

## Hazard Fuel Vegetation Monitoring Mesa Verde National Park, 2000

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### INTRODUCTION

Decades of fire suppression at Mesa Verde National Park have resulted in heavy fuel loading. When ignited, these fuels can burn out of control, as seen in the Chapin 5 fire (1996) and the Bircher and Pony fires (2000). In 1993, the Park decided to develop a Hazard Fuel Reduction program to protect structures on Chapin Mesa in case of a large wildfire incident. The program protocol requires the reduction of canopy cover to 20 feet crown spacing between trees in developed areas to create fuel breaks. Tree reduction involves ground crews and chainsaws; the resulting slash is then removed by hand from the area. In areas where removal of the fuels is unfeasible, such as backcountry alcove sites, the fuels are scattered outside of treatment areas.

Natural Resource concerns are that hazard fuel reduction could have detrimental and long-term impacts on the natural ecosystems of treatment areas. The soil compaction caused by fuel removal crews could affect soil stability and understory plant diversity. Soil erosion could increase with the loss of cryptobiotic soil and herbaceous plants that are trampled. Loss of ground cover plants could alter the nutrient and water content of the soil. Once Hazard Fuel Reduction is done, there often tends to be mortality of some of the remaining trees in the treatment areas; what causes these deaths are not clear. Removal of these dead trees is necessary since they are a fuel source, resulting in larger tree spacing than stated in the protocol. Removal of canopy cover causes changes in light intensity that alter local microclimates and ecology. Changes in canopy cover and species composition of the plant community in turn may affect the fauna present in the area.

There have been no previous attempts to document Hazard Fuel Reduction impacts on plant communities within the Park. By establishing monitoring plots, we hope to measure how Hazard Fuel Reduction impacts vegetation diversity within treatment areas. With increased knowledge, we may then be able to better manage these areas. Management efforts could include non-native plant control, revegetation activities or changes in hazard fuel reduction protocols.

### MATERIALS AND METHODS

The format for the monitoring plots installed was a variation of the forest monitoring protocol used in the 1992 *NPS Western Fire Monitoring handbook*. This handbook was published by USDI National Park Service, Western Region, 600 Harrison Street, Suite 600, San Francisco, California 94107-1372.

### Plot installation and Documentation

During the summer of 2000, two monitoring plots were installed north of the Research Loop. After choosing the general locations of the plots (treatment and control), the plot origins were chosen using a random azimuth and random distance from a random point in the general location. In each plot the randomly located origin was in the middle of the two quadrats and the rest of the plot was laid out as pictured in Diagram 1. Identification of the quadrats (Q1 and Q2) was in accordance with the 6 stakes used to mark the plots (Diagram 1). Stakes are circular, 18-inch long, aluminum poles with orange paint on the top 6 inches. Stakes were pounded in the ground and the corresponding corner numbers stamped on their ends. Twenty-five meter tapes were run from 1 to 2, 6 to 3 and 5 to 4. Twenty meter tapes were run across the ends of the plots. The direction of the 25 meter tapes is **important** because they are used for the vegetation transect data collection, and therefore, they must always be laid in the same direction in order to track vegetation changes at specific sampling points.

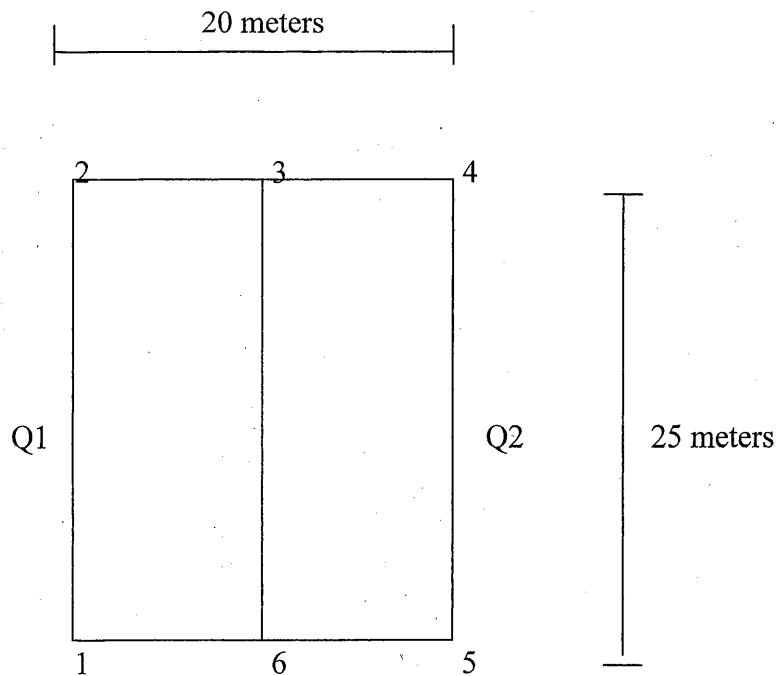


**Diagram 1.** Hazard Fuel Monitoring Plot layout. Stakes used to mark plots are represented by numbers. Q1 and Q2 represent the quadrats in relation to the numbered stakes.

Each plot was photo-documented by taking photos from each end of the three 25 m tapes looking down the tape towards the opposite end. This resulted in 6 photos per plot: 1 to 2; 2 to 1; 3 to 6; 6 to 3; 4 to 5; 5 to 4.

The two plots are located as follows:

*Treatment plot.* This plot is located near the intersection of the Chapin road and the road to the Recreation Hall. From mile marker 19, walk 60 m north along the road to a 35-m.p.h. sign (Photo 1). From the sign, hike  $32^\circ$  for 4.75 m, and you should encounter a "5" imprinted on the top of a metal stake. From this point, we averaged and differentially corrected 100 readings from a Trimble GeoExplorer II, and received a northing and easting of 4119957 m and 722919 m, respectively. This reading has an accuracy of 7 to 12 m.

*Control plot.* This plot is 150 to 200 m and  $279^\circ$  from the treatment plot. An easy access route begins at the corner of the fire cache building (Photo 2). An electrical/telephone pole stands  $353^\circ$  and 34 m away from the corner of the fire cache building. From this pole, follow a single-track trail for 234 m that runs in a  $335^\circ/155^\circ$  direction. You will reach a cut stump (2 dm across) south of a small ditch (Photo 3). Hike  $279^\circ$  cross-country for 60 m, and you should be near one of the stakes. These stakes are about 1 to 2 dm above ground-level. Unfortunately, the GeoExplorer II failed to receive signals from satellites at the control plot, and we don't have UTM coordinates to report.

### Sampling

Sampling in 2000 was done for the treatment plot both before and after hazard fuel reduction. The control plot was sampled just once. Sampling protocol was as follows:

**\*\* Trees forked below diameter at breast height (dbh) were considered separate trees, poles or seedlings.**

**Overstory trees:** Classified as all trees with a **dbh > 15 cm**. Tree data we collected for each tree included: dbh, whether it was dead or alive, location (quadrat) and any special notes (e.g. insect or mammal damage to bark, strong lean to trunk, split tree, etc.). Trees were hand mapped using arbitrary numbers assigned to them on the data sheet.

**Pole trees:** Classified as all trees with a **dbh  $\geq 2.5$  cm and  $\leq 15$  cm**. Pole data we collected for each pole included: dbh, whether it was dead or alive, location (quadrat) and notes on special characteristics were taken.

**Tree seedlings:** Classified as all trees with a **dbh < 2.5 cm**. Seedlings were tallied according to species, height class codes, whether they were dead or alive and what quadrat they were in. Leaning seedlings were measured ALONG the lean. Height was

**Photo 1.** Location of treatment plot. C. Coon is standing at stake #5. Note intersection of Chapin road and the road to the Research Center/Recreation Hall is about 62 meters South of the 35 m.p.h. speed limit sign.

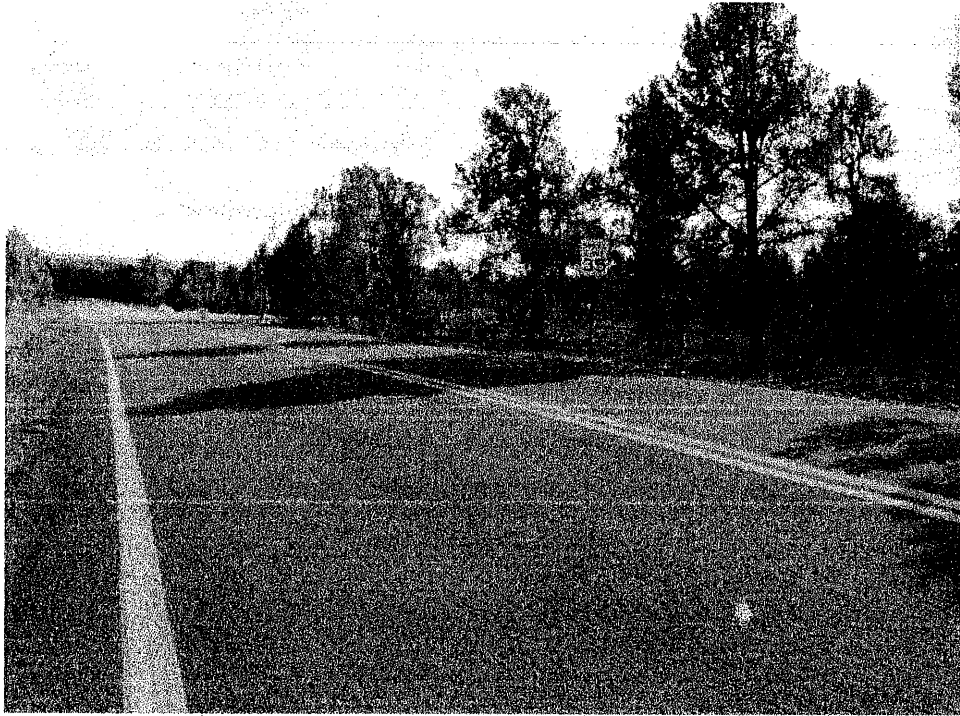


**Photo 2.** Access route to the control plot. It begins between the fire cache/fire management building on the left and the white truck facing out. The trail leads to the telephone pole (pictured near the center) that is behind some trees.



**Photo 3.** Access route to control plot. Cut stump is at bottom of pole held by C. Coon, drainage ditch is approximately 1 meter beyond her.



measured from ground level to the highest point of growth on the tree. A bent tree could have its highest point below the growing apex. Heights class codes were:

| Class | Height (cm) |
|-------|-------------|
| 1     | 0-15        |
| 2     | 15.1-30     |
| 3     | 30.1-60     |
| 4     | 60.1-100    |
| 5     | 100.1-200   |
| 6     | 200.1-300   |
| 7     | 300.1-400   |
| 8     | 400.1-500   |

**Brush:** Two additional 25m tapes were laid 1 meter within each quadrat paralleling the 25m tapes from stakes 1 to 2 and 5 to 4. Within each of these 25 x 1 m transects all brush individuals were counted and recorded. Data for each transect was recorded individually so that they could be distinguished in future comparisons.

**Vegetation:** Using a round stake (tent pole is ideal) that was marked with centimeter intervals the ground vegetation was sampled. Starting at the 0.3 m point on the 25 m tape, the pole was placed upright beside the tape. The height of the tallest vegetation **touching** the pole was recorded along with the species code and then all other species touching the pole further down were also recorded. This was done at each successional 0.3 meters up to the 24.9 m mark on the tape. Measurements were only taken up to 1.0 meter high, anything taller than that (likely a tree anyway) was not included. If branches of trees did intersect the pole below 1.0 m, they were included. If no vegetation touched the pole, a height of zero and the code for bare soil or litter was entered, depending on what the base of the pole rested on. This sampling was done along all three of the 25m tapes from stakes 1 to 2, 6 to 3 and 5 to 4. Again note that the direction of the meter tapes are critical and must be laid the same way each time.

## RESULTS

First of all, it is important to note that a small area in the treatment plot was not cut. Why this occurred is not clear, but it does effect the numbers seen in the following figures. The corner that was not cut was in Quadrat 1, near stake #2.

### Trees

Within the treatment plot (Figure 1), 66 percent of the live pinyon pines (*Pinus edulis*) and 42 percent of the live junipers (*Juniperus utahensis*) were removed. Of the three dead pinyons in the treatment plot, two were removed (66%), the remaining tree was in the uncut area of Quadrat 1. Overall, 48 percent of all the trees were removed.

Within the control plot (Figure 2), there was a higher ratio of junipers to pinyons (19:6) than found in the treatment plot (25:1). While there were no dead pinyons, there were dead junipers. This is completely opposite of the treatment plot where dead trees consisted solely of pinyons (Figure 1).

### Poles

Within the treatment plot (Figure 3), 89 percent of the live pinyons and 60 percent of live junipers were removed. For dead poles there were 81 percent of pinyons removed and 100 percent of junipers. Overall a total of 72 percent of all poles were removed.

Within the control plot (Figure 4), total junipers were more frequent than pinyons (29:20) which was the opposite of the treatment plot (58:66). However, if you exclude dead trees, the junipers are more frequent in both plots (treatment 34:29; control 24:14). While dead pinyons were present in both plots, the number in the treatment plot were much larger, in fact there are almost as many dead pinyon poles as live ones.

### Seedlings

Within the treatment plot (Figure 5), 9 percent of the pinyon seedlings, 18 percent of the juniper seedlings and 100 percent of the oak (*Quercus gambelii*) seedlings were removed. Overall, 26 percent of the total seedlings were removed.

In the control plot (Figure 6), there were more pinyon seedlings than juniper (115:47) while in the treatment plot the trend was the opposite (53:206). Both plots had small numbers of oak seedlings. In the control plot no dead seedlings were found, but there were dead junipers and pinyons in the treatment plot (32 total dead seedlings).

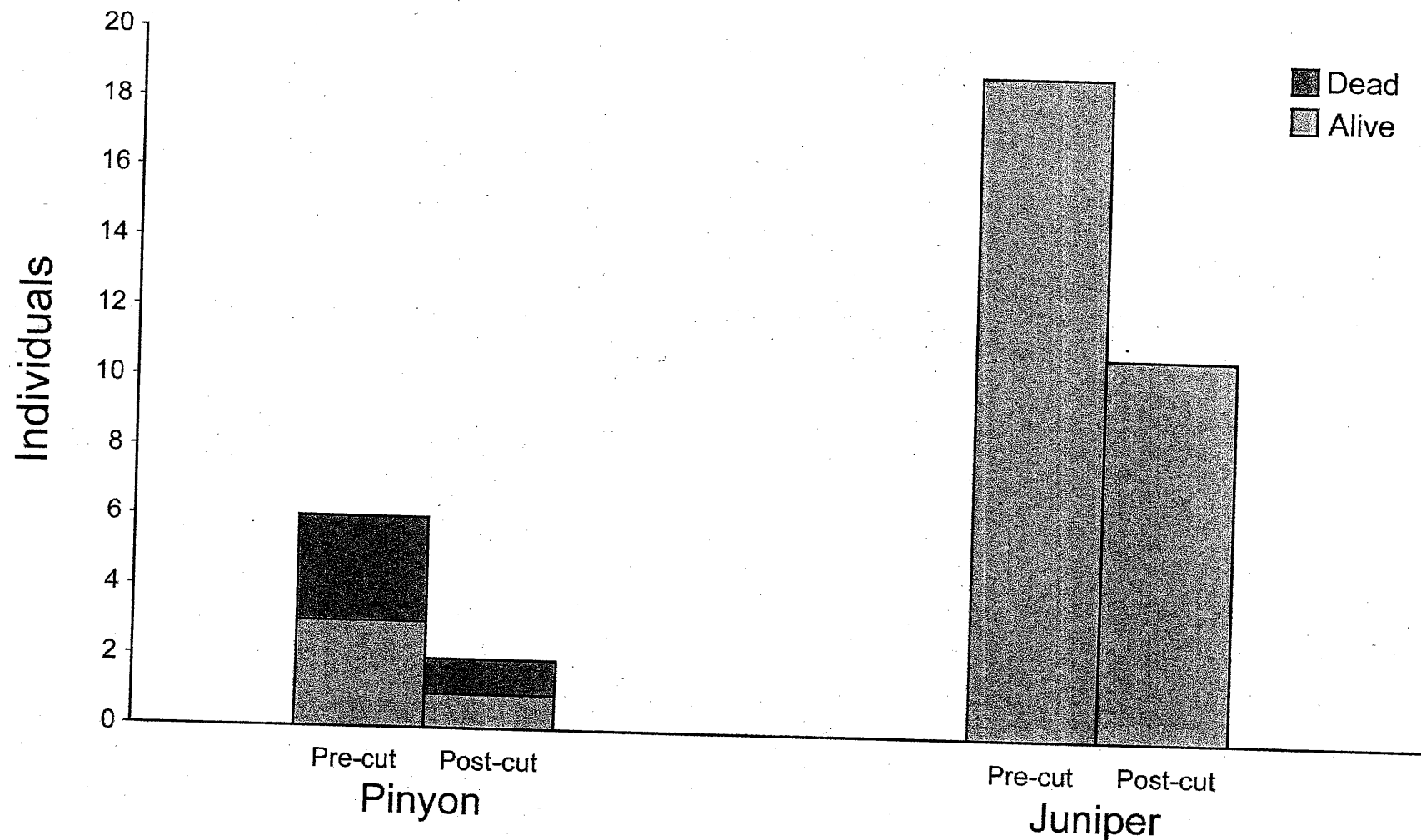
### Brush

The brush composition in the two plots was drastically different (Figure 7). The sampling areas of the treatment plot only had yucca (*Yucca baccata*). In the control there were similar numbers of yucca sampled, but there was also pricklypear (*Opuntia* spp) and large amounts of bitterbrush (*Purshia tridentata*).

### Vegetation

The vegetation results for the two plots (Table 1) were quite different in herbaceous and shrub content. The only common herbaceous plant was penstemon (*Penstemon linarioides*). Yucca was found in both plots, but again the bitterbrush was found only in the control plot. Muttongrass (*Poa fendleriana*) was the most common non-woody plant in both plots. The treatment plot had a decrease in lupine (*Lupinus* species) and penstemon after hazard fuel removal had occurred. There was also an increase in litter seen on the ground after fuel removal had occurred.

**Figure 1 - Trees (d.b.h.>15 cm) Present Before and After Hazard Fuel Reduction**



Species Present Before and After Hazard Fuel Reduction

**Figure 2 - Trees (d.b.h. > 15 cm)  
Present in Control Plot**

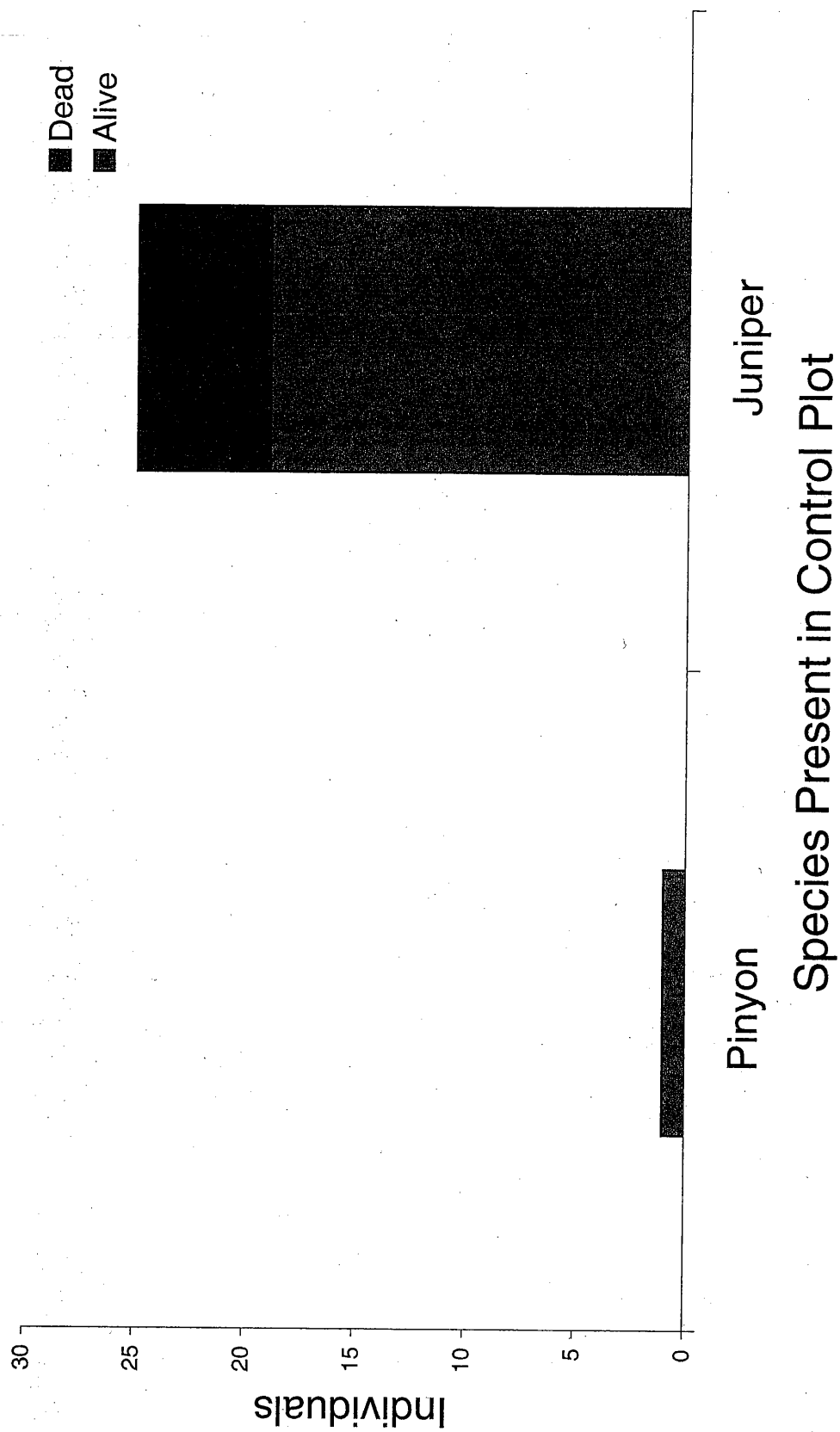
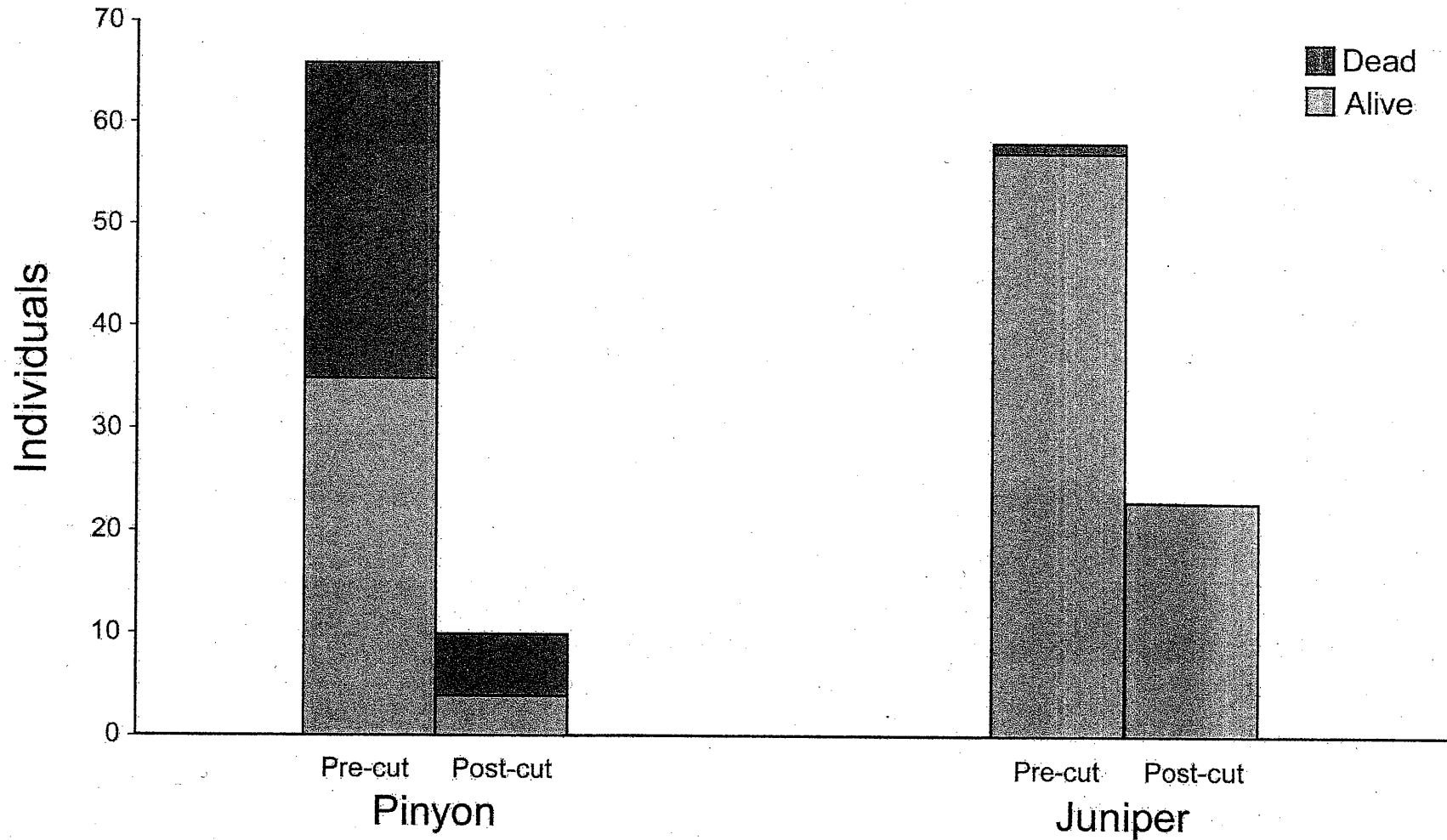


**Figure 3 - Pole Trees ( $2.5 \text{ cm} < \text{d.b.h.} < 15 \text{ cm}$ )  
Present Before and After Hazard Fuel Reduction**



Species Present Before and After Hazard Fuel Reduction

**Figure 4 - Pole Trees ( $2.5\text{cm} < \text{d.b.h.} < 15\text{ cm}$ )  
Present in Control Plot**

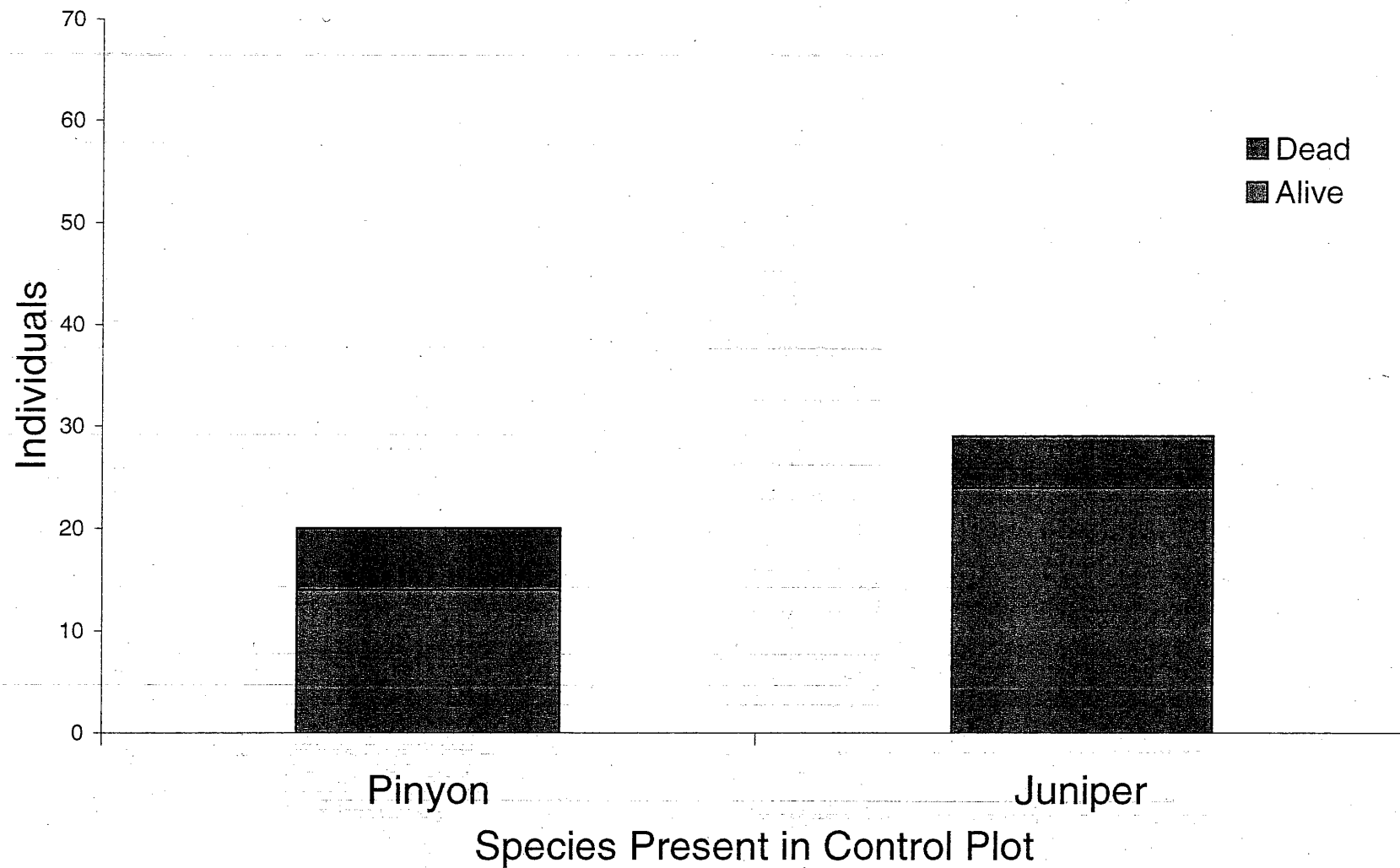
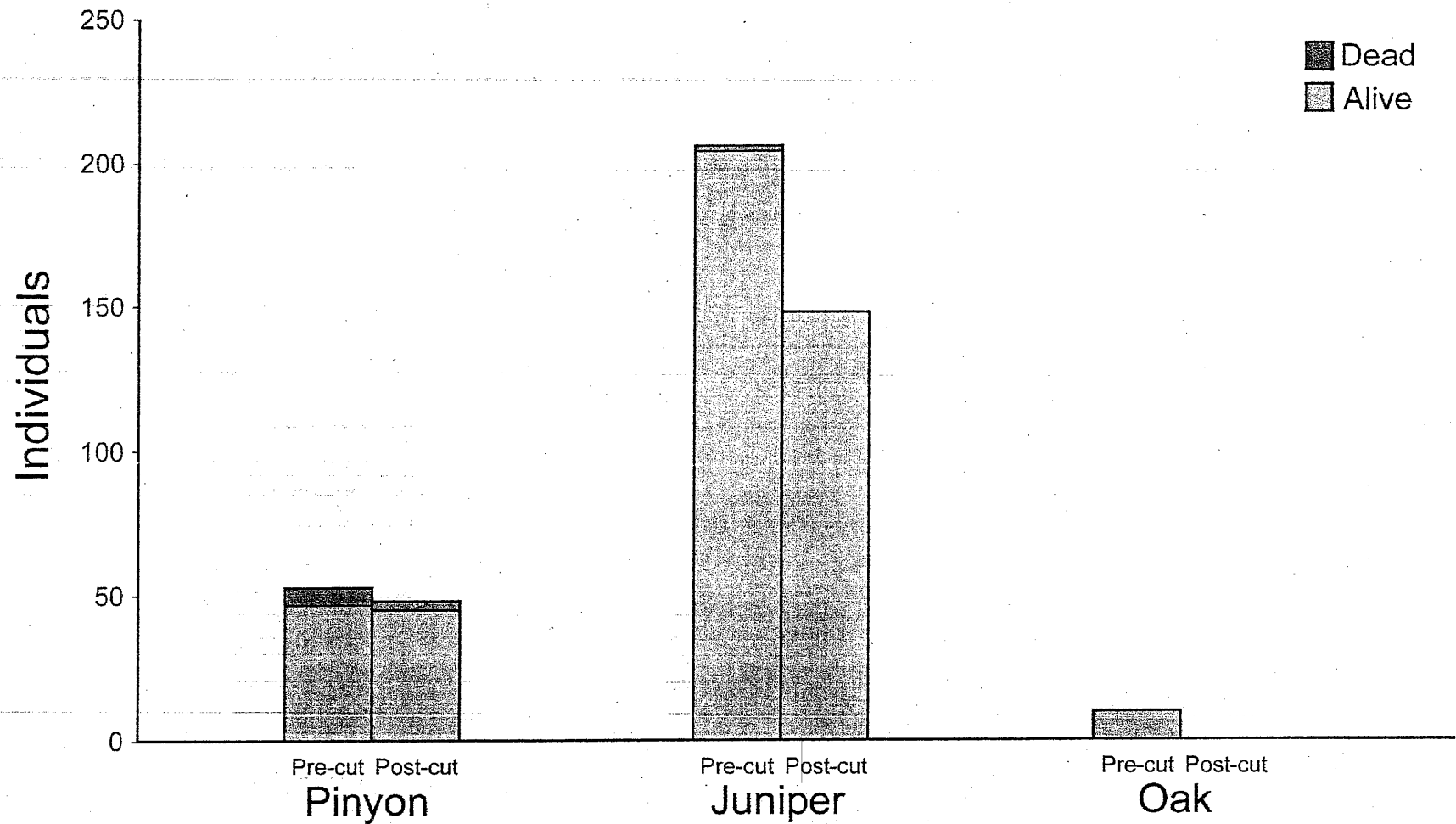




**Figure 5 - Seedlings (d.b.h.<2.5 cm) Present Before and After Hazard Fuel Reduction**



Species Present Before and After Hazard Fuel Reduction



**Figure 6 - Seedlings (d.b.h.<2.5 cm)  
Present in Control Plot**

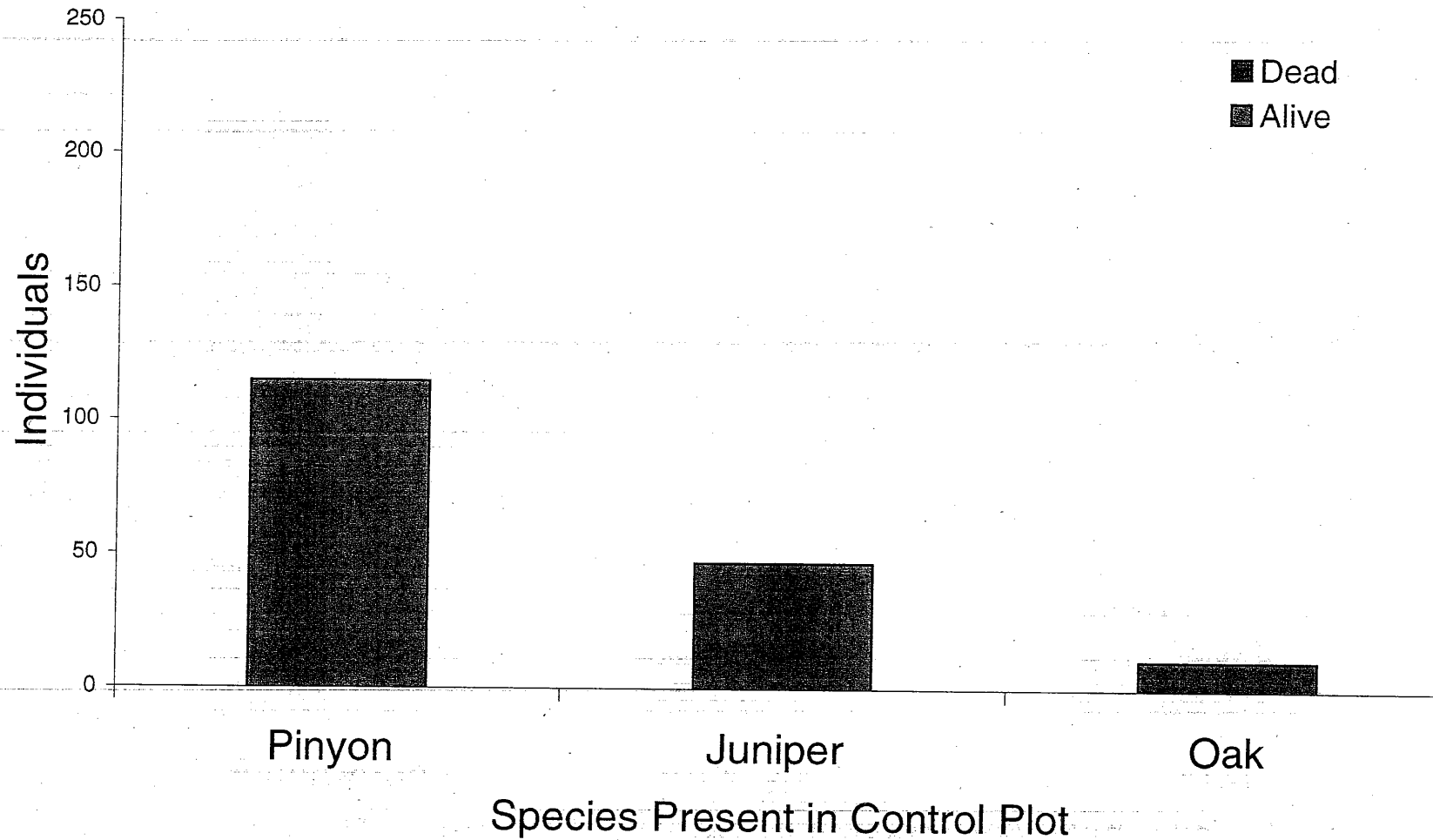
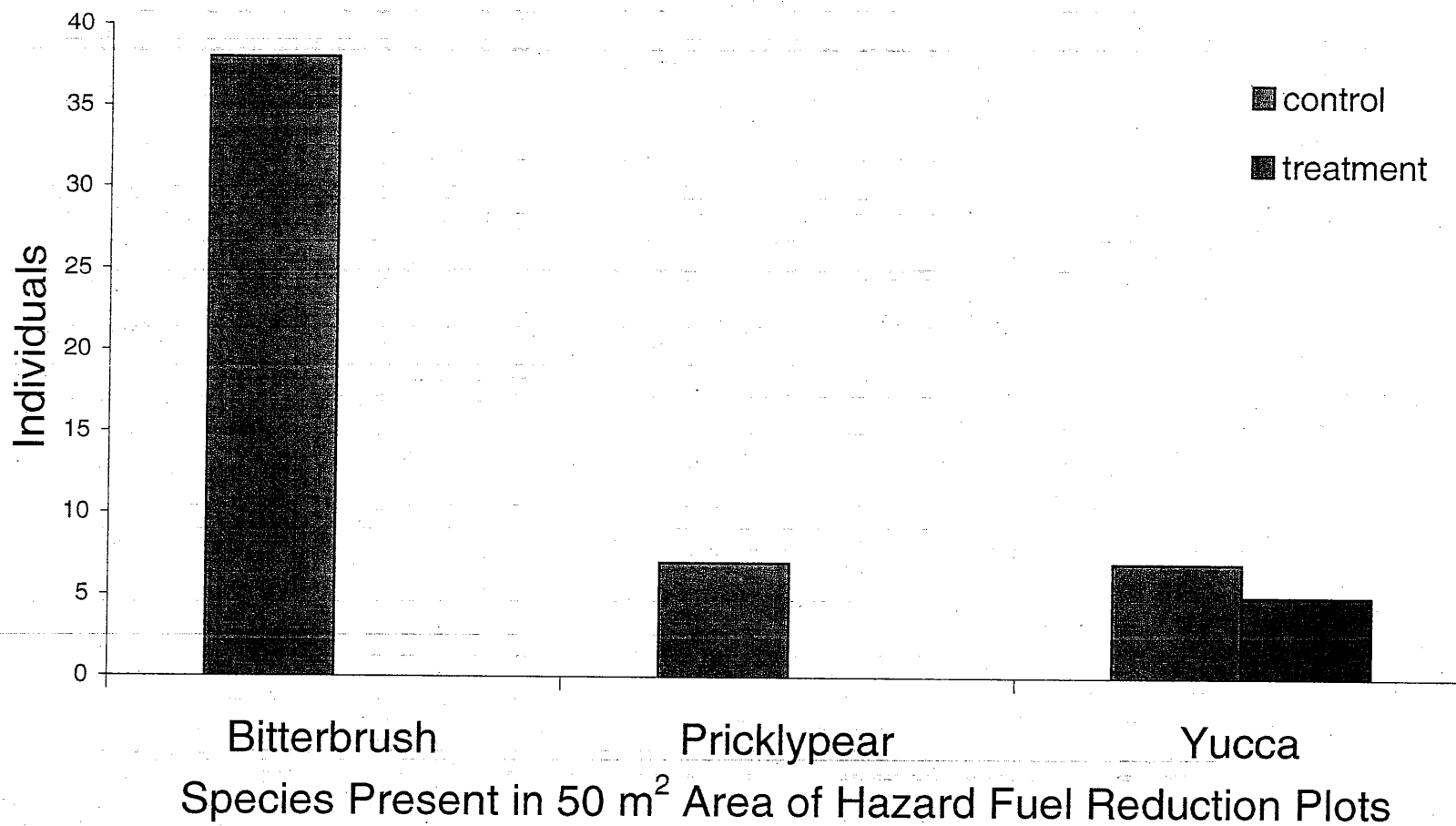




**Figure 7 - Brush in Hazard Fuel Reduction Control  
and Treatment Plots**





| Plant species (lifeform)                                       | Control | Treatment pre-cut | Treatment post-cut |
|----------------------------------------------------------------|---------|-------------------|--------------------|
| <i>Astragalus lentiginosus</i> (herb)                          | 1       | 0                 | 0                  |
| <i>Eriogonum umbellatum</i> (herb)                             | 2       | 0                 | 0                  |
| <i>Lupinus</i> species (herb)                                  | 0       | 3                 | 0                  |
| <i>Penstemon linarioides</i> (herb)                            | 3       | 5                 | 4                  |
| <i>Poa fendleriana</i> (grass)                                 | 65      | 71                | 60                 |
| <i>Purshia tridentata</i> (shrub)                              | 84      | 0                 | 0                  |
| <i>Yucca baccata</i> (succulent included in shrub designation) | 7       | 3                 | 2                  |
| Dirt (bare soil)                                               | 25      | 35                | 12                 |
| Litter (leaf litter or duff)                                   | 74      | 111               | 158                |

**Table 1.** Number of times each species was recorded along vegetation transects for the plots. Pre- and post- results are shown for the treatment plot that had hazard fuel removal. Dirt or litter designations were recorded when no species were present.

## DISCUSSION

Due to the sample size of this monitoring project at present, no statistical analysis could be performed. In the future it is recommended to install more control and treatment plots in Hazard Fuel Reduction areas in order to truly understand how the ecosystem is being affected. The two plots put in during the course of the summer were very different to start off with, and therefore it will be impossible to determine whether subsequent changes will be in response to disturbance by hazard fuel reduction or other parameters. One parameter that should be investigated in subsequent years is soil. Soil depth, composition and moist content should be measured to explain the differences seen in the vegetation. Unfortunately the one area of the treatment plot was not cut. This skews the results of the treatment plot. Again another reason to install several more monitoring plots.

On vegetation sampling lines there should be an added component measured. We only made designations between bare soil and litter. A third component that should be included in the future is cryptobiotic soil. Decreases of cryptobiotic soil cover could have detrimental effects on soil water and nutrient contents. As far as the seedling sampling is concerned, height classes could probably be done away with. Or, different more distinguishing ones made.

Overall, the overstory trees in the two plots were very similar in number and composition. The treatment plot had more pinyon trees overall, but it is interesting what a large proportion of these were dead. Research in the area has found pinyons with black root rot, which is fatal to the trees. Since the million gallon water tank used to have continuous flow in the area (it is now controlled for water flow only when needed), it is possible that the increased water content of the soil was advantageous for the disease. Soil moisture should be measured in this area in the future. Another interesting

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difference was that dead juniper trees (a total of 5 trees) were only found in the control plot. Whether this is coincidental is uncertain. Sampling size should be increased, to determine whether this is a definite trend.

The large number of dead pinyon poles in the treatment plot again might be associated with black root rot disease. Overall, there was a much larger number of pole and seedling trees in the treatment plot as compared to the control. Meanwhile the control plot had a large brush component that was non-existent in the treatment plot. Bitterbrush tends to like shallow, well drained soils. It is possible that the soil composition is different in the two plots and therefore the difference in vegetation. Soil depth measurements are needed to determine if this is true. The control plot had over two times as many pinyon seedlings as the treatment plot. This could be attributed to black root rot in the treatment area, or that bitterbrush fixed nitrogen benefited pinyon seedling establishment in the control plot.

Vegetation changes will be interesting to track in the treatment plot now that the canopy has opened. It should be noted that no exotic species were seen in the plot or near the area when sampled. Whether disturbance in the area will encourage non-native establishment remains to be seen. While there was an increased amount of litter seen immediately after the hazard fuel reduction, over time the amount of litter present to the system will probably be decreased, and soil nutrients will be affected. The only reason this would not occur would be if we see an increase in herbaceous vegetation which will contribute to litter and duff. How changes in litter composition (from wood and tree needles to herbaceous and grass) will affect the soil system is unknown.

The above described possibilities for trends are all conjecture and have no scientific basis at this point. Installation of more fire monitoring plots, soil testing/sampling, and continued sampling over time will help explain the differences seen in the two sample areas. Hopefully, we will gain a better understanding of how hazard fuel reduction disturbances effect the vegetation community. This in turn will lead to a better understanding of the resources and how to manage them.