# Chapin 5 Fire Vegetation Monitoring and Mitigation

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**Abstract**. The Chapin 5 Fire ignited on 17 August 1996, burning 4,781 acres of Mesa Verde National Park. With Burn Area Emergency Rehabilitation (BAER) funding, we are (1) evaluating residual vegetation, (2) monitoring post-fire native plant recovery, and (3) treating non-native plant invasion. To evaluate residual seeds and grass rootstocks, we developed an effective test using the physical strength of the remaining bunch grasses, the "pull test." Residual vegetation was low; grass frequency (average=.52) was reduced (average=.18) after the fire ($t$=7.3, $P$<.05) and few species germinated or re-sprouted in 1996. Vegetation recovery is being monitored at 75 points randomly placed in 20 habitat types defined in a GIS environment. By August 1997, 210 vascular plant species occurred in the burn area. Fire-facilitated species include *Gayophytum ramosissimum, Nicotiana attenuatam* and *Collomia grandiflora.* Re-sprouting shrubs account for 41-60% of the vegetative cover in the mountain shrubland habitats. The intensely burned pinon-juniper habitats support 23-40% forb cover, 14-40% grass cover and bare soils are common. Non-native species are aggressively invading bare soils as well as previously disturbed areas. An integrated pest management approach—seeding native grasses, mechanical removal, herbicide spot-spraying, and 5 biological control agents—is being used to prevent the spread of non-native species.

**Key words**: wildfire, Mesa Verde National Park, non-native species, monitoring, mitigation, Colorado

## SCOPE OF THE PROJECT, YEAR 1

The lightning-initiated Chapin 5 fire in Mesa Verde National Park (MVNP), Colorado, burned 17-24 August 1996. The fire began in the dense pinon-juniper/purshia woodland on Chapin Mesa, and after a short run to the south, continued essentially northward, burning Soda Canyon, Little Soda Canyon, and large portions of the research area Park Mesa, when it stopped at the Visitors Center and hotel complex in the dense oak and serviceberry shrublands. The fire covered 4,781 acres, 7 pre-fire vegetation communities, 2 geologic substrates (Menefee Shale and Cliffhouse Sandstones), and numerous soil types. Using primary soil hydrophobic characteristics, the BAER hydrologic team mapped levels of burn intensities. In addition, pre-fire vegetation communities became the basis for predicting probable post-fire vegetation responses. We identified a "revegetation response potential" for each vegetation community. Communities which included re-sprouting shrubs *Quercus gambelii* and *Amelanchier utahensis* were considered likely to recover rapidly; those which lacked significant re-sprouting understory shrubs would recover slowly.

The first year evaluation of vegetation recovery in the Chapin 5 fire, funded under the Burned Area Emergency Rehabilitation (BAER) program, focused on the following objectives:

- vegetation was monitored across the diversity of habitats burned to determine if plant recovery was adequate to prevent erosion,
- vegetation was monitored to determine if plant recovery was adequate to prevent alien species invasion,
- endemic plant species were surveyed to determine the status of post-burn recovery, and
- mitigation was carried out to prevent the proliferation of non-native weedy plant species.

In the first post-fire year (late fall 1996 through fall 1997) the BAER Vegetation team monitored the recovery of vegetation and initiated mitigation practices to meet the stated objectives. A summary of our methods and first year results is presented in this report.

## METHODS

The 4,781 acre burn area was classified into 19 different ecological habitats. This classification was accomplished in a GIS environment (IDRISI) by cross-tabulating the spatial extent of pre-fire vegetation communities, geologic substrate, and slope. Sampling points (78) were defined in IDRISI with a random point generation function.



### *Examination of Residuals*

The BAER document proposed that a thorough evaluation of the residual seeds and grass rootstocks be made, especially where re-sprouting shrubs were absent. This evaluation took place during September 1996, and uncovered the potential for natural recovery, especially of native grasses. While other means of evaluation, for example the use of tetrazolium chloride to detect dehydrogenase enzymes, were used, the most telling was the "pull test." At each sample point, a 2x20 meter belt transect was laid out and grasses were evaluated for (a) re-sprouting or (b) whether the grass remained intact and rooted when "yanked." If it passed the yank test, we assumed it would re-sprout the next year. The result of this screening led us to carry out aerial seeding of native grasses (see below) in the most severely affected areas.

We returned to each sampling point in May 1997 to evaluate the precision of this method. At 63 of the 78 points, we relocated precisely the transect location, and then measured the distance to individual grass which had been evaluated last year. We determined from re-sprouting of grasses, whether our pull test assessment had been correct.

### *Documentation of Plant Recovery*

Each sampling point was visited in May and late August-September 1997. In May, we documented the plant species within an approximately 100 meter radius of each point. We also laid out an identical belt transect to that described above, documenting for each grass clump whether re-sprouting had occurred. In late August-September, we determined the flora of each site as well as the cover of each plant type (forb, grass, shrub, dead shrub, non-native species, etc.) utilizing a point frequency frame (Mueller-Dombois and Ellenburg 1974). Frequency of each group is an estimate of cover.

We surveyed for the presence of *Astragalus schmollae* and *Hackelia gracilenta*, two endemic species which are restricted in habitat to Mesa Verde and were identified as sensitive species in the BAER plan. Post-fire invasion into the Chapin 5 fire was documented and permanent monitoring plots were established on Park Mesa surrounding a new population of *A. schmollae*.

### *Seeding of Park Mesa*

The pull test indicated that recovery of at least 30% of the perennial grasses was not expected in the severely burned areas (Table 1). Grass recovery on Menefee Shale was better than on Cliffhouse Sandstone (Table 2). Therefore, we aerially seeded the most severely burned 200 acres of Park Mesa with native grass species. This was done in an effort to retard the invasion of non-native species onto the relatively sterile soils, and to stabilize soils and prevent erosion.

Native seeds were difficult to obtain due to the number of fires requiring rehabilitation in 1996. We were able to purchase or obtain Mesa Verde's own native seeds of the following species:

*Poa fendleriana*, Mutton Grass
*Kohleria cristata*, June Grass
*Oryzopsis hymenoides*, Indian Rice Grass
*Agropyron trachycauloum*, Slender Wheat Grass
*Sitanion hystrix*, Squirrel-tail Grass

**Table 1**. Interpretive information defining the habitat types used to direct the placement of sampling points. Habitats were defined based upon underlying geologic substrate, slope, and pre-fire vegetation type.

| Habitat Code | Substrate | Slope | Vegetation Type |
|---|---|---|---|
| 1 | Cliffhouse (1) | Low (1) | Meadow (4) |
| 2 | Menefee (2) | Low (1) | Meadow (4) |
| 3 | Cliffhouse (1) | Low (1) | Mtn. Shrub (5) |
| 4 | Menefee (2) | Low (1) | Mtn. Shrub (5) |
| 5 | Cliffhouse (1) | Mod (2) | Mtn. Shrub (5) |
| 6 | Menefee (2) | Mod (2) | Mtn. Shrub (5) |
| 7 | Cliffhouse (1) | High (3) | Mtn. Shrub (5) |
| 8 | Menefee (2) | High (3) | Mtn. Shrub (5) |
| 9 | Cliffhouse (1) | Low (1) | Oak woodland (6), PJ-Oak (7), PJ Forest (8) |
| 10 | Menefee (2) | Low (1) | Oak woodland (6), PJ-Oak (7), PJ Forest (8) |
| 11 | Cliffhouse (1) | Mod (2) | Oak woodland (6), PJ-Oak (7), PJ Forest (8) |
| 12 | Menefee (2) | Mod (2) | Oak woodland (6), PJ-Oak (7), PJ Forest (8) |
| 13 | Cliffhouse (1) | High (3) | Oak woodland (6), PJ-Oak (7), PJ Forest (8) |
| 14 | Menefee (2) | High (3) | Oak woodland (6), PJ-Oak (7), PJ Forest (8) |
| 15 | Cliffhouse (1) | Low (1) | PJ-Purshia (9) |
| 16 | Menefee (2) | Low (1) | PJ-Purshia (9) |
| 17 | Cliffhouse (1) | Mod (2) | PJ-Purshia (9) |
| 18 | Menefee (2) | Mod (2) | PJ-Purshia (9) |
| 19 | Cliffhouse (1) | High (3) | PJ-Purshia (9) |
| 20 | Menefee (2) | High (3) | PJ-Purshia (9) |



**Table 2**. Effects of the Chapin 5 fire on the abundance of bunch and sod grasses. Abundance is measured as frequency in 75 sample points across the burned area.

| Grass Type | Present Pre-fire | Passing Pull Test | Alive 1996 |
|---|---|---|---|
| Bunch Grasses | .85 | .59 | .31 |
| | ±.22 | ±.40 | ±.30 |
| Sod Grasses | undetectable | .34 | .05 |
| | | ±.23 | ±.08 |

We created two mixes with these seeds, simulating as much as possible the native grass community for the elevation, substrate, and pre-fire vegetation, one for north and one for south ends of the burn. We applied the seed by helicopter on October 20 and 21. It began snowing on October 21 and the winter precipitation was high during 1996/1997.

We evaluated the success of seeding in August by setting out a series of circular plots (radius 10 m$^2$) at approximately 50 meter intervals on a north-south line across Park Mesa (Fig. 1). The number of seeded grasses was counted for each seeded grass species. While we may have included non-seeded individuals of the same species, this is unlikely to have contributed many individuals (see control values below). A similar transect was placed on the adjacent mesa in an untreated area (Fig. 1).

## *Evaluation and Mitigation of Non-Native Plant Species*

### Mechanical treatments

Most of our treatment efforts have been directed toward mechanical removal of Musk and Canada thistles. The treatments consisted of removing the fully formed seed heads, and heat destroying them by keeping them tightly bagged, and throwing them away. The entire plant, stem, and root was removed. If an obvious archeological site was present, the thistle plants were chopped at the surface, but not uprooted to prevent disturbance to subsurface archeological materials. Small patches of the rhizomatous Canada thistle were dug up as well. Approximately 326 acres have been treated mechanically in 116 person-days.

### Biological control

We are coordinating our efforts with those of Dr. Deb Kendall, Fort Lewis College. The areas chosen for release of biological control

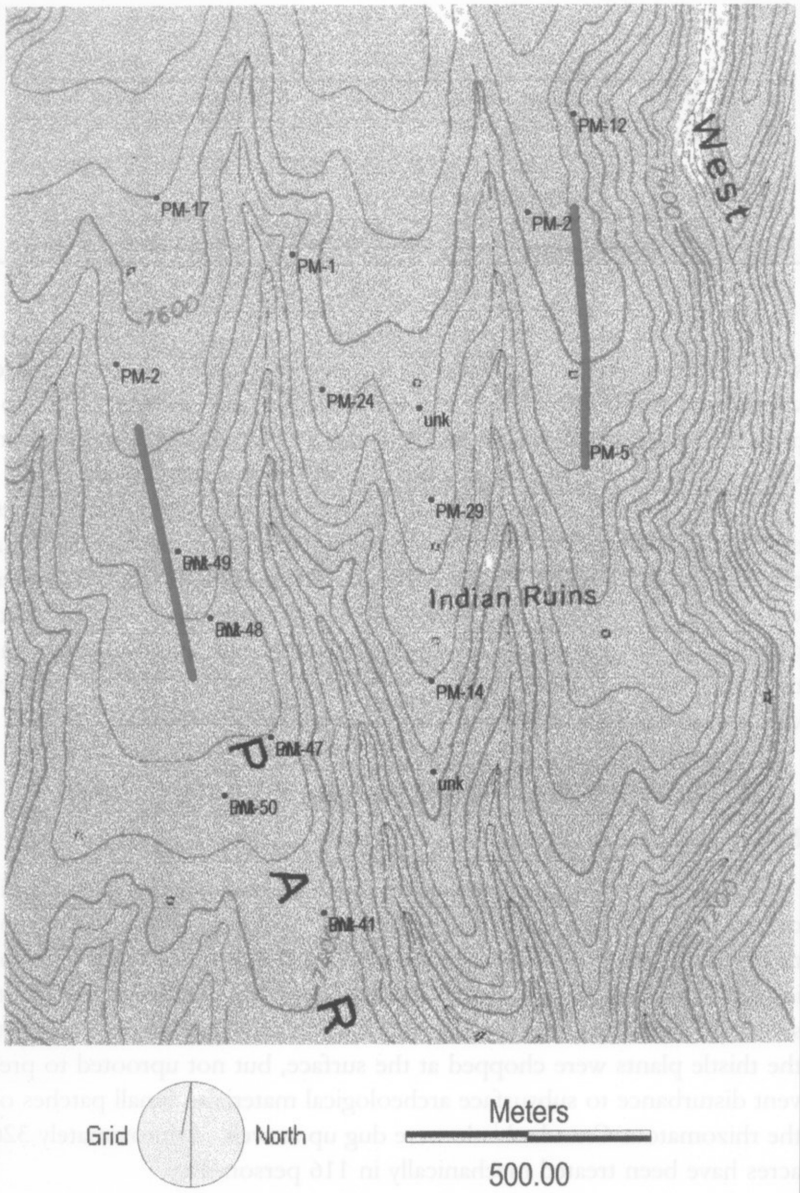


**Figure 1**. Grass seed monitoring transects.



agents did not receive other treatment, except in some cases the removal of seed heads. Dr. Kendall has released on Canada thistle in the Far View Sewage Lagoon and downstream areas: the Canada thistle gall fly, Urophyora cardui; the seed head weevil, Larinus; and she expects to release the stem weevil, Ceutorhynchus litura, when insects become available. Dr. Kendall also released Tricocericaulus horridus on Musk thistles.

### Herbicide application

In particularly dense Canada thistle stands, the 2-4 D derivative herbicide "Curtail" was applied. Herbicide was also used on particularly dense patches of Musk thistle if mechanical treatment was not possible. In mid-April we spot-sprayed Curtail on individual plants throughout the most severe infestation in the Far View Sewage lagoon area. This was done early to alleviate disturbances on native vegetation. Quanah Spencer, a Park employee certified to apply herbicides, also applied Curtail in several areas on Park Mesa. The location and extent of each treatment is shown in Figure 2.

## RESULTS

### *Examination of Residuals*

We returned to each of 78 sampling points distributed in 19 ecological habitats during May 1997 and evaluated the usefulness of the pull test to determine potential grass re-growth after fire. While overall the average percentage of correct calls was 30%, our success varied across the sites (the range was from 0% to 100%) (Table 1). There was a significant difference in our pull test results in Menefee and Cliffhouse substrates ($F=10.6$, $P<.05$): we were better able to detect grass recovery potential on Menefee Shale (mean=44%) than on Cliffhouse sandstone (mean=20%). There was a significant correlation ($r=.54$, $P<.05$) between 1996 bunch grass frequency (e.g., pre-fire) and the grass recovery in 1997 indicating that a large proportion of the bunch grasses present after the fire re-sprouted.

One reason for the lower than expected success of the pull test was our inability to distinguish between burned bunch grasses and burned upland sedges, *Carex geyerii*; overall the bunch grasses had a greater success of re-spouting than did the upland sedges. Another problem was our inability to relocate each grass clump using only distances from the sampling transect. While the pull test is the best way which we have found to determine the potential for residual grass recovery, we suggest that other methods be designed and evaluated.

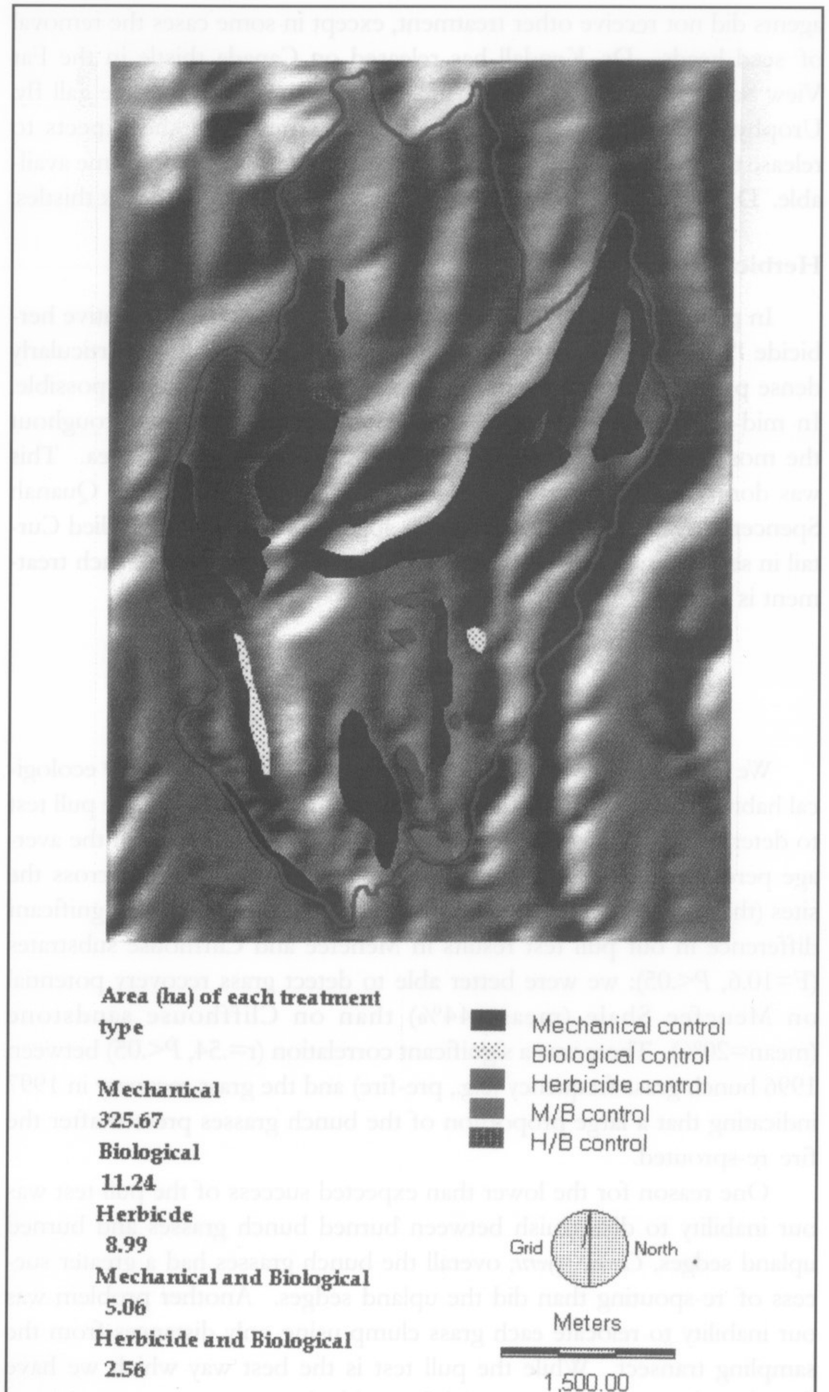


Figure 2. Thistle treatment areas, Chapin 5 burn.



### *Seeding of Park Mesa*

Throughout the summer of 1997, grass seedlings on Park Mesa were informally monitored. The deposition of grass seed appeared to be clumped, probably because runoff patterns moved the seed into small drainages. In August 1997, we evaluated the density of grasses in a series of plots (Fig. 1). We chose density, rather than cover, as the most realistic variable this year because grass growth was significantly increased by the fertilization effect of the fire. Rather than overestimate grass importance by its cover, we determined the number of clumps, each a result of germination of one seed. Grass density was significantly higher in the seeded areas (mean=6/75 m$^2$) than control areas (mean=.5/m$^2$, F=13.7, $P<.05$; Table 3) on Park Mesa. The success of the seeding treatment was enhanced by greater densities of all species when seeded areas were compared to control plots (partial F=3.1, $P<.05$) except Indian Rice Grass. Indian Rice Grass often germinates several years after seeding and we can expect that as testa deterioration occurs, the seeds will germinate. All species flowered and produced seeds this year.

While we demonstrated a successful seeding effort, we cannot yet determine the effect grass competition will have on the invasion of non-native exotics. During the next field season, we will be able to evaluate whether the increase in grass cover actually decreases the incidence of non-native invasions.

### *Documentation of Plant Recovery*

We monitored post-fire recovery on 78 randomly generated sample points. We established the sampling points immediately after the burn (September-October 1997) and returned to each point twice in the 1997 growing season—in early May and in September—in order to determine post-fire vegetation recovery. By September, one year after the fire, vegetation cover (total cover, the sum of all vegetation components)

**Table 3.** Comparison of grass densities (#/75m$^2$) between seeded and unseeded areas.

| Species | Seeded Area | Control |
|---|---|---|
| Poa fendleriana | 11.8 | 1.0 |
| Sitanion hystrix | 5.9 | 0.0 |
| Oryzopsis hymenoides | 0.54 | 1.0 |
| Agropyron trachycaulum | 5.62 | 0.0 |

varied significantly across vegetation categories—lowest (22%) in pinon woodlands and highest (56%) in re-sprouting shrublands (Table 4). A significant difference was detected in the bare soil cover, which was the highest in the pinon-juniper and pinon-juniper/purshia vegetation categories, leaving soils highly exposed to erosion and alien species invasions. Forb cover was not significantly different across the vegetation categories. Grasses are lowest (12%) in pinon-juniper woodlands.

The total vegetation cover was significantly different across geologic types—the mean cover on Menefee Shale was 48% while the mean cover on Cliffhouse Sandstone was 34%.

In addition, the pattern in vegetation recovery in the burned pinon-juniper woodlands—in which intercanopy spaces support forbs and grass, yet the canopy areas are almost entirely bare—may have interesting consequences for erosion and archeological site stabilization. This patchiness in vegetation recovery is being investigated by Resource Management (Colyer pers. com.).

Mountain shrublands, which include Quercus gambelii ("oak wooklands" in Fig. 3) or *Amelancheir utahensis* ("mtn shrub" in Fig. 3) are nearly half covered with re-sprouting oaks. Erosion is unlikely, and non-native species are experiencing competition; therefore, we propose no treatments for the re-sprouting areas.

One ascomycete fungus, *Pyronema domesticum*, formed widespread, confluent patches under logs or rocky ledges, especially in the pinon-juniper woodlands. While it was most visible immediately after the burn, it reappears with significant precipitation.

At each of the sampling points, the flora was recorded during late August-September 1997. As defined above, the samples had been randomly placed in 19 habitat types (Table 1).

Some floristic trends were obvious. *Chenopodium fremontii* occurred in all 19 habitat types, sometimes occupying up to 100% of the sample

**Table 4.** Frequency of bunch grasses resprouting within the Chapin 5 fire by geologic substrate. Data collected 2 months after the burn.

| Geologic Substrate | Presence Pre-fire | Resprouts within 2 months | Seedlings within 2 months |
|---|---|---|---|
| Menefee Shale | .95 | .42 | .84 |
| | ±.07 | ±.31 | ±.64 |
| Cliffhouse Ss. | .78 | .24 | 1.21 |
| | ±.24 | ±.27 | ±1.21 |

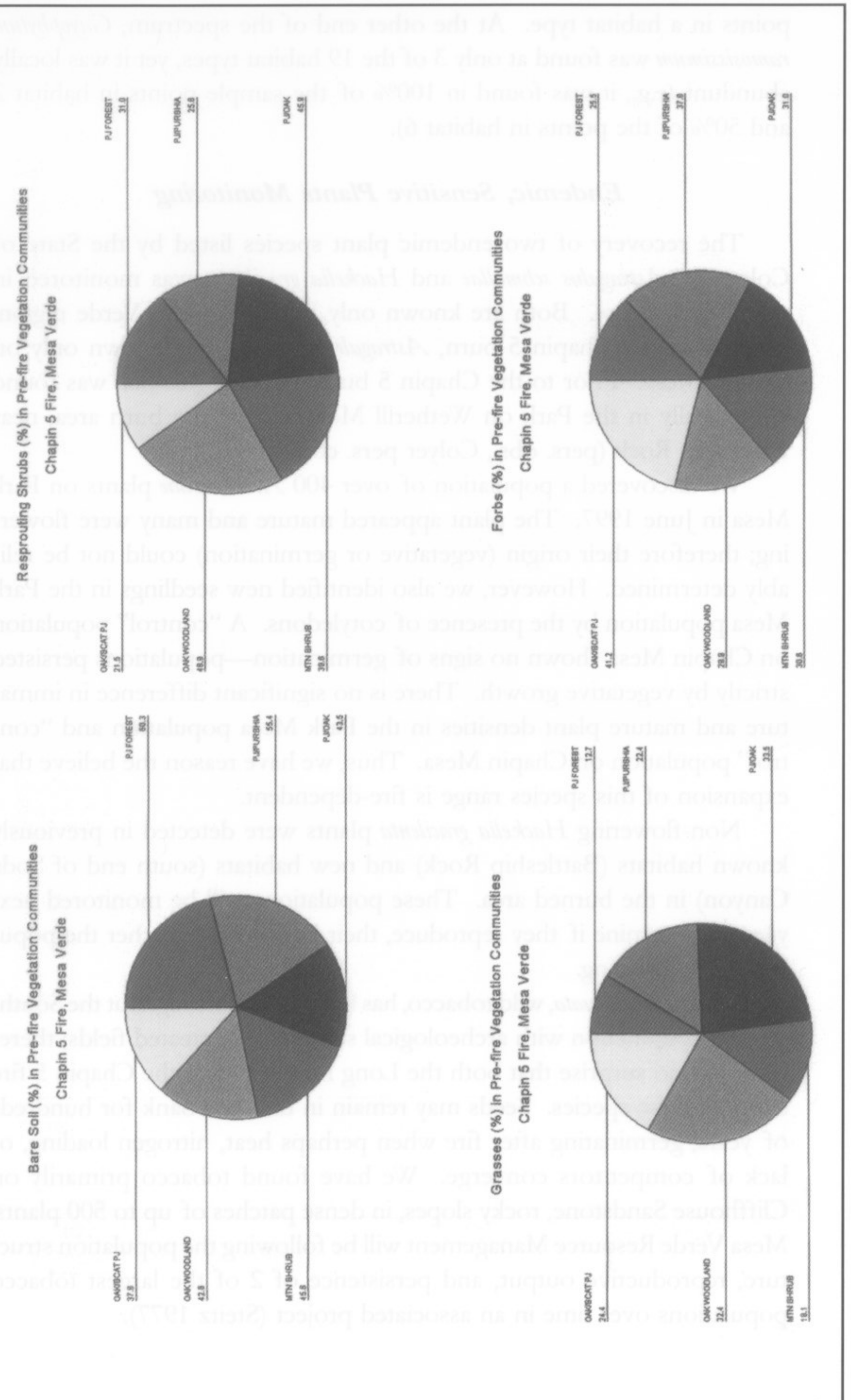


**Figure 3.** The average cover of bare soil, forbs, grasses, and resprouting shrubs by pre-fire vegetation community, Chapin 5 fire.

points in a habitat type. At the other end of the spectrum, *Gayophytum ramosissimum* was found at only 3 of the 19 habitat types, yet it was locally abundunt (e.g., it was found in 100% of the sample points in habitat 2 and 50% of the points in habitat 6).

### *Endemic, Sensitive Plants Monitoring*

The recovery of two endemic plant species listed by the State of Colorado, *Astragalus schmollae* and *Hackelia gracilenta*, was monitored in the Chapin 5 fire. Both are known only from the Mesa Verde region, and before the Chapin 5 burn, *Astragalus schmollae* was known only on Chapin Mesa. Prior to the Chapin 5 burn, *Hackelia gracilenta* was found sporadically in the Park on Wetherill Mesa, and in the burn area, near Battleship Rock (pers. obs., Colyer pers. com.).

We discovered a population of over 400 *A. schmollae* plants on Park Mesa in June 1997. The plant appeared mature and many were flowering; therefore their origin (vegetative or germination) could not be reliably determined. However, we also identified new seedlings in the Park Mesa population by the presence of cotyledons. A "control" population on Chapin Mesa shown no signs of germination—populations persisted strictly by vegetative growth. There is no significant difference in immature and mature plant densities in the Park Mesa population and "control" population on Chapin Mesa. Thus, we have reason the believe that expansion of this species range is fire-dependent.

Non-flowering *Hackelia gracilenta* plants were detected in previously known habitats (Battleship Rock) and new habitats (south end of Soda Canyon) in the burned area. These populations will be monitored next year to determine if they reproduce, their health and whether the population is expanding.

*Nicotiana attenuata*, wild tobacco, has been found throughout the Southwest in conjunction with archeological sites and fire treated fields; therefore, it is no surprise that both the Long Mesa fire and the Chapin 5 fire support these species. Seeds may remain in the seed bank for hundreds of years, germinating after fire when perhaps heat, nitrogen loading, or lack of competitors converge. We have found tobacco primarily on Cliffhouse Sandstone, rocky slopes, in dense patches of up to 500 plants. Mesa Verde Resource Management will be following the population structure, reproductive output, and persistence of 2 of the largest tobacco populations over time in an associated project (Steitz 1977).



### *Evaluation and Mitigation of Non-Native Plant Species*

Past experience with the Long Mesa fire in 1989 has made it clear that Musk and Canada thistles, cheat grass, stickseed and other alien species will possibly dominate the severely burned areas (Floyd-Hanna and Romme 1995). In fact, native species have not yet outcompeted non-native plants, 6 years after the Long Mesa fire, but rather non-native species have expanded their area by 260% (Klein 1997). Populations of Canadian thistle were well-established in the Far View Sewage Lagoon area before the Chapin 5 fire, and they have spread downstream in Little Soda and Soda Canyons. These populations re-sprouted immediately after the burn. Musk thistle was also evident in 1997, but small and extensive populations were scattered throughout the southern portions of the burn.

Most of the first year's effort has been focused on preventing the expansion of Musk and Canadian thistles into the Chapin 5 burn. At varying density, nearly 40% of the burn has been infested with one of these species. The BAER plan defined an integrated pest management plan—limited herbicide application, biological control agents, and manual treatments—and each has been implemented (Fig. 2). One of the primary goals of the second field season will be to determine the effectiveness of our treatments.

Permanent monitoring plots have been established in Little Soda and Soda Canyons in which the density of Canada thistle is being monitored annually. Thus far, no permanent plots have been established for Musk thistle.

## DISCUSSION

Each objective outlined in the vegetation monitoring and threatened/endangered plant sections of the BAER plan for Mesa Verde National Park has been addressed during this first field season. Vegetation monitoring has shown multiple pathways of vegetation recovery, each suggesting a unique monitoring and treatment program. The northern sector of the burn, which has revegetated by re-sprouting shrubs, had nearly 50% vegetation cover after one growing season; therefore, we have no reason to predict that non-native species will become established in the coming years unless conditions change considerably. We suggest that monitoring of this area continue for at least one additional growing season to insure the proliferation of native species (not non-native weeds) and to coordinate with the erosion treatment efforts by the BAER archeological team. At this time, no mitigation treatment is suggested for the burned mountain shrubland areas.

However, on the southern portions of the burn, and on the slopes of Soda Canyon, bare soils still dominate the landscape after the first growing season, and vegetation recovery is more than one half that of the northern sector. Non-native species are gaining a significant hold. We have treated isolated Musk thistle and Canada thistle stands with mechanical, chemical, and biological measures. We have also aerially seeded the most severely burned portions of Park Mesa. We are using the post-fire vegetation of Long Mesa fire (Floyd-Hanna and Romme 1995, Klein 1997) to model and predict what will likely occur in the southern portion of the Chapin 5 fire. The non-native vegetation of Long Mesa has spread by 260% since our last assessment in 1993, and we have no reason to believe that native species will eventually outcompete the aggressive, non-native species (Floyd-Hanna et al. 1993). This has clearly pre-empted the influx of native plant species and is not a desirable condition from the standpoint of natural resource management. Therefore, we recommended that treatment, specifically removal of non-native plant species, continue. Mesa Verde National Park has made a commitment to managing noxious weeds in their recent resource management initiative (L. Towle pers. com.), and our treatments are therefore in keeping with the overall Park goals. During the next growing season, 1997-1998, we will begin to evaluate the effectiveness of each treatment. We also propose a continuation of monitoring which leads to specific treatments of erosion and non-native species problems related to the Chapin 5 fire.

Therefore, the objectives proposed by the BAER Vegetation group for the 1997-1998 growing season are:

- Monitoring the 78 sampling points for vegetation recovery.
- Evaluate the effectiveness of treatments for non-native plant species invasions.
- Continue to treat non-native plant species invasions and monitor treatment success.
- Establish a monitoring program for *Hackelia gracilenta* and continue to monitor the population size and health of *Astragalus schmollae.*

## Acknowledgments

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