden in oak clump.
84	43 deg., 24 ½ paces to #15	Heavier use in past.
85	20 deg., 7 paces to #15	Plot tree #17.
86	301 deg., 10 paces to #8	Many bud tips, probably from pollen cone feeding, only counted substantial terminal clusters as clips. Many early season cores, hard to age and find.
87	200 deg., 15 paces to #2	
88	250 deg., 16 paces to #2	Heavier past use likely.
89	274 deg., 21 paces to #2	Some sign could be from smaller trees to E. and S.
90	110 deg., 15 paces to #10	Young yellow pine.
91	130 deg., 20 paces to #10	
92	142 deg., 21 paces to #10	
93	326 deg., 17 paces to #3	Heavy past use, probably 2+ years ago.
94	113 deg., 27 paces to #9	
95	112 deg., 21 paces to #9	
96	266 deg., 21 paces to #3	

Tree No.	Location	Comments
97	118 deg., 6 paces to #9	Plot tree #32. Young yellow pine.
98	80 deg., 2 paces to #9	Plot tree #38.
99	35 deg., 15 ½ paces to #8	
100	44 deg., 13 paces to #8	
101	54 deg., 7 paces to #8	
102	73 deg., 8 paces to #8	Fairly small search area, but only found one twig. Some clips possibly result of cone feeding, esp. by SPVA?
103	318 deg., 13 paces to #4	Young yellow pine. No rebar for #4, flags only.
104	108 deg., 8 ½ paces to SE corn	No rebar for corner of mapping area, wasn't used as a grid point for veg/track stations but is on same pattern.
105	120 deg., 8 paces to SE corner	See note for tree 104.
106	328 deg., 24 paces to #13	
107	321 deg., 22 paces to #13	Heavier use in past. Several old fungi digs.
108	326 deg., 21 paces to #13	Almost defoliated, very many old clips. Several burrows around base.
109	299 deg., 29 paces to #13	
110	288 deg., 30 paces to #13	
111	122 deg., 14 paces to J1	11 green clips. Several cores may be from SPVA. J1 has no rebar, flag only.
112	226 deg., 19 paces to #13	
113	212 deg., 12 paces to #13	
114	244 deg., 8 paces to #13	
115	186 deg., 14 paces to #12	
116	179 deg., 15 paces to #12	
117	8 deg., 9 paces to #13	Five green clips not counted.
118	38 deg., 5 ½ paces to #10	Plot tree #9
119	260 deg., 9 ½ paces to #1	
120	261 deg., 21 paces to #1	
121	113 deg., 11 paces to #11	Young yellow pine
122	242 deg., 27 paces to #1	
123	160 deg., 21 paces to #11	
124	216 deg., 27 paces to #1	
125	346 deg., 20 paces to #2	Multi-forked top, two dead.
126	296 deg., 23 ½ paces to #2	Overlap with tree 127 likely.
127	292 deg., 25 paces to #2	Overlap with trees 126, 128 likely.
128	286 deg., 26 ½ paces to #2	
129	53 deg., 21 paces to #10	Heavier use in past.
130	46 deg., 17 ½ paces to #10	Very many old clips.

EB-3C

Tree No.	Date	Twig/Cone/Nest	Clips	Cores	Twigs	Digs	DBH (cm)
1	6-27-98	T	20	1	2	0	47.5
2	6-27-98	T, C	38	128	4	4	44.1
3	6-27-98	T	13	1	2	0	37.1
4	6-27-98	C	5	35	0	0	38.2
5	6-27-98	T, C	21	204	1	0	39.6
6	6-27-98	C	7	43	0	0	48.0
7	6-27-98	C	7	53	4	0	40.2
8	6-27-98	C	6	33	0	0	42.2
9	6-27-98	T	31	0	28	0	42.0
10	6-27-98	T	11	13	0	0	49.0
11	6-27-98	T, C	13	36	3	0	48.1
12	6-27-98	T	10	9	7	0	35.2
13	6-27-98	T	14	2	6	0	32.6
14	6-27-98	T	12	6	3	0	27.0
15	6-27-98	T	50	2	26	0	41.9
16	6-27-98	T	63	1	38	0	23.6
17	6-27-98	T	12	2	7	0	32.0
18	6-27-98	T	23	1	15	0	40.9
19	6-27-98	T	25	25	6	0	46.0
20	6-27-98	T, C	42	50	18	0	40.2
21	6-27-98	T, C	16	26	2	2	45.3
22	6-27-98	T, C	12	234	0	0	48.5
23	6-27-98	C	2	51	0	0	51.0
24	6-27-98	T	37	3	17	1	26.9
25	6-27-98	T	29	6	11	0	37.8
26	6-27-98	T	10	0	8	0	23.0
27	6-27-98	T	104	4	50	1	31.7
28	6-27-98	C	3	35	1	0	77.9
29	6-27-98	T	43	0	18	0	31.9
30	6-27-98	T	16	2	2	1	59.4
31	6-27-98	T, C	11	25	0	2	73.8
32	6-27-98	T	45	0	41	0	32.7
33	6-27-98	T	11	6	6	1	41.5
34	6-27-98	T, C	46	211	0	1	88.6
35	6-27-98	T, C	39	214	7	0	89.0
36	6-27-98	T, C	20	21	3	4	51.9
37	6-27-98	T, C	46	59	11	0	65.3
38	6-27-98	T, C	45	35	14	0	34.3

EB-3C

Tree No.	Date	Twig/Cone/Nest	Clips	Cores	Twigs	Digs	DBH (cm)
39	6-27-98	T, C	21	100	0	1	73.5
40	6-27-98	T	12	0	3	0	46.0
41	6-27-98	T	147	0	96	0	31.7
42	6-27-98	T	75	1	54	0	27.4
43	6-27-98	T	24	7	15	0	33.7
44	6-27-98	T	22	0	5	0	32.7
45	6-27-98	T	16	2	2	1	32.3
46	6-27-98	T	10	16	5	0	28.2
47	6-27-98	T	19	4	5	0	38.9
48	6-28-98	C	4	150	1	0	104.8
49	6-28-98	T	31	0	17	0	34.4
50	6-28-98	T	20	15	7	0	43.6
51	6-28-98	T	20	0	8	0	40.0
52	6-28-98	T	28	2	29	0	36.3
53	6-28-98	T	23	6	2	2	72.0
54	6-28-98	T	14	11	2	0	39.5
55	6-28-98	T	19	0	11	0	31.8
56	6-28-98	T	16	2	5	2	30.9
57	6-28-98	T	36	2	36	0	29.7
59	6-28-98	T	88	1	41	0	35.6
60	6-28-98	T	28	0	3	0	21.0
61	6-28-98	T	22	7	5	0	37.3
62	6-28-98	T	44	20	14	0	69.2
63	6-28-98	T, C	43	96	20	1	50.9
64	6-28-98	T	13	5	1	0	53.3
65	6-28-98	T	23	17	2	1	60.0
66	6-28-98	T	49	0	14	0	37.3
67	6-28-98	T	32	3	1	0	?
68	6-28-98	T	17	0	5	0	57.1
69	6-28-98	T	14	0	3	0	29.6
70	6-28-98	T	15	2	5	1	38.1
71	6-28-98	T	21	5	8	0	48.8
72	6-28-98	T	15	0	3	0	42.0
73	6-28-98	T	26	2	8	0	38.9
74	6-28-98	T	50	6	23	0	37.5
75	6-28-98	T, C	24	25	9	0	44.7
76	6-28-98	T	44	0	22	0	40.2

EB-3C

Tree No.	Date	Twig/Cone/Nest	Clips	Cores	Twigs	Digs	DBH (cm)
77	6-28-98	T	16	0	5	0	28.6
78	6-28-98	T	15	1	3	0	28.7
79	6-28-98	C	7	55	0	0	45.5
80	6-28-98	C	5	131	0	0	90.1
81	6-28-98	C	8	147	0	2	55.4
82	6-28-98	T	43	0	23	0	96.1
83	6-28-98	T	18	2	1	0	55.0
84	6-28-98	T	32	0	11	3	32.8
85	6-28-98	T	19	13	3	0	41.2
86	6-28-98	T	306	0	170	0	44.7
87	6-28-98	T	29	1	1	0	49.8
88	6-28-98	T	20	2	0	0	44.4
89	6-28-98	T	25	2	3	0	46.1
90	6-28-98	T	56	2	26	0	45.0
91	6-29-98	T, C	33	415	0	0	72.4
92	6-29-98	T	47	4	26	0	31.6
93	6-29-98	T	72	5	34	0	41.9
94	6-29-98	T	49	0	18	0	21.1
95	6-29-98	T	21	0	14	0	24.1
96	6-29-98	T	17	2	12	1	27.2
97	6-29-98	T	20	0	2	0	40.5
98	6-29-98	C	3	48	0	0	53.5
99	6-29-98	T, C	49	56	11	4	86.6
100	6-29-98	T	41	2	11	1	39.1
101	6-29-98	T	30	0	7	1	77.4
102	6-29-98	T	15	0	4	0	25.0
103	6-29-98	T	80	1	24	0	28.5

EB-3C

Tree No.	Date	Twig/Cone/Nest	Clips	Cores	Twigs	Digs	DBH (cm)
104	6-29-98	T	48	1	11	0	33.6
105	6-29-98	T	14	5	1	0	49.9
106	6-29-98	T, C	33	35	6	1	68.5
107	6-29-98	T	65	15	9	0	86.2
108	6-29-98	T	30	5	7	0	33.4
109	6-29-98	T	41	5	7	0	39.9
110	6-29-98	T, C	92	250	8	1	52.2
111	6-29-98	T	53	0	33	0	28.1
112	6-29-98	T	25	0	8	0	22.3
113	6-29-98	T	44	0	32	0	34.9
114	6-29-98	T	22	0	8	1	48.7
115	6-29-98	T	92	2	49	0	40.0
116	6-29-98	T	63	0	26	0	31.0
117	6-29-98	T	14	2	8	1	35.2
118	6-29-98	T, C	15	54	2	4	61.2
119	6-29-98	T, C	36	44	29	0	42.8
120	6-29-98	T	14	13	13	0	46.5
121	6-29-98	T	14	1	5	0	40.3
122	6-29-98	T	19	3	1	3	50.4
123	6-29-98	T	198	3	141	0	41.3
124	6-29-98	T	30	1	9	0	43.1
125	6-29-98	T	30	0	9	1	37.6
126	6-29-98	T	25	0	3	0	37.3
127	6-29-98	T	12	2	5	0	36.2
128	6-30-98	T	19	3	8	0	39.5
129	6-30-98	T	15	4	6	0	47.4
130	6-30-98	T, C	20	36	8	1	42.8
131	6-30-98	T	10	7	2	1	44.6
132	6-30-98	T	77	2	33	0	34.2
133	6-30-98	T	27	0	3	1	45.4
134	6-30-98	C, N	6	52	2	0	73.1
135	6-30-98	C	5	159	0	0	83.0

EB-3C

Tree No.	Date	Twig/Cone/Nest	Clips	Cores	Twigs	Digs	DBH (cm)
136	6-30-98	T	14	16	2	0	42.2
137	6-30-98	T	17	6	3	0	39.0
138	6-30-98	T	276	2	161	0	41.8
139	6-30-98	T	24	2	15	0	35.0
140	6-30-98	T, C	27	62	8	2	51.3
141	6-30-98	T	17	4	11	0	29.7
142	6-30-98	T	14	2	9	1	36.1
143	6-30-98	T, C	20	23	5	4	52.5
144	6-30-98	T	34	11	7	0	80.0
145	6-30-98	T	12	2	0	0	25.5
146	6-30-98	T	136	1	66	0	34.2
147	6-30-98	T, C	38	47	3	0	73.6
148	6-30-98	T	12	0	0	0	30.7
149	6-30-98	T	52	3	26	0	42.3
150	6-30-98	C	6	85	0	0	40.3
151	6-30-98	T	88	2	33	0	46.6
152	6-30-98	T	166	1	79	0	40.3
153	6-30-98	T	51	1	35	0	36.0
154	6-30-98	T	121	0	34	0	50.1
155	6-30-98	T	26	0	9	0	40.0
156	7-1-98	T, C	14	67	6	0	48.8
157	7-1-98	T	39	1	22	0	53.5

EB-3C

Tree No.	Dominance	Yellow pine	Leave tree	Damage	Old clips	Aspect
1	C	N	Y	MO	M	SE
2	C	N	Y	M	F	SSE
3	C	N	Y	M	N	S
4	C	N	Y	NONE	F	SSE
5	C	N	Y	M	N	SSE
6	C	N	Y	M	N	SSE
7	C	N	Y	M, FT	M	SSE
8	C	N	Y	M	F	SSE
9	C	N	Y	MOH	M	SSE
10	C	N	Y	M	F	SSE
11	C	N	Y	MOH	M	SSE
12	C	N	Y	HS	M	SSE
13	C	N	Y	MOH	F	S
14	C	N	Y	M	F	S
15	I	N	Y	H	M	S
16	C	N	Y	E	M	SSE
17	C	N	Y	HS	M	SSE
18	C	N	Y	M	F	SSE
19	C	N	Y	MOH	F	SSE
20	C	N	Y	H	M	SSE
21	C	N	Y	M	F	SSE
22	C	N	Y	M	N	SSE
23	C	N	Y	BD	N	SSE
24	C	N	Y	H	M	SSE
25	C	N	Y	MO	F	SSE
26	C	N	Y	S	M	SSE
27	C	N	Y	MOH	M	SSW
28	D	Y	Y	M	N	SSW
29	I	N	Y	M	M	SSE
30	C	N	Y	M	F	SSE
31	D	Y	Y	M	N	S
32	C	N	Y	H	M	SSE
33	C	N	Y	HS	M	SSW
34	D	Y	Y	M, MT	F	SSE
35	D	Y	Y	M, BD	F	S
36	C	N	Y	HS	M	S
37	C	N	Y	MO	F	S
38	I	N	Y	MOH	F	SSE

EB-3C

Tree No.	Dominance	Yellow pine	Leave tree	Damage	Old clips	Aspect
39	C	Y	Y	M,FT, PD	F	SSE
40	C	N	Y	MO	M	S
41	C	N	Y	MO, FT	M	SSE
42	C	N	Y	HS	F	SSE
43	C	N	Y	MMO	F	SSE
44	C	N	Y	MO	M	SSE
45	C	N	Y	M	F	SSE
46	I	N	Y	MO, PD	M	SSE
47	C	N	Y	MOH	M	SSE
48	D	Y	Y	M	F	ESE
49	C	N	Y	MOH, FT	F	SE
50	C	N	Y	M	N	SE
51	C	N	Y	MMO	F	SE
52	C	N	Y	H	M	SE
53	C	Y	Y	M, PD	F	SE
54	C	N	Y	M	F	SE
55	C	N	Y	MMO	N	SE
56	C	N	Y	MOH	M	SE
57	C	N	Y	M	F	SE
59	C	N	Y	HS	M	SE
60	C	N	Y	H	M	SE
61	C	N	Y	MMO	F	SE
62	D	Y	Y	M, FT, MT	M	SSE
63	C	N	Y	MMO	F	S
64	D	N	Y	M	N	S
65	D	N	Y	MMO, FT	F	S
66	C	N	Y	E	M	S
67	C	N	Y	M	F	S
68	C	N	Y	M	F	S
69	C	N	Y	M	F	S
70	C	N	Y	MMO	F	S
71	C	N	Y	MMO, FT	M	S
72	C	N	Y	M	F	S
73	C	N	Y	MOH	M	SSE
74	C	N	Y	MO	M	SSE
75	C	N	Y	MO	M	SSE
76	C	N	Y	MO	M	SSE

EB-3C

Tree No.	Dominance	Yellow pine	Leave tree	Damage	Old clips	Aspect
77	C	N	Y	MO	F	SSE
78	C	N	Y	MO	F	SSE
79	C	N	Y	M	N	SSE
80	C	Y	Y	M, MT	N	S
81	C	N	Y	M	F	S
82	C	Y	Y	M, PD, BD	M	S
83	C	N	Y	H, FT	M	S
84	C	N	Y	MMO	N	SE
85	C	N	Y	M	F	SE
86	C	N	Y	H	M	SE
87	C	N	Y	M	M	SE
88	C	N	Y	M	F	SE
89	C	N	Y	M	F	SE
90	C	N	Y	MOH	M	SE
91	C	Y	Y	M, MT	M	SSE
92	C	N	Y	H	M	SE
93	C	N	Y	MMO	M	SE
94	C	N	Y	H	F	SSE
95	C	N	Y	HS	F	SSE
96	C	N	Y	MO	M	SSE
97	C	N	Y	M	F	SE
98	C	N	Y	M	N	SE
99	C	Y	Y	MO, PD	M	ENE
100	C	N	Y	MO, FT	M	ENE
101	C	Y	Y	M, MT	M	ENE
102	C	N	Y	H	M	E
103	C	N	Y	H	M	E

EB-3C

Tree No.	Dominance	Yellow pine	Leave tree	Damage	Old clips	Aspect
104	C	N	Y	H	M	E
105	D	N	Y	MMO, FT	M	E
106	C	Y	Y	MMO, PD	M	E
107	D	Y	Y	MO, MT	M	SE
108	C	N	Y	H	M	SSE
109	C	N	Y	MO	M	SSE
110	C	N	Y	MO	M	SSE
111	C	N	Y	S	M	SSE
112	C	N	Y	MO	M	SSE
113	C	N	Y	S	M	SE
114	C	N	Y	MOH	M	SE
115	D	N	Y	E	M	SSE
116	D	N	Y	E	M	SSE
117	I	N	Y	MOH	F	SE
118	D	Y	Y	M	F	SE
119	C	N	Y	MMO	M	S
120	C	N	Y	M	F	S
121	C	N	Y	E	M	S
122	C	N	Y	M, FT	F	SE
123	C	N	Y	H	M	SE
124	C	N	Y	MMO	M	SE
125	C	N	Y	M	M	SE
126	C	N	Y	M	M	SE
127	C	N	Y	M, FT	M	SE
128	C	N	Y	MO	M	SE
129	C	N	Y	M	M	SE
130	C	N	Y	M	F	SE
131	C	N	Y	M	F	SE
132	C	N	Y	H	M	SE
133	C	N	Y	MOH, PD	F	SE
134	C	Y	Y	M	F	SE
135	C	Y	Y	M	N	SE

EB-3C

Tree No.	Dominance	Yellow pine	Leave free	Damage	Old clips	Aspect
136	C	N	Y	M	M	SE
137	C	N	Y	MO	F	SE
138	C	N	Y	H	M	SE
139	C	N	Y	MOH	M	SE
140	C	N	Y	M	F	SE
141	C	N	Y	MO, FT	F	SE
142	C	N	Y	MMO	F	SE
143	D	N	Y	M	F	SE
144	D	Y	Y	M	M	SE
145	I	N	Y	MMO	F	SE
146	C	N	Y	HS	M	SE
147	D	Y	Y	M, MT	M	SE
148	D	N	Y	SE, FT	M	SE
149	C	N	Y	H	M	SE
150	C	N	Y	M	F	E
151	C	N	Y	MO	M	SE
152	C	N	Y	S	M	SSE
153	C	N	Y	S	M	SSE
154	C	N	Y	H	M	SSE
155	C	N	Y	MO	F	SSE
156	C	N	Y	M	M	S
157	D	N	Y	MO	M	W

Tree No.	Location	Comments
1	262 deg., 7 paces to #24	
2	207 deg., 19 ½ paces to #24	No very fresh cores, saw squirrels eating fungi this AM.
3	205 deg., 25 paces to #24	
4	54 deg., 24 paces to #14	Hard to separate cone cores of trees 4 and 5 in one area.
5	50 deg., 23 paces to #14	Clips may be by-product of cone clipping, few twigs.
6	45 deg., 25 paces to #14	
7	298 deg., 1.5 feet to #23	
8	314 deg., 5 paces to #23	Difficult to separate sign of trees 8,10, 11,12 due to interlocking crowns.
9	272 deg., 7 ½ paces to #23	Heavy past use
10	324 deg., 8 paces to #23	
11	323 deg., 3 paces to #23	Heavy past use
12	292 deg., 5 paces to #23	
13	274 deg., 13 paces to #23	Sign difficult to separate, surrounding trees all appear to have a few clips.
14	286 deg., 16 paces to #23	DBH estimated, another tree next to trunk.
15	124 deg., 8 ½ paces to #13	
16	57 deg., 19 paces to #14	
17	59 deg., 19 paces to #14	
18	61 deg., 20 paces to #14	
19	57 deg., 21 paces to #14	
20	194 deg., 5 paces to #13	Some clips from smaller adjacent tree.
21	142 deg., 2 ½ paces to #13	
22	182 deg., 12 paces to #13	
23	170 deg., 12 paces to #13	Some overlap with tree 22, small scar on N. side of trunk.
24	29 deg., 8 paces to #14	
25	52 deg., 7 ½ paces to #14	
26	36 deg., 7 ½ paces to #14	Heavy past use
27	306 deg., 15 ½ paces to #22	
28	256 deg., 3 ½ paces to #22	
29	104 deg., 14 paces to #14	
30	114 deg., 18 paces to #14	Young yellow pine
31	61 deg., 24 paces to #15	
32	81 deg., 13 ½ paces to #15	
33	76 deg., 8 paces to #15	
34	18 deg., 18 ½ paces to #15	Old, slightly misshapen trunk
35	266 deg., 10 ½ paces to #13	Four small trees to E. have clip damage apparent, but only a few clips each. Mostly healed old lightning scar (?).
36	269 deg., 18 paces to #13	Heavy past use
37	269 deg., 21 ½ paces to #13	
38	149 deg., 17 paces to #12	Some overlap (primarily cone cores) with adjacent yellow pine.

Tree No.	Location	Comments
39	324 deg., 12 ½ paces to #14	Cone cores estimated, multiple tops and dead limbs.
40	142 deg., 21 paces to #12	
41	290 deg., 17 paces to #14	DBH from north trunk, both similar in diameter.
42	292 deg., 22 paces to #14	Sign from trees 42 and 43 overlap.
43	289 deg., 23 paces to #14	
44	278 deg., 27 paces to #14	
45	359 deg., 17 ½ paces to #11	
46	0 deg., 11 paces to #11	Cone core overlap with tree 48, only attributed some to tree 46 due to condition--broken top.
47	2 deg., 14 paces to #11	
48	356 deg., 10 paces to #11	Cone cores estimated. Old, scraggly tree.
49	34 deg., 11 ½ paces to #11	
50	220 deg., 16 paces to #14	Sign of trees 50, 51, 52 overlap somewhat.
51	212 deg., 15 paces to #14	
52	212 deg., 16 paces to #14	Heavy past use
53	232 deg., 13 paces to #14	Possibly some clips from smaller adjacent tree on SE side.
54	274 deg., 8 paces to #15	
55	244 deg., 30 ½ paces to #14	
56	240 deg., 17 ½ paces to #14	Adjacent, smaller trees may contribute a few clips.
57	43 deg., 20 paces to #10	
59	214 deg., 14 paces to #22	A few clips from nearby trees.
60	240 deg., 14 ½ paces to #22	Some clips from surrounding trees.
61	236 deg., 16 paces to #22	
62	334 deg., 1 ½ paces to #21	Some clips from nearby trees, some overlap. Heavy past use. Crooked, forked top.
63	184 deg., 19 paces to #21	Dead top tree under it might have contributed a few clips.
64	348 deg., 7 paces to #20	Several clips with long twigs, no nest though.
65	321 deg., 15 paces to #20	
66	72 deg., 22 paces to #17	Very many old clips, essentially defoliated at top, lower limbs relatively full.
67	11 deg., 6 paces to #17	Smaller tree joined at base may add a few clips, one long twig, no nest.
68	44 deg., 1 ½ paces to #17	Some look like nest clips (long twigs attached), can't see a nest though. No peeled twigs.
69	120 deg., 18 ½ paces to #15	
70	120 deg., 20 ½ paces to #15	
71	140 deg., 17 ½ paces to #15	Very many old clips
72	170 deg., 11 paces to #15	
73	208 deg., 5 ½ paces to #15	Sign of trees 73, 74, and 75 overlap.
74	189 deg., 7 paces to #15	
75	186 deg., 9 ½ paces to #15	Many fresh cone cores, many old clips, pollen cone/bud tip cuttings
76	131 deg., 28 paces to #15	

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Tree No.	Location	Comments
77	135 deg., 31 paces to #15	Very difficult to tell if all sign coming from this treee, intermediate between 77 and 78, positioned right for much of sign, but doesn't show any damage.
78	138 deg., 31 paces to #15	Tree joined at base may be contributing some sign.
79	134 deg., 34 paces to #15	
80	124 deg., 24 paces to #16	Short and squat, possibly broken top in past?
81	58 deg., 10 ½ paces to #16	
82	140 deg., 16 paces to #16	Tree broken halfway up, only a few lower limbs still left, missing bark N. side. Many old clips, considering condition amazing it's still alive (and brake looks very old).
83	195 deg., 11 paces to #16	Very many old clips
84	266 deg., 16 paces to #15	Difficult to tell which tree sign is from.
85	218 deg., 8 ½ paces to #15	Some of sign may be from feed trees uphill (73, 74, 75) and upwind.
86	204 deg., 20 ½ paces to #15	Tree in surprisingly good shape considering level of use and past use.
87	59 deg., 20 paces to #8	Difficult to tell which tree sign is from (87, 88 and possibly a tree joined to base of 87).
88	64 deg., 19 ½ paces to #8	
89	19 deg., 17 ½ paces to #8	Very hard to assign sign to trees, counted most in "dispersed clips" category.
90	19 deg., 21 ½ paces to #8	
91	118 deg., 22 paces to #10	Big search area, may be twigs I didn't see, probably quite a few more cones too. Crooked top, scraggly.
92	116 deg., 29 ½ paces to #10	Uphill from tree 91, beyond likely cone fall range if just gravity involved. Many yellow pine below in fairly steep little swale--no running water.
93	120 deg., 29 ½ paces to #10	Some clips from surrounding trees.
94	157 deg., 20 paces to #10	Trees 94 and 95 in dense thicket of small PIPO, damage to crown is primary indicator these trees contribute majority of sign.
95	155 deg., 16 paces to #10	
96	155 deg., 14 paces to #10	Heavy past use
97	30 deg., 13 paces to #9	Nest in adjacent tree, didn't count clips w/very long twigs attached.
98	119 deg., 13 paces to #9	
99	115 deg., 16 paces to #1	May be osme overlap with other trees. Old fire scar East side. Dead top.
100	107 deg., 19 ½ paces to #1	Some overlap with tree 101.
101	112 deg., 19 paces to #1	Crooked, scraggly top. Possibly some overlap with understory trees, old fire scar W. side.
102	110 deg., 23 paces to #1	Trees 102, 103, and 104 overlap somewhat.
103	118 deg., 22 paces to #1	

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Tree No.	Location	Comments
104	114 deg., 22 ½ paces to #1	
105	98 deg., 26 paces to #1	Heavy past use
106	122 deg., 27 paces to #1	Some overlap with other trees, dead top.
107	135 deg., 38 ½ paces to #1	Leaning and branches twisted around YP snag next to it. A few clips like nest clips, but no next visible. Some clips hard to age, could be quite a few more than 65--I was conservative in aging them.
108	34 deg., 19 paces to #2	Sign of 108, 109, 110 overlap extensively. Many cores attributed to tree 110 which are near this tree.
109	32 deg., 20 paces to #2	
110	40 deg., 18 paces to #2	Number of cone cores estimated.
111	168 deg., 22 ½ paces to #1	Trees surrounding 111, 112 also contributing some clips.
112	160 deg., 21 paces to #1	
113	52 deg., 3 paces to #2	
114	20 deg., 1m to #2	Tree between 113 and 114 may be contributing clips.
115	120 deg., 20 ½ paces to #2	
116	110 deg., 23 ½ paces to #2	
117	28 deg., 15 paces to #3	
118	30 deg., 11 paces to #3	Flat top, scraggly.
119	202 deg., 21 paces to #10	
120	212 deg., 19 paces to #10	Trees 119, 120 overlap somewhat.
121	230 deg., 10 paces to #10	Very heavy past use, most damaged at top.
122	234 deg., 30 paces to #10	
123	224 deg., 24 paces to #10	
124	161 deg., 18 paces to #3	
125	168 deg., 15 paces to #3	Surrounding trees also a few clips, some look more damaged, but less sign.
126	173 deg., 22 paces to #3	
127	170 deg., 25 paces to #3	Also clips from nearby trees.
128	296 deg., 9 paces to #9	Adjacent tree might contribute a few clips.
129	338 deg., 9 paces to #9	
130	326 deg., 11 paces to #9	
131	314 deg., 9 paces to #9	
132	191 deg., 20 paces to #9	Some clips from surrounding trees.
133	299 deg., 24 ½ paces to #8	Several limbs dead, brown needles, uncertain of cause.
134	220 deg., 28 paces to #9	Flat top. Saw squirrel shred bark from dead ARTR nearby, then carry mouthful to top of this tree (assume for a nest, but can't see--went to very top where it's flat).
135	222 deg., 27 paces to #9	Flat top. Cones of trees 134, 135 overlap somewhat. Many of the cores are from mostly mature cones, only bottom portion eaten.

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Tree No.	Location	Comments
136	111 deg., 19 paces to #4	
137	92 deg., 21 paces to #4	Surrounding trees show damage from past use, may contribute a few clips.
138	168 deg., 3 ½ paces to #4	Probably many more twigs under clips.
139	149 deg., 13 paces to #4	Sign of 139-142 overlap in continuous belt of clips.
140	142 deg., 10 ½ paces to #4	
141	128 deg., 8 ½ paces to #4	Difficult to be sure sign is being correctly assigned to this tree.
142	140 deg., 6 paces to #4	
143	180 deg., 13 ½ paces to #4	
144	205 deg., 16 paces to #9	Some clips had long twigs, others didn't--no nest and 7+ twigs.
145	202 deg., 22 paces to #9	
146	300 deg., 18 paces to #7	
147	295 deg., 14 paces to #7	Flat, crooked top, scraggly.
148	288 deg., 7 ½ paces to #7	Several trees in area appear to have been used fairly heavy in past, some feed trees off sampled area. Very heavy past use of this tree.
149	304 deg., 27 ½ paces to #7	Heaviest damage at top.
150	34 deg., 8 paces to #7	Many fresh cone cores from trees to N., not from last year though.
151	334 deg., 26 ½ paces to #18	
152	210 deg., 11 ½ paces to #17	
153	216 deg., 11 ½ paces to #17	Trees 152, 153 overlap.
154	10 deg., 16 paces to #18	Heaviest damage at top.
155	346 deg., 25 paces to #18	DBH estimated, dead tree next to trunk.
156	14-0 deg., 13 ½ paces to #17	
157	300 deg., 6 ½ paces to #19	Open grown.

EB-3T

Tree No.	Date	Twig/Cone/Nest	Clips	Cores	Twigs	Digs	DBH (cm)
1	7-1-98	T	18	7	8	2	53.0
2	7-1-98	T	28	13	11	1	55.0
3	7-1-98	T, C	25	67	4	1	69.1
4	7-1-98	T	12	2	10	2	27.3
5	7-1-98	T	10	2	8	0	26.3
6	7-1-98	T	12	3	3	0	31.3
7	7-1-98	T	16	6	18	0	24.8
8	7-1-98	T	37	1	16	0	33.9
9	7-1-98	T	27	1	22	1	36.9
10	7-1-98	T	52	1	24	1	28.5
11	7-1-98	T	13	0	2	1	45.2
12	7-1-98	T	23	1	5	0	37.4
13	7-1-98	T	31	1	18	0	32.4
14	7-1-98	T	184	1	133	0	38.9
15	7-1-98	T	14	2	1	1	42.0
16	7-1-98	T	16	0	7	1	33.3
17	7-1-98	T	66	0	41	0	28.2
18	7-10-98	T	28	4	7	1	38.0
19	7-10-98	T	23	3	12	3	43.9
20	7-10-98	T	43	0	10	0	32.2
21	7-10-98	T	49	1	16	0	38.2
22	7-11-98	T	15	0	4	0	34.6
23	7-11-98	T	27	0	9	0	22.1
24	7-11-98	T	27	0		3	36.1
25	7-11-98	T	19	15	1	0	63.3
26	7-11-98	T	12	2	4	1	40.7
27	7-11-98	T, N	25	17	3	7	107.9
28	7-11-98	T, C	47	47	2	6	96.1
29	7-11-98	T	18	0	10	0	26.2
30	7-11-98	T	20	7	1	4	96.4
31	7-11-98	T	19	3	5	4	50.4
32	7-11-98	T	23	0	8	0	34.1
33	7-11-98	T	26	1	5	0	29.1

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Tree No.	Date	Twig/Cone/Nest	Clips	Cores	Twigs	Digs	DBH (cm)
34	7-11-98	T	12	0	4	1	37.8
35	7-11-98	T	33	0	16	0	25.5
36	7-11-98	T	28	0	6	0	38.9
37	7-11-98	T	38	2	13	0	30.5
38	7-11-98	T	31	2	7	0	33.0
39	7-11-98	T	52	5	8	0	30.0
40	7-11-98	C	6	32	0	0	37.3
41	7-11-98	T	18	4	2	0	41.2
42	7-11-98	T	20	2	0	0	43.2
43	7-11-98	T	18	0	8	0	32.0
44	7-11-98	T	11	0	6	0	25.6
45	7-11-98	T	20	0	8	0	31.3
46	7-11-98	T	19	10	0	0	32.9
47	7-11-98	T	16	4	6	0	37.8
48	7-11-98	T	17	1	2	0	25.9
49	7-11-98	T	26	0	12	1	35.1
50	7-11-98	T	38	5	23	0	21.2
51	7-11-98	T	66	0	28	0	35.7
52	7-11-98	T	23	0	5	0	24.8
53	7-11-98	T	65	2	22	0	36.4
54	7-11-98	T	83	4	32	0	41.8
55	7-11-98	T	56	1	19	1	40.4
56	7-11-98	T	14	0	3	0	38.6
57	7-11-98	T	102	0	38	0	42.5
58	7-11-98	T	28	0	4	0	38.2
59	7-11-98	T	65	2	39	1	43.7
60	7-11-98	T	14	2	0	0	36.2
61	7-12-98	T	14	1	2	0	28.6
62	7-12-98	T	17	1	1	0	36.7
63	7-12-98	T	12	0	3	0	34.3
64	7-12-98	T	30	3	15	0	42.7
65	7-12-98	T	12	2	0	0	38.3
66	7-12-98	T	23	1	2	0	33.0
67	7-12-98	T	27	2	10	2	35.4
68	7-12-98	T, C	22	22	0	0	35.9
69	7-12-98	T	24	2	2	0	44.2
70	7-12-98	T	14	1	2	0	42.1
71	7-12-98	T	56	2	17	0	36.9
72	7-12-98	T	45	1	6	0	46.3

EB-3T

Tree No.	Date	Twig/Cone/Nest	Clips	Cores	Twigs	Digs	DBH (cm)
73	7-12-98	T	23	1	0	1	92.0
74	7-12-98	T	12	1	3	0	40.9
75	7-12-98	T	13	3	1	0	38.3
76	7-12-98	T	21	0	6	0	40.4
77	7-12-98	T, C	12	84	0	0	88.8
79	7-12-98	T	32	7	9	0	41.2
81	7-12-98	T	22	4	1	0	54.0
82	7-12-98	T	18	0	7	0	43.1
83	7-12-98	T	17	0	8	1	32.7
84	7-12-98	T	19	1	2	0	38.6
85	7-12-98	C	2	117	0	3	89.7
86	7-12-98	T, N	17	9	1	3	85.5
87	7-12-98	T	24	0	3	0	37.5
88	7-12-98	T	13	0	1	0	33.6
89	7-12-98	T	36	2	6	0	38.5
90	7-12-98	T, C	61	81	2	0	41.1
91	7-12-98	T	20	0	0	0	41.8
92	7-12-98	T	38	0	1	1	42.3
93	7-12-98	T	110	1	64	0	30.6
94	7-12-98	T	47	0	25	1	30.6
95	7-12-98	T, C	17	114	0	0	41.3
96	7-12-98	T, C	15	23	0	2	39.5
97	7-12-98	T	11	1	1	0	45.2
98	7-12-98	T	10	0	4	0	35.9
99	7-12-98	T	23	1	18	0	29.2
100	7-12-98	T	22	0	9	0	40.1
101	7-12-98	T, C	35	34	0	0	47.5
102	7-12-98	T	17	0	3	0	38.0
103	7-12-98	T	16	0	2	0	33.5
104	7-12-98	T	29	0	6	0	53.4
105	7-12-98	T	32	4	5	0	50.0
106	7-13-98	T	23	1	5	1	50.5
107	7-13-98	T, C	44	33	1	0	61.5

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Tree No.	Date	Twig/Cone/Nest	Clips	Cores	Twigs	Digs	DBH (cm)
108	7-13-98	T	15	15	0	0	74.4
109	7-13-98	T	22	4	8	0	40.5
110	7-13-98	T	24	1	2	0	36.6
111	7-13-98	T	16	0	6	0	30.8
112	7-13-98	T	27	0	15	0	20.4
113	7-13-98	T	14	1	4	1	79.2
114	7-13-98	T	98	4	25	7	43.8
115	7-13-98	T	28	0	7	2	28.9
116	7-13-98	T	23	0	5	1	37.7
117	7-13-98	T	25	1	7	3	39.8
118	7-13-98	T	40	1	21	1	33.4
119	7-13-98	T	20	5	0	0	35.9
120	7-13-98	T	15	18	0	0	54.9
121	7-13-98	T, N*	15	1	0	0	54.6
122	7-13-98	T	28	5	6	0	43.1
123	7-13-98	T	30	3	1	0	41.4
124	7-13-98	T	17	1	0	6	114.3
125	7-13-98	T	39	3	9	0	48.8
126	7-13-98	T, N*	20	1	1	0	47.9
127	7-13-98	T	23	0	8	0	40.0
128	7-13-98	T	34	0	3	0	35.6
129	7-13-98	T	21	2	8	1	54.7
130	7-14-98	T	20	8	3	0	38.8
131	7-14-98	T	110	0	48	0	36.1
132	7-14-98	T	19	0	7	2	30.0
133	7-14-98	T	19	1	2	0	31.5
134	7-14-98	T	32	1	18	0	37.5
135	7-14-98	T, C	12	44	3	1	38.9
136	7-14-98	T	19	1	2	0	42.5
137	7-14-98	T	18	1	1	0	43.5
138	7-14-98	T	11	9	1	0	37.0
139	7-14-98	T	20	1	1	1	46.5
140	7-14-98	T, C	24	56	1	0	51.8
141	7-14-98	T	30	0	3	2	64.8
142	7-14-98	T	32	0	3	0	48.8
143	7-14-98	T	94	2	30	0	64.3
144	7-14-98	T	269	0	135	1	36.1

EB-3T

Tree No.	Date	Twig/Cone/Nest	Clips	Cores	Twigs	Digs	DBH (cm)
145	7-14-98	T	23	5	0	0	80.1
146	7-14-98	T	12	19	1	1	71.2
147	7-14-98	T, C	40	273	4	1	61.1
148	7-14-98	T, C	94	231	4	0	92.2
149	7-14-98	T	33	2	7	0	26.9
150	7-14-98	T, C	136	280	6	0	58.4
151	7-15-98	T	120	0	65	0	31.7
152	7-15-98	T	33	0	9	0	26.7
153	7-15-98	T	17	1	3	0	28.5
154	7-15-98	T	50	1	19	1	35.6
155	7-15-98	T	16	0	2	1	27.2
156	7-15-98	T	26	18	3	0	55.5
157	7-15-98	T, C	15	119	3	0	40.0
158	7-15-98	T, C	21	33	4	0	39.4
159	7-15-98	T	23	2	5	0	38.8
160	7-15-98	T	177	3	43	3	55.9
161	7-15-98	T	21	1	7	0	44.9
162	7-15-98	T, C	12	60	1	0	54.8
163	7-15-98	T	27	2	1	0	55.4
164	7-15-98	T	33	3	9	0	36.3
165	7-15-98	T	28	1	16	0	31.2
166	7-15-98	T	15	13	0	1	47.4
167	7-15-98	T, C	22	20	1	0	43.0
168	7-15-98	T	24	3	1	1	45.3
169	7-15-98	T	10	3	5	0	53.3
42B	7-11-98	T	14	0	3	0	41.3

EB-3T

Tree No.	Dominance	Yellow pine	Leave tree	Damage	Old clips	Aspect
1	C	Y	Y	MMO, MT	F	SSE
2	C	Y	Y	M	F	SSE
3	C	Y	Y	M	F	SSE
4	I	N	N	MOH	M	ESE
5	I	N	N	MO	F	ESE
6	C	N	N	H	M	SE
7	C	N	N	HS	M	SE
8	C	N	N	HS	M	SE
9	C	N	N	MMO	M	SE
10	C	N	N	MO	M	SE
11	D	N	N	MO	M	SE
12	C	N	N	H	M	SSW
13	C	N	N	MOH	M	ESE
14	C	N	N	H	M	S
15	D	N	N	MO	M	SE
16	C	N	Y*	MO	M	SSE
17	C	N	N	HS	M	SW
18	C	N	Y*	M	M	ESE
19	D	N	Y*	MO	M	E
20	C	N	Y*	MOH	M	ESE
21	C	N	N	MO	M	SE
22	C	N	N	MOH	M	SE
23	C	N	N	MO	M	SE
24	C	N	N	M	F	ESE
25	C	Y	Y	MO, BD	M	SE
26	C	N	Y	MOH	F	SE
27	C	Y	Y	M	M	SE
28	C	Y	Y	M	M	E
29	I	N	N	MOH	M	SSW
30	D	Y	Y	M	F	SW
31	C	N	N	M	F	SW
32	C	N	N	MO	F	SSW
33	C	N	N	HS	M	SW

Tree No.	Dominance	Yellow pine	Leave tree	Damage	Old clips	Aspect
34	I	N	Y	S	F	S
35	C	N	N	MO	M	S
36	C	N	N	E	M	S
37	C	N	N	S, FT	M	S
38	C	N	N	HS	F	SSE
39	C	N	N	S	M	E
40	D	N	N	N	N	E
41	D	N	N	MOH	M	ESE
42	C	N	N	M	F	ESE
43	C	N	N	MMO, FT	F	ESE
44	I	N	N	MMO	F	SE
45	C	N	N	MMO	F	SE
46	C	N	N	M	F	SSE
47	C	N	N	MMO, PD	F	ESE
48	I	N	N	S, FT, PD	M	S
49	C	N	Y	H	M	
50	C	N	N	H	N	SE
51	C	N	N	MOH, FT	N	SE
52	C	N	N	MMO	F	SE
53	C	N	N	MOH	M	SE
54	C	N	Y	H, FT	M	ESE
55	D	N	N	H	M	SE
56	D	N	N	M	F	SE
57	D	N	N	MOH	M	SE
58	C	N	N	M	F	SE
59	C	N	Y	MMO	F	SE
60	D	N	N	M	F	SE
61	C	N	N	M	M	S
62	C	N	N	M	M	S
63	C	N	N	MO	M	SSE
64	D	N	Y	MOH	M	SE
65	C	N	N	M	F	SSE
66	C	N	N	MO	F	SSE
67	C	N	N	MOH	M	SE
68	C	N	N	M	N	SE
69	C	N	N	H, FT	M	SE
70	C	N	N	M	M	SE
71	C	N	N	H, FT	M	SE
72	C	N	N	MO	F	SE

EB-3T

Tree No.	Dominance	Yellow pine	Leave tree	Damage	Old clips	Aspect
73	D	Y	Y	M	F	SE
74	C	N	N	M	M	SE
75	C	N	N	M, FT	F	SSE
76	C	N	N	M	M	SE
77	D	Y	Y	M	N	SE
79	C	N	N	MO	F	SE
81	D	N	Y	M	N	SE
82	D	N	N	MO	M	E
83	C	N	N	H	M	ESE
84	D	N	Y	MO	F	E
85	D	Y	Y	N	F	SSE
86	D	Y	Y	M	M	SE
87	D	N	Y	H	M	SE
88	C	N	Y	M	F	SE
89	D	N	N	MO	F	SE
90	C	N	N	MO	F	SE
91	C	N	N	H	M	ESE
92	D	N	N	H	M	SE
93	C	N	N	MO	M	SE
94	I	N	N	MOH	M	SE
95	C	N	N	MO	M	SSE
96	D	N	N	MO	F	SE
97	D	N	Y	MOH	M	SSE
98	I	N	N	MMO	M	SSE
99	I	N	N	MOH	M	SSE
100	D	N	N	M	F	SSE
101	C	N	N	M	M	SE
102	C	N	N	M	N	SE
103	C	N	N	MO	F	SE
104	D	N	N	MOH	F	SE
105	C	N	N	MO	F	SE
106	D	N	N	MO	F	SE
107	C	Y	Y	M, BD	F	SE

EB-3T

Tree No.	Dominance	Yellow pine	Leave tree	Damage	Old clips	Aspect
108	I	Y	Y	M, BD	F	SE
109	C	N	Y	MOH	M	SE
110	C	N	Y	M	M	E
111	I	N	N	MMO	M	NNE
112	I	N	N	M	M	NNE
113	D	Y	Y	MMO	M	E
114	C	N	N	MOH	F	E
115	C	N	N	H, MT	M	E
116	C	N	N	H, MT	M	SE
117	C	N	N	MOH	F	SE
118	C	N	N	H	M	SE
119	D	N	N	MO	F	SE
120	D	N	Y	MMO	F	SE
121	C	N	N	M	N	SE
122	C	N	N	M	M	SE
123	C	N	N	MMO	M	SE
124	D	Y	Y	M, MT, BD	N	SE
125	C	Y	Y	H	M	SE
126	C	N	Y	M	M	SE
127	C	N	N	MOH	M	SE
128	C	N	N	M	N	SE
129	C	N	Y	H	M	SSE
130	D	N	Y	M	F	SE
131	C	N	Y	S	M	SE
132	I	N	N	H, PD	M	SE
133	D	N	N	M	F	SE
134	C	N	N	MMO	N	SE
135	C	N	N	M	N	SE
136	C	N	N	H	M	SE
137	C	N	N	MO	F	SSE
138	C	N	N	MMO	F	SE
139	C	N	N	MMO	F	SE
140	D	N	Y	M	F	SSE
141	C	Y	Y	M, FT	F	S
142	C	N	N	MO	M	SSE
143	D	N	Y	MO	M	SE
144	I	N	N	S	F	SSE

EB-3T

Tree No.	Dominance	Yellow pine	Leave tree	Damage	Old clips	Aspect
145	D	Y	Y	M	F	S
146	C	Y	Y	M	F	S
147	D	N	Y	M	M	S
148	D	Y	Y	MO	M	S
149	C	N	N	M	F	S
150	C	Y	Y	H, MT	M	S
151	C	N	N	HS	M	ESE
152	C	N	N	H	M	ESE
153	C	N	N	MO	N	E
154	C	N	N	HS	M	NE
155	C	N	N	MO, FT	M	ENE
156	D	N	N	MO	M	E
157	D	N	N	MO	M	E
158	C	N	N	M	M	ENE
159	D	N	N	M	M	ENE
160	C	N	N	HS, MT	M	E
161	C	N	N	M	M	ENE
162	C	N	N	M	M	E
163	C	N	N	M	F	E
164	C	N	Y	M	F	SE
165	C	N	Y	M	F	SSE
166	C	N	N	M	N	S
167	C	N	Y	H	M	S
168	C	N	N	MOH	M	S
169	C	N	N	MO, FT	N	S
42B	D	N	N	HS, FT	M	ESE

EB-3T

Tree No.	Location	Comments
1	238 deg., 11 ½ paces to #1	Trees 1 and 2 are joined for about the first 4 feed above the ground, sign is therefore difficult to separate. DBH is estimated.
2	238 deg., 11 ½ paces to #1	DBH estimated.
3	212 deg., 14 paces to #1	Several clips w/long twigs attached, couldn't see a nest.
4	204 deg., 17 paces to #1	Sign from trees 4 and 5 overlaps.
5	205 deg., 18 ½ paces to #1	
6	350 deg., 11 ½ paces to #2	
7	346 deg., 13 paces to #2	Some clips from surrounding trees. Overlap between trees 6 and 7.
8	334 deg., 15 paces to #2	
9	343 deg., 17 paces to #2	
10	336 deg., 17 paces to #2	
11	323 deg., 23 ½ paces to #2	
12	304 deg., 10 paces to #2	
13	242 deg., 19 paces to #1	
14	168 deg., 17 ½ paces to #10	Some clips in "dispersed clips" on map to E may be from tree 14, no peeled twigss down around those trees.
15	20 deg., 8 paces to #9	Heavy past use, many old clips. Evidence of pollen cone feeding.
16	52 deg., 10 paces to #9	Leave tree only because it is an arch. site boundary tree.
17	89 deg., 23 paces to #9	
18	215 deg., 18 paces to #10	Leave tree because within arch. site boundaries.
19	322 deg., 13 paces to #9	Arch. site boundary tree.
20	331 deg., 12 paces to #9	Within arch. site.
21	318 deg., 10 paces to #9	Very close to arch. boundary, might be retained.
22	212 deg., 2 ½ paces to #9	Plot tree #3. A couple clips from nearby small PIED.
23	226 deg., 6 paces to #9	Plot tree #14. Some clips possibly from adjacent tree.
24	212 deg., 7 ½ paces to #9	Some overlap with tree 23 or tree in between possible.
25	124 deg., 16 ½ paces to #11	Broken top, 1 lower limb left. Arch. site boundary tree.
26	6 deg., 9 paces to #12	
27	42 deg., 7 ½ paces to #12	Possible overlap with surrounding trees. Nest on south side on low limb (about 20 ft. up).
28	40 deg., 4 paces to #12	Plot tree #47. Possible overlap with surrounding trees.
29	254 deg., 22 paces to #2	
30	241 deg., 16 paces to #2	
31	348 deg., 20 ½ paces to #3	
32	330 deg., 15 paces to #3	Flat top.
33	310 deg., 13 paces to #3	

EB-3T

Tree No.	Location	Comments
34	295 deg., 15 ½ paces to #3	
35	294 deg., 14 paces to #3	
36	310 deg., 22 ½ paces to #3	Very heavy past use.
37	308 deg., 21 paces to #3	Damage worst at top. One fresh cone.
38	302 deg., 23 paces to #3	Damage worst at top.
39	297 deg., 25 ½ paces to #3	Some cone cores may be from tree to NW. 4m to cone tree, 8m to twig tree.
40	296 deg., 23 paces to #3	4m to twig tree.
41	54 deg., 13 paces to #8	
42	91 deg., 9 ½ paces to #8	
43	145 deg., 16 paces to #9	
44	152 deg., 12 paces to #9	
45	160 deg., 13 paces to #9	
46	34 deg., 26 paces to #8	No twigs, but not nest clips.
47	38 deg., 23 ½ paces to #8	Dead top.
48	49 deg., 29 paces to #8	Heavy past use. Dead forked top. Adj. tree also deat top, possibly a few clips.
49	43 deg., 24 paces to #8	Very many old clips. Possibly some clips from adjacent tree. A couple small, fresh cone cores.
50	9 deg., 22 ½ paces to #8	Trees 50, 51, 52 overlap significantly. Lots of clips for such a small tree.
51	13 deg., 21 ½ paces to #8	
52	8 deg., 19 ½ paces to #8	
53	341 deg., 17 paces to #8	Very many old clips.
54	306 deg., 23 ½ paces to #8	A few clips from nearby trees.
55	318 deg., 27 paces to #8	Very possible that some clips are from surrounding trees.
56	317 deg., 23 paces to #8	
57	299 deg., 29 paces to #8	
58	299 deg., 32 paces to #8	
59	289 deg., 32 paces to #8	
60	271 deg., 24 ½ paces to #8	Some clips may be from trees uphill.
61	350 deg., 4 paces to #4	Overlap with tree 62 and probably some clips form tree to E. Plot tree #11.
62	346 deg., 1 pace to #4	Plot tree #9 or 6.
63	261 deg., 8 ½ paces to #4	Trees 63 and 64 overlap in one area. Also a couple green clips not included in count.
64	253 deg. 10 ½ paces to #4	Very many old clips.
65	352 deg., 26 paces to #5	Possibly some clips from surrounding trees.
66	348 deg., 27 paces to #5	Possibly some clips from surrounding trees.
67	345 deg., 12 ½ paces to #5	Very many old clips.
68	271 deg., 13 paces to #5	Quite a few cone cores from tree to SW also.
69	62 deg., 5 paces to #6	Surrounding trees also look damaged, but not enough clips to record. Plot tree #20.
70	5 deg., 5 ½ paces to #6	Plot tree #16
71	356 deg., 9 paces to #6	Trees 71 and 72 overlap in part.
72	358 deg., 11 paces to #6	

Tree No.	Location	Comments
73	27 deg., 16 paces to #6	Clips widely dispersed over large area, may overlap with surrounding trees a bit. Only 1 cone core, despite good cone production.
74	329 deg., 21 paces to #6	Tree to SE may be former feed tree.
75	338 deg., 24 paces to #6	Nest tree--not counting 5 probable nest clips in total.
76	89 deg., 11 paces to #15	Heavier feed trees just north of mapping area.
77	50 deg., 5 ½ paces to #15	Plot tree #10.
79	42 deg., 9 paces to #15	
81	36 deg., 19 paces to #15	
82	154 deg., 17 paces to #14	
83	150 deg., 19 paces to #8	Appears to have been more heavily used in the past. Surrounding trees also look like they were used more in the past, now just a few clips.
84	134 deg., 23 paces to #8	Tree to N also looks like it has past clip damage.
85	224 deg., 2 ½ paces to #3	
86	138 deg., 31 paces to #8	Nest on S limb out from trunk, 2nd tier of limbs--about 45 ft. up. 111 clips total, most nest clips.
87	26 deg., 8 ½ paces to #7	
88	60 deg., 5 ½ paces to #7	Plot tree #42. Some clips from surrounding
89	296 deg., 4 ½ paces to #7	Plot tree #24. Trees 89 and 90 overlap in part. Many bud tips, probably from previous pollen cone feeding.
90	320 deg., 8 paces to #7	Not nest clips, but surprisingly few clipped twigs.
91	92 deg., 15 paces to #14	No twigs, but definitely a bonified feed tree--damage, old clips, no nest, etc.
92	86 deg., 15 paces to #14	Yellow pine to E may be former feed tree--old clips and scragly appearance. Most current clips appear to be nest clips.
93	66 deg., 15 pacest to #14	
94	52 deg., 23 ½ paces to #14	
95	15 deg., 16 paces to #14	
96	154 deg., 15 ½ paces to #13	
97	140 deg., 3 ½ paces to #13	Plot tree #34. Heavier use in past.
98	136 deg., 6 paces to #13	Plot tree #33. Overlap w/tree 99.
99	135 deg., 9 paces to #13	Overlap w/neighboring trees likely.
100	148 deg., 9 paces to #13	Possible overlap w/neighboring trees.
101	129 deg., 16 paces to #13	Why no twigs? Likely overlap w/other trees.
102	218 deg., 15 paces to #8	
103	227 deg., 16 paces to #8	
104	226 deg., 3 ½ paces to #8	Plot tree #1. Some clips may be from smaller adjacent tree.
105	255 deg., 13 paces to #8	
106	288 deg., 17 paces to #15	
107	318 deg., 10 paces to #15	Appear to be feeding clips, don't know why so few twigs. Broken top.

EB-3T

Tree No.	Location	Comments
108	6 deg., 6 ½ paces to #15	Plot tree #8. About 16 clips that look like nest clips (not included in total), but no nest. Broken top.
109	10 deg., 18 paces to #15	Tree to N. may contribute some clips.
110	357 deg., 19 ½ paces to #15	Neighboring tree may contribute some clips.
111	192 deg., 14 paces to #14	Trees 111 and 112 overlap, relying mainly on location since little crown damage.
112	204 deg., 13 paces to #14	A few clips from surrounding trees.
113	224 deg., 17 ½ paces to #14	Overlap with tree 114 in part. Few branches, scragly appearance.
114	226 deg., 14 paces to #14	
115	218 deg., 9 ½ paces to #14	Crooked trunk at base.
116	227 deg., 9 paces to #14	Crooked trunk halfway up.
117	216 deg., 7 paces to #14	Plot tree #5
118	254 deg., 7 ½ paces to #14	Possibly some clips from neighboring tree.
119	266 deg., 16 paces to #14	Plot tree #10 (EM plot?)
120	272 deg., 20 ½ paces to #14	
121	319 deg., 6 paces to #17	Tree to S. looks more damaged, but fewer clips. Don't see a nest, but about 14 clips look like nest clips.
122	257 deg., 13 ½ paces to #13	
123	250 deg., 17 paces to #13	Only 1 twig?
124	223 deg., 13 paces to #13	Twisted trunk and many dead branches. Only 1 core despite many cones produced.
125	208 deg., 18 ½ paces to #13	Very many old clips.
126	212 deg., 23 ½ paces to #13	Possible nest. Possible overlap w/adjacent tree directly W, appears more damaged.
127	316 deg., 23 paces to #14	
128	310 deg., 24 paces to #14	Neighboring trees may contribute a few clips.
129	338 deg., 9 paces to #14	Very many old clips.
130	74 deg., 8 paces to #18	Some overlap with tree 131
131	70 deg., 10 ½ paces to #18	
132	80 deg., 16 ½ paces to #18	Very many old clips. Dead top.
133	58 deg., 13 paces to #18	
134	47 deg., 16 paces to #18	
135	144 deg., 20 ½ paces to #19	Possible overlap with adjacent tree to W., also has a few cores.
136	152 deg., 14 ½ paces to #19	
137	145 deg., 12 paces to #19	Possible overlap w/trees 136, 139
138	130 deg., 16 ½ paces to #19	
139	133 deg., 11 paces to #19	Overlap possible
140	120 deg., 16 ½ paces to #19	
141	100 deg., 7 ½ paces to #19	One fresh cone core, large for this time of year.
142	270 deg., 17 ½ paces to #12	
143	270 deg., 15 ½ paces to #12	
144	178 deg., 17 ½ paces to #19	

EB-3T

Tree No.	Location	Comments
145	236 deg., 11 paces to #19	Clips spread over a wide area, not immediately apparent it's a feed tree.
146	265 deg., 13 ½ paces to #19	Overlap possible
147	255 deg., 24 paces to #19	Young yellow pine. Not very tall, but open enough to call dominant.
148	146 deg., 8 ½ paces to #22	Surprisingly few twigs--some clips possibly by-product of cone feeding? Twigs are difficult to spot here.
149	80 deg., 10 ½ paces to #22	
150	280 deg., 18 paces to #19	Surprisingly few twigs. Not nest clips. Twigs hard to spot, but not that hard.
151	254 deg., 11 paces to #11	
152	247 deg., 14 paces to #11	
153	214 deg., 11 ½ paces to #11	
154	222 deg., 23 paces to #11	Maybe a few clips from adjacent trees.
155	206 deg., 19 ½ paces to #11	Probably some overlap. Didn't count obvious nest clips (nest in adjacent tree).
156	320 deg., 17 paces to #12	
157	107 deg., 14 ½ paces to #20	
158	136 deg., 14 paces to #20	
159	140 deg., 9 ½ paces to #20	
160	177 deg., 2 paces to #20	Plot tree #17. Not marked as leave tree, but larger non-YP is. Young yellow pine, only yellow plates on E. side.
161	182 deg., 10 paces to #20	
162	211 deg., 13 paces to #20	
163	355 deg., 22 ½ paces to #19	Possible overlap on one side. Hard place to search for twigs (RONE, etc.)
164	324 deg., 22 paces to #19	Maybe a few clips from adjacent tree to N.
165	320 deg., 20 paces to #19	Maybe a few clips from adjacent trees.
166	32 deg., 19 paces to #22	Tree to SE looks fairly heavily damaged--heavy feed tree in past, but only a few clips now.
167	12 deg., 24 paces to #22	
168	150 deg., 19 paces to #21	
169	234 deg., 25 paces to #20	
42B	132 deg., 13 paces to #9	

EB-5C

Tree No.	Date	Twig/Cone/Nest	Clips	Cores	Twigs	Digs	DBH (cm)
1	6-12-98	C, N	0	32	0	0	57.0
2	6-12-98	T	27	0	8	0	28.9
3	6-12-98	T	48	2	9	0	38.6
4	6-12-98	T	17	2	4	0	33.0
5	6-12-98	T	11	0	1	0	36.0
6	6-12-98	T	37	0	22	0	29.6
7	6-12-98	T	17	1	1	0	30.8
8	6-12-98	T	22	0	5	0	23.0
9	6-12-98	T	12	1	0	0	38.0
10	6-12-98	T	53	0	16	0	33.1
11	6-12-98	T	15	1	8	0	31.7
12	6-12-98	T	15	0	7	0	21.2
13	6-12-98	T	14	0	7	0	23.5
14	6-12-98	T	10	0	2	0	28.0
15	6-12-98	T	52	0	22	0	23.8
16	6-12-98	T	45	3	19	0	34.4
17	6-12-98	T	10	0	3	0	26.3
18	6-12-98	T	77	0	35	0	21.5
19	6-12-98	T	50	0	20	0	25.6
20	6-12-98	T	35	0	6	0	28.2
21	6-12-98	T	13	0	1	0	23.3
22	6-12-98	T	21	0	4	1	33.9
23	6-12-98	T	11	0	2	0	24.8
24	6-12-98	N	141*	1	2	0	30.3
25	6-13-98	T	13	1	3	0	26.6
26	6-13-98	T	16	1	1	0	27.1
27	6-13-98	T	11	0	2	0	30.2
28	6-13-98	T	16	0	5	1	16.1
29	6-13-98	T	17	0	4	0	24.6
30	6-13-98	T	19	0	7	0	18.2
31	6-13-98	T	20	0	7	0	22.8
32	6-13-98	T	12	1	4	0	31.9
33	6-13-98	T	16	0	5	1	28.9

EB-5C

Tree No.	Date	Twig/Cone/Nest	Clips	Cores	Twigs	Digs	DBH (cm)
34	6-13-98	T	45	0	9	0	33.0
35	6-13-98	T	33	0	14	0	22.9
36	6-13-98	T	31	1	9	0	21.6
37	6-13-98	T	47	0	15	0	30.2
38	6-13-98	T	78	0	31	0	28.2
39	6-13-98	T	19	0	4	0	24.8
40	6-13-98	C	2	24	0	0	76.5
41	6-13-98	T	166	0	79	0	29.4
42	6-13-98	T	67	1	8	0	37.0
43	6-13-98	T	18	0	0	0	31.5
44	6-13-98	T	88	2	23	0	26.9
45	6-13-98	T	13	0	1	0	17.9
46	6-13-98	T	24	0	8	0	29.0
47	6-13-98	T	68	2	12	0	31.1
48	6-13-98	T	85	1	23	0	28.6
49	6-13-98	T	47	0	13	1	33.5
50	6-13-98	T	22	2	6	0	32.8
51	6-13-98	T	17	0	8	0	27.8
52	6-13-98	T	14	1	6	0	24.2
53	6-13-98	T	15	0	1	0	22.6
54	6-13-98	T	39	0	8	0	22.1
55	6-13-98	T	48	0	8	0	27.1
56	6-14-98	T	13	0	0	0	24.4
57	6-14-98	T	88	4	22	1	39.4
58	6-14-98	T	14	1	0	0	30.9
59	6-14-98	T	28	0	6	0	22.8
60	6-14-98	T	20	0	5	0	25.0
61	6-14-98	T	21	0	6	0	27.9
62	6-14-98	T	32	0	13	0	21.1
63	6-14-98	T	11	0	5	0	28.4
64	6-14-98	T	45	0	22	0	34.1
65	6-14-98	T	64	0	26	0	33.2
66	6-14-98	T	68	0	30	0	31.8
67	6-14-98	T	23	0	10	0	37.8
68	6-14-98	T	37	3	17	0	36.9
69	6-14-98	T	21	0	3	1	39.0
70	6-14-98	T	16	0	6	0	29.3
71	6-14-98	T	21	0	7	0	33.3
72	6-14-98	T	23	0	10	1	31.9

EB-5C

Tree No.	Date	Twig/Cone/Nest	Clips	Cores	Twigs	Digs	DBH (cm)
73	6-14-98	T	35	0	21	0	20.9
74	6-14-98	T	54	0	18	0	25.5
75	6-14-98	T	38	2	11	1	60.4
76	6-14-98	T	28	2	12	0	24.5
77	6-14-98	T	25	0	11	0	27.9
78	6-14-98	T	31	1	5	0	22.5
79	6-14-98	T	34	0	6	0	25.5
80	6-14-98	T	29	0	6	0	32.6
81	6-14-98	T	25	0	7	0	26.8

EB-5C

Tree No.	Dominance	Yellow pine	Leave tree	Damage	Old clips	Aspect
1	D	Y	Y	N	M	None
2	C	N	Y	M	N	E
3	C	N	Y	M	F	NE
4	C	N	Y	M	F	NE
5	C	N	Y	M	N	NNE
6	C	N	Y	M	F	NNE
7	C	N	Y	M	N	N
8	I	N	Y	H	F	N
9	C	N	Y	N	N	N
10	C	N	Y	MO, F.T.	N	NNE
11	C	N	Y	M	N	NNE
12	C	N	Y	M	N	NNE
13	C	N	Y	M	N	NNE
14	C	N	Y	M	N	NNE
15	C	N	Y	S	F	NNE
16	C	N	Y	M	F	NNE
17	C	N	Y	MO	F	NNE
18	C	N	Y	MH	F	N
19	C	N	Y	S	F	N
20	C	N	Y	MO	F	N
21	C	N	Y	M	F	N
22	C	N	Y	S	F	N
23	C	N	Y	S	F	N
24	D	N	Y	M	F	N
25	C	N	Y	MO	N	N
26	C	N	Y	M	F	N
27	C	N	Y	H	F	N
28	I	N	Y	H, L	N	N
29	C	N	Y	MO	F	N
30	C	N	Y	MO	N	N
31	C	N	Y	MO	N	N
32	D	N	Y	MO	F	N
33	C	N	Y	MO	F	N

EB-5C

Tree No.	Dominance	Yellow pine	Leave tree	Damage	Old clips	Aspect
34	D	N	Y	M	N	N
35	C	N	Y	M	N	N
36	I	N	Y	MO	N	ENE
37	C	N	Y	M	F	E
38	C	N	Y	S	N	E
39	C	N	Y	SE	F	E
40	D	Y	Y	LT,PD	F	E
41	D	N	Y	MO	F	E
42	C	N	Y	MOH	F	E
43	C	N	Y	MO	M	N
44	C	N	Y	H	M	N
45	I	N	Y	M	N	NNE
46	C	N	Y	H	M	NNE
47	C	N	Y	H	M	NNE
48	C	N	Y	MOH	M	NNE
49	C	N	Y	MO	F	NNE
50	C	N	Y	M	N	NNE
51	D	N	Y	MO	F	NNE
52	C	N	Y	H	F	NNE
53	C	N	Y	M	N	NE
54	C	N	Y	MOH	F	NE
55	C	N	Y	MOH, F.T.	M	NE
56	C	N	Y	H	M	N
57	D	N	Y	MOH	M	NE
58	C	N	Y	M	F	NE
59	C	N	Y	MO	F	NE
60	C	N	Y	MO	F	
61	C	N	Y	MMO	N	NE
62	I	N	Y	MO	N	NE
63	C	N	Y	M	N	NE
64	C	N	Y	MMO	F	NE
65	C	N	Y	MO	F	N
66	D	N	Y	MOH	M	N
67	D	N	Y	M	F	N
68	C	N	Y	M	N	N
69	C	N	Y	M	N	N
70	C	N	Y	M	F	N
71	D	N	Y	M	M	N
72	C	N	Y	M	N	NE

EB-5C

Tree No.	Dominance	Yellow pine	Leave tree	Damage	Old clips	Aspect
73	C	N	Y	MOH	N	NE
74	I	N	Y	MOH	M	ENE
75	D	Y	Y	MO	F	NE
76	C	N	Y	S	M	NE
77	C	N	Y	M		NE
78	C	N	Y	MO	N	NE
79	C	N	Y	MOH	F	NE
80	C	N	Y	M	F	NE
81	C	N	Y	MO	F	NE

EB-5C

Tree No.	Location	Comments
1	21 deg., 9 paces to # 21	Nest on east side of crown (squirrel), only yellow pine nearby, good cone producer, many cones not eaten
2	94 deg., 16 paces to #20	Forked top, clipped twigs seem unusually long
3	3 deg., 5 ½ paces to #20	
4	334 deg., 8 ½ paces to #20	
5	10 deg., 15 ½ paces to #20	
6	62 deg., 24 paces to #20	
7	38 deg., 13 paces to #19	
8	0 deg., 4 paces to #19	Probably heavier use in past, circ. plot tree #39
9	29 deg., 5 ½ paces to #19	circ. plot tree #41
10	319 deg., 15 paces to #19	
11	296 deg., 25 paces to #19	
12	144 deg., 12 paces to #14	Difficult to separate clips of trees 12 and 13
13	136 deg., 12 paces to #14	
14	187 deg., 13 paces to #14	Probably heavy past use, but no old clips apparent
15	348 deg., 8 paces to #22	Nearby trees getting some dispersed use
16	260 deg., 16 paces to #18	Adjacent trees may contribute some clips attributed to trees 16 and17
17	237 deg., 17 paces to #18	Neighboring tree many old clips, few new. Squirrel nest in tree about 15m away
18	226 deg., 11 paces to #17	
19	204 deg., 5 paces to #17	Fewer clips than tree 18, but damage much worse (surprisingly few old clips evident). Some clips from nearby trees. Circ. plot tree 6 or 9
20	4 deg., 10 paces to #18	Two trees joined at base, treated as one (measured DBH on southern trunk, bigger tree. Neighboring trees have a few clips
21	199 deg., 14 paces to #16	In midst of oak/downfall. Some clips from neighboring trees
22	172 deg., 3 paces to #16	Sign from trees 22 and 23 overlaps, trees look worse than # of clips would indicate. Circ. plot tree #134. A few clips from neighboring trees
23	171 deg., 5 paces to #16	Circ. plot tree # 127
24	136 deg., 18 paces to #16	Nest tree, mostly nest clips, pile of nest material found nearby. Neighboring trees appear to have past clip damage.
25	259 deg., 14 paces to #16	
26	254 deg., 17 paces to #16	
27	268 deg., 19 paces to #16	
28	268 deg., 19 paces to #16	A few clips may be from neighboring trees
29	266 deg., 3 paces to #16	Circ. plot tree # 23
30	212 deg., 24 paces to #9	Sign from trees 30 and 31 overlap
31	210 deg., 24 paces to #9	Some clips from neighboring trees
32	93 deg., 17 ½ paces to #10	
33	114 deg., 18 ½ paces to #10	Some clips might be from neighboring trees

EB-5C

Tree No.	Location	Comments
34	7 deg., 28 paces to #10	
35	7 deg., 28 paces to #10	
36	262 deg., 11 ½ paces to #8	Just NE of big Yellow pine (ref. tree for circ. plot)
37	139 deg., 24 paces to #1	About 10m SE of Yellow pine ref. tree
38	134 deg., 10 ½ paces to #1	Sign from trees 38 and 39 overlaps
39	127 deg., 10 paces to #1	Despite apparently fewer clips, crown damage worse than tree 38.
40	230 deg., 24 paces to #1	Many uneaten old cones, most of last yrs. are cores or aborted.
41	80 deg., 9 paces to #2	Clips hard to count, in/under QUQA (166+)
42	108 deg., 9 ½ paces to #2	
43	182 deg., 7 ½ paces to #10	Many old clips
44	159 deg., 18 paces to #7	
45	194 deg., 13 paces to #7	Some clips from nearby trees
46	198 deg., 12 paces to #7	Sign from trees 46 and 47 overlap
47	198 deg., 12 paces to #7	
48	48 deg., 16 paces to #6	Three old feed trees, little used in past year, nearby
49	58 deg., 12 ½ paces to #6	
50	85 deg., 10 ½ paces to #6	Evidence of feeding on pollen cones apparent
51	86 deg., 23 paces to #6	
52	89 deg., 28 paces to #6	Neighboring trees may have contributed a few clips
53	89 deg., 24 paces to #6	Also some clips from adjacent trees
54	354 deg., 19 paces to #11	
55	359 deg., 17 paces to #11	
56	247 deg., 14 ½ paces to #14	Light use last yr., heavy past use
57	118 deg., 14 paces to #12	
58	54 deg., 17 paces to #12	Some clips and cones also from YP just N. of tree (4 cores, 3 clips)
59	125 deg., 10 paces to #11	
60	65 deg., 21 paces to #11	Dispersed clips from nearby trees
61	115 deg., 16 paces to #6	
62	137 deg., 21 paces to #6	A few clips from surrounding trees, possible overlap with tree 63 in one area.
63	139 deg., 21 paces to #6	
64	271 deg., 19 paces to #11	
65	2 deg., 19 ½ paces to #12	
66	69 deg., 29 paces to #5	Tree immediately to W. looks like an old feed tree not used last year.
67	219 deg., 15 ½ paces to #6	Narrow crown, some clips from surrounding trees
68	352 deg., 20 paces to #5	
69	9 deg., 22 paces to #5	
70	180 deg., 20 paces to #3	Sign of trees 70 and 71 difficult to separate
71	177 deg., 18 ½ paces to #3	
72	183 deg., 13 paces to #2	Might be a few clips from neighboring trees mixed in

EB-5C

Tree No.	Location	Comments
73	144 deg., 14 ½ paces to #2	
74	264 deg., 15 paces to #7	Plot tree #1
75	247 deg., 17 ½ paces to #7	Abundant evidence of feeding on pollen cones. Clips widely dispersed around large YP, hard to find all twigs, etc. Some clips from small nearby PIED. Ref. tree for plot 678.
76	192 deg., 25 paces to #2	
77	178 deg., 25 paces to #2	Nearby trees also some clips, apparently heavy use in past
78	260 deg., 26 paces to #7	Many trees in area clipped, hard to assign sign to tree. Plot tree #8
79	259 deg., 25 ½ paces to #7	Plot tree #14, see comments for tree 78
80	281 deg., 20 paces to #7	In a clump, difficult to assign sign to tree. Plot tree #20
81	274 deg., 20 paces to #7	Plot tree #21

EB-5T

Tree No.	Date	Twig/Cone/Nest	Clips	Cores	Twigs	Digs	DBH (cm)
1	6-15-98	T	17	0	3	0	21.0
2	6-15-98	T	16	0	6	0	19.8
3	6-15-98	T	10	0	2	0	21.9
4	6-15-98	T	25	2	4	0	29.1
5	6-15-98	T	12	1	1	0	17.2
6	6-15-98	T	35	0	17	0	26.1
7	6-15-98	T	47	1	20	0	25.4
8	6-15-98	T	17	0	4	0	25.2
9	6-15-98	N	75*	0	4	0	61.7
10	6-15-98	T	140	0	74	0	29.2
11	6-15-98	T	11	2	5	0	30.8
12	6-15-98	T	25	0	14	0	23.1
13	6-15-98	T	396	3	177	0	64.2
14	6-15-98	T	15	0	2	0	27.1
15	6-15-98	T	20	7	4	0	41.5
16	6-15-98	T	13	10	5	0	35.9
17	6-15-98	T	10	2	1	0	28.6
18	6-15-98	C	1	36	0	0	84.6
19	6-15-98	T	10	0	7	0	23.0
20	6-15-98	T	13	0	4	0	29.3
21	6-15-98	T	57	2	15	0	29.3
22	6-15-98	T	12	0	3	0	23.6
23	6-15-98	T	19	2	4	0	31.5
24	6-15-98	T	14	3	1	0	29.9
25	6-15-98	T	19	0	7	0	21.0
26	6-15-98	T	40	0	17	0	31.0
27	6-15-98	T	88	2	17	0	30.3
28	6-15-98	T	16	6	1	0	32.0
29	6-15-98	N	85*	2	0	0	62.2

EB-5T

Tree No.	Date	Twig/Cone/Nest	Clips	Cores	Twigs	Digs	DBH (cm)
30	6-15-98	T	65	3	24	0	31.0
31	6-15-98	T	18	3	2	0	25.2
32	6-15-98	T	112	0	44	0	24.0
33	6-16-98	T	86	0	22	0	24.1
34	6-16-98	T	10	1	2	0	17.7
36	6-16-98	T	13	1	3	0	29.8
37	6-16-98	T	35	0	12	0	24.4
38	6-16-98	T	12	5	2	0	35.3
39	6-16-98	T	16	3	1	0	28.0
40	6-16-98	T	28	1	7	0	33.2
41	6-16-98	T	16	0	4	0	34.8
42	6-16-98	T	37	1	9	0	31.3
43	6-16-98	T	32	0	13	0	22.3
44	6-16-98	T	79	0	23	0	27.2
45	6-16-98	T	29	1	9	0	27.0
46	6-16-98	T	46	2	15	0	31.7
47	6-16-98	C	3	33	0	0	52.8
48	6-16-98	T	14	1	6	0	35.7
49	6-16-98	T	55	1	21	0	27.4
50	6-16-98	T	25	2	5	0	32.3
51	6-16-98	T	17	0	2	0	35.9
52	6-16-98	T	32	0	6	0	40.1
53	6-16-98	T	24	2	9	0	62.1
54	6-16-98	T	13	1	5	0	35.0
55	6-16-98	T	31	2	5	0	36.7
56	6-16-98	T	20	0	11	0	17.4
57	6-16-98	T	35	0	10	0	24.7
58	6-16-98	T	51	1	12	0	32.3
59	6-16-98	T	24	0	9	0	28.6
60	6-16-98	T	11	0	2	0	18.5
61	6-16-98	T	73	0	29	0	23.4
62	6-16-98	T	100	1	40	1	26.6
63	6-16-98	T	49	0	30	0	24.1
64	6-17-98	T	30	0	11	0	23.3
65	6-17-98	T, C	10	44	0	0	59.5
66	6-17-98	T	17	0	7	0	21.3
67	6-17-98	T	18	0	8	0	21.2
68	6-17-98	T	18	1	10	0	23.4

EB-5T

Tree No.	Date	Twig/Cone/Nest	Clips	Cores	Twigs	Digs	DBH (cm)
69	6-17-98	T	22	1	8	0	23.6
70	6-17-98	C	4	21	0	0	54.0
71	6-17-98	T	11	0	6	1	23.3
72	6-17-98	T	17	0	2	0	22.4
73	6-17-98	T	13	1	6	0	29.0
74	6-17-98	T	14	0	7	0	18.3
75	6-17-98	T	36	1	3	0	32.9
76	6-17-98	T	21	0	11	0	27.4
77	6-17-98	T	20	1	7	0	19.5
78	6-17-98	T	16	0	6	0	16.8
79	6-17-98	T	33	0	12	0	27.8
80	6-17-98	T	13	0	4	0	25.5
81	6-17-98	T	79	1	33	0	34.0
82	6-17-98	T	48	3	14	0	52.2
83	6-17-98	T, C	12	42	3	0	35.7
84	6-17-98	T	107	2	31	0	22.6
85	6-17-98	T	21	2	3	0	32.9
86	6-17-98	T	44	0	11	0	24.8
87	6-17-98	T	54	17	8	0	95.9
88	6-17-98	T	84	4	18	0	36.2
89	6-17-98	T	30	0	10	0	23.7
90	6-17-98	T	26	1	7	0	32.3
91	6-17-98	T	71	5	7	0	38.5
92	6-17-98	T	42	0	12	0	24.9
93	6-26-98	T	78	0	17	0	29.7
94	6-26-98	T	12	0	2	0	27.6
95	6-26-98	T	87	0	53	1	30.8
96	6-26-98	T	24	2	6	0	31.5
97	6-26-98	T	40	0	13	0	19.3
98	6-26-98	T	44	2	7	0	18.1
99	6-26-98	T	27	0	13	0	21.1
100	6-26-98	T	11	1	2	0	24.0
101	6-26-98	T	10	0	4	0	18.2
102	6-26-98	T	15	1	3	1	36.7

EB-5T

Tree No.	Date	Twig/Cone/Nest	Clips	Cores	Twigs	Digs	DBH (cm)
103	6-26-98	T	77	9	15	1	31.3
104	6-26-98	T	10	4	3	0	29.0
105	6-26-98	C	0	23	0	2	63.0
106	6-26-98	C	2	20	0	1	48.6
107	6-26-98	T	15	0	6	0	24.0
108	6-26-98	T	15	1	5	0	38.7
109	6-26-98	T	15	0	3	0	22.0
110	6-26-98	T	23	1	8	0	22.1
111	6-26-98	T	43	0	14	0	18.8
112	6-26-98	T	33	1	14	0	22.6
113	6-26-98	T	67	0	36	0	25.1

EB-5T

Tree No.	Dominance	Yellow pine	Leave tree	Damage	Old clips	Aspect
1	C	N	N	M	F	N
2	C	N	N	M	F	N
3	C	N	N	SE	F	NNW
4	C	N	N	H	F	NNW
5	I	N	N	MMO	F	NNW
6	C	N	Y	MOH	F	N
7	C	N	N	M	N	N
8	C	N	N	MO	N	N
9	D	Y	Y	MOH	M	N
10	C	N	N	MOH	F	N
11	C	N	Y	M	N	N
12	C	N	N	MMO	N	NNW
13	D	Y	Y	MOH	F	WNW
14	C	N	N	M	F	N
15	C	N	Y	M	M	NW
16	C	N	N	M	F	NW
17	C	N	Y	M	M	WNW
18	D	Y	Y	BD	N	NNW
19	C	N	N	M	N	NNE
20	C	N	N	MMO	F	NNE
21	C	N	Y	MO	F	NE
22	C	N	N	M	N	NE
23	D	N	Y	MMO	N	NE
24	C	N	Y	M	F	NE
25	C	N	Y	MO	N	NE
26	D	N	N	MMO	F	NW
27	C	N	Y	H,FT,PD	M	NNW
28	C	N	N	MO	M	NW
29	D	Y	Y	MO	M	

EB-5T

Tree No.	Dominance	Yellow pine	Leave tree	Damage	Old clips	Aspect
30	C	N	N	H	M	NW
31	C	N	N	H	F	NW
32	C	N	N	MMO	F	NW
33	C	N	N	MO	F	N
34	D	N	N	MOH	M	NW
36	C	N	Y	M	N	N
37	D	N	N	MO	F	N
38	C	N	Y	M	F	N
39	C	N	N	MOH	M	N
40	D	N	N	MO	F	N
41	D	N	Y	M	N	N
42	D	N	Y	MMO	N	NNE
43	I	N	N	MOH	F	NNE
44	D	N	N	MOH	F	NE
45	C	N	Y	MO	N	NE
46	D	N	Y	MO	M	NE
47	D	Y	Y	L,BD	F	NE
48	C	N	Y	MO	F	NNE
49	C	N	Y	S	M	NNE
50	C	N	Y	MOH	F	NE
51	D	N	Y	MOH	M	NNE
52	D	N	Y	MOH	M	NE
53	D	Y	Y	M	M	NE
54	D	N	N	M	F	NE
55	D	N	N	MOH	M	NE
56	C	N	N	MO	N	WNW
57	C	N	N	M	N	WNW
58	D	N	N	MOH	F	NW
59	C	N	N	MO	N	WNW
60	C	N	N	MO	N	NNW
61	C	N	N	H	N	NNE
62	C	N	N	H	F	NNE
63	C	N	N	MMO	F	NNW
64	C	N	N	MO	F	N
65	D	Y	Y	M	F	N
66	C	N	N	M,FT	N	NNW
67	C	N	N	MMO, FT	F	N
68	C	N	N	MO	F	N

EB-5T

Tree No.	Dominance	Yellow pine	Leave tree	Damage	Old clips	Aspect
69	C	N	Y	MOH, MT	F	N
70	D	Y	Y	N	F	N
71	C	N	N	M	N	N
72	C	N	N	MOH	F	N
73	D	N	Y	MO	F	N
74	C	N	N	H	M	N
75	C	N	Y	MOH, FT	M	NNE
76	C	N	N	MOH	F	NNE
77	C	N	N	S	M	N
78	I	N	N	S	M	N
79	D	N	N	MOH	M	N
80	C	N	N	M	N	NNW
81	D	N	Y	H	M	N
82	C	Y	Y	H	M	NNW
83	C	N	N	MO	M	N
84	D	N	N	S	M	N
85	D	N	N	H	M	N
86	C	N	N	MMO	F	N
87	D	Y	Y	M, PD	M	NNE
88	D	N	Y	MO	F	NNE
89	I	N	N	M	F	NNE
90	C	N	Y	MMO, FT	N	NNW
91	D	N	N	M	F	NNW
92	C	N	N	M	N	NNW
93	C	N	N	MMO	F	W
94	C	N	Y	M	N	W
95	D	N	Y	M	F	WNW
96	D	N	N	M	F	NW
97	C	N	N	E	M	
98	I	N	N	MO	F	NW
99	C	N	N	S	M	WNW
100	C	N	N	S	M	NNW
101	C	N	N	MO	N	NW
102	D	N	Y*	MOH	M	NW

EB-5T

Tree No.	Dominance	Yellow pine	Leave tree	Damage	Old clips	Aspect
103	C	N	N*	MOH	M	NNW
104	C	N	N*	M	N	N
105	D	Y	Y*	N	N	NW
106	C	Y	Y*	FT	F	NW
107	D	N	N*	MOH	N	N
108	D	N	Y*	M	N	N
109	C	N	N*	M	F	N
110	C	N	N*	HS	M	N
111	C	N	N*	SE	F	N
112	C	N	N*	MO	N	N
113	C	N	N*	MOH	N	N

EB-5T

Tree No.	Location	Comments
1	279 deg., 1 ft. to #23	In group of light to mod. feed trees. Plot tree #1
2	313 deg., 1 pace to #23	Sign of trees 2 and 14 impossible to separate in much of area--grow right together, similar crown cover region. Plot tree #67
3	356 deg., 1 ½ paces to #23	Very difficult to assign clips to trees in this area, but severe clip damage, probably used heavier in past. Plot tree #68
4	10 deg., 3 ½ paces to #23	Sign easier to distinguish than other trees in group, no clips from surrounding tree to outside of clump. Plot tree #84
5	38 deg., 2 ½ paces to #23	Plot tree #87
6	312 deg., 7 ½ paces to #23	Sign of trees 6,7,8 overlap some
7	329 deg., 9 paces to #23	Bird nest in top
8	324 deg., 6 ½ paces to #23	Plot tree #46
9	70 deg., 12 paces to #16	Some evidence of feeding on pollen cones. No cores despite many cones produced. A few clips from small PIED to S. of tree. Most clips probably nest clips.
10	103 deg., 25 paces to #16	Relatively isolated feed tree. Only found 1 old clip. Seemed to have a higher proportion of twigs to clips than most trees.
11	84 deg., 28 paces to #16	
12	73 deg., 32 paces to #16	Two trees joined at base, most sign seems to be from larger (western) stem; one I measured for DBH.
13	141 deg., 17 paces to #17	Twig/clip counts probably less than actual number. Most cones old, 3 cores appear to be only cones from last year.
14	313 deg., 1 pace to #23	
15	14 deg., 9 paces to #22	
16	14 deg., 11 ½ paces to #22	
17	70 deg., 10 paces to #17	
18	74 deg., 25 paces to #17	Bark falling off on NE side
19	216 deg., 21 ½ paces to #21	
20	236 deg., 27 paces to #21	
21	242 deg., 27 paces to #21	
22	236 deg., 20 paces to #21	
23	61 deg., 31 ½ paces to #17	Surrounded by very dense PIPO, evidence of some feeding on pollen cones
24	54 deg., 33 paces to #17	
25	193 deg., 9 ½ paces to #18	
26	183 deg., 19 paces to #13	
27	216 deg., 8 paces to #13	
28	188 deg., 10 ½ paces to #13	Two neighboring trees almost qualify as feed trees. Evidence of pollen cone feeding.
29	83 deg., 21 paces to #14	Nest on SW side, most clips nest clips, centered below nest.

Tree No.	Location	Comments
30	212 deg., 23 paces to #13	
31	210 deg., 21 paces to #13	
32	51 deg., 13 ½ paces to #14	
33	96 deg., 9 ½ paces to #14	
34	33 deg., 11 paces to #14	
36	75 deg., 18 paces to #15	
37	63 deg., 17 paces to #15	Two adjacent trees may be contributing a few clips, most damage on this tree.
38	55 deg., 29 paces to #15	Evidence of pollen cone feeding
39	323 deg., 17 paces to #16	
40	337 deg., 15 paces to #16	
41	336 deg., 19 paces to #16	
42	6 deg., 15 ½ paces to #16	
43	16 deg., 15 paces to #16	Some overlap of sign with tree 42.
44	96 deg., 17 ½ paces to #18	
45	84 deg., 14 ½ paces to #18	
46	59 deg., 5 paces to #18	Plot tree #225
47	21 deg., 19 paces to #21	Hole (not a bird cavity) about 3/4 way up on SW side
48	292 deg., 16 ½ paces to #20	
49	292 deg., 19 ½ paces to #20	Also smaller tree right next to it with clip damage, can't distinguish but probably hasn't contributed much.
50	290 deg., 14 ½ paces to #20	
51	271 deg., 3 ½ paces to #20	
52	46 deg., 12 ½ paces to #18	Small trees around may have contributed a few clips, but not many--no damage apparent.
53	298 deg., 10 paces to #19	
54	321 deg., 19 ½ paces to #18	
55	185 deg., 20 paces to #12	
56	30 deg., 3 paces to #13	Several trees in area may have some clips, 56,57,58 appear to contribute the majority. Plot tree #125
57	39 deg., 3 ½ paces to #13	Plot tree #126
58	85 deg., 6 ½ paces to #13	Plot tree #132
59	90 deg., 11 paces to #13	
60	127 deg., 3 ½ paces to #10	Plot tree #92
61	181 deg., 13 ½ paces to #10	Trees 61 and 62 obviously main sources, but some clips may be from other trees
62	192 deg., 12 paces to #10	
63	194 deg., 10 paces to #5	
64	294 deg., 7 paces to #10	
65	12 deg., 20 paces to #14	Many cones from last year, both good and aborted.
66	74 deg., 22 paces to #9	Nest tree about 20m away in Yellow pine.
67	86 deg., 15 ½ paces to #9	Nearby trees possibly contributing a few clips
68	66 deg., 17 paces to #9	

Tree No.	Location	Comments
69	59 deg., 13 paces to #9	Might be a few clips from neighboring trees. Misshapen crown at top.
70	35 deg., 19 paces to #9	
71	64 deg., 16 paces to #6	
72	300 deg., 3 paces to #14	Plot tree #35
73	124 deg., 7 paces to #9	Might be a couple clips from trees between trees 73 and 74
74	122 deg., 9 paces to #9	Joined at very base to red-marked tree not being used by squirrels.
75	270 deg., 3 paces to #9	Plot tree #44. Very many old clips.
76	288 deg., 6 paces to #9	Plot tree #60
77	110 deg., 14 ½ paces to #6	Evidence of feeding on pollen cones, top almost defoliated.
78	97 deg., 13 ½ paces to #6	
79	92 deg., 13 paces to #6	Very many old clips.
80	168 deg., 20 paces to #6	
81	173 deg., 21 paces to #9	
82	96 deg., 17 paces to #8	Only counted clips w/o twigs attached, nest clips scattered around and 2 nest trees within 10m of this tree. First 4 green cones of the season from this clump, and saw squirrel. No specific cone tree, but probably 30-40 cores in clump of 11 Yellow pine.
83	62 deg., 13 ½ paces to #8	
84	318 deg., 16 paces to #8	
85	16 deg., 14 paces to #8	
86	239 deg., 21 ½ paces to #9	Difficult to count sign in QUGA seedlings.
87	183 deg., 30 paces to #6	Dead top, many dead limbs.
88	76 deg., 13 ½ paces to #7	Sign from trees 88 and 89 overlaps.
89	76 deg., 12 ½ paces to #7	
90	150 deg., 18 paces to #11	In dense thicket of QUGA and PIPO. Largest dbh for some distance, but no taller.
91	15 deg., 26 paces to #10	On SW side some sign may be from neighboring tree.
92	16 deg., 19 paces to #10	
93	76 deg., 22 ½ paces to #10	
94	64 deg., 23 ½ paces to #10	
95	51 deg., 17 ½ paces to #10	
96	350 deg., 17 paces to #10	EM plot tree #13
97	344 deg., 20 paces to #10	EM plot tree #6 or 9
98	12 deg., 26 ½ paces to #10	
99	332 deg., 17 paces to #13	Very large clusters.
100	145 deg., 7 paces to #10	Heavily used in past. DBH estimated.
101	118 deg., 14 paces to #5	Large clusters.
102	79 deg., 6 ½ paces to #5	Area not yet marked(trees 102-113), probably will be a leave tree. Circ. plot tree #94. Very many old clips.

EB-5T

Tree No.	Location	Comments
103	13 deg., 13 paces to #7	14 fresh cores, not including this year's cores in count.
104	254 deg., 6 paces to #6	Circ. plot tree #23
105	186 deg., 15 ½ paces to #3	Many cones from last year not eaten.
106	202 deg., 12 paces to #3	
107	321 deg., 20 paces to #5	
108	122 deg., 9 paces to #3	Almost a yellow pine, especially on E. side. Four fresh cone cores.
109	358 deg., 17 ½ paces to #5	
110	254 deg., 11 paces to #4	
111	8 deg., 20 ½ paces to #5	
112	0 deg., 26 paces to #5	
113	64 deg., 26 paces to #3	

APPENDIX B

Track station data

Explanation:

Track stations (Drennan et al. 1998) were used in 1997 and 1998 to determine the relative abundance of sciurids in experimental blocks. This data was not reported in the text of the thesis due to inconsistent results for tassel-eared squirrels, and incomplete analysis for rock squirrel (*Spermophilus variegatus*) and cliff chipmunk (*Eutamias dorsalis*) results. Using this method only presence or absence can be determined for a particular track station, so the number 1 on data forms is intended only to indicate presence of tracks. Track station numbers correspond to rebar locations as numbered on maps in Appendix D, not as numbered on NAU Ecology Lab maps.

<u>Data Codes</u>:
SCAB = *Sciurus aberti kaibabensis*
SPVA = *Spermophilus variegatus*
EUDO = *Eutamias dorsalis*

Summary of Track Station Results

Unit	Date	SCAB	SPVA	EUDO	OTHR
[redacted]	Aug 97	0	6	16	0
	May 98	0	9	4	1
	Aug 98	0	7	7	5
[redacted]	Aug 97	1	7	16	0
	May 98	3	0	12	4
	Aug 98	1	9	10	4
[redacted]	Aug 97	0	1	10	2
	May 98	0	4	0	0
	Aug 98	0	13	1	3
[redacted]	Aug 97	0	5	7	2
	May 98	1	13	1	3
	Aug 98	1	11	1	6
[redacted]	Aug 97	0	0	5	0
	May 98	0	1	1	3
	Aug 98	0	6	0	6
[redacted]	Aug 97	1	4	3	0
	May 98	0	1	0	1
	Aug 98	4	3	2	1
[redacted]	Aug 97	0	4	11	0
	May 98	0	0	1	8
	Aug 98	0	2	4	18
[redacted]	Aug 97	0	0	5	0
	May 98	0	0	0	6
	Aug 98	0	0	1	12
[redacted]	Aug 97	0	0	8	1
	May 98	1	11	0	1
	Aug 98	0	7	1	9
[redacted]	Aug 97	0	1	2	2
	May 98	0	0	0	18
	Aug 98	1	0	2	6

UNIT	DATE	RECORDER
EB-1 C	14 AUG 97	MTE

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1		1	1	2		2
2		1	1	2		2
3			1	1		1
4			1	1		1
5			1	1		1
6		1	1	2		2
7		1	1	2		2
8			1	1		1
9			1	1		1
10			1	1		1
11			1	1		1
12		1		1		1
~~12a~~			1	1		1
13		1		1		1
14			1	1		1
15			1	1		1
16				0		0
17			1	1		1
18				0		0
19				0		0
20			1	1		1
21				0		0
22				0		0
23				0		0
24				0		0
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	0	6	16	22	0	22

UNIT	DATE	RECORDER
EB-1 C	17 MAY 98	CLC(6,7,12b,15-20), KA(1-5, 8-14)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0		0
2		1		1		1
3		1		1		1
4		1		1		1
5		1		1		1
6		1		1		1
7			1	1		1
8				0		0
9			1	1		1
10		1	1	2		2
11				0		0
12		1		1		1
12a		1		1		1
13				0		0
14				0		0
15				0		0
16			1	1		1
17				0		0
18		1		1		1
19				0	1	1
20				0		0
21				0		0
22				0		0
23				0		0
24				0		0
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	0	9	4	13	1	14

UNIT	DATE	RECORDER
EB-1 C	9 Aug 98	LSC (1-20)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0		0
2		1		1		1
3				0	1	1
4		1		1		1
5		1		1		1
6		1		1		1
7			1	1		1
8				0	1	1
9		1		1		1
10				0		0
11			1	1		1
12			1	1		1
12a			1	1		1
13				0		0
14				0	1	1
15			1	1		1
16				0	1	1
17				0		0
18				0		0
19		1	1	2		2
20		1	1	2	1	3
21				0		0
22				0		0
23				0		0
24				0		0
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	0	7	7	14	5	19

UNIT	DATE	RECORDER
EB-1 T	14 AUG 97	BK (1-11) JDW (12-21)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1			1	1		1
2			1	1		1
3		1		1		1
4			1	1		1
5			1	1		1
6			1	1		1
7				0		0
8			1	1		1
9		1	1	2		2
10		1	1	2		2
11			1	1		1
12			1	1		1
				0		0
13		1	1	2		2
14	1			1		1
15		1	1	2		2
16			1	1		1
17				0		0
18				0		0
19			1	1		1
20		1	1	2		2
21		1	1	2		2
22				0		0
23				0		0
24				0		0
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	1	7	16	24	0	24

UNIT	DATE	RECORDER
EB-1 T	17 MAY 98	MTE(6-21), CLC(1-5)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0		0
2				0	1	1
3				0	1	1
4			1	1		1
5			1	1		1
6				0	1	1
7				0	1	1
8	1		1	2		2
9			1	1		1
10				0		0
11			1	1		1
12			1	1		1
				0		0
13			1	1		1
14	1			1		1
15			1	1		1
16			1	1		1
17	1			1		1
18				0		0
19			1	1		1
20			1	1		1
21			1	1		1
22				0		0
23				0		0
24				0		0
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	3	0	12	15	4	19

UNIT	DATE	RECORDER
EB-1 T	9 Aug 98	MTE (1-21)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1			1	1		1
2			1	1		1
3			1	1		1
4				0	1	1
5		1		1		1
6				0	1	1
7		1		1		1
8	1			1		1
9				0	1	1
10		1	1	2		2
11			1	1		1
12			1	1		1
				0		0
13		1	1	2		2
14		1		1		1
15				0		0
16		1		1		1
17			1	1	1	2
18				0		0
19		1	1	2		2
20		1	1	2		2
21		1		1		1
22				0		0
23				0		0
24				0		0
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	1	9	10	20	4	24

UNIT	DATE	RECORDER
EB-2 C	14 AUG 97	AM (1-13) BK (14-25)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0	1	1
2			1	1		1
3			1	1		1
4				0	1	1
5				0		0
6			1	1		1
7			1	1		1
8			1	1		1
9				0		0
10			1	1		1
11			1	1		1
12			1	1		1
				0		0
13		1		1		1
14				0		0
15				0		0
16				0		0
17				0		0
18				0		0
19				0		0
20				0		0
21				0		0
22				0		0
23			1	1		1
24				0		0
25			1	1		1
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	0	1	10	11	2	13

UNIT	DATE	RECORDER
EB-2C	17 MAY 98	MTE(5-25), CLC(1-4)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0		0
2				0		0
3		1		1		1
4		1		1		1
5				0		0
6				0		0
7				0		0
8		1		1		1
9		1		1		1
10				0		0
11				0		0
12				0		0
				0		0
13				0		0
14				0		0
15				0		0
16				0		0
17				0		0
18				0		0
19				0		0
20				0		0
21				0		0
22				0		0
23				0		0
24				0		0
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	0	4	0	4	0	4

UNIT	DATE	RECORDER
EB-2 C	9 Aug 98	LSC (1-25)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1		1		1		1
2		1		1		1
3		1		1		1
4		1		1		1
5				0	1	1
6		1		1		1
7				0		0
8		1		1		1
9		1		1		1
10		1		1		1
11				0		0
12				0		0
				0		0
13				0		0
14				0		0
15				0	1	1
16				0		0
17		1		1		1
18				0		0
19		1		1		1
20				0	1	1
21		1		1		1
22		1		1		1
23				0		0
24			1	1		1
25		1		1		1
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	0	13	1	14	3	17

UNIT	DATE	RECORDER
EB-2 T	14 AUG 97	MTE (1-13) JDW (14-23)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0		0
2				0		0
3				0		0
4		1		1		1
5			1	1		1
6		1	1	2		2
7				0		0
8		1	1	2		2
9				0		0
10		1		1		1
11				0		0
12		1	1	2		2
				0		0
13				0		0
14				0		0
15				0	1	1
16				0		0
17				0		0
18				0		0
19				0		0
20			1	1		1
21			1	1		1
22				0	1	1
23			1	1		1
24				0		0
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	0	5	7	12	2	14

UNIT	DATE	RECORDER
EB-2 T	17 MAY 98	CLC(8-12, 16-23), KA(1-7,13-15)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1		1		1		1
2		1		1		1
3				0		0
4				0		0
5				0	1	1
6				0		0
7				0		0
8		1		1		1
9		1		1		1
10		1		1		1
11				0		0
12				0		0
				0		0
13		1		1	1	2
14		1		1		1
15		1		1		1
16		1		1		1
17	1			1		1
18		1		1		1
19		1		1		1
20		1	1	2	1	3
21				0		0
22				0		0
23		1		1		1
24				0		0
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	1	13	1	15	3	18

UNIT	DATE	RECORDER
EB-2 T	9 Aug 98	MTE (1-23)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1		1		1		1
2		1		1		1
3		1		1		1
4				0		0
5				0	1	1
6				0		0
7				0		0
8	1			1		1
9		1		1		1
10		1		1		1
11				0	1	1
12		1		1		1
				0		0
13				0	1	1
14				0	1	1
15				0		0
16				0		0
17		1		1		1
18		1		1		1
19		1		1		1
20		1		1	1	2
21		1		1		1
22				0	1	1
23			1	1		1
24				0		0
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	1	11	1	13	6	19

UNIT	DATE	RECORDER
EB-3 C	15 AUG 97 AM (1-12) JDW (13-24)	

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0		0
2				0		0
3				0		0
4				0		0
5			1	1		1
6				0		0
7			1	1		1
8				0		0
9				0		0
10				0		0
11				0		0
12				0		0
				0		0
13				0		0
14				0		0
15				0		0
16			1	1		1
17				0		0
18				0		0
19				0		0
20			1	1		1
21				0		0
22				0		0
23				0		0
24			1	1		1
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	0	0	5	5	0	5

UNIT	DATE	RECORDER
EB-3 C	18 MAY 98	HAS (1-10), CLC (11-24)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0		0
2		1		1		1
3				0	1	1
4				0		0
5				0		0
6				0		0
7				0	1	1
8				0		0
9				0		0
10				0		0
11				0		0
12			1	1		1
				0		0
13				0		0
14				0		0
15				0		0
16				0		0
17				0		0
18				0	1	1
19				0		0
20				0		0
21				0		0
22				0		0
23				0		0
24				0		0
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	0	1	1	2	3	5

UNIT	DATE	RECORDER
EB-3 C	10 Aug 98	MTE (1-24)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1		1		1		1
2		1		1		1
3		1		1		1
4				0		0
5				0	1	1
6				0		0
7				0		0
8				0		0
9				0	1	1
10				0		0
11		1		1		1
12		1		1		1
				0		0
13		1		1		1
14				0		0
15				0		0
16				0	1	1
17				0		0
18				0		0
19				0		0
20				0	1	1
21				0		0
22				0	1	1
23				0		0
24				0	1	1
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	0	6	0	6	6	12

UNIT	DATE	RECORDER
EB-3 T	15 AUG 97 TA (1-10) MTE (11-25)	

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0		0
2			1	1		1
3				0		0
4		1		1		1
5		1		1		1
6				0		0
7				0		0
8				0		0
9		1	1	2		2
10				0		0
11				0		0
12		1		1		1
				0		0
13				0		0
14				0		0
15				0		0
16			1	1		1
17				0		0
18				0		0
19				0		0
20				0		0
21				0		0
22	1			1		1
23				0		0
24				0		0
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	1	4	3	8	0	8

UNIT	DATE	RECORDER
EB-3 T	18 MAY 98	MTE(1-25)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0		0
2				0		0
3				0		0
4				0		0
5				0		0
6				0	1	1
7				0		0
8				0		0
9				0		0
10				0		0
11				0		0
12				0		0
				0		0
13				0		0
14				0		0
15				0		0
16				0		0
17				0		0
18				0		0
19				0		0
20		1		1		1
21				0		0
22				0		0
23				0		0
24				0		0
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	0	1	0	1	1	2

UNIT	DATE	RECORDER
EB-3 T	10 Aug 98	JAV (1-15)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0		0
2				0		0
3			1	1		1
4				0		0
5				0		0
6				0		0
7				0		0
8				0		0
9		1		1		1
10		1		1		1
11		1		1		1
12	1			1		1
				0		0
13	1			1		1
14			1	1		1
15				0		0
16				0		0
17				0		0
18				0	1	1
19	1			1		1
20	1			1		1
21				0		0
22				0		0
23				0		0
24				0		0
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	4	3	2	9	1	10

UNIT	DATE	RECORDER
EB-4 C	15 AUG 97	TA (1-11) MTE (12-27)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0		0
2				0		0
3		1	1	2		2
4			1	1		1
5			1	1		1
6				0		0
7				0		0
8				0		0
9			1	1		1
10			1	1		1
11			1	1		1
12			1	1		1
				0		0
13		1	1	2		2
14		1		1		1
15				0		0
16				0		0
17		1		1		1
18				0		0
19			1	1		1
20				0		0
21				0		0
22				0		0
23				0		0
24				0		0
25				0		0
26			1	1		1
27			1	1		1
28				0		0
29				0		0
30				0		0
TOTAL	0	4	11	15	0	15

UNIT	DATE	RECORDER
EB-4 C	18 MAY 98	CLC(1-4, 12-19, 24-27), HAS (5-11, 20-23)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0		0
2				0		0
3				0	1	1
4				0	1	1
5				0		0
6				0		0
7				0		0
8				0		0
9				0	1	1
10				0	1	1
11				0	1	1
12				0		0
				0		0
13				0		0
14			1	1		1
15				0	1	1
16				0		0
17				0		0
18				0		0
19				0		0
20				0		0
21				0		0
22				0		0
23				0		0
24				0		0
25				0		0
26				0	1	1
27				0	1	1
28				0		0
29				0		0
30				0		0
TOTAL	0	0	1	1	8	9

UNIT	DATE	RECORDER
EB-4 C	10 Aug 98	JAV (1-27)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0	1	1
2				0	1	1
3				0	1	1
4				0	1	1
5			1	1		1
6				0	1	1
7				0		0
8				0	1	1
9				0		0
10				0		0
11				0	1	1
12			1	1		1
				0		0
13				0	1	1
14				0	1	1
15				0	1	1
16			1	1	1	2
17				0	1	1
18				0	1	1
19				0	1	1
20				0	1	1
21				0		0
22				0		0
23			1	1	1	2
24		1		1		1
25		1		1		1
26				0	1	1
27				0	1	1
28				0		0
29				0		0
30				0		0
TOTAL	0	2	4	6	18	24

UNIT	DATE	RECORDER
EB-4 T	15 AUG 97	AM (1-10) JDW (11-22)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0		0
2			1	1		1
3				0		0
4				0		0
5				0		0
6				0		0
7				0		0
8				0		0
9a						
9				0		0
10				0		0
11				0		0
12				0		0
				0		0
13			1	1		1
14			1	1		1
15				0		0
16				0		0
17				0		0
18			1	1		1
19				0		0
20			1	1		1
21				0		0
22				0		0
23				0		0
24				0		0
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	0	0	5	5	0	5

UNIT	DATE	RECORDER
EB-4 T	18 MAY 98	MTE(1-22)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0		0
2				0	1	1
3				0		0
4				0		0
5				0	1	1
6				0		0
7				0		0
8				0		0
9a						
9				0		0
10				0		0
11				0		0
12				0	1	1
				0		0
13				0	1	1
14				0		0
15				0		0
16				0		0
17				0		0
18				0	1	1
19				0		0
20				0	1	1
21				0		0
22				0		0
23				0		0
24				0		0
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	0	0	0	0	6	6

UNIT	DATE	RECORDER
EB-4 T	10 Aug 98	MTE (1-22)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0	1	1
2				0		0
3				0	1	1
4				0	1	1
5				0	1	1
6				0		0
7				0		0
8				0		0
9a						
9				0		0
10				0	1	1
11				0		0
12				0		0
				0		0
13				0	1	1
14				0	1	1
15				0		0
16			1	1	1	2
17				0	1	1
18				0	1	1
19				0	1	1
20				0	1	1
21				0		0
22				0		0
23				0		0
24				0		0
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	0	0	1	1	12	13

UNIT	DATE	RECORDER
EB-5 C	16 AUG 97	AM (1-8) BK (9-16) TA (17-24)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0		0
2			1	1		1
3			1	1		1
4			1	1		1
5			1	1		1
6			1	1		1
7				0		0
8				0		0
9				0		0
10				0		0
11				0		0
12				0		0
				0		0
13			1	1		1
14				0		0
15				0		0
16				0		0
17				0		0
18				0		0
19				0		0
20				0	1	1
21			1	1		1
22				0		0
23				0		0
24			1	1		1
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	0	0	8	8	1	9

UNIT	DATE	RECORDER
EB-5 C	20 MAY 98	MTE(1-24)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0		0
2		1		1		1
3				0		0
4		1		1		1
5		1		1		1
6				0		0
7				0		0
8				0		0
9				0		0
10		1		1		1
11				0		0
12		1		1		1
				0		0
13				0		0
14				0		0
15		1		1		1
16		1		1		1
17				0		0
18				0	1	1
19		1		1		1
20		1		1		1
21	1			1		1
22		1		1		1
23		1		1		1
24				0		0
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	1	11	0	12	1	13

UNIT	DATE	RECORDER
EB-5 C	11 Aug 98	LSC (1-12) JEK (13-24)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0	1	1
2				0		0
3				0	1	1
4			1	1	1	2
5				0		0
6				0		0
7				0		0
8				0		0
9				0		0
10				0	1	1
11		1		1		1
12				0		0
				0		0
13				0	1	1
14		1		1		1
15		1		1		1
16		1		1	1	2
17		1		1		1
18				0		0
19				0	1	1
20				0		0
21				0	1	1
22				0	1	1
23		1		1		1
24		1		1		1
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	0	7	1	8	9	17

UNIT	DATE	RECORDER
EB-5 T	16 AUG 97	MTE (1-11) JDW (12-23)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0		0
2			1	1		1
3				0		0
4				0		0
5				0		0
6			1	1		1
7				0		0
8				0		0
9				0		0
10				0		0
11				0		0
12				0		0
				0		0
13		1		1		1
14				0		0
15				0		0
16				0		0
17				0		0
18				0	1	1
19				0		0
20				0	1	1
21				0		0
22				0		0
23				0		0
24				0		0
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	0	1	2	3	2	5

UNIT	DATE	RECORDER
EB-5 T	20 MAY 98	MTE(1-23)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0	1	1
2				0	1	1
3				0		0
4				0	1	1
5				0	1	1
6				0	1	1
7				0	1	1
8				0		0
9				0	1	1
10				0		0
11				0	1	1
12				0	1	1
				0	1	1
13				0	1	1
14				0	1	1
15				0	1	1
16				0	1	1
17				0	1	1
18				0	1	1
19				0		0
20				0		0
21				0	1	1
22				0		0
23				0	1	1
24				0		0
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	0	0	0	0	18	18

UNIT	DATE	RECORDER
EB-5 T	11 Aug 98	JAV (1-11) MTE (12-23)

STATION #	SCAB	SPVA	EUDO	TOTAL SCIURIDS	OTHR	TOTAL HITS
1				0		0
2				0	1	1
3				0		0
4				0		0
5				0	1	1
6			1	1	1	2
7				0		0
8				0		0
9				0		0
10				0	1	1
11				0		0
12				0		0
				0		0
13			1	1		1
14	1			1		1
15				0		0
16				0		0
17				0		0
18				0		0
19				0		0
20				0	1	1
21				0		0
22				0		0
23				0	1	1
24				0		0
25				0		0
26				0		0
27				0		0
28				0		0
29				0		0
30				0		0
TOTAL	1	0	2	3	6	9

APPENDIX C

Tassel-eared squirrel feeding index data

Explanation:

A tassel-eared squirrel feeding index was used to determine relative levels of foraging activity by squirrels in the experimental blocks. This data is not presented in the text of the thesis due to incomplete analysis. The index was conducted by placing a 1 m^2 frame on the ground and counting the amount of feeding evidence from the past year in the listed categories. Counts were made approximately 15 m apart on transects beginning in front of rebar grid points and progressing in the direction of the next grid point in a straight line. A transect as defined on the data forms consists of four counts between grid points, so the total number of times counts were made in 1 m^2 frames may be obtained by multiplying the number of transects by four. See Dodd et al. (1998) for further details.

August 1997 - Tassel-eared squirrel feeding index

Unit	Fungi Digs	Cone Cores	Clipped Twigs	Terminal Clusters	Total Sign	Total Transects
EB-1 Control	1	0	0	11	12	17
EB-1 Treatment	1	3	11	13	28	17
EB-1 (Combined)	**2**	**3**	**11**	**24**	**40**	**34**
EB-2 Control	1	2	2	12	17	19
EB-2 Treatment	0	2	0	11	13	19
EB-2 (Combined)	**1**	**4**	**2**	**23**	**30**	**38**
EB-3 Control	3	8	1	14	26	20
EB-3 Treatment	4	0	1	6	11	20
EB-3 (Combined)	**7**	**8**	**2**	**20**	**37**	**40**
EB-4 Control	0	0	0	8	8	23
EB-4 Treatment	2	0	2	7	11	20
EB-4 (Combined)	**2**	**0**	**2**	**15**	**19**	**43**
EB-5 Control	0	3	0	13	16	23
EB-5 Treatment	0	0	0	2	2	21
EB-5 (Combined)	**0**	**3**	**0**	**15**	**18**	**44**

Units EB-2 and EB-3 sampled on 7/31/97. Units EB-1, EB-4, and EB-5 sampled on 8/1/97.

May 1998 - Tassel-eared squirrel feeding index

Unit	Fungi Digs	Cone Cores	Clipped Twigs	Terminal Clusters	Total Sign	Total Transects
EB-1 Control	1	3	3	16	23	17
EB-1 Treatment	0	7	21	30	58	18
EB-1 (Combined)	**1**	**10**	**24**	**46**	**81**	**34**
EB-2 Control	1	10	2	7	20	19
EB-2 Treatment	1	4	5	7	17	19
EB-2 (Combined)	**2**	**14**	**7**	**14**	**37**	**38**
EB-3 Control	0	25	6	36	64	20
EB-3 Treatment	0	4	3	27	34	20
EB-3 (Combined)	**0**	**29**	**9**	**63**	**98**	**40**
EB-4 Control	5	3	1	12	21	23
EB-4 Treatment	1	2	2	14	19	20
EB-4 (Combined)	**6**	**5**	**3**	**26**	**40**	**43**
EB-5 Control	3	1	3	37	44	23
EB-5 Treatment	1	1	4	22	28	21
EB-5 (Combined)	**4**	**2**	**7**	**59**	**72**	**44**

Unit EB-1 sampled on 5/15/98, EB-2 on 5/16/98, EB-3 on 5/18/98, EB-4 on 5/18/98 & 5/19/98, and EB-5 sampled on 5/19/98.

August 1998 - Tassel-eared squirrel feeding index

Unit	Fungi Digs	Cone Cores	Clipped Twigs	Terminal Clusters	Total Sign	Total Transects
EB-1 Control	3	4	1	12	20	18
EB-1 Treatment	1	7	21	23	52	18
EB-1 (Combined)	**4**	**11**	**22**	**35**	**72**	**36**
EB-2 Control	5	12	6	24	47	19
EB-2 Treatment	4	3	1	13	21	19
EB-2 (Combined)	**9**	**15**	**7**	**37**	**68**	**38**
EB-3 Control	0	18	4	29	51	20
EB-3 Treatment	0	4	0	11	15	20
EB-3 (Combined)	**0**	**22**	**4**	**40**	**66**	**40**
EB-4 Control	1	3	1	12	17	23
EB-4 Treatment	3	3	0	1	7	20
EB-4 (Combined)	**4**	**6**	**1**	**13**	**24**	**43**
EB-5 Control	1	0	2	7	10	23
EB-5 Treatment	1	3	3	7	14	21
EB-5 (Combined)	**2**	**3**	**5**	**14**	**24**	**44**

Unit EB-1 sampled on 7/29/98, EB-2 on 8/7/98, EB-3 on 7/29/98 & 8/7/98, EB-4 on 8/8/98 & 8/9/98, and EB-5 sampled on 8/10/98.

APPENDIX D

Maps