

Chapter 2: *Alternatives*



June Grass
Koleria cristata

ALTERNATIVES

INTRODUCTION

This section describes the action alternatives developed during scoping that are considered technically, economically and otherwise feasible. Each action alternative would wholly or in large part resolve the stated need for action, and meet to a large degree the purpose and objectives described above in *Purpose of and Need for the Plan*. The No Action alternative is also discussed as required by NEPA. This section also describes the environmentally preferred alternative, identifies the preferred alternative and briefly describes any alternatives considered but dismissed from analysis. It provides an alternative comparison matrix, an impact comparison matrix, and a description of mitigation measures for each action alternative.

STUDY AREA DEFINITION

The study area for impact analysis in this plan is the piñon- juniper woodland in Bandelier National Monument. Piñon and juniper dominated woodland occupies nearly a third of the monument, or approximately 10,000 acres, and extends from the lowest elevations along the Rio Grande (ca. 5,300') to around 7,500' at the interface with ponderosa pine savanna (Figure 2). While piñon- juniper woodland can be an important component of many canyon slope, lower ponderosa pine, and canyon bottom communities, the woodland system is best expressed on mesa top settings between 6,000 and 7,000 feet elevation. Mesa top settings are also where the soil erosion issues are most critical, and therefore the focus of treatment as described in this *Draft Ecological Restoration Plan and EIS*. About 4,000 acres of mesa top piñon- juniper woodland (or 40% of total woodland area) have been identified as degraded and in need of treatment.

Bandelier is situated on the Pajarito Plateau (Figure 3), and the same general pattern of resources and impacts to piñon- juniper vegetation, soil, cultural resources, etc. as described for the monument occurs throughout the plateau area. The Pajarito Plateau is a volcanic bench defining the eastern escarpment of the Jemez Volcanic field; it can be generally defined as extending from Cochiti Pueblo on the south to Santa Clara Pueblo on the north, with the Rio Grande generally delineating the eastern boundary. In addition to the plateau, the study area also includes basaltic upland areas with woodland cover east of White Rock Canyon (e.g., the Cerro del Rio area across the Rio Grande from Bandelier).

Prior to a recent drought, one- seed juniper dominated lower elevations across the Pajarito Plateau below 6,300 feet, with increasing dominance of Colorado piñon pine above 6,300 feet. However, the drought has killed off much of the Colorado piñon pine community, and most woodland areas across Bandelier and the Pajarito Plateau are now dominated by one- seed juniper regardless of elevation. Former piñon

dominated woodland has essentially been converted to the more open juniper woodland and savannas typical of lower elevations. Despite the recent piñon mortality event, woodland (now dominated by juniper) is still the common vegetation type within the monument and across the Pajarito Plateau area. Several additional juniper tree species (Rocky Mountain and Alligator bark junipers) also occur within the monument and across the Pajarito Plateau, but generally are not found in areas with erosional issues or are of only minor importance in terms of actual land area occupied.

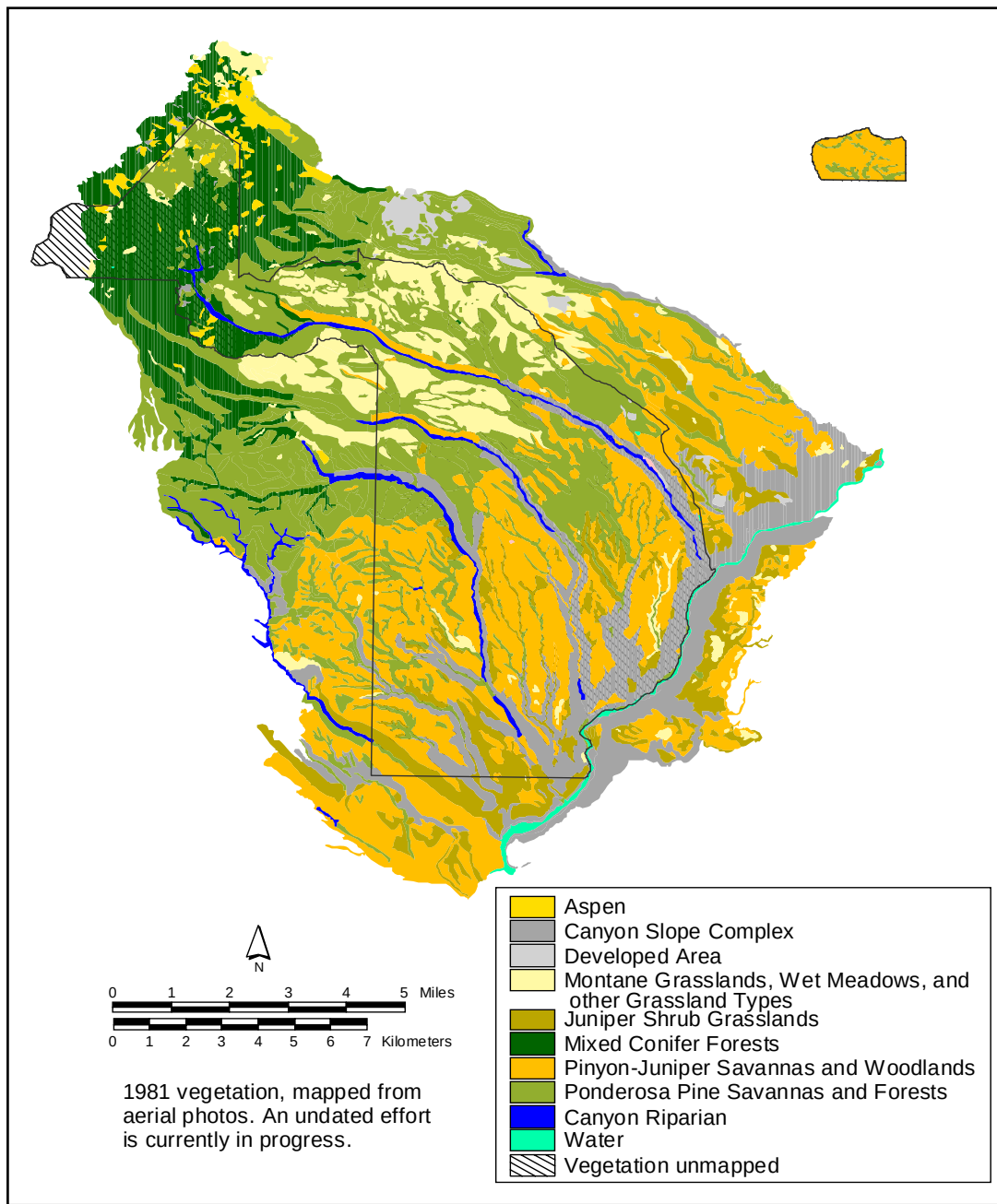


Figure 2. Vegetation of Bandelier National Monument.

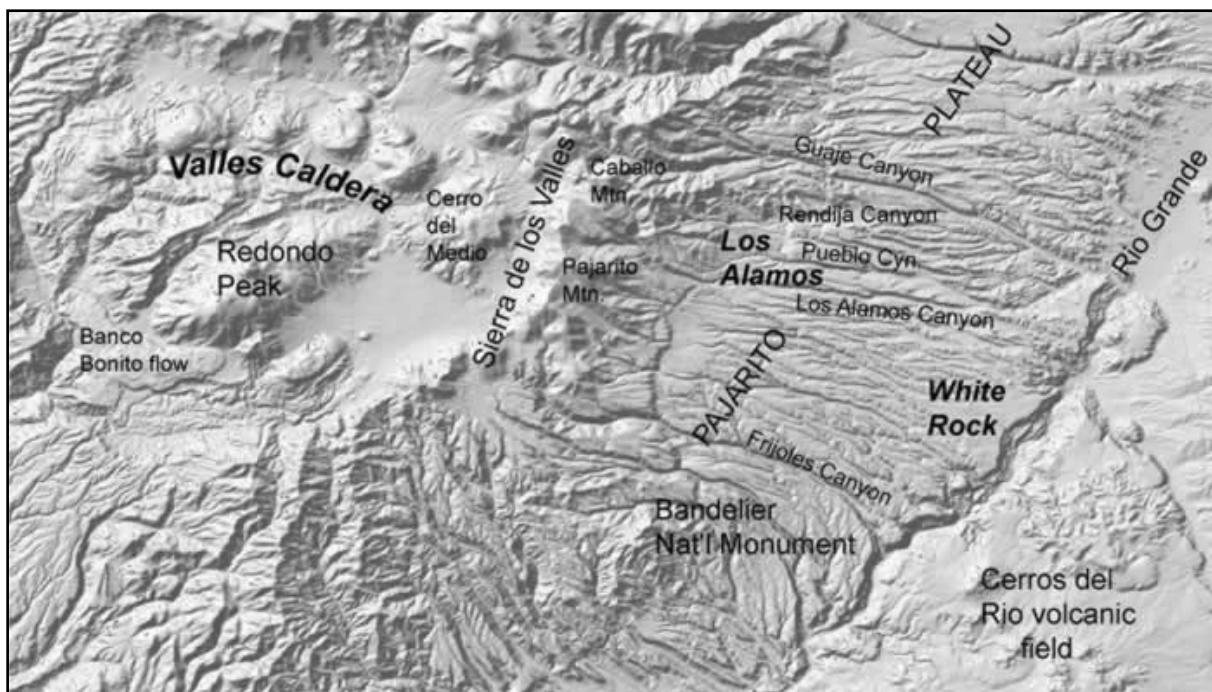


Figure 3. Pajarito Plateau and Bandelier National Monument

ALTERNATIVES DEVELOPMENT PROCESS

The appropriate range of alternatives includes those alternatives that would be reasonable, substantially meet the stated purpose, need, and objectives, and minimize environmental impacts. The purpose, need and objectives, impact topics, planning issues and constraints were developed through internal scoping by the interdisciplinary team of park, NPS and contracting personnel. Existing plans, policies, laws, results of ongoing research at the monument and in the scientific literature, as well as results from public scoping (see *Consultation and Coordination* section of this DEIS for more information) were integrated to define these factors. This information was also used in conjunction with the results of a second set of external scoping meetings to help in deciding whether an alternative was reasonable.

Research at the monument was critical in determining the range of reasonable alternatives. The results of test plots and other research at Bandelier (see *Research at Bandelier* section, above) and other literature have shown that successful treatment of the piñon-juniper woodland can be achieved through the removal of selected trees and lop and scatter of their branches. Removal of trees frees up limited soil moisture for herbaceous growth, while slash mulch improves conditions for herbaceous plant establishment by capturing runoff, enhancing infiltration, reducing evaporation, and providing protection from grazing (Jacobs and Gatewood 1999). Seeding, out-planting, irrigation, chaining, prescribed fire, and various agronomic approaches are either infeasible (prescribed fire, for example, would not burn without an herbaceous

understory to carry it, and the combination of rugged terrain, wilderness, and cultural values preclude most agronomic techniques) or would only be possible on a very small scale (Jacobs and Gatewood 1999). Therefore, only the selected thinning and slash mulch treatment is considered as a reasonable approach for Bandelier, and it is the treatment method analyzed in both action alternatives.

Initially, the internal scoping team from the park included as part of this planning effort all vegetative types in Bandelier where ecological processes are outside the range of natural variability. The team also identified three action alternatives that varied in the amount of mechanized or motorized tool vs. hand tool use only, but relied on the same basic approach. This study area and set of alternatives was the one reviewed by the public during scoping sessions in 2003.

Since then, monument staff met with other specialists across the National Park Service and decided on several changes to the alternatives. First, because the focus of research to develop and evaluate restoration treatments for the mitigation of soil erosion and stabilizing of cultural resources was in piñon- juniper woodland, and because the means to restore other vegetative communities outside the piñon- juniper woodland involved tools more traditionally part of a fire management program, the scope of the project was limited to piñon- juniper woodland.

When NPS specialists evaluated the feasibility of treating 4,000+ acres of woodland in the monument exclusively with hand tools to address wilderness concerns, they found it would take more than 20 times as long as compared with using motorized tools such as chainsaws (NPS, unpublished data on file at Bandelier). Given that treatment of this large area with dedicated crews working eight months of the year with chainsaws would take about five years, a hand tool approach was considered both unreasonable and one that would result in significant losses of cultural resources, soil, and the ability to restore large areas of piñon- juniper woodland. An alternative that relied completely on mechanized equipment was also considered unrealistic, as hand tools might be useful in some situations, for instance to carefully remove vegetation around important cultural resources or perhaps in areas where the noise of chainsaws would disturb wildlife special status species. Therefore, the park team of specialists refocused its efforts on the appropriate range of options that used both hand and mechanized tools.

Two different approaches to treating the piñon- juniper woodland were created. The first would focus on efficiency, and assumes the project would be initially or annually fully funded as needed. Treatment would begin in one corner of the monument and proceed across the landscape treating the maximum amount (see *Definition of Sub-Basins* below) for the eight months when the park is least visited each year.

A second approach would focus on areas of the monument where important cultural resources are most at risk. The monument's cultural resources staff have completed an initial survey of most of the archeological and historic sites in the study area, and used a system of ranking (see *Cultural Resource Ranking* below) to define those areas

in the piñon- juniper woodland where these resources have the most integrity, data potential, and are most threatened by accelerated soil erosion. Particularly if the treatment effort is funded more sporadically, this alternative would decrease the risk of losing these priority resources.

Minimum Requirement Results

Most of the piñon- juniper woodland at Bandelier is in designated wilderness. According to the NPS *Management Policies 2006* (NPS 2006a), any activities occurring in wilderness must be consistent with the minimum requirement concept. This concept is applied as a two- step process that determines:

- Whether the proposed management action is appropriate or necessary for the administration of the area as wilderness and does not pose a significant impact to wilderness resources and character; and
- The techniques and types of equipment needed to ensure that impact to wilderness resources and character is minimized.

The National Park Service utilizes the Arthur Carhart National Wilderness Training Center's *Minimum Requirements Decision Guide* (Arthur Carhart National Wilderness Training Center 2002) to apply the minimum requirement concept. The results of this process for Bandelier National Monument indicated that treatment of the area is critical to promote sustainable ecological conditions in the piñon- juniper woodland and to protect the high number of valuable cultural resources, for which the monument was created.

Further, the analysis indicated that motorized tools would be necessary to administer or manage the area based on the extent of treatment required in order to effectively restore piñon- juniper woodland and thus better protect cultural resources in the wilderness. The analysis showed that the speed with which the treatment would occur using motorized tools would result in better overall protection of wilderness values, cultural resources, soils and vegetation, and would offset the short- term adverse noise impacts to wilderness (Appendix A).

Should the plan be implemented, subsequent site- specific minimum requirement analysis would be completed on an annual or treatment area basis to determine whether intervention in designated sub- basins is needed, and to decide whether and to what extent mechanized or hand tools (see *Actions Common to All Action Alternatives* below).

Definition of Sub-basins

The project area was divided into 44 treatment areas of roughly 100 to 300 acres (Figure 4). These were based on mesa top hydrologic sub- basins modified to create hydrologically functioning work areas. Besides being hydrologically distinct, the sub-basins were useful in helping to define reasonably sized treatment areas where cultural resource priorities could be identified in Alternative C.

The methods used to divide the piñon- juniper woodland in Bandelier into sub-basins involved using an algorithm in the Geographic Information Systems (GIS) software ArcView 3.3 (ESRI 2002) that creates hydrologic units from 10- meter USGS digital elevation models (DEM) using the watershed command. The resulting ArcView shape file of the hydrologically functioning treatment basins was selected and clipped to the park boundary. Within each sub- basin, the acres and spatial distribution of soil types and vegetation type were quantified using GIS, which provided the number of treatable acres. For each soil complex, the total number of acres was reduced by the percentage of each complex that is untreatable (e.g., rock outcrops); this ranges between 10- 20% for both upper and lower soil complexes.

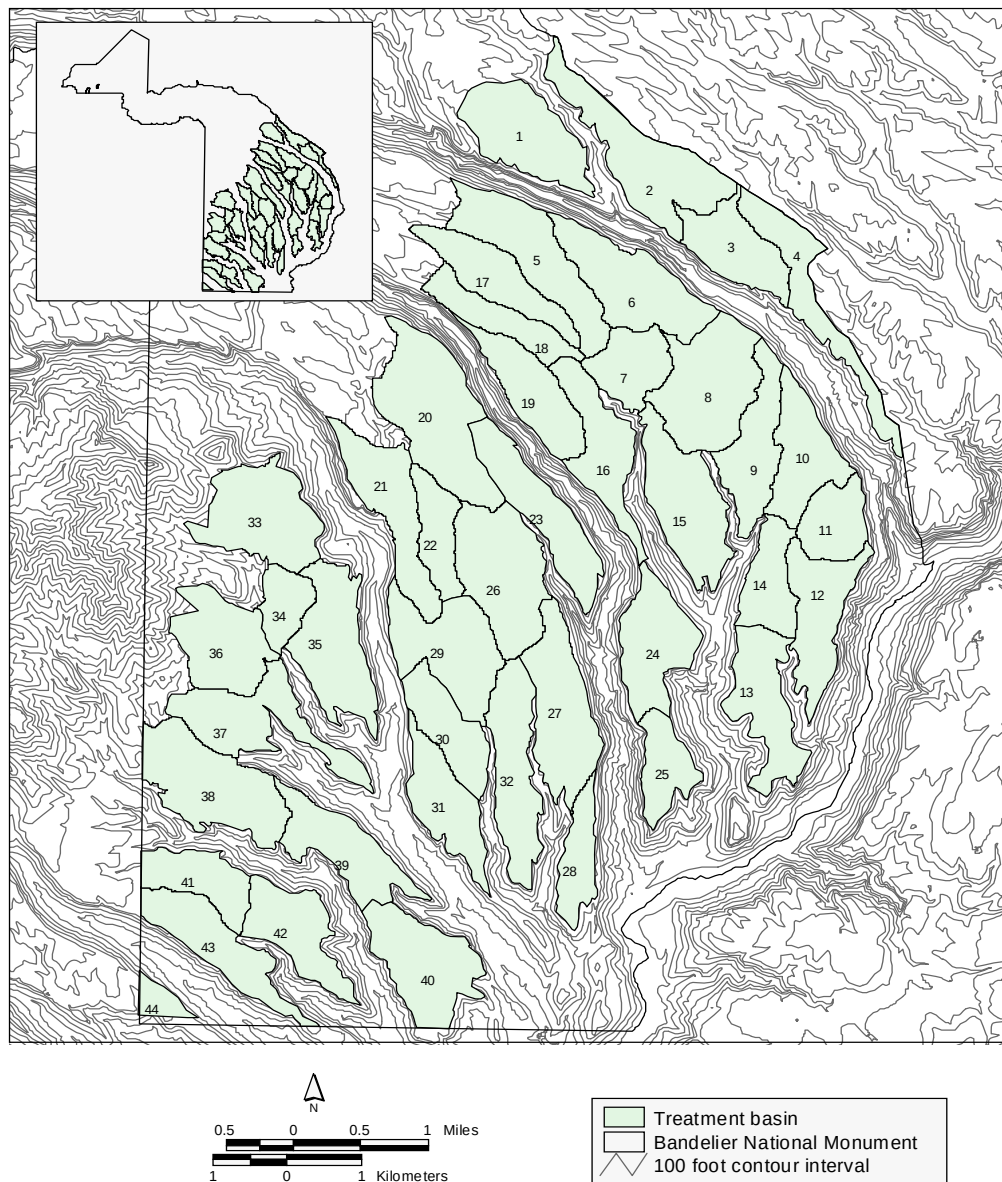


Figure 4. Hydrologic Sub-basins in Piñon-Juniper Woodland

Cultural Resource Ranking

Alternative C prioritizes sub-basins for treatment based on their ranking for important cultural resources. This section describes the variables evaluated and the process used to rank sub-basins. For each site, three variables were considered for prioritization. These variables included 1) data potential, 2) depositional integrity, and 3) threat timeframe. The first two variables were measured on an inverse ordinal scale, with sites with the highest data potential and depositional integrity given a value of “1,” and the sites with the lowest potential and integrity a value of “4.” Time frame is also an ordinal scale variable, with the most immediately threatened sites given a value of “1” and the most stable a value of “4.”

These values were assigned based on threat timeframe data collected during site condition assessments. Threat timeframe is an estimate of the number of years estimated to pass before identified threats will be realized and the site’s integrity and data potential fall to a range that would undermine the site’s eligibility for listing on the NRHP. The variable states were as follows:

1= Immediate to three years

2= Four to six years

3= Seven to 15 years

4= Twenty years or more

Using GIS (ArcView 3.3), sites were grouped by the treatment sub-unit in which they are located and treatment averages of site data potential, depositional integrity, and threat time frames were calculated. To obtain a single composite ranking variable for each treatment sub-unit, a weighted average of the three variables was obtained. Data potential and depositional integrity were each weighted at 40%, while timeframe was weighted at 20%. This scheme was designed to identify the most significant resources, while still taking into account the urgency of the threat to them. This single weighted average for each sub-unit was used to determine the order of treatment.

NPS PREFERRED ALTERNATIVE

Alternative B (Operational Priority) is the NPS preferred alternative. It is believed that action must occur to stabilize natural and cultural resources, and therefore that the No Action alternative is not reasonable. Alternative B would result in fewer adverse impacts, primarily due to the accelerated project schedule (five years vs. 20 years under Alternative C). While some effects may be more noticeable in the early phase of the project, impacts would be reduced over the lifetime of the project under Alternative B.

ALTERNATIVE A—NO ACTION

Alternative A is a summary of the existing management of resources that may change if one of the action alternatives (Alternative B or C) were implemented. It is also called the No Action alternative. The analysis of impacts of continuing existing management practices (in the *Environmental Consequences* section of this EIS) serve as a baseline for comparison of the impacts of either Alternative B or C.

Current management of most resources in piñon- juniper woodland at Bandelier is limited; there is no active management of soils, vegetation, or wildlife beyond ongoing research and monitoring activities. As noted above (see *Fire Management Plan* description), wildland and prescribed fire, as well as fire suppression, are allowed in piñon- juniper woodland, however the likelihood of any of these occurring is low given the generally sparse fuel conditions and minimal potential to affect park resources. No thinning or mechanical removal of trees except for occasional removal of heavy fuels from archeological sites at the request of cultural resource staff occurs under the *Fire Management Plan* in piñon- juniper woodland, although it and other fire management tools are likely to be used if piñon- juniper woodland is restored through treatment. Fuel breaks are created and hazard trees removed along right- of- ways in front country areas and along developed road corridors in piñon- juniper woodland (e.g., entrance road).

Research on soils and vegetation in piñon- juniper woodland is described above (see Research at Bandelier section). Monitoring activities on wildlife and special status species that would continue in or near piñon- juniper woodland under current management includes bird counts each summer and monitoring of listed species such as peregrine falcons, bald eagles, and Mexican spotted owls. Currently no research is being conducted on wildlife or special status species.

Ongoing research for cultural resources includes revisitation of sites lacking a current condition assessment, recording of insufficiently documented sites, inventory of unsurveyed areas, and limited data recovery through detailed surface recording or excavation. These activities are dependent upon funding.

Cultural resources have been initially surveyed throughout much of the piñon- juniper woodland over the past 15 years, and this work is expected to be complete within an additional five years. The condition of these resources is monitored, and stabilizing treatment in the form of lopping and scattering via hand tools has been taking place on a random basis for a few individual sites over the past few field seasons with funding assistance that ended in 2005. Emergency data recovery for sites that are in imminent danger of being lost from soil erosion occurs as park staff are able to detect and document these sites. However, as noted above, 1,900 sites in the piñon- juniper woodland are considered at risk and park staff are unable to continuously monitor all threatened cultural resources. Selected trees are also occasionally removed from cultural sites where deemed necessary by park

archeologists to reduce the likelihood of damage to structures from root penetration, windthrow, or heat effects where prescribed fires are planned.

As mentioned in the *Purpose of* and *Need for the Plan* section, Bandelier National Monument currently has a Memorandum of Understanding (MOU) with the six pueblos that are most closely affiliated with Bandelier: Santa Clara, Santo Domingo, San Ildefonso, San Felipe, Zuni, and Cochiti. This MOU requires Bandelier to regularly and actively consult with these pueblos regarding monument activities, sacred materials or places, or other ethnographic resources with which they are historically associated. A Consultation Committee has been established consisting of tribal representatives from the six pueblos and serves to maintain an effective means of communication and consultation between Bandelier and Pueblo communities that are traditionally associated with Bandelier National Monument. This consultation is a key element in the identification and evaluation of any sensitive areas or resources (plants and minerals) that may be affected by a proposed action. Bandelier National Monument, through this MOU, is committed to maintaining an on- going, long- term relationship with these Pueblos to determine appropriate courses of action to minimize impacts to ethnographic resources and/or to provide maximum protection for these resources to ensure continued access and use by the Pueblo peoples for traditional purposes.

Wilderness is managed through issuing overnight backcountry use permits and following the precepts of the *NPS Management Policies 2006* (NPS 2006) that wilderness be maintained to provide a primitive and natural experience. Maximum group size per permit is 10 people. Camping in mid- Capulin and Frijoles Canyons is restricted to designated zones at the time the backcountry permit is issued. Camping is not allowed within one- quarter mile of major archeological sites, and within 250 feet of any other cultural resource. No fires are allowed in the wilderness. Visitors to the backcountry are not restricted to established trails and may travel to any part of the backcountry. Stock use is restricted to trails approved for that purpose, and is allowed by permit only. No overnight stays are allowed for public stock.

The front and backcountry areas are patrolled throughout the year, with particular attention to trails. With increased visitation in the late spring, summer, and fall seasons, patrol frequency shifts from the frontcountry zones to a split between the front and backcountry, or wilderness, areas. Patrol emphasis is on visitor and employee safety, resource protection—especially of sensitive cultural and archeological sites—fire prevention, and minor maintenance of trails. Patrols are primarily via foot, but may include horse work.

The following schedule is for the eight- month period treatment would occur, and assumes full staffing. Not all of these areas are in piñon- juniper woodland, but most include some areas of this vegetative type:

- In the Cerro Unit, patrols in the Alamo Headwaters area and Cerro Peak area occur weekly, and all others occur monthly.

- In the western area of the monument, patrols occur monthly or once per season in accessible areas.
- In the Dome Road area, Sawyer Mesa is patrolled twice per month and upper areas would be patrolled daily via road.
- Areas along Highway 4 are patrolled once or twice per month.
- The east boundary with the Department of Energy's (DOE) Los Alamos National Laboratory (LANL) is patrolled monthly.
- Interior and trail areas are patrolled monthly or more frequently weekly (Falls Trail, Mid- Alamo), several times per week (Falls Trail, Burnt Mesa), twice per month (Frijoles Canyon, Upper Alamo Trail, Turkey Springs) or monthly.

ACTIONS COMMON TO ALL ACTION ALTERNATIVES

Annual Treatment Plan

This *Draft Ecological Restoration Plan and EIS* is a programmatic guide for restoring vegetative communities in piñon- juniper woodland. This means it evaluates large-scale approaches to meeting the stated purpose, need, and objectives and that selecting an action alternative will set a certain direction for management of the piñon- juniper woodland. While it analyzes actions that are as specific as possible to identify at this scale, a myriad of site- specific sub- basin level details would need to be worked out before proceeding with each season of treatment. Therefore, both action alternatives include the use of annual site- specific treatment plans consistent with this programmatic plan to flesh out the details of treatment within particular sub- basins to maximize the chances of success, minimize logistical problems, avoid site specific impacts to cultural and natural resources, and to determine whether intervention in wilderness is needed and if so, the minimum tool for conducting that intervention (e.g., the “minimum requirement process” described above).

Identification of individual treatment areas within each sub- basin would be completed through analysis of soil suitability (i.e., soil type and depth), vegetation type, and status of cultural resource sites. The availability of woody biomass (i.e., tree density) would be used to further delineate treatment areas. For the upper soils approximately 75% of the area has sufficient woody biomass for treatment. Only approximately 60% of the lower soil complexes have sufficient biomass for treatment¹. While these parameters would be emphasized in the implementation of the *Ecological Restoration Plan* at a site- specific level, it is recognized that fine- scale heterogeneity in soils, vegetation structure, and topography would be considered when annual treatment plans are developed.

¹60% may underestimate the portion of the landscape with sufficient biomass for treatment, but this is likely to be compensated for by the overestimate of the percent of the land surface in the lower soil complexes with suitable soils (areas not covered by rock outcrop or other shallow soils).

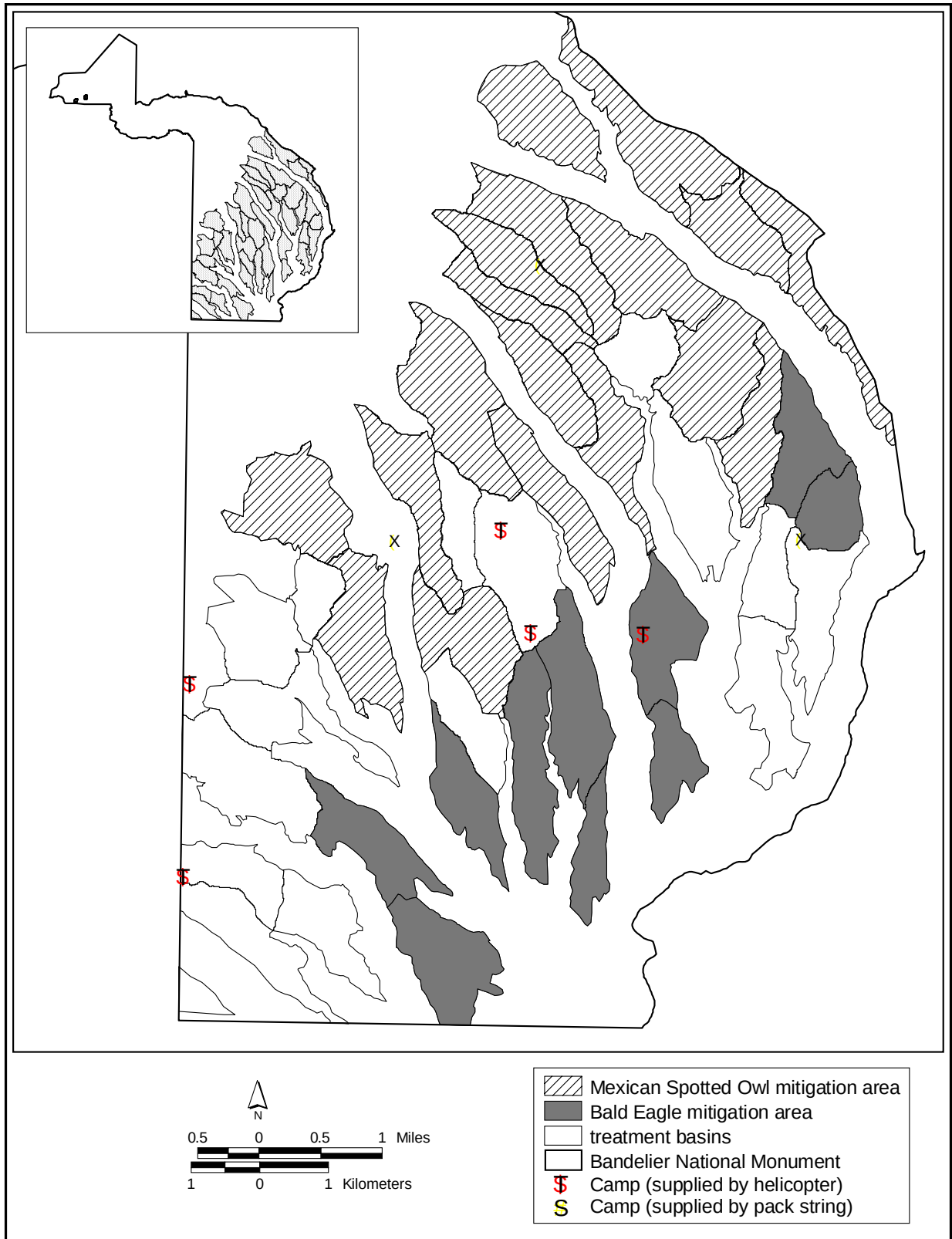


Figure 5. Helicopter and Chainsaw Restrictions for Mexican Spotted Owl and Bald Eagle, Based on Documented Areas of Habitat Use.

Annual treatment plans would include cultural survey and mitigation information (see *Impacts to Cultural Resources* section for Alternative B, for example) and would be reviewed and subject to approval by the New Mexico State Historic Preservation Officer.

Treatment of sub-basins would occur during a field season that generally runs from September to as long as May of the following year. In the description of alternatives, “season” is meant to define the period of field work within a given year of treatment and “year” to define the temporal range (or span) of implementation across the lifetime of the project.

Mitigation Measures

Restoration work would not take place during the summer months of June, July, and August to reduce the number of backcountry users exposed to the activities during peak visitation season, reduce trampling impacts to wet soils or actively growing vegetation, and limit exposures of work crews to adverse weather conditions (e.g., heat and lightning) which would limit productivity and pose safety issues.

WILDLIFE MITIGATION

Special Status Species

When treating piñon-juniper woodland near or in habitat that could be or is occupied by special status or federally listed species, hand tools might be the preferred method of treatment. The use of hand tools in select areas during the spring might allow crews to keep working while at the same time preventing impacts to these species. A biological monitor would be present during treatment to ensure no listed plant or animal species are disturbed, and to avoid or minimize impacts to other sensitive or unique species.

The following are species specific mitigations designed to reduce impacts to species and their potential habitat.

Mexican Spotted Owl (MSO)

At the start of the Mexican spotted owl breeding season (March 1), in order to mitigate any potential impacts to any nesting owls, occupancy surveys will be conducted to determine whether Mexican spotted owls are present in the monument and if so, their nesting status. If nesting MSOs are detected, the use of chainsaws and aircraft will not be allowed within 600 meters of an **occupied** suitable nesting area (SNA, described in *Affected Environment*) unless intervening topography attenuates the sound.

The following mitigation measures will also be implemented from March 1 to May 15 every year of treatment, regardless of surveys.

- Motorized activities on mesa tops will be prohibited within 100 meters of canyon rims within the shaded treatment basins shown in Figure 5 between March 1 and May 15.

- In general, helicopter flights will be avoided over the shaded treatment basins shown in Figure 5 between March 1 and May 15.

Bald Eagle

- No chainsaws will be utilized within 425 meters (0.26 miles) from fishing habitats and no helicopters will be flown within 1000 meters (0.62 miles) of fishing habitat along the Rio Grande from November 1 through February 28. .
- Helicopter and chainsaw activities will avoid the shaded basins shown in Figure 5 after 4:30 p.m. MST and before 8:00 a.m. MST from November 1 through February 28.

Peregrine Falcon

- In general, helicopter flights will be avoided over the basins indicated in Figure 6, which include peregrine falcon habitat management Zones A and B, from March 1 through May 15.
- Motorized activities in basins indicated in Figure 6 will be prohibited within 100 meters of canyon rims from March 1 through May 15.

ARCHEOLOGICAL RESOURCES MITIGATION

Mitigation measures specific to archeological resources include the following:

- Camp areas, helicopter drop zones, and pack train/human access trails will be located away from archeological sites.
- Prior to the start of work, the archeologist will instruct crews in identification of cultural materials and review federal and state laws protecting archeological sites and artifacts.
- Work crews (treatment and monitoring) will minimize walking over architectural and other features.
- All cultural sites within the treatment area will be identified and relocated by an archeologist.
- One archeological technician per work crew will be present on site during treatments to identify site components and supervise directional tree felling and placement of slash.

In addition, archeological sites within the treatment area will be treated following the prescription for the soil and vegetation type with the following modifications:

- All dead trees, regardless of species, will be removed from structural elements of sites. Non- structural elements of sites should be treated using the same prescription as the surrounding landscape.
- All 3- inch diameter and smaller trees will be removed. Cactus and other non- tree vegetation will be retained.
- Larger (>3- inch) diameter junipers growing in structures will be retained unless deemed by an archeologist to be detrimental to the stability or integrity of the structure.
- Larger (>5- inch) diameter ponderosa pines growing in structures that are deemed unstable will be removed.

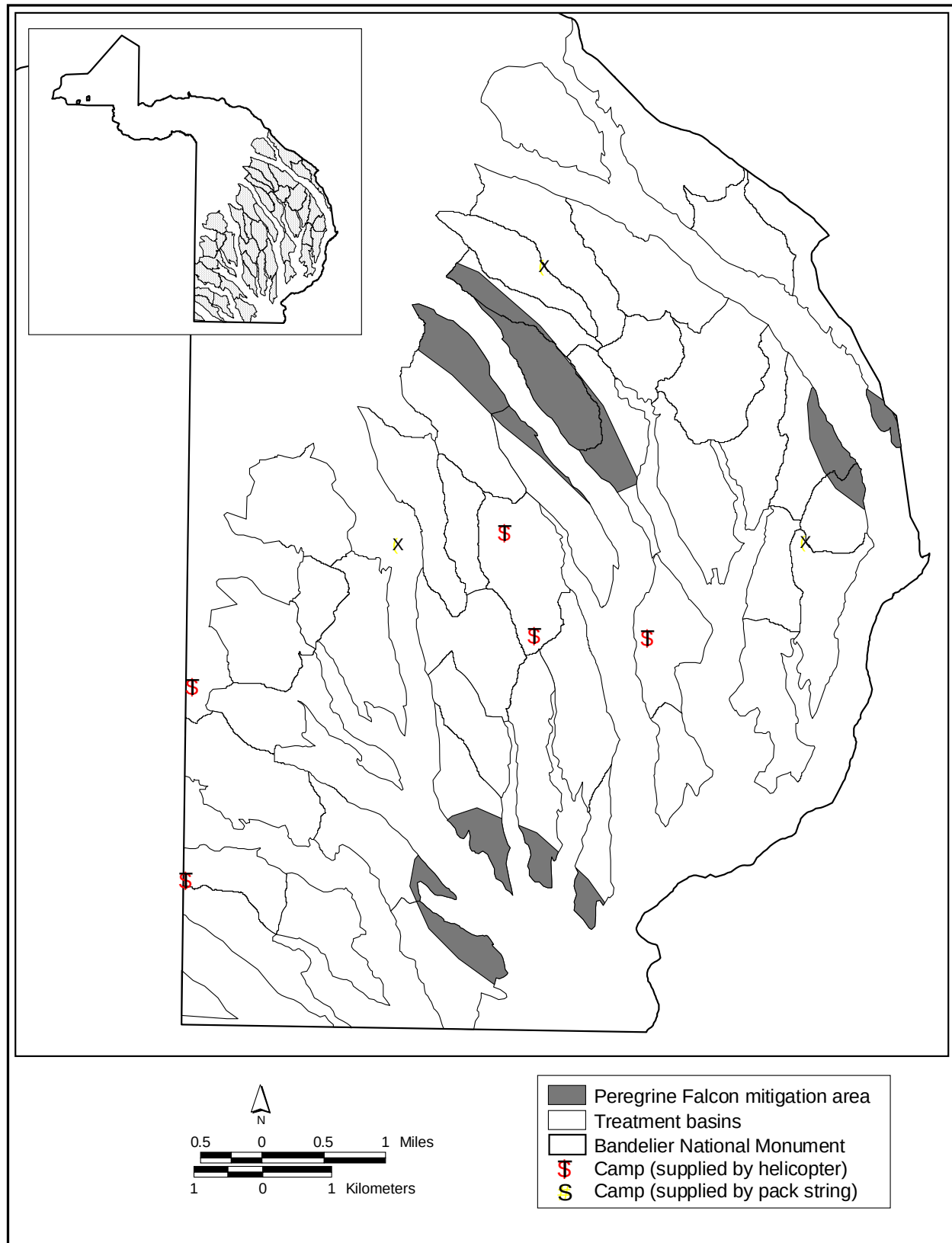


Figure 6. Helicopter and Chainsaw Restrictions for American Peregrine Falcon.

- Heavy fuels (and woody material greater than 3- inch diameter) will be hand carried off structural elements. Lighter slash can remain if deemed necessary by the on- site archeological technician.

Before treatment is initiated, NPS staff at the monument will consult with affiliated Pueblo tribes to determine the location and importance of sacred sites and how best to protect their integrity during treatment. This could include avoidance of an area if necessary, or the use of hand tools to treat woodland vegetation.

ETHNOGRAPHIC RESOURCES MITIGATION

Bandelier National Monument will continue to consult with the six affiliated pueblos identified above under the description of No Action. These consultations would identify treatment plans, site specific treatment maps, detailed archeological site maps, the need for tribal monitoring of treatment activities, proposed camp locations sites, and proposed mitigations for known ethnographic or culturally sensitive areas. The pueblos would be invited to identify potential Traditional Cultural Properties and express their concerns about any sensitive cultural or ethnographic resources or make their needs for access and use of traditional resources in the treatment area known. The monument intends to make the results of cultural resource field inventories available to the Pueblos, and will document consultation efforts and identify any proposed measures to avoid adverse effects to historic properties. Because of their sensitive nature, the locations of properties of traditional religious or cultural value will be kept confidential and unavailable to the general public. However, it will become part of a required submittal to the State Historic Preservation Officer under the National Historic Preservation Act. The required report will evaluate whether the selected alternative might adversely affect historic properties and if so, to what degree (pursuant to 36 CFR 800.4 and 800.5) If avoidance of adverse effects is not possible, Bandelier would work to mitigate them to the greatest possible degree with the SHPO and other appropriate parties in accordance with 36 CFR 800.6.

VISITOR EXPERIENCE MITIGATION

Backcountry permit applicants will be informed of locations of on- going restoration work (including locations of crew campsites). Visitor Center staff and rangers will be able to provide similar information to hikers requesting information. This information will allow visitors the opportunity to avoid restoration activities should they so choose.

Treatment Techniques

As stated above, annual treatment plans for work in piñon- juniper woodland implemented under this alternative would be prepared, and site specific treatment activities would be subject to minimum requirement analysis. If results of the analysis continue to demonstrate that motorized tools are the most appropriate tool

treatment sites in specific sub- basins, chainsaws and other motorized equipment may be used within designated wilderness.

In areas where minimum requirements analyses indicate motorized tools should be used, small diameter piñon and juniper trees would be flush cut at their base using chainsaws. Limbs would be lopped and scattered over bare soil. Although seeding or erosion fabric generally would not be applied, it may be beneficial in select areas of high ecological value that would not otherwise respond to more typical treatments because of existing soil loss or other factors. In areas where the minimum requirements analysis indicates motorized tools would not be appropriate, hand tools (e.g., axes, crowbars, handsaws) would be used to cut and limb trees.

Within each sub- basin, monument experts would orient crews to a basic thinning/slash prescription. Primary emphasis for treatment would be placed on more productive sites with deeper soils and remnant herbaceous cover and/or dominated by smaller diameter or younger trees. Shallow, rocky, or otherwise low productivity sites within the watershed unit and/ or those dominated by larger diameter or older trees would generally receive little to no thinning. Monument staff would monitor treatment sites (see Appendix B) and use information gathered from the sites to modify future treatments, site selection or other factors if needed.

Monument research results suggest that while ground cover is sufficient to carry a light surface fire in only five to ten years after treatment, application of prescribed fire will not promote recovery of the herbaceous component until native, perennial grasses constitute at least 10% basal cover (Jacobs 2004; Jacobs and Gatewood 2002). Until this occurs, the current practice of suppressing fires in piñon - juniper woodland would remain in effect.

Research and Monitoring

Research activities would establish controls to assess ongoing erosion potential in other areas of the monument for comparison to treated areas. Following treatment, an area would be monitored annually, and the information used to modify future work as needed. Indicators of success would include the degree of change in herbaceous cover, sediment production, or erosion, and the relative reduction in threat to the integrity of cultural resources (see Appendix B).

SOIL AND WATER

Effects of proposed actions on soil and water resources would be monitored primarily using a single integrated metric which would be based on monthly (July-September) volumetric measurements of sediment production for discrete contributing areas (e.g., 0.1 to 1.0 hectares) located wholly within representative treatment and control areas. Comparable contributing areas within representative treatment and control areas would be instrumented with fabric sediment dams and sediment removed and measured on a monthly basis. Sediment production estimates would be adjusted using precipitation data obtained from rain gauges co- located

with each sediment dam. Detailed procedures for measuring sediment production in relation to restoration treatments are detailed in supporting research by Hastings, et al. (2003). Supplemental information from repeat photography, erosion bridges, and vegetation cover may also be utilized to clarify system response.

VEGETATION

Effects of treatment on vegetation would be monitored on the basis of data collected annually from vegetation transects established located wholly within representative treatment and control areas. Two permanently marked, 100- meter vegetation line transects running downslope (perpendicular to contours) from the watershed divide and spaced at least 25 meters apart would be established within representative treatment and control areas. Vegetation and ground cover data (per species and ground cover type) would be collected at centimeter resolution during the early fall of each year, with basal and aerial cover intercepts recorded separately. Detailed procedures for measuring vegetation in relation to restoration treatments are detailed in supporting research in Jacobs, et al. (2000, 2002b). Supplemental information from repeat photography may also be utilized to clarify system response.

WILDLIFE, INCLUDING LISTED SPECIES

Monitoring occupancy of federally listed species, including the Mexican spotted owl and bald eagle, and the state- listed peregrine falcon, would continue as identified above under Alternative A—No Action. Although the state listed gray vireo breeds south of Bandelier in the Caja del Rio, it has not been documented in the monument and no information exists to suggest its presence in the project area. Breeding bird atlas field work conducted during 2002 throughout the piñon- juniper- dominated backcountry of the park did not detect any Gray Vireos after over 160 hours of observations. All proposed restoration treatments will be conducted outside of the breeding season for Gray Vireos (June through July based on data from Colorado National Monument, Colorado). Thus, there will be no direct effects on Gray Vireos from the proposed restoration work. If, during implementation of the project, gray vireos are found to be breeding in the park, surveys would be conducted. No additional monitoring specifically designed to measure the response of wildlife to treatment is planned. Pre- treatment surveys to determine the presence of the state-listed gray vireo in piñon- juniper woodland in the monument may be conducted.

CULTURAL RESOURCES

The effects of the two action alternatives on archeological resources would be monitored through qualitative data collection on the key variables of site condition, depositional integrity, and information potential, each of which relates to the eligibility of a site for listing on the National Register of Historic Places (NRHP). In addition, quantitative proxy measures of site stability would be monitored following an established protocol using Bandelier Archeological Site Condition Assessment and Monitoring forms. These forms record site condition, depositional integrity, data potential, detectable threats and disturbances from natural or human forces,

presence of invasive species, site- wide and 2- by- 2- meter vegetation plot estimates of surface cover and sheetwash, repeat photography, and surface topography along a single transect across the site.

Monitoring would occur on a 10% representative sample of treated archeological sites one year after treatment, then every three to five years afterward, for a period up to 15 years. Data collection would occur from mid- August to mid- September, which is the end of the growing season. The purpose of the monitoring is to determine what, if any, changes are observed pre- and post- treatment, and in successive years following treatment. Collection of the full range of qualitative and quantitative data would provide the opportunity to identify unforeseen consequences (beneficial or detrimental) to treated archeological sites. Vegetation plots and site- wide estimates of ground cover provide a proxy measure of soil and site stabilization. Monitoring would be scheduled for the end of the summer growing season, which falls during the month of August.

In addition, research and monitoring on archeological sites will be a subject of consultation with the park's affiliated American Indian tribes. It is often the case that cultural resources (such as archeological sites) overlap with ethnographic resource values. On- going consultation with affected Pueblo communities will ensure that appropriate treatment of these sites or resources are fully considered.

Education and Consultation

Educational and collaborative activities common to all alternatives would include field tours, public presentations of post- treatment response, and articles in the park, local newspapers, and postings on the park and NPS websites. Visitors and interested and affected publics would be regularly informed through annual reports on the woodland restoration efforts including monitoring results, and would be asked to provide feedback about project related effects (e.g., on the park environment or visitor experience) that might require additional mitigation or adjustments in how treatment is implemented. The park staff would provide regular project updates to interested neighbors including federal, state, and local entities, as well as private landowners and affiliated Pueblo groups to inform and consult on planned restoration activities at Bandelier National Monument.

Cumulative Actions

Cumulative actions are those historic, current, or future planned actions and activities by agencies or private parties that would have a positive or negative additive effect on the same resources as described in this *Draft Ecological Restoration Plan and EIS*. Each resource affected (air, water, soils, etc.) may have a different set of cumulative actions that affect it and each may also cover a different geographic boundary.

SOILS AND VEGETATION

The soils that would be affected in the park are volcanic in origin and comparable to soils which are found on adjacent lands (i.e., Santa Fe National Forest [Caja del Rio], the Pueblo of Santa Clara, LANL, and Los Alamos County) on the Pajarito Plateau. The piñon- juniper woodland in the monument is also part of a larger expanse of comparable woodland that extends over the same general area. The historic land uses, including grazing and fire suppression, and climatic conditions that have changed vegetation and soil erosion rates have also affected these same resources across the Pajarito Plateau. In addition, building of homes, roads, Los Alamos National Laboratory, and commercial development have removed soils and vegetation in this region.

CULTURAL RESOURCES

The Pajarito Plateau is an appropriate cumulative boundary for the type of cultural resources found in the study area as well. The factors leading to soil erosion and loss of cultural resources have occurred across much of the plateau. In addition to these factors, visitor use in the park or neighboring forest may have resulted in removal of cultural resources. Neglect, surveying and data recovery, development, and other factors may have contributed beneficial or adverse impacts to these resources.

WILDLIFE

Wildlife may have experienced cumulative effects across the entire geographic boundary of a population. Peregrine falcons, for example, were historically affected by the use of pesticides whose residues may remain in the environment today. Obligate southwestern breeding birds may have experienced loss of habitat from development and human disturbance. Other wildlife species, such as grasshoppers or mammals, may also have been subject to cumulative actions resulting in habitat loss.

WILDERNESS

The geographic boundary for Bandelier wilderness includes the neighboring Dome wilderness in the Santa Fe National Forest (Figure 7). Actions that have affected this wilderness area include historic grazing, fire suppression and development. Because piñon- juniper is quite open, development of housing, Los Alamos National Laboratory facilities, etc. on the landscape outside of the wilderness boundaries is nonetheless visible and has a cumulative adverse effect on the natural, primitive experience wilderness is intended to provide.

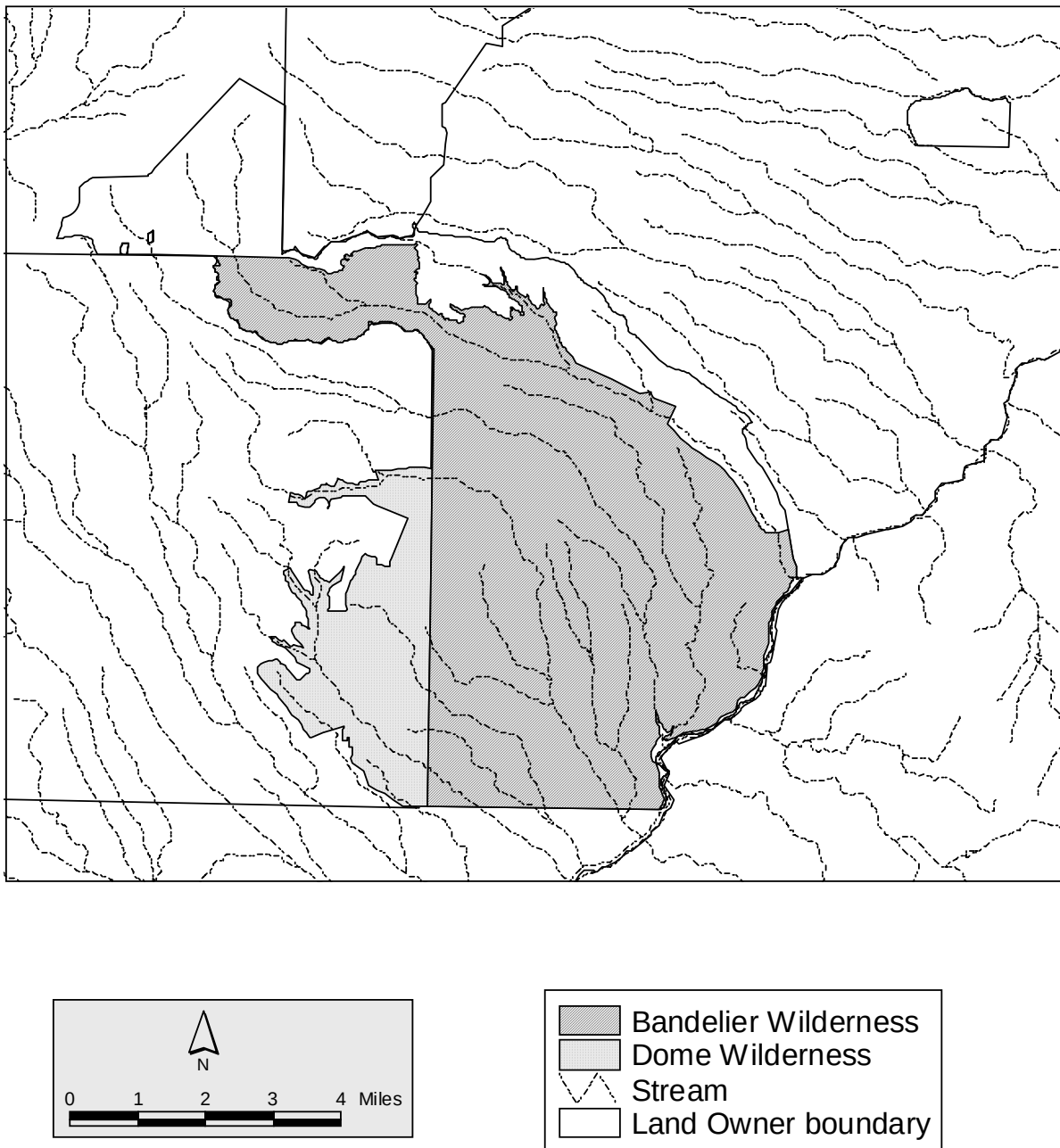


Figure 7. Bandelier and USFS Dome Wilderness Areas.

ALTERNATIVE B—OPERATIONAL PRIORITY

General Concept

Alternative B, the preferred alternative, would maximize the efficiency of treatment and minimize impacts associated with the amount of time treatment takes. Geography and logistics would determine the location and timing of treatment, and crews would complete restoration in a wave- like fashion by working systematically across the monument from one end to the other. This alternative would require either full funding initially, or full sequential funding for each season of treatment. For the purposes of the impact analysis of Alternative B in this EIS, implementation is assumed to take place over a period of five consecutive years, with the sequence of basin treatments shown in Figure 8. Basins scheduled for treatment may be switched from a given year to another, based on considerations such as presence of snow and inclement weather. However, although this may mean the year in which a particular sub- basin is treated might change, the impacts described in the *Environmental Consequences* section or those across the lifetime of the project would not change. Project costs over 5 years are estimated at \$1,975,343 in nominal terms, \$1,813,743 with a 3 percent discount rate applied, and \$1,628,887 with a 7 percent discount rate applied (see Appendix E).

Proposed Management Program

TREATMENT PRIORITIES

Clusters of sub- basins prioritized for treatment each season would be those that are in close proximity or adjacent to one another. This would allow crews to treat as large an area as possible each season, and would minimize the number of camps and impacts of those camps. Up to two crews would be working at any one time, as this would be the maximum number of personnel that park natural and cultural resource monitors could adequately manage at any one time.

Piñon- juniper woodland would be divided into approximately equal combination of subunits across the landscape and treated in five successive years. About 4,000 acres of piñon- juniper woodland would be treated over this time period. It is anticipated that in year one, treatments would occur in the southwestern most unit and that over the remaining treatment years they would proceed in a northeasterly direction towards the main headquarters area and north of Frijoles Canyon. Contingency units, or those nearest headquarters and accessible by walking from developed areas, would be treated during inclement weather when access to more remote treatment units is deemed unsafe. All tools and activities described under *Actions Common to All Action Alternatives* would be used under Alternative B.

As stated above, an average of five years for treatment is assumed in Alternative B, and the acreages of scheduled for treatment in each of the five successive years are summarized in Table 1 and shown in Figure 8.

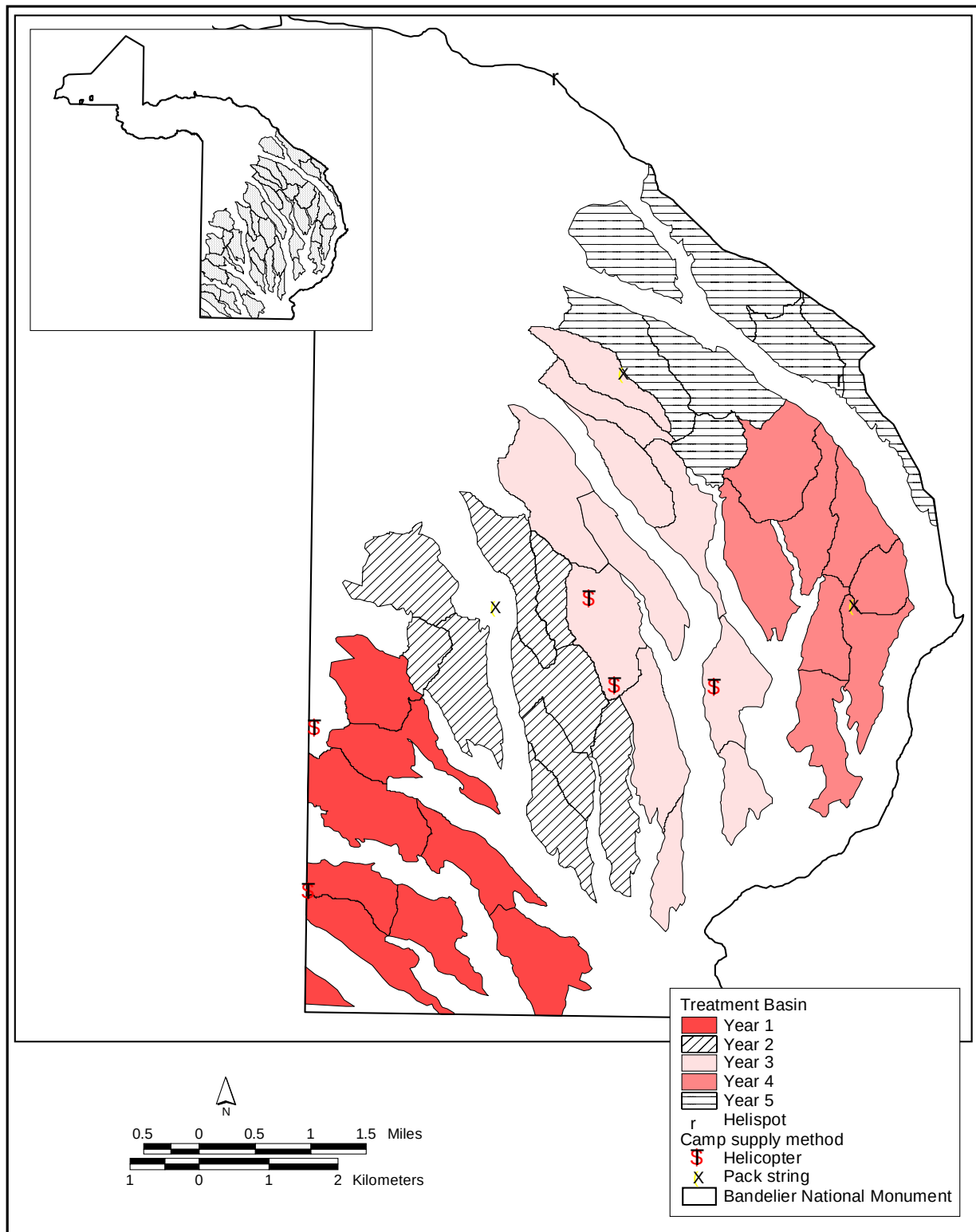


Figure 8. Treatment Areas, Alternative B.

Table 1: Treatable Acres for Each Project Season, Alternative B.

Treatment Year	Treatable Acres
1	792
2	780
3	877
4	857
5	745
Total	4051

CREWS AND CAMPS

Under Alternative B, up to two crews of six to ten personnel would be simultaneously implementing treatment activities each season. Optimally, the two crews would work at two different locations, often in adjacent or nearby sub-basins. Workers would walk to camps and mesas along existing trails if trails are available,, but would likely need to walk off trail to access treatment locations. Crews would work approximately eight to ten hours per day (depending on day length and sunlight) and eight to ten days per work session. Crews would treat a particular location, cutting an average estimate of 0.25 acres per day per person. This estimate includes time to walk to and from work locations, cutting, lopping, and scattering of branches, and other activities. For one 10- person crew, an estimated two and a half acres could be treated per day, with 50 acres treated per month (assuming crews work for an average 20 days per month). Using two 10- person crews simultaneously over the course of the eight-month season, approximately 800 acres could be treated each season.

Under Alternative B, a total of up to eight backcountry camp locations would be utilized over the five years of implementation. Both crews would camp at a central location near the work sites, i.e., 12–20 people would occupy the camp. A minimum of two camps would be required each season for the first and third years, as treatment would be conducted in the most remote areas of the monument. In the remaining other three years, it is anticipated that only one camp would be needed each season because crews would be able to hike each day to the treatment location as treatment moves closer to developed areas, or as in year two, is close to the Base Camp cabin in Capulin Canyon. The camps would be selected based on a series of criteria and would be located away from main trails. Each camp must also be within one and a half hours walking time from a work area, be located away from sensitive cultural or natural resource sites, and be situated such that it is accessible for helicopter drops or pack train support and so that it will accommodate the crew.

All crews would be briefed on emergency procedures and contact information (e.g. basic first aid, two- way radio protocol, cell numbers, after- hours contact numbers) to protect the health and safety of crew members or in the event of an emergency. In the event of an emergency in the backcountry, Bandelier protection rangers would likely be the first people contacted and based on the nature of the situation and their training, appropriate search and rescue procedures would be implemented (including the possibility of emergency helicopter transport).

The camp areas would be approximately one acre in size and would contain tent sites for up to 20 people, two kitchen tents, a paperwork/equipment storage tent, a dining canopy, and a portable self- contained latrine. Figure 8 shows the approximate location of proposed camp sites within treatment areas under Alternative B.

PACK STRING USE

A pack string of four to six mules would be used to establish and supply camps in areas that would not require supplies to be hauled in by helicopter, or that are located within three hours walking time to Bandelier headquarters (an estimated three camp locations across all five treatment years, as shown in Figure 8). Supplies, equipment, and water would be loaded into panniers carried by animals into camp locations. Camp locations would be located off main trails, so some off- trail travel by pack strings may occur. Under Alternative B, crews of 12–20 people may be camped at each location, necessitating several trips in and out by animals over the course of the season. It is estimated the supply trips by pack string would occur once every week during work sessions. Thus, pack strings would be utilized to set up and take down each of the three camps identified in Figure 8 and would return once to each camp location during each work session to deliver supplies to crews.

HELICOPTER USE

Where areas are not accessible by pack trains or where pack trains would be infeasible, helicopters would be used to establish and supply camps. In this alternative, a total of five camps would be supplied by helicopter over the five- year implementation period: two camps in year one, one camp in year two, and two camps in year three. Supplies, equipment, and water would be flown into camp locations using long line sling load techniques, which do not necessitate landing at the drop zone. The sling load would be placed on the ground and offloaded to the camp area. Since there are no proposed landings, the approximate number of helicopter trips is recorded as flight time (FT) per season over the five- year implementation period under Alternative B and is shown in Table 2 below. The results shown in the table include assumptions based on one hour of FT equal to approximately three round trips from the Bandelier heliport located at TA- 49 located along New Mexico Highway 4 (NM 4) or the helispot located along the Bandelier entrance road, as shown in Figure 8. An average of three hours FT (nine round trips) would be required per each camp set- up and each camp take down. In addition, one helicopter would be used to deliver supplies to the camps during the course of the season. It is estimated that the helicopter would deliver supplies to crews once per work session

(three round trips per supply delivery for one hour of FT per work session). Based on two work sessions per month over an eight-month period, there would be an estimated eight supply deliveries (24 round trips, eight hours of total FT) completed per each camp, assuming camp occupancy duration of four months each, over the course of an eight-month season. Years one and three would have two helicopter supplied camps per season, with 42 round trips per camp (nine trips for set-up + nine trips for take-down + 24 trips for supplies), which equals 84 round trip flights per season. This equates to 28 total hours of FT each for year one and year three, respectively. For year two, only one helicopter-supplied camp would be used, for a total of 42 round trips and 14 total FT hours.

Table 2. Approximate Flight Time (FT) to Set-up, Take-down, and Supply Camps by Helicopter for Implementation Years One through Three, Alternative B.

Implementation Year	Number of camps supplied by helicopter per year	Number of Round Trip Flights per Camp (set-up, take-down, and supplies)	Number of round trip flights year	Amount of total FT per year
1	2	42	84	28
2	1	42	42	14
3	2	42	84	28
Total over 5-year implementation	5	126	210	70

In this alternative, restoration work would generally be scheduled during the eight-month period from September to May to avoid the bulk of backcountry visitors to Bandelier. Flight routes and seasonal timing schedules discussed in wildlife mitigation measures (*Mitigation Measures* section above) would be implemented in order to avoid adverse impacts to sensitive species. In addition, as treatment moves closer to monument headquarters and pack strings become more feasible, helicopter use may be eliminated during the period from mid-March to May.

ALTERNATIVE C—PHASED APPROACH

General Concept

Alternative C focuses on treating sub-basins containing the highest priority cultural resource sites in piñon-juniper woodland to stabilize them first. As noted above under *Alternatives Development Process* above, three features of cultural resources were evaluated, weighted and averaged to determine a sub-basin's priority for treatment. For this alternative, work will occur over a 20-year time frame and project costs are estimated at \$3,519,164 in nominal terms, \$2,619,954 with a 3 percent

discount rate applied, and \$1,862,464 with a 7 percent discount rate applied (see Appendix E).

Proposed Management Program

TREATMENT PRIORITIES

As noted above, ranking methodology was used to determine the location and timing of treatment. Each sub-basin containing cultural sites was ranked based on criteria including the significance of and threat of losing cultural sites (e.g., imminent, permanent loss, or less than imminent). This methodology was used to prioritize sub-basins for treatment. However, in addition to the stabilization of cultural resources, factors described above under the *Annual Treatment Plan* section including the type of vegetation, soils, and woody biomass would be used to determine specifically where in the sub-basin treatment would occur. All specific locations in a particular sub-unit that require treatment would be treated before the crew moves to the next highest priority sub-basin.

All tools and activities described under the section *Actions Common to All Action Alternatives* would be used under Alternative C. One crew of six to ten people each would work throughout the field season. This alternative would target treatment in a particular sub-unit which may be located far from the section with the next highest cultural resources priority. Consequently, one crew would move around the monument more than in Alternative B, treatment of the 4,000+ acres of piñon-juniper woodland that are degraded would take longer, perhaps up to 20 years. The number of acres treated during each of the 20 seasons is shown in Table 3 below.

In addition, under Alternative C it is assumed the field season would last from September to March, instead of May as described in Alternative B. This abbreviated work year would avoid the bulk of backcountry visitors to Bandelier and the spring nesting season of sensitive bird species in the monument. If treatment in the spring would be located so that it either does not require the use of a helicopter for supplies, or so that a helicopter could supply the camp without disturbing nesting birds, treatment may continue through until the end of May. If so, the impacts of this scenario would be within the range analyzed in Alternative B. In summary, for the purposes of the impact analysis in this EIS, Alternative C would generally have a six-month field season from September to March and work with one field crew per season.

Table 3: Treatable Acres for Each Project Season, Alternative C.

Treatment Year	Treatable Acres
1	208
2	217
3	195
4	211
5	193
6	211
7	210
8	171
9	207
10	190
11	209
12	210
13	210
14	210
15	209
16	202
17	210
18	220
19	211
20	147
Total	4051

CREWS AND CAMPS

As described above, one crew per field season is assumed for Alternative C. Despite the reduction in field crews per season, a total of eight backcountry camp locations would still be utilized over the 20 years of implementation, which is the same as Alternative B. However, there may be fewer workers occupying the camps per occupation period due to only one crew working at any given time. The camp areas would be centrally located and be approximately one- acre in size and would contain tent sites for up to 12 people, two kitchen tents, a paperwork/equipment storage tent, a dining canopy, and a portable self- contained latrine.

It is anticipated that there would be one to three different camp locations utilized per season depending on the location of treatment units. Because of the more varied location of treatment areas, the duration for each camp would be shorter than in Alternative B and the same camp locations may be reused from year to year over the expected 20 years of implementation. As in Alternative B, camps would be selected based on environmental and logistic criteria. They would be sited away from sensitive cultural or natural resources, and be situated so that they are accessible to helicopter drops or pack train support. Figure 9 shows the approximate location of proposed camp sites within treatment areas under Alternative C.

As in Alternative B, workers would walk to mesas along existing trails if trails are available, but would likely need to walk off trail to access treatment locations. Crew members would be trained by NPS vegetation specialists and archeologists at Bandelier National Monument on how to cut trees, how best to avoid impacts to site-specific resources, and how to achieve maximum treatment results. As in Alternative B, crews would work approximately eight to ten hours per day, depending on sunlight conditions and eight to ten days per work session, over a period of 20 work days per month. Since the field season is shorter by two months in this alternative, less acreage would be treated per season.

Using the conservative estimate of 0.25 acre treated per day per person as used in Alternative B, one 10-person crew would be expected to treat approximately 50 acres per month, or approximately 200- 300 acres per year in this alternative.

PACK STRING USE

As in Alternative B, a pack string of four to six mules would be used to establish and supply camps that would not require water to be hauled in, or that are located within three hours walking time to Bandelier headquarters (approximately three camp locations over the course of the project). However, under Alternative C, camp locations would be reused from year to year over the duration of the 20- year implementation. This would result in a greater number of times each camp would have to be established, supplied, and packed back out. Based on a 20- year implementation plan, a total of nine backcountry camps requiring off- trail travel by pack strings would have to be established, supplied, and carried back out at the end of occupation. The greater number of trips to establish and carry out camps would be partially offset by fewer per camp supply trips required due to the smaller number of people at each camp, but the overall number of back- and- forth trips is expected to be at least twice the number required by Alternative B.

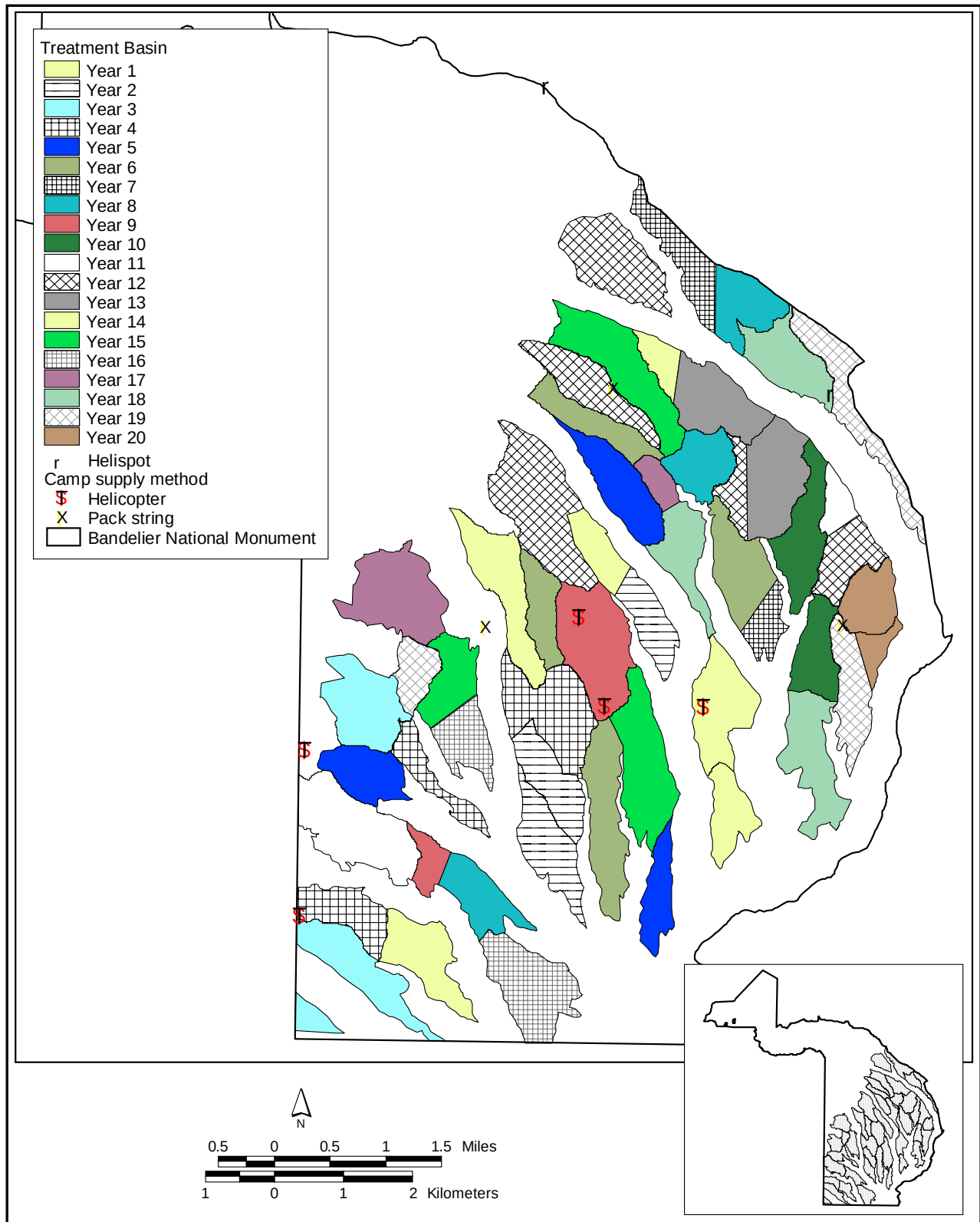


Figure 9. Treatment Areas, Alternative C

HELICOPTER USE

As described under Alternative B, helicopters would be used to establish and supply camps in areas not accessible by pack trains, and where pack trains would be unfeasible. Supplies, equipment, and water would be flown into camp locations using long line sling load techniques, which do not necessitate landing at the drop zone. The sling load would be placed on the ground and offloaded to the camp area. A total of 14 camps over 11 different field seasons would require helicopter support during the 20- year implementation period. Some camp locations would be reused from year to year over the duration of the project. Under Alternative C, the approximate number of helicopter trips required for the 14 camps is recorded as flight time per season over the 20- year implementation period and is shown in Table 4 below. The same assumptions applied under Alternative B are used here, with one hour of FT equal to approximately three round trips from the Bandelier heliport located at TA-49 along NM 4 or the helispot located along the Bandelier entrance road. However, because of the reduced crew size, the amount of required camp supplies would be less, thus reducing the number of round trips needed to supply one camp. It is estimated that six round trips (two hours of FT) would be needed per each camp set-up and each take- down. It is further estimated that helicopter supply trips per work session would be reduced to two round trips for each supply delivery (one delivery per work session), or 0.6 hours of FT. Thus, for years requiring two helicopter-supplied camps, there would be a total of 48 round trips flown for a total of 22.4 hours of FT. For years requiring only one helicopter- supplied camp, there would be a total of 24 round trips flown for a total of 15.2 hours of FT.

Table 4. Approximate Flight Time (FT) to Set-up, Take-down, and Supply Camps Requiring Helicopter Use for Each Year, Alternative C.

Implementation Year	Number of camps supplied by helicopter per year	Number of Round Trip Flights per Camp (set-up, take-down, and supplies)	Number of round trip flights per year	Amount of total FT per year (hours)
1	2	24	48	22.4
2	1	24	24	15.2
3	1	24	24	15.2
4	1	24	24	15.2
5	2	24	48	22.4
6	1	24	24	15.2
7	1	24	24	15.2
9	2	24	48	22.4
11	1	24	24	15.2
14	1	24	24	15.2
15	1	24	24	15.2
Total over 20-year implementation	14	264	336	188.8

Table 5 summarizes the elements of the alternatives analyzed in this EIS.

Table 5. Summary of Elements of Alternatives.

Action Categories	Alternative A No Action	Alternative B Operational Priority	Alternative C Phased Approach
Approach	No landscape treatment; continue individual removal at cultural sites, monitoring and small-scale research in piñon-juniper woodland.	Quick implementation to provide quickest means of slowing erosion, restoring vegetation and minimizing loss and degradation of cultural resources in project area.	Phased approach that identifies the most at-risk cultural resource sites and treating those first, regardless of efficiency of operations.
Implementation Period	Not applicable	5-year implementation period	20-year implementation period.
Actions	Hazard tree removal from cultural sites. Trees cut to create fuel breaks in sensitive areas. Ad hoc cultural site stabilization as funds allow. Monitoring and research of test plots.	Cut trees where soils are deeper or cultural resources require stabilization, and lop and scatter branches. Treat approximately 4,000 acres. Use minimum requirement analysis to determine motorized or hand tool use for project level implementation.	Same as Alternative B, except site specific cutting would include stabilizing cultural sites as top priority.
Crews	Research or individual cultural resource stabilization crews stay on or near roads; no supplies required	Two crews of six to ten walk to site from camp or developed area; camps set up by helicopter and supplied by helicopter in remote locations. Crews work eight months each season and cut a minimum of 0.25 acre per day per person (likely closer to one acre per day)	One crew of six to ten walks from camp or developed area to site; camps set up by helicopter and supplied by helicopter in remote locations. Assume crew works six months each season and cuts a minimum of 0.25 acre per day per person
Mitigations	No mitigation measures proposed.	Biological monitor on site Cultural monitor on site Crew training Trees removed from archeological sites No treatment May to	Same as Alternative B except: No treatment March to May to avoid visitor impacts and helicopter overflights in habitat occupied by nesting listed birds.

Action Categories	Alternative A No Action	Alternative B Operational Priority	Alternative C Phased Approach
		August to avoid high visitor use Hand tools in arch sites or near sensitive wildlife habitat. Some helicopter over flight restrictions and chainsaw use restrictions for listed species in certain areas.	Some helicopter overflight restrictions and chainsaw use restrictions for listed species in certain areas.
Research & Information Sharing	Share research results. Provide education through site tours of test plots; annually compile results of monitoring.	Same as the No Action alternative, and: provide wayside exhibits, visitor center exhibit, website stories, public involvement in accordance with the National Environmental Policy Act.	Same as Alternative B.
Tribal Consultation	Continue with tribal consultations per MOU.	Continue tribal consultations per MOU and meet with tribes annually to discuss treatment projects for the year to identify any issues or concerns.	Same as Alternative B.

ALTERNATIVES DISMISSED FROM FURTHER ANALYSIS

This section describes alternatives considered by NPS staff or suggested by the public during scoping but dismissed from further analysis. The reasons each was not considered further are also explained.

Hand tool only alternative—Quantitative data (NPS, unpublished data on file at Bandelier) documenting a minimum 20- fold increase in the amount of time required to cut down a juniper using hand tools versus a chainsaw demonstrates that a hand tool only alternative would not meet the plan objectives because the threat to the cultural resources would be realized before the treatment could be completed. To implement the treatment with hand tools over a shorter time frame using a greater number of sawyers, biological technicians, and archeological technicians would not be feasible or economically practical, and would impact the wilderness value of solitude to an unacceptable degree.

Widespread reseeding of native grasses to jump start regeneration in the piñon- juniper and hand scarifying in some areas to establish grasses—Two separate studies conducted at Bandelier suggest that reseeding with native grass by itself is not an effective restoration treatment in the absence of overstory

reduction and slash mulch treatments (Chong 1994) and may not significantly enhance herbaceous response when applied as a supplement to mechanical treatments (Jacobs and Gatewood 1999). Under Alternatives B and C, limited supplemental seeding in high resource value areas may occur in areas where basic treatments do not produce acceptable results.

Reestablishment of beaver populations in Upper Frijoles Canyon—This action is beyond the scope and objectives of the plan as treatment activities described in this environmental impact statement would occur outside potential beaver habitat. In addition, adding this feature to alternatives would not help meet the stated objectives of restoring the physical and biotic natural range of variability to the piñon- juniper woodland of Bandelier.\

Move the boundary of the park to include Capulin and Alamo watersheds—This is also beyond the scope of the *Draft Ecological Restoration Plan and EIS*, which is focusing on restoring piñon- juniper woodland ecological processes. Congressional action would be required to change Bandelier's boundaries.

Hand remove exotic vegetation—The hand removal of exotic vegetation on a small scale is feasible; however, it does not meet the objectives of this plan to restore woodland ecological processes across the landscape. Action alternatives could involve some removal of exotics during implementation, but the extent would be small and incidental to the larger scale vegetation removal activities considered in this plan.

Allow drought and bark beetles to kill off trees instead of using human intervention—The current drought induced beetle mortality of piñon pine across much of Bandelier is being monitored to assess response of the understory community. In addition to extensive tree mortality, perennial herbaceous cover has also been significantly reduced by the drought. While herbaceous cover is expected to recover with a return to more normal moisture conditions and would likely exceed pre- drought levels in response to piñon overstory mortality, the level and pattern of increase (in herbaceous cover) would likely be insufficient in most areas to significantly reduce rates of soil erosion. However, monument staff intend to continue monitoring herbaceous response to overstory tree mortality and use this information to inform proposed or ongoing management actions, including making adjustments to restoration actions and priorities.

Use only prescribed fire instead of motorized and hand tools—As noted in the description of the monument's *Fire Management Plan*, prescribed fire is allowed in piñon- juniper woodland, but without the herbaceous understory to carry it, is not considered likely to burn. Also, for a period of at least 10- 15 years after treatment in either action alternative, fire would be actively suppressed within restored areas of the woodland, or until native, perennial grass cover achieves a minimum of 10% basal cover. When understory objectives are achieved and a ground fire is capable of burning, the treated areas may be further treated with prescribed fire.

ENVIRONMENTALLY PREFERRED ALTERNATIVE

The CEQ's implementing regulations requires that agencies evaluate how each of the analyzed alternative meets certain policy statements set forth in Section 101(b) of the National Environmental Policy Act (NEPA). The environmentally preferred alternative is defined as the alternative that best meets these criteria, as well as the one that (CEQ 40 Most Commonly Asked Questions):

... causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural, and natural resources.

The section 101(b) criteria are as follows:

- Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
- Ensure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings.
- Attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences.
- Preserve important historic, cultural, and natural aspects of our national heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice.
- Achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities.
- Enhance the quality if renewable resources and approach the maximum attainable recycling of depletable resources.

Based on an analysis of each alternative and its ability to meet relevant portions of these criteria and which "causes the least damage to the biological and physical environment" and best "protects, preserves, and enhances historic, cultural, and natural resources," Alternative B is the environmentally preferred alternative. Compared to the other two alternatives, Alternative B better protects important park resources, particularly vegetation, soils, water resources and cultural resources, without degradation. Because of its faster timeframe, the risk of ongoing degradation and loss of soil, vegetation and cultural resources would be lower than in Alternative C. Fewer sites would be so degraded as to be untreatable during the five- year treatment period in Alternative B than in Alternative C, and therefore more acres of piñon- juniper woodland and the resources in the woodland would be saved and restored. The ability to protect and preserve additional natural and cultural resources is pertinent to both CEQ's interpretation of the NEPA 101(b) criteria, as well as criterion four ("Preserve important historic, cultural, and natural aspects of our national heritage...") itself. In a similar vein, Alternative B also fares best on criterion one, because it will preserve more of the woodland for succeeding generations to appreciate.

Alternative B offers the best balance of protection of resources in the short- and long- term with fewer permanent adverse impacts, particularly to natural and cultural resources. Because the adverse effects take place over a shorter period of time, it causes the “least damage” to most elements of the biological and physical environment. In the case of air quality and health and safety, taking no action would result in the “least damage.” However, for all other resources and values, any short-term impact from treatment is far outweighed by its beneficial effects.

Again because it accomplishes the same or greater restoration than Alternative C in a shorter period of time, Alternative B would also best assure safe, healthful, productive, and esthetically and culturally pleasing surroundings, as resources would be restored to a more natural or stabilized state and the impacts of treatment would be minimized by completing work quickly.

While both action alternatives would promote the quality of renewable resources (in this case, natural resources), Alternative B would accomplish this in a significantly shorter time period and so it environmentally preferred under this criterion (number six) as well.

Both Alternatives B and C were found to equally meet the criteria for achieving a balance between population and resource use and promoting health and safety.

DEGREE TO WHICH ALTERNATIVES MEET OBJECTIVES

As previously discussed, all action alternatives analyzed within this EIS must meet all objectives to a large degree, as well as address the stated purpose of taking action and resolving the need for action. Table 6 describes how effectively each of the alternatives meets the stated objectives.

SUMMARY OF IMPACTS OF EACH ALTERNATIVE

Table 7 summarizes the effects of each analyzed alternative, by resource. More detailed information on resource effects is provided in the *Environmental Consequences* section of this document.

Table 6. Degree to which Alternatives Meet Stated Objectives.

OBJECTIVE	ALTERNATIVE A NO ACTION	ALTERNATIVE B OPERATIONAL PRIORITY	ALTERNATIVE C PHASED APPROACH
Increase cover of native, perennial, herbaceous plants within degraded portions of the piñon-juniper woodland zone in order to reduce soil erosion, runoff, and loss of cultural resource integrity (possible impairment).	Does not meet objective. Degradation of the majority of the piñon- juniper woodland within the monument would continue (closed stands with dense needle litter mats beneath canopies and bare soil dominating intercanopy spaces). The continuing lack of herbaceous understory cover would, in many settings, yield irreversible loss/redistribution of upland soils and associated cultural resources.	Fully meets objective (five year implementation period). Actions are expected to result in re- establishment/maintenance of viable grass- dominated communities (understory) within the piñon- juniper woodland through reduced competition and enhanced site conditions. Runoff and sediment production will be considerably mitigated over current conditions, aiding in the stabilization of numerous cultural resources.	Meets objective to a large degree, but not as fully as under Alternative B due to the fact that some additional soils and cultural resources may be jeopardized because of the extended treatment time (20 years vs. five years in Alternative B).
Create conditions within degraded portions of the piñon-juniper woodland zone that will support a surface fire regime within the natural range of variability (for example, sufficient to maintain restored grass-dominated communities).	Does not meet objective. The on- going degraded condition of the piñon- juniper woodland is expected to continue to deteriorate, with increased potential for patchy, severe wildfire activity and subsequent weed invasion.	Fully meets objective. Herbaceous vegetation would have sufficient opportunity to recover to the point where surface fire regimes within the natural range of variability (e.g. frequency, intensity) could be supported. At the same time, potential for patchy, high severity fire and subsequent weed colonization would be minimized.	Fully meets objective as described in Alternative B; however, the time required to create conditions that would support a surface fire regime within the natural range of variability (20 year implementation period) would be considerably longer than under Alternative B (5 year implementation period).

OBJECTIVE	ALTERNATIVE A NO ACTION	ALTERNATIVE B OPERATIONAL PRIORITY	ALTERNATIVE C PHASED APPROACH
Manage degraded portions of the piñon-juniper community using information gained through an active program of research and monitoring.	Does not meet objective. Although research and monitoring would continue, the results would not be used to manage degraded piñon- juniper woodland.	Fully meets objective. In particular, vegetation, soils, water resources, and cultural resources will be systematically monitored to guide future project implementation work, on an annual basis.	Fully meets objectives as described under Alternative B.
Build support for, and actively share information about restoration actions and related research and monitoring efforts with government agencies, pueblos, and communities.	Partially meets objective. Information from research and monitoring is currently shared with interested agencies, pueblos and communities; however, no restoration would take place.	Fully meets objective. Objective would be met through providing project status information related to restoration efforts, including monitoring results, to interested and affected entities (public and private). Requests for feedback from interested and affected entities would be encouraged.	Fully meets objective as described under Alternative B.

Table 7. Summary of Environmental Consequences, by Alternative.

	ALTERNATIVE A NO ACTION	ALTERNATIVE B OPERATIONAL PRIORITY	ALTERNATIVE C PHASED APPROACH
VEGETATION	Soil erosion and loss, increase in extent of piñon- juniper woodland into former grassland would worsen with long- term, indirect, major, adverse impacts on herbaceous understory vegetation. Long- term, indirect, minor, adverse impacts to individual piñon or juniper from competition and drought. Minor to moderate, long- term adverse impacts from increased potential for wildfire from dying piñon pines and the potential for weed invasion.	Long- term, major, beneficial impact to understory from treatment (reduced competition/enhanced site conditions) Long- term, major adverse impact to individual piñon or juniper trees from thinning, but reduced competition and short- term, minor benefits for those remaining. Short- term, moderate, adverse impacts from increased potential for wildfire from thinned trees left on the ground. This would change to minor, long- term beneficial impacts from reduced potential for severe wildfires as understory returns. Treatment activities would result in short- term, minor, adverse impacts from trampling and soil compaction.	Same as under Alternative B, possibly occurring across fewer total acres Same as under Alternative B Same as under Alternative B Same as Alternative B but impacts would occur over a longer duration (20 years vs. five years).
SOILS AND WATER RESOURCES	Continued erosion and desertification across the woodland beyond the ability to recover resulting in major, long- term adverse impacts.	Reduction in erosion rates averaging two to four times, with localized slowing of 10 times or more. Moderate to major, long- term, beneficial impact.	Moderate to major beneficial impact, but less than Alternative B because of longer treatment period and certainty that more soils would be irreparably lost as compared to Alternative B.

ALTERNATIVE A NO ACTION		ALTERNATIVE B OPERATIONAL PRIORITY	ALTERNATIVE C PHASED APPROACH
SOILS AND WATER RESOURCES (cont.)		Treatment activities would result in short- term, minor, adverse impacts from trampling and soil compaction.	Same as Alternative B but impacts would occur over a longer duration (20 years vs. 5 years).
Increased runoff would worsen with long- term, minor, adverse effects.		Moderate to major benefits to hydrologic function related to reduced runoff, sediment production, increased infiltration.	Moderate benefits to hydrologic function related to reduced runoff, increased infiltration.
		Short- term, negligible impacts to water quality possible from unintentional disposal of waste.	Same as Alternative B
CULTURAL RESOURCES			
<i>Archeological Resources</i>		Residual long- term, direct and indirect, minor to major, adverse effects to some individual sites due to loss of integrity of those sites not mitigated before NRHP eligibility is jeopardized.	Same as Alternative B but the integrity of more sites may be threatened due to the extended treatment time (20 years vs. five years in Alternative B).
Long- term, direct and indirect, major, adverse impacts to cultural resources at the landscape scale due to the lack of plan to mitigate impacts related to soil erosion and potential loss of highly significant archeological resources. Impairment is possible.		Long- term, direct and indirect, minor, adverse effects to archeological resources at the landscape scale due to loss of integrity of sites not mitigated before NRHP eligibility is jeopardized.	Long term, direct and indirect, moderate, adverse effects to archeological resources at the landscape scale due to loss of integrity of sites not mitigated before NRHP eligibility is jeopardized. More sites may be jeopardized due to the extended treatment time (20 years vs. five years in Alternative B).
Short- and long- term, direct, localized, major benefits to a few		Long- and short- term, major, indirect and direct beneficial effects	Long- and short- term, major, indirect and direct beneficial effects

	ALTERNATIVE A NO ACTION	ALTERNATIVE B OPERATIONAL PRIORITY	ALTERNATIVE C PHASED APPROACH
CULTURAL RESOURCES (cont.)	individual sites from ad hoc treatment, but negligible landscape scale benefit	to individual sites and on the landscape scale through the stabilization of 98% of sites by end of five- year project. Long- term, direct, negligible to minor adverse effects to individual sites as a result of vegetation treatment methods (falling trees, cutting, lopping, etc.). Short- and long- term, direct, minor to major benefits to individual archeological resources as a result of slash mulching (soil stabilization/ erosion reduction).	to individual sites and on the landscape scale through the stabilization of 94% of sites by end of 20- year project. Same as Alternative B Same as Alternative B
<i>Ethnographic Resources</i>	Negligible to minor, adverse effects caused by biological, ecological and archeological research and management actions to mitigate erosion.	Short- to long- term, negligible to moderate benefits from increased availability of culturally important plants/plant parts. Short- term, negligible adverse effects from loss of small piñon and juniper trees used in traditional practices. Short- term, negligible effects from locations of camps and camp activities.	Same as Alternative B Same as Alternative B Long- term, major adverse effects from location of camps and camp activities over 20 year project period.

	ALTERNATIVE A NO ACTION	ALTERNATIVE B OPERATIONAL PRIORITY	ALTERNATIVE C PHASED APPROACH
			Short to long- term, moderate benefits related to extended time for consultation with appropriate Pueblos over the 20- year project period.
VISITOR EXPERIENCE	Continuing, long- term, site- specific to local, minor, benefits due to lack of disruptive vegetation management actions.	Short to long- term, negligible to moderate, site- specific to local, adverse impacts to views, wildlife viewing, and introduction of odors/emissions. Long- term, negligible to minor benefits to wildlife viewing resulting from increased biological productivity.	Short to long- term, negligible to minor, site- specific, adverse impacts to views, wildlife viewing, and introduction of odors/emissions. Same as Alternative B
	Continuing, long- term, minor to moderate, local to regional, adverse effects due to lack of cultural resource stabilization (primary reason for visitation).	Long- term, moderate to major, local to regional, benefits resulting from vegetation treatment/cultural resource stabilization within five years.	Long- term, minor to moderate, local, adverse impacts from the loss of resources and general resource integrity due to slow rate (15- 20 years) of vegetation treatment/cultural resource stabilization; Long- term, minor, site- specific, benefits from stabilization of sites in areas of early treatment.
<i>Soundscapes</i>	Backcountry and Frontcountry—existing noise from overflights, autos, visitors results in negligible or minor, adverse, long- term effects.	Backcountry—short to long- term, minor to moderate, site- specific to local, adverse effects caused by noise from mechanized equipment (helicopters/chainsaws) over five year project period.	Backcountry—short- term, minor adverse, site- specific to local effects caused by noise from mechanized equipment (helicopters/chainsaws) over the 20- year project period.

	ALTERNATIVE A NO ACTION	ALTERNATIVE B OPERATIONAL PRIORITY	ALTERNATIVE C PHASED APPROACH
VISITOR EXPERIENCE (cont.)		Frontcountry—short to long- term, negligible to moderate, site- specific to local adverse effects caused by noise from mechanized equipment (helicopters/chainsaws) over five year project period.	Frontcountry—short to long- term, negligible to minor, adverse, site- specific to local effects caused by noise from mechanized equipment (helicopters/chainsaws) over the 20- year project period.
VISUAL RESOURCES	Long- term, moderate, adverse effects due to continuing degraded condition of visual quality of piñon- juniper woodland.	Short- term, minor to moderate, adverse effects due to visual effects of 800- acre treatment areas. Long- term, moderate, beneficial effects resulting from improved visual quality (successful revegetation/restoration of a more natural ecosystem).	Short- term, minor, adverse effects due to visual effects of 200- 300- acre treatment areas. Same as Alternative B, but impacts would last longer due to the 20 year duration of treatment.
WILDERNESS	Wilderness Character: Long- term, major, adverse (“trammeled” appearance) Negligible to minor adverse effects (recreational experience) Wilderness Values: Minor to major, adverse Minor beneficial (recreational issues)	Wilderness Character: Short- term, minor to major, adverse (noise, activity, landscape appearance) Long- term, major, beneficial (natural character returned) Wilderness Values: Minor to major, adverse Long- term, moderate to major, beneficial	Wilderness Character: Same as Alternative B but duration of adverse impacts would be longer (20 years vs. five years in Alternative B). Same as Alternative B Wilderness Values: Same as Alternative B but duration of adverse impacts would be longer (20 years vs. five years in Alternative B).

	ALTERNATIVE A NO ACTION	ALTERNATIVE B OPERATIONAL PRIORITY	ALTERNATIVE C PHASED APPROACH
WILDLIFE	Occasional disturbance from ongoing management and visitors; negligible and indirect Continued expansion of woodland would have negligible adverse impacts on most species.	Negligible to minor, short- term, adverse impacts from treatment (temporary noise disturbance) Treatment and return of herbaceous vegetation would have indirect and direct, negligible to minor impacts to wildlife. For some species these would be long- term and beneficial and for piñon juniper dependent species, they would be adverse and long- term.	Same as Alternative B, although fewer animals may be disturbed during shorter season, but over a 20 year duration. Same as Alternative B
SPECIAL STATUS SPECIES			
<i>Mexican spotted owl</i>	Occasional noise from researchers, visitors, and cultural resource specialists treating individual sites may have negligible, short- term impacts through noise. Long- term, negligible adverse impacts from continued expansion of woodland.	Mitigation would prevent noise impacts from treatment (chainsaws, helicopters) from becoming more than negligible. Minor, short- to long- term, beneficial impacts from increased prey availability as open savanna and understory are restored.	No impacts Same as Alternative B
<i>Bald eagle</i>	Occasional noise from researchers, visitors, and cultural resource specialists treating individual sites may have negligible, short- and long- term impacts through noise. Long- term, indirect, negligible	Mitigation would prevent noise impacts from treatment (chainsaws, helicopters) from becoming more than negligible. Same as Alternative A but short-	Same as Alternative B Same as Alternative B

	ALTERNATIVE A NO ACTION	ALTERNATIVE B OPERATIONAL PRIORITY	ALTERNATIVE C PHASED APPROACH
SPECIAL STATUS SPECIES (cont.) <i>American peregrine falcon</i>	effects from continued expansion of woodland. Occasional noise from researchers, cultural resource specialists treating individual sites may have negligible, short- term impacts through noise. Negligible, long- term impacts from continued expansion of woodland.	term in duration. Mitigation would prevent noise impacts from treatment (chainsaws, helicopters) from becoming more than minor (direct impacts to nesting peregrines would be avoided). Negligible to minor, long- term beneficial impacts from increased prey availability as open savanna and understory are restored.	Same as Alternative B Same as Alternative B
AIR QUALITY	Current management in woodland has negligible impacts on air quality. Good air quality and visibility would continue.	Short- term, negligible, adverse effects resulting from helicopter and chainsaw emissions over the five- year treatment period.	Short- term, negligible, adverse effects resulting from helicopter and chainsaw emissions over the 15- 20 year treatment period.
PARK OPERATIONS	Short and long- term, direct, minor to moderate, adverse effects to Resource Management by on- going need to mitigate effects of erosion on park resources (e.g., cultural resources).	Short and long- term, negligible to minor, direct, adverse effects to Resource Management related to project management/implementation, monitoring, etc. over the five- year treatment period. Short- term, direct, negligible, adverse impacts to Administration, Interpretation and Visitor Services, and Visitor & Resource Protection from project related tasks (human resources, budget, contracting, public information efforts, increased patrols, etc.) over a five- year period.	Short to long- term, minor to moderate, adverse effects to Resource Management related to project management/implementation, monitoring, etc., over the 20- year treatment period. Same as under Alternative B but over a 20- year duration.

ALTERNATIVE A NO ACTION		ALTERNATIVE B OPERATIONAL PRIORITY	ALTERNATIVE C PHASED APPROACH
PARK OPERATIONS (CONT.)		Short- term, negligible to minor, direct, adverse effects to Facility Management resulting from pack operations and camp set- up duties over a five year period.	Same as under Alternative B but over a 20- year duration.
HEALTH AND SAFETY	Ongoing management activities including research, selective treatment of cultural sites would have negligible to minor impacts to workers.	Chainsaws—moderate, adverse impacts to workers.	Chainsaws—moderate adverse impacts to workers, but less total dose to workers than in Alternative B.
		Hand tools may have short- term, minor to moderate, adverse impacts to workers.	Same as Alternative B.
		Helicopters—short- term, moderate, adverse impacts to workers.	Same as Alternative B, although total dose to workers likely to be lower.