

ROI

File

POST-FIRE VEGETATION RECOVERY AT EL MALPAIS NATIONAL MONUMENT

David L. Bleakly¹ and David C. Lightfoot²

¹ 3813 Monroe NE, Albuquerque, NM, 87110.

² University of New Mexico, Albuquerque, NM, 87131

8 May 1995

FINAL REPORT

POST-FIRE VEGETATION RECOVERY AT EL MALPAIS NATIONAL MONUMENT

David L. Bleakly¹ and David C. Lightfoot²

¹3813 Monroe NE, Albuquerque, NM, 87110. ² University of New Mexico, Albuquerque, NM 87131

INTRODUCTION

Forest fires are an important disturbance or perturbation in forest ecosystems that influence the taxonomic composition and physical structure of vegetation (Wright & Bailey 1982). Following fires, forest vegetation goes through a change or succession over time, usually resulting in vegetation similar to that present prior to the fire. Forest managers now use fire as a tool to maintain the condition of forests (New Mexico Forestry and Resources Conservation Division 1992). Predictive models have been developed to help managers predict how vegetation succession may proceed to yield desired results (Kessell & Fischer 1981, Fischer & Clayton 1983).

Ponderosa pine forests of the southwest United States are fire-adapted ecosystems where forest fire frequency was on the order of 8-12 years prior to human fire suppression beginning in the early 1900's (Potter & Foxx 1984, Kozlowski & Ahlgren 1974, Wright & Bailey 1982). The pre-1900 fire frequency on the lava flows at El Malpais National Monument was about 10 years (Henri Grissino-Mayer, pers. comm.). Ponderosa pine is fire adapted, and seedling establishment is generally dependent upon forest fires (Dick-Peddie 1993, Potter & Foxx 1984, Kozlowski & Ahlgren 1974). Fires remove or reduce some vegetation which may compete with pine seedlings for moisture and light and other vegetation which may allelopathically inhibit seedling growth (USFS 1974). Many herbaceous plant species in ponderosa pine forests are also adapted to fire and increase in numbers and biomass following fires (Fischer & Clayton 1983, Oppenheimer 1978). In New Mexican ponderosa pine forests, perennial grasses remain abundant in open parkland environments that are maintained by frequent fire (Potter & Foxx 1984), and native forbs tend reach maximum abundance

in open burned areas 2 to 3 years after fires (Oppenheimer 1978).

Post-fire vegetation consists of foliage that was not killed by the fire, new growth from perennial plants that survived the fire, and seedlings of plants that survived the fire either as seeds present in the soil, or that germinate from seeds that dispersed to the burned area after the fire (Kozlowski & Ahlgren 1974). The composition of perennial plants that survive a fire versus new plants resulting from seedling establishment depends upon the initial forest stand conditions and fire intensity (Fischer & Clayton 1983). Generally, any one fire produces a mosaic of different burn intensities across the landscape resulting in a mosaic of different successional patches.

An important component of the post-fire flora are forbs that are characteristically weedy and colonized intensely burned areas via seed dispersal. These plants tend to be annuals that have good dispersal capabilities and are able to colonize disturbed sites where other plants have been eliminated or reduced. Such weedy plants tend to be poor competitors, and, over time, are generally replaced by long-lived perennial plants in the absence of further disturbance. Examples of such plants colonizing recently burned ponderosa pine forest in New Mexico include mullein (*Verbascum thapsus*; Oppenheimer 1978) and pigweed (*Chenopodium* spp., Potter & Foxx 1984) both of which were found at ELMA during this study.

The potential for forest fires to increase the distribution and abundance of exotic weedy plant species is a concern of land managers. As a disturbance, forest fires may create environmental conditions that are favorable to the introduction and establishment of exotic weeds into areas that were previously not occupied by such weeds, or where exotic weeds were present but not common.

Substrate type has not been treated as a variable in the study of fires in Southwestern ponderosa forests and there is essentially no literature available on the subject. Ponderosas grow in soils derived from all rock types and basalts are common substrates for Southwestern ponderosa forests (USFS 1974). Rocks of volcanic origin (basalts, tuffs, cinders, etc.) are very widespread in the Southwest and may be found in the Mogollon Rim of Arizona and the Jemez Mountains of New Mexico as well as at El

Malpais where there exist extensive ponderosa forests.

The purpose of this project was to evaluate the post-fire vegetation of several natural and prescribed forest fires in ponderosa/mixed conifer woodlands at El Malpais National Monument, relative to plant succession and the establishment of exotic weeds.

METHODS

Several factors influenced the choices of fire sites visited during this investigation. Official fire reports, supplied by ELMA, were studied to find the fires that fit certain criteria. The initial screening factors were (1) size of fire (arbitrarily, those > 40 acres were chosen), (2) ease of access, and (3) location on the monument (the fire reports included all fires in the area responded to by ELMA personnel). The resulting pool of possible fires was then narrowed to reflect (1) limited field time which restricted the number of fires that could be investigated; (2) a range of burn ages; and (3) a range of lava flows of different ages. The final total of fire sites visited was eight (Maps 1-3). The vegetation type at each location was ponderosa/mixed conifer woodland. Other vegetation types were initially considered for study, but virtually all fires > 40 acres were found to have occurred in ponderosa/mixed conifer woodland, which is the dominant vegetation in the monument. PJ woodlands are not common in ELMA and are found mostly on sedimentary outcrops and kipukas and in the Chain of Craters area. There were no grassland fires listed in the information supplied by the Park Service. For comparative purposes, adjacent unburned areas of the same size as the burned sample area were investigated at each fire. The control sites were chosen to account for all other factors such as soils, slope, aspect, presence of drainages, and proximity to previously disturbed areas that might serve as sources for exotic weeds.

Of 139 fires that occurred between 6 May 1989 and 10 August 1994, most (80 %) were small (< 5 acres). Size of fire was considered important because small fires may be difficult to locate and the "island" of burned vegetation from a small fire may be too small to be different than a bare patch of lava in an otherwise normal, unburned woodland. Ease of access and limited field time were somewhat related issues because

of budgetary constraints--sites had to be relatively near roads so that the greatest number of locations could be visited during the two days available for the field work. Some of the fires documented in the fire reports were located outside of the monument's boundaries and thus were not considered further. Of the greatest nonlogistics importance was to sample fires of different ages since the point of the investigation was to follow vegetation change over time. Different aged lava flows added another variable which may or may not be of importance in this type of investigation. Some of the fires were prescribed, but this was not considered to be critical in choosing a fire for study.

The chosen sites were visited on 24 and 25 September 1994. Descriptions of each site include location, soil type, vegetation type, burn results, tree recovery, herbaceous recovery, weedy plant species, and disturbance factors (Appendix). Other basic information, from fire ELMA records, is summarized in Table 1. This study was not designed to collect quantitative data, so tree mortality figures are estimates and successional processes or rates were not measured. Representative portions about 200 meters wide and 1 km into the burned area from an edge of the fire were sampled during this study. No quantitative comparisons were made between the study and the nearby nonburned areas. Fire intensity was designated as light if the fire was limited to the ground and killed only the lower branches of mature ponderosa pine trees, moderate if approximately 20%-50% of the trees were killed, and intense if more than 50% of the trees were killed. If the fire occurred near a road, the survey area was located adjacent to it since such areas are likely to serve as sources for exotic weeds. Almost all fires are patchy at some scale and interpretation of the results of any fire will depend on the portions studied.

RESULTS

TABLE 1. BURNS VISITED DURING THIS SURVEY. MOST RECENT FIRE FIRST.

FIRE NAME	FIRE START DATE	SIZE (ACRES)	LAVA FLOW
Tube	8 July 1994	240	Rendija
Corral Road *	4 April 1994	190	Twin Craters
Sawmill	21 April 1993	40	Old Basalt
Volcano *	22 October 1992	200	El Calderon
Lava Field *	20 October 1992	350	Twin Craters
Lava	1992		Bandera
Collapse	5 July 1989	2800	Hoya
Hoya	5 July 1989	2000	Hoya

* = prescribed burn

The following results refer only to the small sections of the whole fire that were surveyed for this investigation. All the fires occurred in ponderosa pine/mixed conifer woodlands and were located on lava flows (except the Lava Field Fire, which was on granitic alluvium). The fires were very patchy with few intensely burned areas and with many larger lightly burned sections. Apparently the most intense fire was the Tube Fire (1994) followed by the Lava Fire (1992; both with about 30% tree mortality). The rest of the fires were of low to moderate intensity (10-20% tree mortality).

None of the fires we examined were particularly damaging in either the short or the longer (5 year) term. Usually young but occasionally mature junipers, ponderosas, and pinyons were killed. The junipers (apparently mostly *J. monosperma*) appeared to burn the hottest and most completely; sometimes they caused adjacent large ponderosas to burn to death when they might not have otherwise. Many shrubs, grasses, and herbs did not appear to be seriously affected by the fires.

Vegetation recovery seemed to be fairly rapid. Except for charred wood and

sometimes lack of lichens, the oldest and/or coolest fires or parts of fires looked similar to unburned areas. Some shrubs, such as rabbitbrush and Gambel oak, were crown sprouting even in very recently burned areas. Many ponderosa seedlings were seen at the Lava Field Fire probably because of adequate moisture in the alluvium of the drainage, but few were seen elsewhere. There was no evidence of lichen recovery.

There was no apparent invasion of non-native weeds into the burned areas. Because fires do cause disturbance, some weedy species are to be expected and were found. Such plants were also found in suitable habitat off the burns and include *Chamaesyce*, *Spheralcea*, *Portulaca*, *Polygonum arvense*, *Chenopodium graveolens*, and *Bahia dissecta*. The areas around the bases of burned, dead trees, near down burned logs, and around burned stumps were the most intensely incinerated locations we saw. These areas were typically denuded of vegetation and lichens down to bare rock or soil. Afterward these areas were the most densely covered by weedy plants. A similar situation was noted in Bandelier National Monument on volcanic substrates (Craig Allen, pers. comm.). Open areas with previously sparse vegetation and low litter values were generally not intensely burned so supported few weedy species after fire.

All but two of the sites (Lava Fire and Collapse Fire), and about half the other large fires that were not surveyed, were near roads. However there was no evidence of any invasion of non-native weedy plants into burned areas near roads. Burned or not, the roadsides near the paved highways (NM-53 and NM-117) are probably the most likely areas for exotic plant introduction because of greater traffic volume and more frequent disturbance from mowing and roadside parking. Increased visitor use will more likely cause an increase in the number of alien plants in suitable habitats along roads and trails (Lesica & Ahlenslager 1993) than fires or lack of them will.

Control sites were all located in unburned ponderosa pine/mixed conifer woodlands adjacent to the burned area surveyed. Ponderosa pine was the dominant tree species with occasional Rocky Mountain juniper, pinyon pine, oneseed juniper, and Gambel oak. Shrubs included rabbitbrush, wax currant, skunkbush, and New Mexico olive. Numerous grasses included mountain muhly, pine dropseed, side oats

and blue grama, little bluestem, squirreltail, and others. Many forbs were also found, such as *Heterotheca villosa*, *Glandularia wrightii*, *Ipomopsis aggregata*, and *Silene laciniata*. Native weedy species included *Chamaesyce*, *Spheralcea*, *Portulaca*, *Polygonum arvense*, *Chenopodium graveolens*, and *Bahia dissecta*. The only significant non-native weed was mullein (*Verbascum thaspus*) which was often more abundant on burned areas than off but was also found throughout the monument on all substrates. This plant is the only alien that has apparently fully integrated into the native flora. It also grows on lava flows where no significant numbers of other non-native plants can survive.

DISCUSSION

The prehistoric and historic presence of fires in ponderosa pine forest ecosystems in the Southwest is well-documented (Potter & Foxx 1984, Kozlowski & Ahlgren 1974, Wright & Bailey 1982). Fire has been a significant part of the history of El Malpais as well (Grissino-Mayer, pers. comm.). Presumably the plant and animal components of the ponderosa forest have adapted to frequent, light fires. In spite of previously frequent fires (every 2-10 years), many very old trees and snags have survived on certain lava flows at El Malpais for many centuries (Grissino-Mayer, pers. comm.) so earlier fires do not appear to have been particularly devastating. Guarding against wildfires, especially near the ancient trees, could lead to fuel buildup which could result in very damaging fires, similar to those that occurred in Yellowstone N.P. area in 1988 and which are possible in some sequoia groves in the California Sierras (Tom Swetnam, pers. comm.).

Recruitment of new trees was not evident except at the Lava Field Fire where numerous first-year ponderosa seedlings were noted. This site is located on granitic alluvium that has been deposited in a small drainage. Germination circumstances were apparently favorable during part of 1994. Conditions for germination of large numbers of ponderosa seeds occur only every few years in the Southwest (USFS 1974) and this is probably also true at most sites at ELMA including the lava flows. However, this

phenomenon at the Lava Field Fire was probably not related to the fire but rather favorable germination conditions since large numbers of first-year seedlings were also seen in the fall of 1993 on Mesita Blanca, an area that has not burned recently.

The results of our investigation do not indicate an increase in non-native weedy plants on burned areas. Weedy plants, both native and alien, were present on all the disturbed areas, including burns and roads, but not in unusual numbers. However, lack of large numbers of weedy plants may be attributed to the fact that the fires occurred on lava flows where such plants are rare anyway. The investigated fires occurred in 1989, 1992, 1993, and 1994 so some evidence of weed or alien plant invasion would probably be evident if it were occurring.

The addition of exotic plants to the ELMA area flora, particularly along roadsides, appears to be inevitable due to increased long-distance travel and growing visitor numbers. Since our earlier work (Lightfoot *et al.* 1994) showed little evidence of alien plant presence on the lava flows, these areas may not be suitable for invasion by alien species. The major exception is mullein (*Verbascum thaspus*) which has invaded every habitat in the area including undisturbed ones. Therefore, certain opportunistic or well-adapted aliens could colonize the lava flows in the future. Roadsides, especially along paved highways where traffic is greatest, are the most likely areas for initial invasion of non-native plants. Indeed, most of the alien plants found during the previous study were located along NM-53 (Lightfoot *et al.* 1994). This habitat is frequently disturbed, relatively well-watered from road runoff, and composed of mostly alluvial material which make it substantially different than the lava flows. It is also possible that most alien plants may never leave roadsides because the lava flows provide unfavorable habitats. Another possible but undocumented source of introduction is by the cattle industry. Cattle are often wintered far from their summer grazing areas and could bring back foreign seeds in their droppings. Also cattle may be fed hay that was grown in remote regions. Any site that is frequently disturbed, such as dirt roads and trails and near dwellings, is potential habitat for the introduction or spread of alien plant species. Any alien plants that may be introduced in the future are

mostly likely to be found initially along roads or other disturbed or heavily-used areas and to remain in or spread to other such areas. Lava flows, the most unique, valuable, and extensive portion of the Monument, will probably remain relatively alien plant-free in the future.

MANAGEMENT SUGGESTIONS

With very rare exceptions, once a plant, native or not, has begun to reproduce in an area it cannot be successfully removed (Burgess et al. 1991). Therefore, all the plants found today in the ELMA area are likely to remain for the foreseeable future. It is also inevitable that new native and non-native plants will be found in the years to come. The addition of new native plants to a flora typically results from the finding of rare, cryptic, or late- or early-growing plants already present or from the spread of nearby populations into the study area. Alien plant introductions are mostly the result of human activities and increase with increased vehicular and human traffic (Lesica & Ahlenslager 1993; Rejmanek & Randall 1994). The only way to ascertain additions to the flora is by continuing to look for them. To monitor alien plant introductions, the roadsides and other disturbed areas particularly on non-lava substrates are the most probable locations and work should be concentrated there. This would be an easy and inexpensive procedure because of ease of access.

During the next few years or decades some areas or habitats in the monument will very likely see great increases in disturbance, vehicular traffic, and visitor usage. Affected areas should be surveyed before disturbance and afterwards for several years to identify potentially aggressive weeds before they become problems. Revegetation with native plants should always be a part of the restoration process in disturbed areas. The following is a list of possible specific circumstances that could occur in ELMA that might result in the introduction, fostering, or spread of weedy plants.

1. increased numbers of visitors and vehicles
2. road construction within or near the monument
3. construction and use of trails, campgrounds, and other public facilities

4. presence of permanent residences in the monument area where cultivated plants might occur and escape
5. off-road vehicle travel
6. presence of livestock particularly in heavily-used areas such as near corrals, in corners of fenced pastures, and if imported hay is used as feed
7. seeding of alien plants (usually grasses, e.g. various lovegrasses [*Eragrostis* sp.]) for erosion control or revegetation along roads and in pastures by such agencies as the Soil Conservation Service
8. use of baled hay to control runoff in roadside ditches and spreading of hay or straw near roads in reseeding projects

Quantitative fire succession or revegetation studies should be contemplated for the future. These would involve prescribed burns and should be several years in duration. Detailed information on pre- and post fire vegetation cover, species composition, plant recovery, and recruitment among other potential data could be obtained. Such work has rarely if ever been done on lava flows and would add to the knowledge of fire in Southwestern ponderosa/mixed conifer woodlands and on a seemingly unusual but common substrate.

LITERATURE CITED

- Burgess, T.L., J.E. Bowers, and R.M. Turner. 1991. Exotic plants at the Desert Laboratory, Tucson, Arizona. *Madroño* **38**(2):96-114.
- Dick-Peddie, W. A. with contributors. 1993. *New Mexico vegetation: past, present, and future*. University of New Mexico Press, Albuquerque.
- Fischer, W. C. and B. D. Clayton. 1983. *Fire ecology of Montana forest habitat types east of the continental divide*. US Department of Agriculture, Forest Service. General Technical Report INT-141. Intermountain Forest and Range Experiment Station. Ogden, UT.
- Kessell, S. R. and W. C. Fischer. 1981. *Predicting postfire plant succession for fire management planning*. US Department of Agriculture, Forest Service. General

Technical Report INT-94. Intermountain Forest and Range Experiment Station. Ogden, UT.

Kozlowski, T. T. and C. E. Ahlgren, editors. 1974. Fire and ecosystems. Academic Press, New York, NY.

Lesica, P. and K. Ahlenslager. 1993. New vascular plant records and the increase of exotic plants in Glacier National Park, Montana. *Madroño* **40(2)**:126-131.

Lightfoot, D.L., D.L. Bleakly, R.R. Parmenter, & J.R. Gosz. 1994. Vegetation and wildlife inventory of El Malpais National Monument. Department of Biology, University of New Mexico, Albuquerque, NM.

New Mexico Forestry and Resources Conservation Division. 1992. Guidelines for prescribed fire in New Mexico. New Mexico Department of Energy, Minerals and Natural Resources. Santa Fe, New Mexico.

Oppenheimer, S. J. 1978. Patterns of early revegetation in post-fire ponderosa pine forests. Thesis, New Mexico Highlands University. Las Vegas, New Mexico.

Potter, L. D. and T. S. Foxx. 1984. Postfire recovery and mortality of the ponderosa pine forest after the La Mesa Fire. Pages 39-56, In: T. S. Foxx, editor. La Mesa Fire Symposium. Los Alamos National Laboratory, New Mexico. US Government Printing Office.

Rejmanek, M. and J.M. Randall. 1994. Invasive alien plants in California: 1993 summary and comparison with other areas in North America. *Madroño* **41(3)**:161-177.

USDA Forest Service. 1974. Schuber, G.H. Silviculture of southwestern ponderosa pine: the status of our knowledge. Research Paper RM-123.

Wright, H. A. and A. W. Bailey. 1982. Fire ecology: United States and southern Canada. John Wiley & Sons, New York.

OTHER REFERENCES

Frankel, R.E. 1970. Ruderal vegetation along some California roadsides. University of California Press, Berkeley.

Mack, R.N. 1991. The commercial seed trade: an early disperser of weeds in the United States. *Economic Botany* **45(2)**:257-273.

APPENDIX

FIRE SITE DESCRIPTIONS

FIRE NAME: Tube

FIRE START DATE: 8 July 1994

LOCATION: R 12 W, T 8 N Section 4 sw 1/4; near the east base of Cerro Rendija near and mostly north and west of Big Lava Tubes trailhead; the fire apparently stayed mostly on Rendija with the typically abrupt boundary with the adjacent Bandera flow acting as a firebreak; a few trees were burned at the edge of the Bandera flow

SOIL TYPE: mostly alluvial and eolian

VEGETATION TYPE: open ponderosa pine woodland

BURN RESULTS: relatively hot, probably the hottest of all investigated (this may not be entirely true since this is also the newest of the investigated fires); moderate (10-30%) tree mortality; many small trees, including Rocky Mountain juniper, pinyon, and ponderosa, killed; many large trees killed also

TREE RECOVERY: little evidence of regrowth or crown sprouting at this time

HERBACEOUS RECOVERY: nothing was seen flowering, but grasses and *Hymenoxys richardsonii* were sprouting; many seedling including *Chamaesyce*, *Spheralcea*, and *Glandularia* species

WEEDS: only native weedy species, such as the last three listed above, that naturally and normally occur after disturbance were seen

DISTURBANCE: a relatively well-used dirt road partly parallels the edge of the Bandera flow but it apparently has not been an avenue for the introduction of alien plant species at this time

FIRE SITE DESCRIPTIONS

FIRE NAME: Corral Road

FIRE START DATE: 4 April 1994

LOCATION: R 11 W, T 9 N, section 31 se 1/4; approximately 1 mile west-northwest of El Calderon, north of the north end of the large Cerrito de Jaspe (most of which is not part of El Malpais N.M.) and north of the dirt road that skirts the north and northwest base of Cerrito de Jaspe

SOIL TYPE: eolian soil on Twin Craters lava flow

VEGETATION TYPE: ponderosa pine woodland

BURN RESULTS: burn was light, <10% tree mortality; some dead pinyon pine and large ponderosa; burn very patchy

TREE RECOVERY: some fairly dense clusters of ponderosa were not killed by the fire although they were scorched; the density of tree growth in such areas probably created too much shade for undergrowth and simultaneously deposited much dead leaf litter which carried the fire; otherwise little evidence of tree recovery

HERBACEOUS RECOVERY: little herbaceous recovery although some grasses are coming back; at the edges of the fire, common weedy plants are growing

WEEDS: few native or introduced weeds noted

DISTURBANCE: the presence of the road has apparently not brought about and increase in weeds probably because it is seldom used and almost impassible part of the year

FIRE SITE DESCRIPTIONS

FIRE NAME: Sawmill
April 1993

FIRE START DATE: 21

LOCATION: R 12 W, T 8 N, section 22 ne 1/4; near east end of Little Hole-in-the-Wall, west of the road, and south of the turnoff to Navajo Collapse trailhead

SOIL TYPE: on the Old Basalt, mostly covered with eolian soil and with a few outcrops and small collapses

VEGETATION TYPE: very open ponderosa pine woodland with many grasses including *Muhlenbergia montana* and *Blepharoneuron tricholepis*

BURN RESULTS: appears to have been a relatively cool fire; <10% tree mortality; burn pattern very patchy; very little difference in vegetation on and off the burn; lower needles burned and some small trees killed

TREE RECOVERY: tree density was not high before the burn and little evidence of tree recovery seen; many burned shrubs were crown-sprouting

HERBACEOUS RECOVERY: some *Glandularia* and *Bahia* seedling seen in burn areas and may be more numerous there than off the burns

WEEDS: a few native weeds in roadbed (*Portulaca* sp. and *Polygonum arvense*); *Verbascum thaspus* essentially absent

DISTURBANCE: dirt road apparently not heavily used and there is little evidence that it has been a corridor for introduction of exotics

FIRE SITE DESCRIPTIONS

FIRE NAME: Volcano
October 1992

FIRE START DATE: 22

LOCATION: R 11 W, T 9 N, section 33 nw 1/4; approximately 1 mile northeast of El Calderon, north of the dirt road, and a few hundred yards west of Junction Cave

SOIL TYPE: mostly eolian on a relatively rough section of the El Calderon Flow

VEGETATION TYPE: ponderosa pine woodland with grasses and forbs such as *Silene laciniata*, *Ipomopsis aggregata*, and *Penstemon barbatus*

BURN RESULTS: a cool fire; <10% tree mortality

TREE RECOVERY: a relatively old fire, but little sign of tree recovery

HERBACEOUS RECOVERY: good recovery of normal, mostly nonweedy flora

WEEDS: relatively few weedy species

DISTURBANCE: the dirt road has not been a significant factor in the introduction of exotic weeds

FIRE SITE DESCRIPTIONS

FIRE NAME: Lava Field
October 1992

FIRE START DATE: 20

LOCATION: R 11 W, T 9 N, section 34 center; at and near the "Research Camp", just south of NM-53, approximately 1 1/4 miles southeast of El Calderon parking lot

SOIL TYPE: alluvial, mostly granitic; a small drainage exists in the burn

VEGETATION TYPE: ponderosa pine woodland with *Bouteloua gracilis* and a variety of herbs

BURN RESULTS: mostly light, cool ground fire; <10% tree mortality; tree bases scorched; some small trees and shrubs killed or burned off

TREE RECOVERY: many ponderosa seedlings were seen; many burned off shrubs were crown sprouting (e.g. *Chrysothamnus nauseosus*)

HERBACEOUS RECOVERY: the herbaceous cover on the burned areas appears similar to that on the unburned areas

WEEDS: *Chenopodium graveolens* may be slightly increased in density, although this plant may not be considered a weed; *Verbascum thaspus* present

DISTURBANCE: NM-53 borders the burn to the north and east; a few native and rare non-native weeds are present; this site appears to be the most likely to be influenced by the nearness of the paved road which has a fairly large number of vehicles travelling on it

FIRE SITE DESCRIPTIONS

FIRE NAME: Lava

FIRE START DATE: 1992

LOCATION: R 11 W, T 8 N section 12 middle south border and section 13, middle north border; approximately 1 3/4 miles south of Zuni-Acoma Trailhead, just north of a sedimentary kipuka in the Bandera flow

SOIL TYPE: sparse eolian soil on pahoehoe Bandera flow with small collapses and ridges

VEGETATION TYPE: ponderosa pine woodland with a variety of grasses and forbs

BURN RESULTS: moderately hot burn with approximately 30% tree mostly ponderosa mortality; some 40 foot tall trees killed

TREE RECOVERY: little evidence of tree recovery, but Gambel oak was crown sprouting

HERBACEOUS RECOVERY: some native annual and native species recovering

WEEDS: the introduced plant *Verbascum thaspus* was very common on the burn but uncommon off it; common native weedy species present on and off the burn include *Bahia dissecta* and two *Chenopodium* species

DISTURBANCE: this remote burn site has no roads or trails near it, so the presence of the introduced weedy plant *Verbascum thaspus* has resulted from natural processes; this plant may be the most common introduced plant in the monument area and appears to have become fully integrated into the flora

FIRE SITE DESCRIPTIONS

FIRE NAME: Collapse

FIRE START DATE: 5 July 1989

LOCATION: R 12 W, T 7 N, section 1 ne 1/4; approximately 5 1/2 miles north of the junction of County Road 42 and NM-117 and 2 3/4 miles south of Hole-in-the-Wall on the Hoya Flow

SOIL TYPE: sparse eolian soil

VEGETATION TYPE: ponderosa pine woodland with occasional Rocky Mountain juniper and a variety of grasses including little bluestem, pine dropseed, and side oats and blue grama

BURN RESULTS: mild to moderate fire with up to about 20% tree mortality

TREE RECOVERY: little or no evidence of tree recruitment

HERBACEOUS RECOVERY: some perennial resprouting

WEEDS: native weedy species commonly associated with intensely burned areas such as under standing dead ponderosas, along burned downed logs, and near burned stumps

DISTURBANCE: this is a remote site with no near roads or trails

FIRE SITE DESCRIPTIONS

FIRE NAME: Hoya

FIRE START DATE: 5 July 1989

LOCATION: R 12 W, T 7 N, section 6 nw 1/4; approximately 1 1/2 miles southeast of Cerro Hueco; study area started at boundary between Old Basalt and Hoya Flow

SOIL TYPE: sparse eolian soil on Hoya Flow

VEGETATION TYPE: ponderosa pine woodland

BURN RESULTS: mostly a cool ground fire with <10% tree mortality; a few mature ponderosas and relatively more saplings killed

TREE RECOVERY: little evidence of tree recovery or recruitment

HERBACEOUS RECOVERY: grasses slow to recover in intensely burned areas

WEEDS: purslane, *Bahia dissecta*, and *Glandularia wrightii* respond positively to fire especially around burned downed logs

DISTURBANCE: the edge of this fire is near County Road 42 and the Mechenbier (Los Cerros) Ranch so it is possible that introductions of weedy species may occur, although there is little evidence of that occurring at this time



MAP 1. NORTHEASTERN PART OF STUDY AREA



MAP 2. NORTHWESTERN PART OF STUDY AREA

SAWMILL

Qbu

Pd?

Pd?

Qbw

Qb

HOLE IN THE WALL

DU

Qbw

COLLAPSE

MAP 3. SOUTHERN PART OF STUDY AREA

22

