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ENVIRONMENTAL ASSESSMENT

Watershed Restoration in Degraded Pinyon-Juniper Woodlands

A DEMONSTRATION PROJECT

November 25, 1996

BANDELIER NATIONAL MONUMENT

**National Park Service
Department of the Interior**

Table of Contents

Introduction	
Purpose of and Need for Action.....	1
Action Objectives.....	5
Action Constraints.....	5
Legal Authority.....	6
Decisions to be Made.....	7
Description of Alternative Actions.....	8
<i>Alternatives Considered and Eliminated.....</i>	<i>8</i>
<i>No Action (Alternative 1).....</i>	<i>9</i>
<i>Proposed Action (Alternative 2).....</i>	<i>10</i>
Affected Environment.....	19
Major Issues.....	21
<i>Issues Considered in Detail.....</i>	<i>22</i>
Summary Environmental Consequences.....	23
<i>No Action Summary.....</i>	<i>23</i>
<i>Proposed Action Summary.....</i>	<i>24</i>
Proposed Action Environmental Consequences.....	25
List of Participants.....	33
References Consulted.....	34
Distribution List.....	36

Illustrations

Chart 1 (<i>Herbaceous overstory data</i>).....	3
Chart 2 (<i>Soil moisture data</i>).....	4
Figure 1 (<i>General location of project area within Bandelier</i>).....	14
Figure 2 (<i>Vegetation cover/ biomass and arthropod sampling design</i>).....	15
Figure 3 (<i>Soil moisture monitoring site locations</i>).....	16
Figure 4 (<i>Soil erosion bridge site locations</i>).....	17
Figure 5 (<i>Ungulate exclosure locations</i>).....	18

Introduction

Bandelier National Monument was established, in large part, for the protection and preservation of endangered archeological resources. Today, the greatest threat to these archeological resources at Bandelier is accelerated soil erosion in the pinyon-juniper community. Significant numbers of archeological sites could be lost to these erosional processes in the next 100 years.

Pinyon-juniper communities are in a degraded state across much of the Southwest; overgrazing, fire suppression and climatic variability during the last 150 years are thought to be causative factors. At Bandelier, degraded pinyon-juniper woodland sites are characterized by high tree densities, scant herbaceous cover and vast expanses of exposed, rapidly eroding soil. On exposed ground, harsh physical conditions inhibit plant establishment and preclude a natural vegetative recovery. Rapid soil loss in pinyon-juniper woodlands at Bandelier also threatens the thousands of archeological sites embedded in this cultural landscape.

Results from ongoing experimental work at Bandelier suggest recovery of degraded pinyon-juniper woodlands is possible through the application of a coordinated woody overstory thinning/ slash mulching/ seeding restoration treatment. Testing of this restoration treatment at a small plot scale has produced compelling results relative to both pre-treatment condition and to controls; after only two growing seasons, seven-fold increases in overstory herbaceous (grass and forb) coverage were observed.

Validation of the small scale experimental results, at functional ecosystem (i.e. watershed) scales, is necessary to ensure the ecological response is sufficient to control erosional processes and stabilize cultural resources. This demonstration project will enable the park to assess both the feasibility of large scale restoration efforts as well as provide educational opportunities for the public to learn about restoration of degraded lands.

Purpose of and Need for Action

Accelerated soil erosion in pinyon-juniper woodlands and the associated threat to archeological resources has been well characterized through an extensive network of permanent vegetation transects and erosion bridges. Ongoing studies at Bandelier are providing detailed information on runoff and sediment transport, relative to vegetative cover and precipitation events, in a degraded pinyon-juniper watershed. Related studies (age-class of standing trees and historical reconstructions) are helping to characterize the pre-grazing status of pinyon-juniper woodlands at Bandelier.

Soil loss within pinyon-juniper woodlands at Bandelier has been estimated at nearly one inch per decade. Many areas of the park could be eroded to bedrock in only 100 years, given shallow soil depths of from one to three feet. Nearly sixty percent of all known Ancestral Puebloan archeological sites at Bandelier occur within the pinyon-juniper woodlands. Currently more than seventy-five percent of 1,500 archeological sites surveyed at Bandelier, show significant erosional impacts.

Pinyon-juniper woodlands near park headquarters at Bandelier exhibit tree canopy coverages of 25 to 60%, herbaceous overstory coverages of 8 to 15% and exposed soil coverages of between 35 and 55%. Intensive characterization of erosional processes on a one hectare pinyon-juniper hillslope at Bandelier suggest soil losses of 25,000-50,000 kg over a two year period, most of it occurring during a few intense summer rain events during year 1 of the study (Wilcox et al., 1996).

Cessation of domestic livestock grazing and removal of feral burros have been insufficient to promote vegetative recovery in degraded pinyon-juniper woodlands at Bandelier. Biological thresholds have been crossed and physical processes now dominate exposed soil sites. If management takes no action to mitigate accelerated erosional processes, there will be wholesale loss of unique cultural resources.

Ongoing restoration studies at Bandelier (Jacobs and Snyderman, 1995; Jacobs, pers comm.) have shown promising results in support of pinyon-juniper overstory thinning/ slash mulching/ native seeding treatments. Response to treatment after two growing seasons has resulted in a fundamental transformation of the study site; grasses and forbs now provide nearly continuous cover across much of the treated area. In addition, the health, vigor and diversity of herbaceous plants on the treated site has increased dramatically. Measurements of herbaceous (grass and

forb) coverage (on treated sites near park headquarters) document, on average, a seven-fold increase in overstory cover after two growing seasons (from 10% cover in 1994 to 75% cover in 1996). Control areas, by contrast, were nearly unchanged two years later (chart 1). In mid-June of 1996, despite nearly eight months of drought, treated areas were green with lush herbaceous cover; by contrast, adjacent control areas remained brown with no sign of spring growth.

Pinyon-juniper restoration studies (Jacobs and Snyderman, 1995; Jacobs, pers. comm.; Loftin, pers. comm.) have demonstrated the benefits of woody overstory reduction treatment in terms of increased availability of soil moisture for herbaceous plants (chart 2). Slash mulch treatments have been shown to provide a much needed protective layer over exposed soils which reduces runoff, sediment transport, and siltation while increasing infiltration, moderating soil temperature and soil moisture, redistributing soil nutrients, and providing some protection from grazing. Combined, these effects create favorable microsites for herbaceous plant establishment and growth.

Evaluation of promising restoration methodologies at the watershed level is the next logical step towards implementation of a parkwide pinyon-juniper woodland restoration program. It will allow an assessment of restoration efforts at an operational scale, from both natural and cultural resource perspectives. Many ecological processes (i.e. runoff, sediment transport, grazing pressures, etc.) operate at relatively large scales and it is critical to assess potential restoration treatments in this context.

Restoration treatments need to be tested at functional ecosystem scales, and within the context of Bandelier National Monument, before erosional control efforts can move into an operational phase. Restoration projects at the watershed level are necessary to demonstrate that recovery of degraded pinyon-juniper woodland systems is desirable, physically possible and economically feasible, particularly where high value natural and cultural resources are at stake.

A demonstration project provides the park with opportunities to educate the public about degraded lands, impacts on park resources and the value of restoration efforts. It is important for park visitors to understand the necessity for active restoration of Bandelier's degraded pinyon-juniper woodlands and protection of threatened cultural resources, since overstory reduction in a wilderness setting might be misconstrued.

Change in Herbaceous Canopy Cover

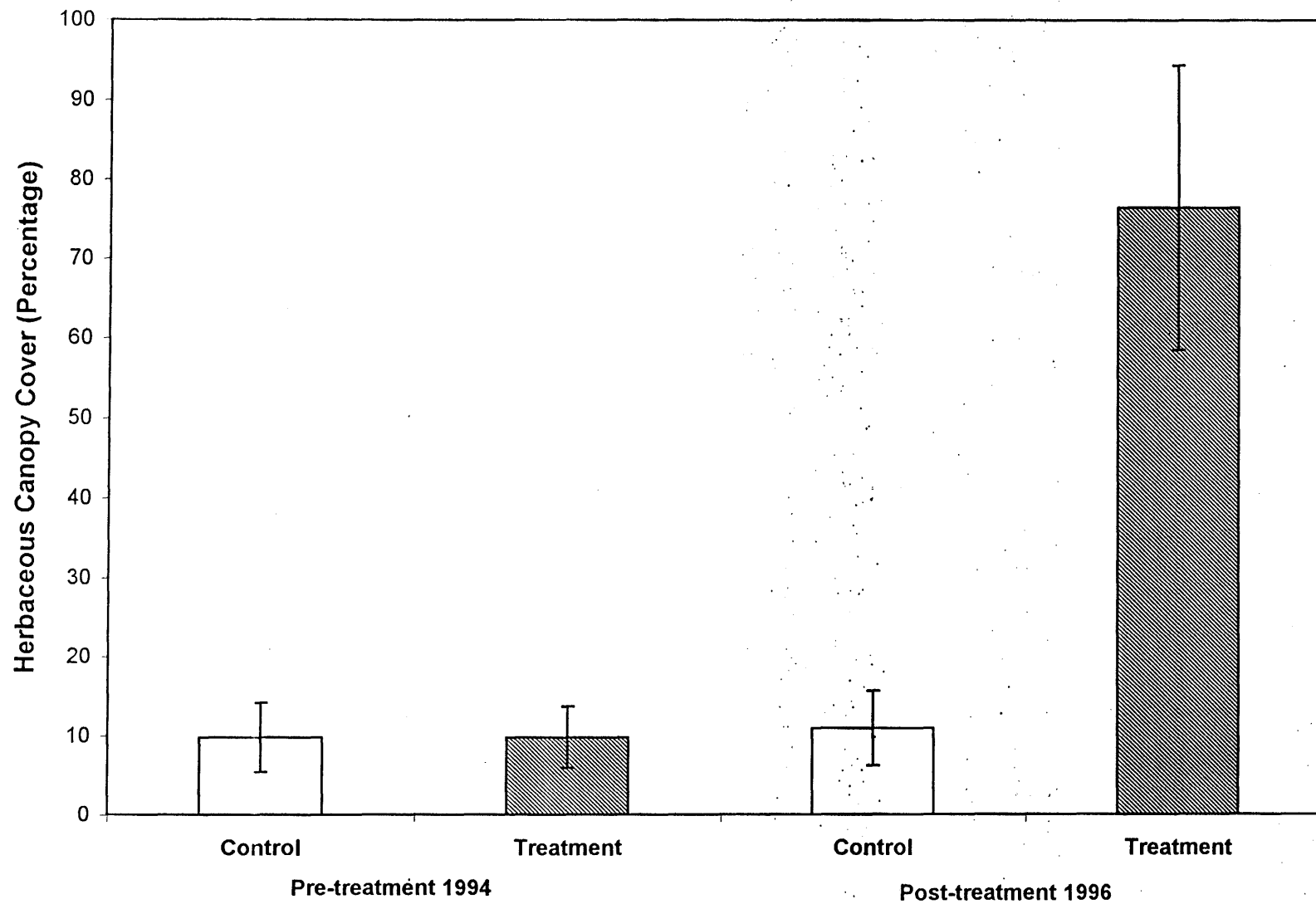


Chart 1

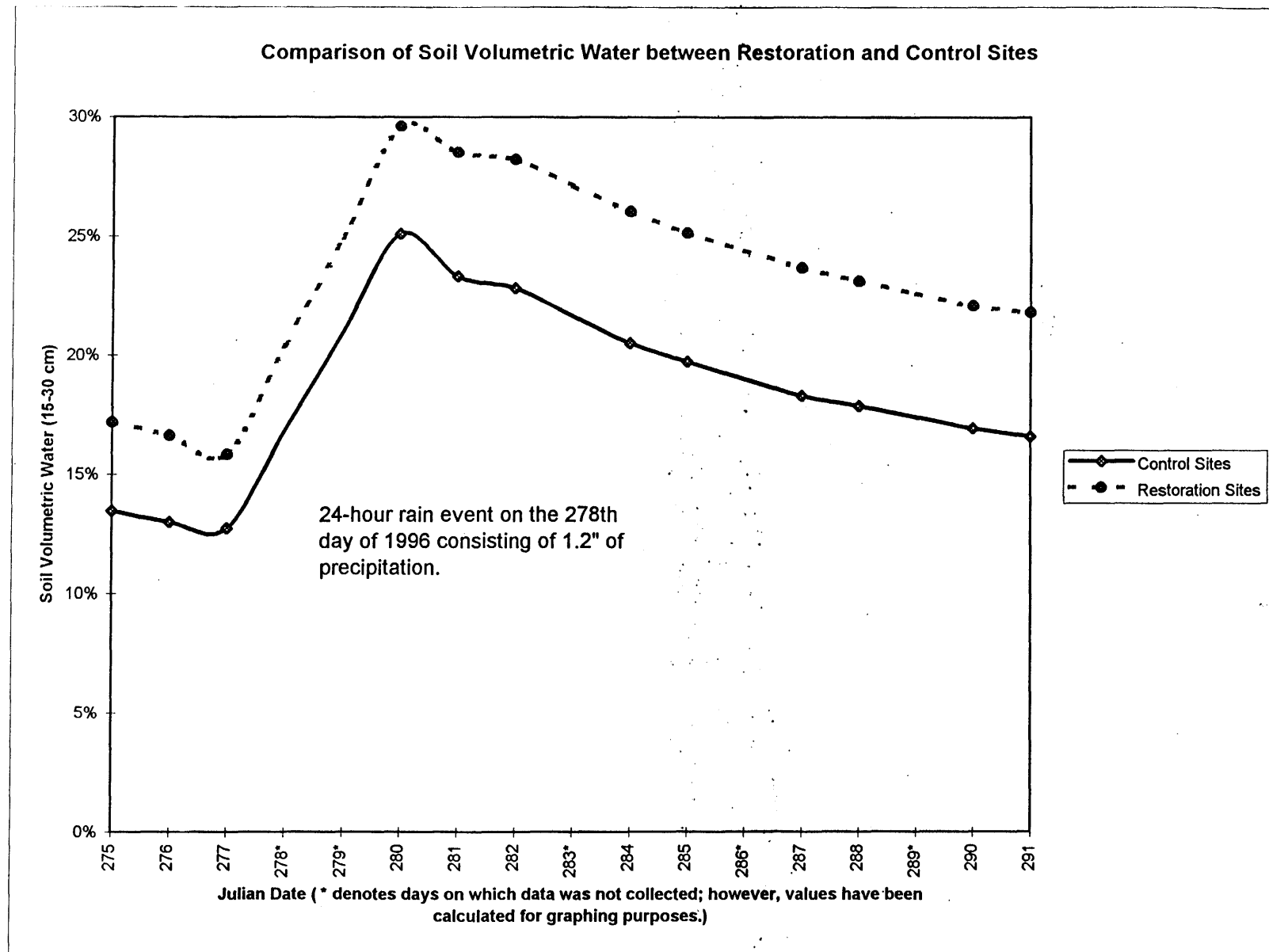


Chart 2

Action Objectives

The proposed alternative will be implemented with the following objectives in mind:

- 1) Develop and validate restoration methodologies for stabilization of degraded pinyon-juniper communities and protection of eroding cultural resources at functional ecosystem scales. We expect to document statistically significant responses (i.e. herbaceous cover, soil erosion, soil moisture, etc.) to restoration treatment after two growing seasons (comparable to those reported here for ongoing small scale studies at Bandelier) as compared with both pre-treatment condition and controls. A successful restoration treatment will also be visually impressive to the untrained observer with dramatic increases in herbaceous cover and associated decreases in erosional processes. *~4-7-fold increase in herbaceous cover*
- 2) Educate the public about the critical need for restoration of degraded pinyon-juniper communities and stabilization of cultural landscapes by providing opportunities to experience both restored and degraded watersheds. A successful restoration project, as described, above will disarm much of the public concern over active management of degraded lands. This change in public perception is an educational process that will be assessed informally by tracking unsolicited visitor comments received over the three year span of this project.

Action Constraints

Selection of restoration methodologies, choice of study location and design of the study, as presented in the proposed alternative, were influenced by the following constraints:

- 1) Designated wilderness area restrictions,
- 2) Sensitive species and sensitive habitat considerations,
- 3) Location and site density of pre-historic cultural resources,
- 4) DOI, NPS and Bandelier National Monument laws, regulations, policies and guidelines relevant to research and resource management activities
- 5) Applicability of project results to Bandelier, and
- 6) Logistical (i.e. access, timing, personnel, funding) considerations.

Legal Authority

Bandelier was established for the protection and preservation of endangered archeological resources. Today, the greatest threat to these archeological resources at Bandelier is accelerated soil erosion in the pinyon-juniper community. ~~Significant numbers of archeological sites could be lost to these erosional processes in the next 100 years.~~ Soil loss and the threat to archeological resources ranks as the highest priority in Bandelier's Resource Management Plan and is cited as a significant issue in the Statement for Management.

Restoration of degraded park lands for the protection of natural and cultural resources is authorized and supported by numerous laws, regulations, policies and guidelines pertaining to management of lands administered by the National Park Service. A listing of legal references relevant to the management of national park lands can be found in the Bandelier Resource Management Plan, Appendix F and in the Natural Resource Management Guidelines, NPS-77, Chapter 2 and Appendix A.

All projects proposed for Bandelier National Monument must gain initial concept approval from the management staff. Subsequently, proposed projects must gain natural and cultural clearances through compliance with a variety of laws regulating how federal agencies manage natural and cultural resources under their administration. The current environmental assessment is in partial fulfillment of requirements under the National Environment Policy Act. In addition, this project has been subject to cultural compliance under the National Historic Preservation Act and biological compliance under the Endangered Species Act. Finally, this project is subject to all guidelines and restrictions as set forth in the Bandelier National Monument, Guidelines for Scientific Research.

Decisions to be Made

This environmental assessment presents information necessary for the decision maker (Superintendent of Bandelier) to decide whether the proposed action, as described, should be implemented. The proposed action would establish an eighty hectare watershed restoration project within Bandelier National Monument for the purpose of demonstrating the feasibility of restoring degraded pinyon-juniper communities, stabilizing eroding soils and protecting cultural resources. Two, forty hectare watersheds would be intensively sampled to establish baseline conditions; one of the watersheds would subsequently receive the restoration treatment. Restoration actions would consist of a coordinated overstory reduction, slash mulch and native seeding treatment. For a minimum of two years after treatment is applied, both watersheds will be intensively sampled to assess changes in herbaceous cover, soil moisture, soil erosion, and faunal populations. Response to restoration treatment will be evaluated on the basis of measured variables (i.e. herbaceous cover, soil erosion, soil moisture, etc.) over two growing seasons post-treatment as compared with both pre-treatment condition and controls.

Description of Alternative Actions

This EA considers two alternatives in detail: no action (continuation of present management action/ inaction); and the proposed action (implementation of the watershed study/ demonstration project at Bandelier National Monument). One alternative, considered and eliminated, proposed the action (restoration demonstration project) be implemented on adjacent federal land managed by the Santa Fe National Forest.

ALTERNATIVES CONSIDERED AND ELIMINATED

Locate project on adjacent national forest lands

Under this alternative the project would have been located on the Santa Fe National Forest instead of on Bandelier National Monument; implementation of the project would otherwise have been as described under the proposed alternative (alternative 2).

Suitable sites could be found on the Santa Fe National Forest, but given the different management objectives of national forest lands much less control could be maintained over the study site. In addition, a significantly increased potential exists for introduction of uncontrolled experimental variables and loss or damage to sampling points and equipment. Finally, a large scale study (Loftin, 1994) is already in progress on the Santa Fe National Forest designed to meet the needs of that agency.

For these reasons the project will be located within Bandelier National Monument, as shown in figure 1. The demonstration project will have the most relevance to park management and will best fulfill the desired objectives if it is located within the monument. While general results of pinyon-juniper restoration studies may be broadly applicable, it is important to test methodologies in the context in which they will ultimately be applied. Bandelier has a number of constraints on the implementation of restoration efforts (see: Action Constraints) which make it important to test methodology and assess feasibility within the context of the park. In addition, the park can provide a much more secure and stable long-term study site for this project minimizing a number of potential impacts (i.e. livestock grazing, fuel-wooding, vehicle impacts, vandalism to equipment, etc.) likely to occur on national forest lands which could complicate interpretation of experimental results.

NO ACTION (ALTERNATIVE 1)

Continue current management of pinyon-juniper community

The no action alternative will allow for continued implementation of ongoing resource management activities in the pinyon-juniper community as detailed in the Bandelier Resources Management Plan (Sydoriak et al., 1995). These activities include continued documentation and quantification of existing resource conditions, as well as completion of ongoing restoration experiments.

The park maintains a dispersed vegetation and soil monitoring network, in part sampling degraded pinyon-juniper sites, which provides a baseline for assessing future changes in lieu of active management. This monitoring system is modeled after the Long Term Ecological Research design developed by the University of New Mexico. The park also conducts extensive photo-documentation of baseline conditions in the pinyon-juniper community. Baseline assessments of cultural resource condition are also in progress.

Hydrologic studies were initiated in 1993 to correlate the effects of precisely measured rain events (from watersheds of known size) on the amount of surface runoff, quantity of sediment transport and volume of displaced cultural materials generated (Wilcox et al., 1996).

Small-scale restoration studies (Jacobs, 1994) were initiated in 1994 to develop and test methodologies for stabilization of rapidly eroding pinyon-juniper woodland sites.

All of these ongoing efforts have provided compelling results, both in terms of documenting existing conditions as well as in demonstrating the potential for restoration to stabilize degraded sites. Under the no action alternative, documentation of existing conditions and small scale testing of restoration treatments will continue, but evaluation of restoration methodologies at functional ecosystem scales will not occur.

PROPOSED ACTION (ALTERNATIVE 2)

Implement the proposed action:

Watershed Restoration in Degraded Pinyon-Juniper Woodlands

The proposed action will validate results from small-scale experimental restoration studies at functional landscape scales (i.e. watershed level). A watershed level evaluation of restoration methodology will ensure that results are ecologically relevant and provides management with an opportunity to assess the feasibility of large scale restoration efforts.

Paired watersheds of comparable size, ca. 40 hectares (100 acres), slope, aspect, elevation, vegetative cover and soil condition have been identified within Bandelier (figure 1). One of the watersheds will serve as a control, while the second will receive a restoration treatment consisting of woody overstory thinning, slash mulching and seeding with native species. Response to treatment, and success of the restoration effort, will be assessed by documenting changes in herbaceous plant and exposed soil cover (figure 2), soil erosion rates (figure 3), soil moisture content (figure 4), soil nutrient levels, soil seed bank potential, and cultural site stability. Ecosystem response will be assessed by documenting changes in ground dwelling arthropod populations (figure 2) and site utilization by avian and ungulate species (figure 5). Related greenhouse germination studies will also be conducted. Effects of restoration treatment on many ecological processes (i.e. runoff, sediment transport, grazing pressures, etc.) can only be evaluated at functional scales and it is critical to assess potential restoration treatments in this context. A detailed study plan, **Watershed restoration in degraded pinyon-juniper woodlands** (Jacobs et al, 1996), documents experimental design, sampling methodology, experimental timetable, and statistical considerations.

SCHEDULE:

YEAR 1:

- 1) select study sites,
- 2) establish sample points, and
- 3) collect pre-treatment data

YEAR 2:

- 1) implement restoration treatments,
- 2) collect year 1 post-treatment data, and
- 3) begin preliminary data analysis

YEAR 3:

- 1) collect year 2 post-treatment data,
- 2) conduct final data analysis and
- 3) draft final report

DETAILED DESCRIPTION OF PROPOSED ACTIONS:

Infrastructure development

UNGULATE ENCLOSURES:

Two, one-hectare, solar electric fenced, ungulate enclosures will be constructed in each of the watersheds. Nine-gauge electric fence wire will be strung at one foot intervals, and to a height of eight feet (i.e. eight strands), between ceramic insulators mounted on existing trees. Ceramic insulators will be of a neutral color and will be attached to the trunks of trees using 3" lag bolts. Each enclosure will be powered by a 10 watt solar panel and 12 volt marine battery through a standard solar fence charger. Materials will be packed in using horse stock.

GREENHOUSE:

A traditional peaked roof greenhouse (15 ft. x 24 ft.) with aluminum frame construction, 8mm lexan panel covering, benches, gas heat, automatic roof vent, cooling water wall, exhaust fan and controller will be constructed in the park mesa residential area. Construction of the greenhouse may require a slight expansion of the pad area and the addition of new, clean gravel using a small bobcat. Hand tools will be used to assemble the frame structure and apply the lexan covering. The greenhouse will be located in the Bandelier National Monument mesa residential area, lower loop, site 16. This site is in an existing residential area where a old mobile home unit was recently removed. Utilities (gas, water and electricity) are available at this site, solar exposure is good, the site is previously impacted and the existing trailer pad will be utilized with minor addition of clean gravel.

Baseline Data Collection

SOIL SAMPLES/ ARTHROPOD PITFALLS:

Soil samples for seedbank/ nutrient analysis will be obtained from 10 locations in each of two watersheds. Soil samples from each of the 10 locations will be composites from six subsamples; each subsample will remove a 2 inch deep x 6 inch diameter soil core. Installation of arthropod pitfall traps, at 30 locations in each of two watersheds, will necessitate excavation of a small pits (i.e. 6 inches deep x 3 inches wide) at each sample point.

Soil samples will also be required in support of an intensive soil survey of the watersheds. Approximately six to ten map delineations will be identified on the basis of slope, aspect, slope position, vegetative cover and other topographic parameters. In order to delineate individually mapped units across the watersheds, a one hundred foot sampling grid would be imposed on the study area; one inch diameter, sixty inch deep soil cores would be taken at each grid intersection. One soil pit (appropriately one to two feet in diameter and sixty inches deep) will be dug for classification of each soil mapping delineation. Pits would be approximately one foot square in

diameter and dug to a depth of sixty inches.

SAMPLE POINT STAKES/ EROSION BRIDGES/ SOIL MOISTURE PROBES:

Sample point stakes (for vegetation sampling) utilize two foot (3/4"x1/4") aluminum stock set approximately one foot deep; the experimental design requires placement of ca. 150 sample stakes per watershed. Erosion bridge stakes utilize two foot (3/4") rebar set approximately one foot deep; the experimental design requires placement of ca. 150 stakes per watershed. Soil moisture probes (15" long) will be installed in the ground (ca. 15" deep) at 27 locations in each of two watersheds. Materials will be packed in using horse stock.

CULTURAL RESOURCES:

In consultation with the park archeologist, five representative sites in each of the two watersheds will be sampled to document pre- and post- vegetative cover and soil erosion rates. Two, 25 meter vegetation transects will be set up at each site to document vegetative cover; a series of ten, six inch nails and washers will also be placed along each transect as erosion pins to provide a measure of changes in soil surface.

In addition to quantitative assessments of selected cultural resources, all cultural resources within the project area will be qualitatively documented, pre- and post-treatment using a modified Dome Fire Cultural Resources Condition Assessment protocol.

WILDLIFE MEASUREMENTS:

Ungulate utilization of control and treatment sites will be compared using pellet count and vegetation cover/ biomass measures inside and outside of exclosures. Birds will be sampled using an avian point count method. Arthropods will be destructively sampled using pit traps with non-toxic propylene-glycol as a collection trap medium.

Restoration Treatments

OVERSTORY REDUCTION/ SLASH MULCH:

The overstory component will be reduced a minimum of 75% through removal of the smaller age-class trees (i.e. those less than six to eight inches in diameter at breast height). Overstory thinning will be accomplished using chainsaws operated by a four-six person fire crew.

Individual trees to be saved will be flagged; all others will be flush cut. Branches will be lopped off the main trunks and distributed uniformly across the site. Larger trunk sections will be laid perpendicular to the slope to slow sheet runoff and interrupt micro-drainage patterns.

Overstory thinning treatment will be applied for approximately a one month period, between March 1 and June 1, over all of the

treatment watershed, except for a narrow strip along the rim of Frijoles Canyon. The strip along the rim of Frijoles Canyon will be treated prior to March 1st to mitigate TES concerns; approximately three work days will be required to implement overstory treatment in this area.

SEEDING/ RAKING:

Seed will be applied by hand at a rate of approximately 400 seeds per square meter. This relatively high seeding rate is necessary to compensate for high seed loss due to ant predation and mortality from harsh physical site conditions. Seed material to be applied is native with origins in the park and includes:

Little bluestem, (Andropogon scoparius); Mountain Muhly, (Muhlenbergia montana); Sand dropseed, (Sporobolus cryptandrus); Blue gramma, (Bouteloua gracilis); Sideoats gramma, (Bouteloua curtipendula); White prairie clover, (Petalostemum candidum).

Soil surface preparation will be accomplished by hand, subsequent to slash mulch treatment, using council rakes to pull shallow (1/4-1/2 inch) furrows perpendicular to the slope. Immediately after broadcast seeding, the dirt will be lightly brushed back into the shallow furrows using juniper branches as brooms.

Raking and broadcast seeding treatments will be applied in early summer of the year spring overstory treatment is implemented. If necessary due to high loss or mortality of applied seed, raking and seeding treatment may also be repeated during the second summer post overstory treatment.

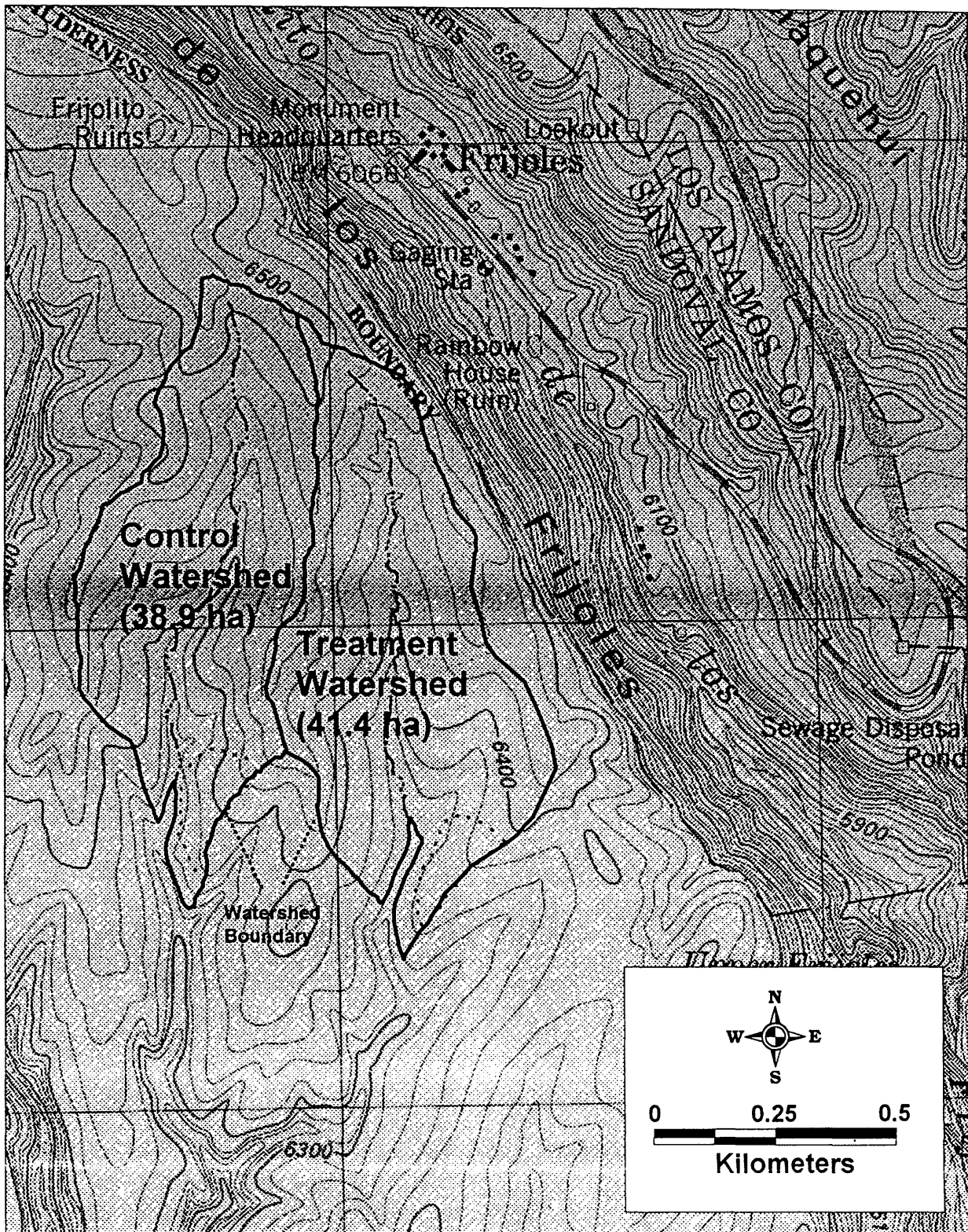


Figure 1. General location of project area within Bandelier National Monument.

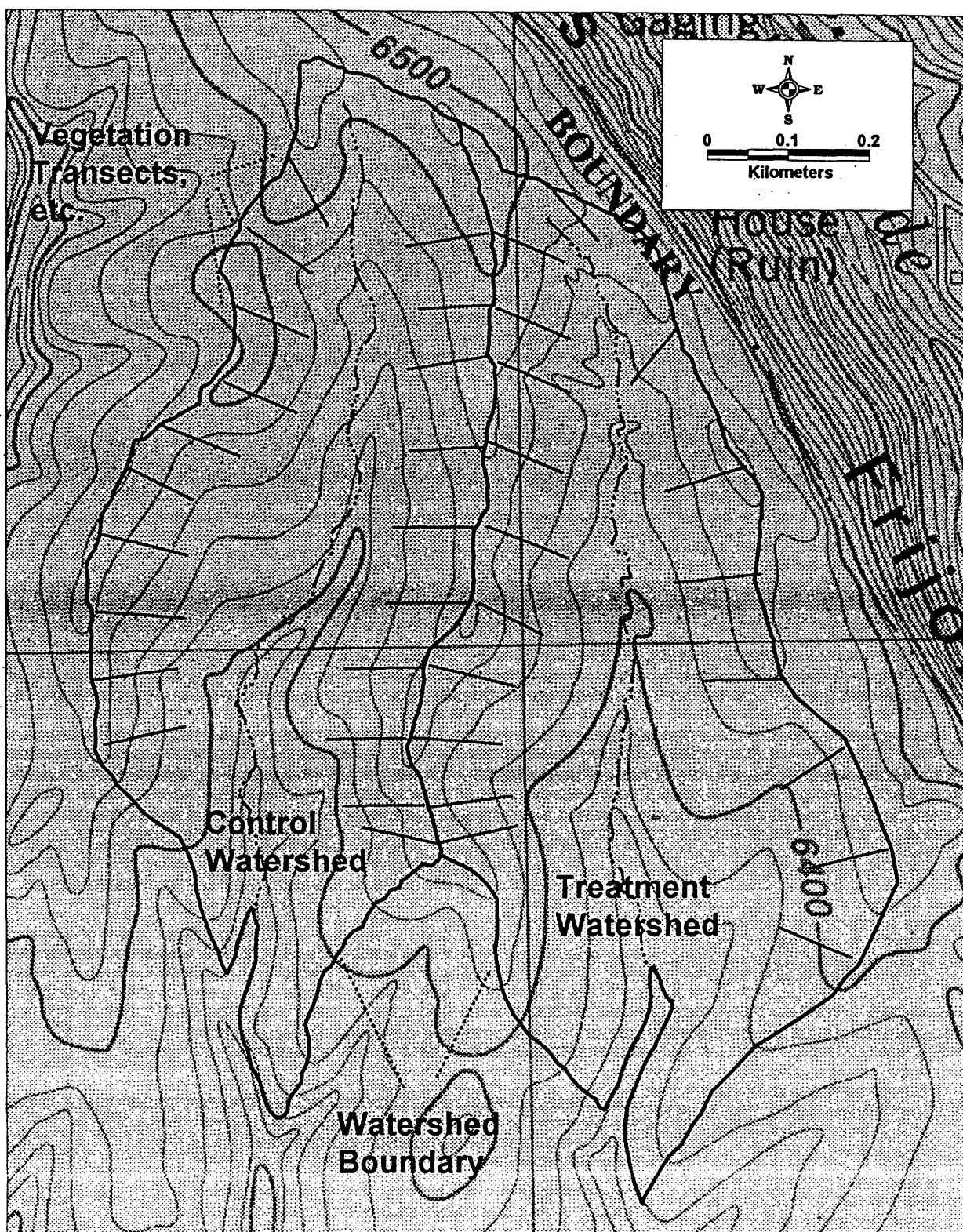


Figure 2. Approximate location of vegetation transects, and three to five meters off each transect, there will be associated arthropod pitfalls and soil sampling points.

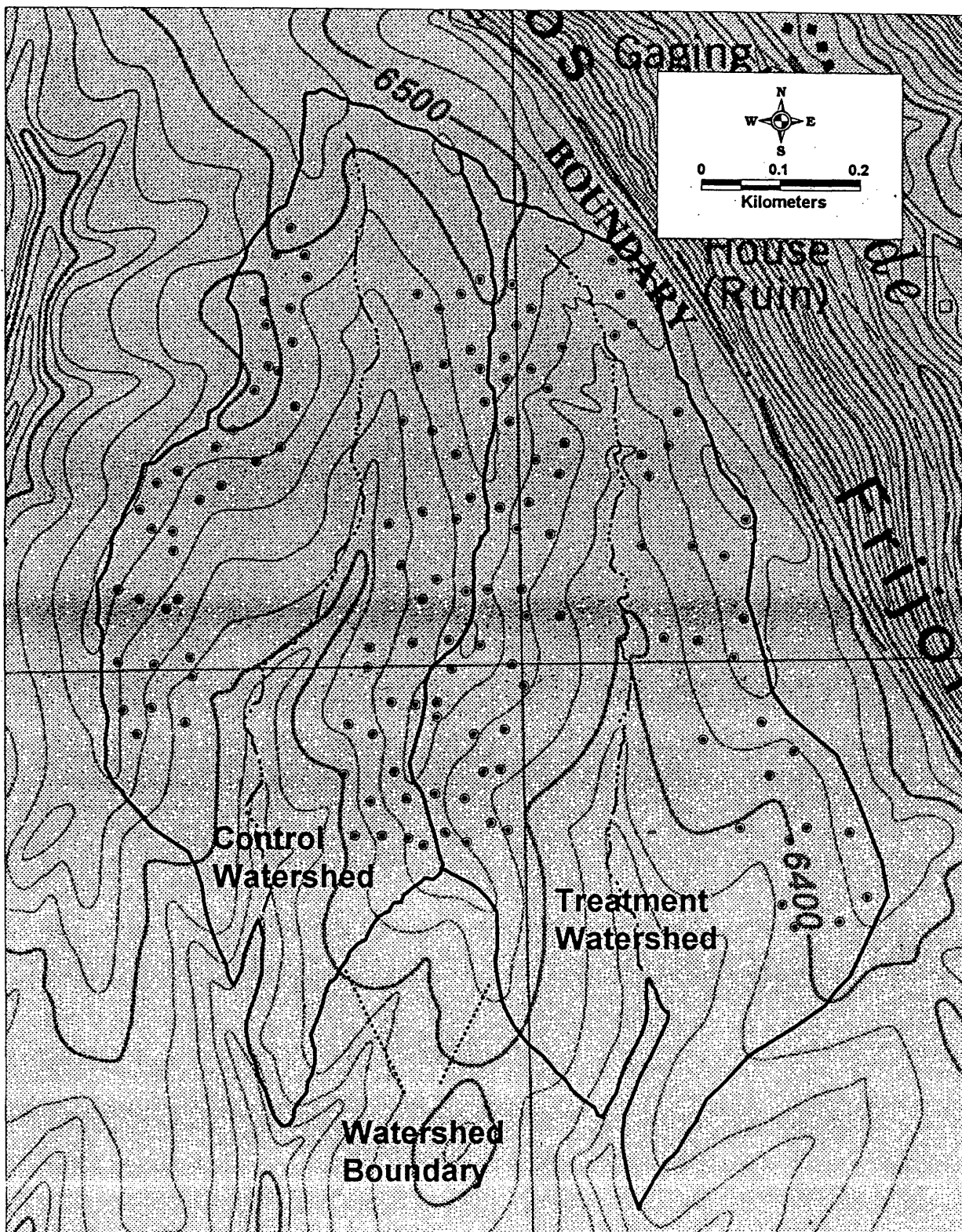


Figure 3. General location of soil erosion monitoring sites using soil erosion bridges.

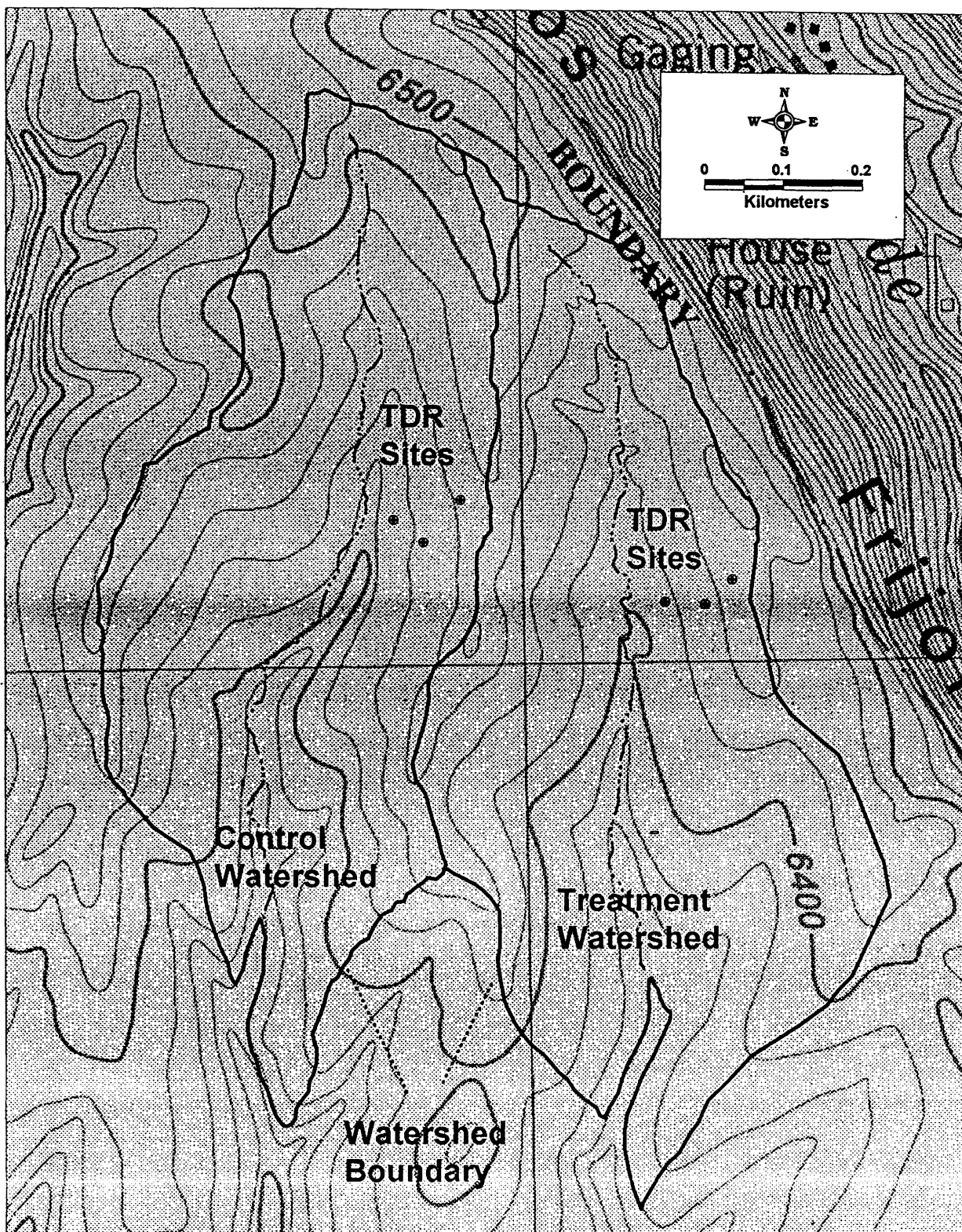


Figure 4. General location of soil moisture monitoring sites using Time-Domain Reflectometry (TDR). Three similar sites in each watershed will be selected.

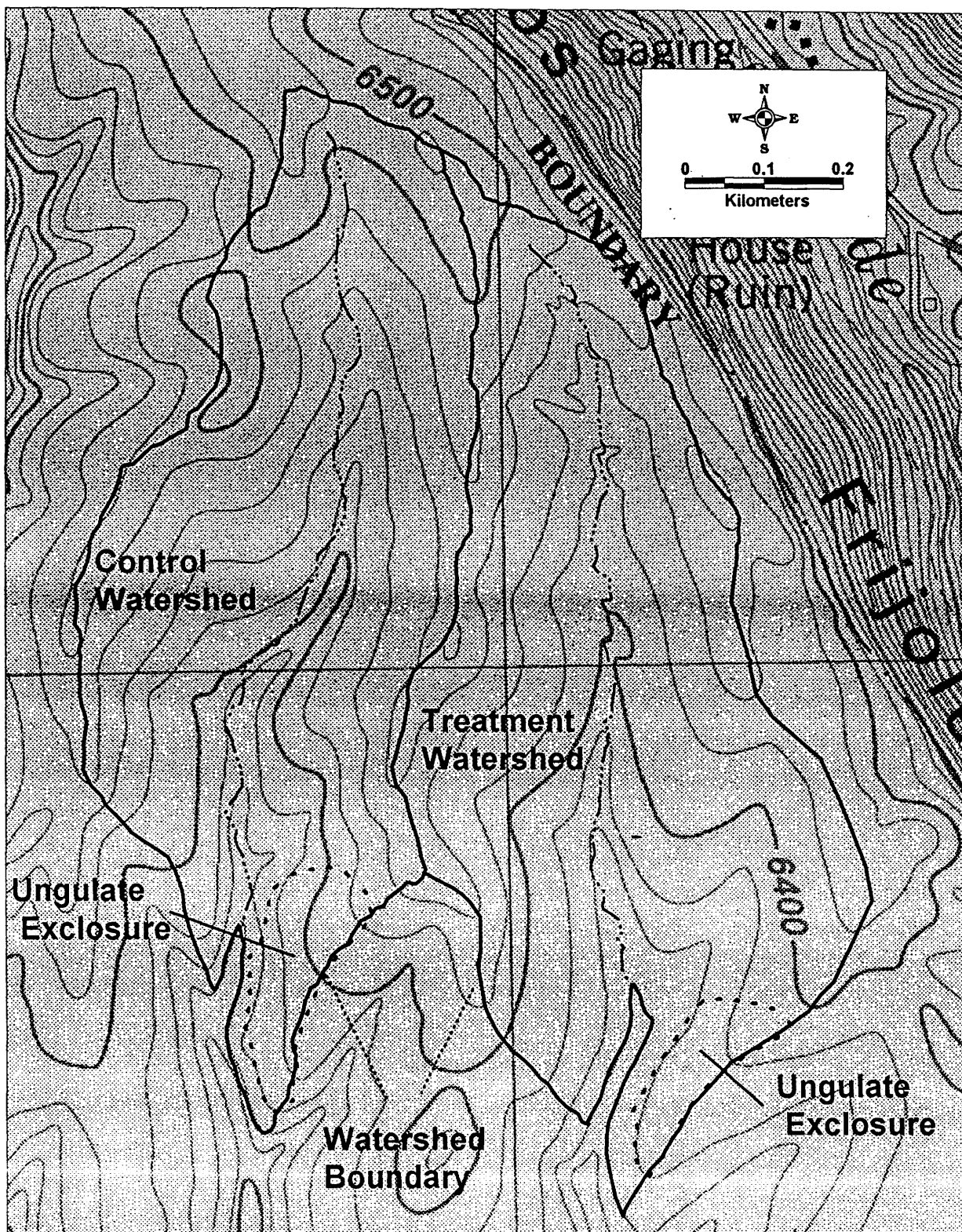


Figure 5. General location of 2 ha ungulate exclosures. One will be located in each watershed. The same variables being measured outside of the exclosures will be measures inside.

Affected Environment

Bandelier is located on the southern portion of the Pajarito Plateau in the Jemez Mountains at the southern edge of the Rocky Mountains in north central New Mexico. The area is composed of volcanic ash and lava flows that have been eroded into deep canyons. The park comprises 13,250 hectares (32,727 ac) and extends from the Rio Grande at 1,680 meters (5,300 ft) to the summit of Cerro Grande at 3,240 meters (10,200 ft) on the Jemez Caldera rim. The park's landforms and vegetation have been subjected to a variety of significant human influences, particularly grazing and fire suppression (Allen 1989).

Located on the eastern slopes of the Jemez Mountains, most of the park is on the Pajarito Plateau. The plateau slopes toward the Rio Grande and five canyons dissect the plateau in a northwest to southeast alignment. The five canyons support base flows originated from springs and seeps along the mountain/plateau interface.

The climate is semi-arid, the area receiving an average precipitation total of about 16 inches per year with 70% of the moisture occurring during the monsoons which typically arrive in July and run through August. The average temperature ranges from 29° to 82° F (Allen 1989).

The significance of Bandelier lies in its superb combination of cultural, natural, and Wilderness values. To recognize the Wilderness values, President Ford signed legislation in October, 1976, creating a 9,423 hectares (23,267 ac) Bandelier Wilderness (P.L. 94-567). Ninety percent of the park is managed as backcountry/wilderness and more than half of its trails (Frijoles Canyon and Bandelier Backcountry) are part of the National Trail System.

Native Americans are believed to have lived in the region for the past 10,000 years. However, the ruins noted in the enabling legislation were occupied by the Ancestral Puebloans between 1100 and 1600 A.D. The full extent of archeological resources is unknown. However, the Bandelier Archeological Survey of 1987-91 surveyed 43 percent of the park, recording over 1500 sites with an overall site density of one site per 2.7 hectares (6.8 ac). Such an abundance of archeological sites clearly indicates that despite previous excavation, the park still contains excellent resources for research into the lifestyle of the Ancestral Puebloans.

Nearly one-third of Bandelier National Monument is pinyon-juniper

woodland (dominated by Pinus edulis and Juniperus monosperma). Approximately sixty percent of the known Ancestral Puebloan prehistoric sites surveyed at Bandelier occur in pinyon-juniper woodlands. More than seventy-five percent of 1,500 Ancestral Puebloan sites, recently surveyed for erosional damage at Bandelier, have significant impacts. Pinyon-juniper woodlands have been harvested since prehistoric times for fuel-wood. In the last 150 years these areas have also been utilized for livestock grazing. Across most of Bandelier, fuel-wood harvesting has not been a factor in historic times, but intensive livestock grazing was pervasive until around 1940. Until the early-1980's a sizable feral burro population also roamed the southern portion of the park. Currently an large population of native ungulates (elk) wintering on parklands is thought to be impacting these degraded woodland areas.

Pinyon-juniper woodlands near park headquarters at Bandelier exhibit tree canopy coverages of 25 to 60%, herbaceous overstory coverages of 8 to 15% and exposed soil coverages of between 35 and 55%. Soil loss has been estimated at nearly one inch per decade; an unsustainable rate given shallow soil depths of one to three feet. Intensive characterization of erosional processes on a one hectare pinyon-juniper hillslope at Bandelier suggest soil losses of 25,000-50,000 kg over a two year period, most of it occurring during a few intense summer rain events during year 1 of the study (Wilcox et al., 1996).

Major Issues

ISSUES CONSIDERED FOR AFFECTS FROM ALTERNATIVE ACTIONS

CRITICAL ELEMENTS	AFFECTED	
	Yes	No
Air Quality		X
American Indian Religious Uses	X	
Cultural/Historical Resources	X	
Farmlands, Prime/Unique lands		X
Floodplains	X	
Hazardous Materials		X
Health and Safety	X	
T&E Species	X	
Vegetation and Soils	X	
Visitor Use/Education	X	
Water Quality	X	
Wetlands/Riparian Zones	X	
Wilderness/Scenic Values	X	
Wildlife	X	
Other Connected Actions	X	

ISSUES CONSIDERED IN DETAIL

*American Indian Religious Uses

*Cultural/ Historical Resources

(impacts from application of restoration treatments)

- physical effects
- aesthetic effects
- other considerations

*Floodplains

*Health and Safety

*T&E (Threatened and Endangered) Species

*Vegetation and Soils

- overstory thinning/ slash treatments
- soil surface preparation
- introduction of native seed materials
- miscellaneous impacts from data collection efforts

*Visitor Use/ Education

*Water Quality

*Wetlands/ Riparian Zones

*Wilderness

(impacts on wilderness values and visitor experience)

- aesthetic effects
- auditory effects
- other tangible effects

*Wildlife

*Other Connected Actions

(construction of greenhouse structure in residential area)

Environmental Consequences

NO ACTION (ALTERNATIVE 1)... SUMMARY ENVIRONMENTAL EFFECTS

AMERICAN INDIAN RELIGIOUS USES

-no change

CULTURAL RESOURCES

-incremental loss of cultural materials short-term (10-20 years) with ultimate wholesale loss of structures long-term (100-200 years)

FLOODPLAINS

-continued inputs of soil and sediment from eroding mesas into the Rio Grande/ Cochiti reservoir system

HEALTH AND SAFETY

-low infiltration rates in degraded pinyon-juniper systems and increasing expanses of bedrock will intensify flash flood events and pose increasing risks to the public

T&E SPECIES

-degradation of the system would result in reduced prey bases for listed species of concern

VEGETATION AND SOILS

-continued degradation of the plant and soil resources

VISITOR USE/EDUCATION

-lost opportunity to educate visitors about restoration of degraded parklands, otherwise no effect

WATER QUALITY

-water quality would continue to be negatively impacted by significant inputs of suspended and bed sediments into the riparian systems

WETLANDS/RIPARIAN ZONES

-poor upper watershed conditions would continue to generate high runoff into riparian areas

WILDERNESS/SCENIC VALUE

-accelerated erosional processes would ultimately convert much of the monument into bedrock badlands

WILDLIFE

-continued long-term degradation of pinyon-juniper habitat with unknown consequences on a variety of wildlife species

OTHER CONNECTED ACTIONS

-lost opportunity to procure a greenhouse structure in support of restoration and developed area landscape maintenance

PROPOSED ACTION (ALTERNATIVE 2)... SUMMARY ENVIRONMENTAL EFFECTS

AMERICAN INDIAN RELIGIOUS USES

-no restrictions on use anticipated

CULTURAL RESOURCES

-enhanced stability of cultural resources with mitigation of erosional processes

FLOODPLAINS

-probable reduction of soil and sediment transport into the Rio Grande/ Cochiti reservoir system

HEALTH AND SAFETY

-enhanced infiltration and retention of water and soil on site will reduce flash flood risks to the public

T&E SPECIES

-likely enhancement of prey base for listed species; noise degradation of TES habitat if treatment is applied during sensitive time frames

VEGETATION AND SOILS

-stabilization of eroding soils, increased soil moisture and recovery of the herbaceous community; reduction in woody overstory coverage

VISITOR USE/EDUCATION

-negative impacts during implementation of overstory treatment and increased use of trail through project area as a self-guiding interpretative walk

WATER QUALITY

-enhancement of water quality with reductions in suspended and bed sediments input to riparian systems

WETLANDS/RIPARIAN ZONES

-enhancement of upper watershed conditions by increasing infiltration and soil water storage and reducing magnitude of runoff into riparian areas

WILDERNESS/SCENIC VALUES

-short-term (1-5 years) negative changes in the aesthetic appearance of the treatment watershed from overstory reduction/ slash mulch treatment; temporary (1 month) noise impacts from chainsaw use will impair wilderness solitude; long-term (beginning year 2) improvements in herbaceous component with increased diversity and vigor of grasses and forbs

WILDLIFE

-likely enhancement of habitat and food base for many species through increased site productivity; destructive sampling of arthropods using pit traps

OTHER CONNECTED ACTIONS

-incremental addition to the negative viewshed impact of the mesa residential area on wilderness

ENVIRONMENTAL CONSEQUENCES OF PROPOSED ACTION

American Indian Religious Uses

No change in use of cultural sites by the indigenous people is anticipated as a result of restoration activities at the proposed site. Appropriate consultation will be conducted through the park Native American liaison.

Cultural/ Historical Resources

Consultation with the park archeologist, park Native American liaison, and the State Historic Preservation Office (SHPO) will be conducted if a review of the proposed project by the park archeologist suggests any likelihood of adverse effects on cultural resources. At a minimum, the SHPO will be notified of the proposed project and asked if they desire additional information or consultation.

***physical effects**

Application of the overstory thinning treatment using chainsaws could inadvertently damage prehistoric structural sites, if removal of trees on sites is not implemented carefully. Data collection efforts could potentially impact cultural resources if sample points were advertently placed on cultural sites.

To ensure overstory removal does not impact cultural sites, the park archeologist or designated representative will be present during removal of the vegetation canopy at archeological sites. No rocks will be moved in the process of cutting trees, all cuts will be made well above and away from structural rocks. Felled trees and logs will not be dragged across sites. Trunk sections will be carried off of structural sites to minimize heavy fuels.

All known cultural sites will be located, geo-referenced and minimally flagged prior to establishment of sampling points to ensure sample points are not inadvertently set up on top of cultural sites. Cultural sites will be minimally flagged, to reduce highlighting these sensitive resources, by using only a single piece of flagging attached to each site stake; all flagging will be removed promptly following pre-treatment data collection. In addition, any area suspected of having cultural significance will be avoided for the purpose of establishing sampling points, erosion bridges, collection of soil samples or placement of soil moisture probes. The exception to this is where sampling points are established specifically for the purpose of documenting vegetation cover and soil erosion on cultural sites proper. All work is being done in consultation with the park archeologist who will be contacted in the event established protocols for mitigation of cultural resource impacts are either unclear or inadequate.

The placement of aluminum stakes to mark transect ends in vicinity of cultural sites will be located so that the end points are well off the structural portion of the site and near the outer margin of any observed surface artifact scatter. Erosion pins used on cultural sites will be only six inches in length and will gently inserted to avoid impacts to any sub-surface features. It is important to collect representative quantitative data from cultural sites in order to definitively link response of the treated watershed with effects on cultural resources.

***visual effects**

Application of the overstory thinning treatment may make some structural sites more visible to the visiting public; they will also change the general look of the landscape in which they are located. However the current look of the Bandelier landscape has been influenced by historic landuse practices resulting in significant tree invasion during the last 150 years. It is expected the restored cultural landscape will be more pleasing visually than the existing degraded landscape, based on observations of other restored sites.

***philosophical considerations**

The appearance of pinyon-juniper communities today is likely very different than in the last 1000 years. Significant numbers of trees have established in the last 150 years, transforming a fire dependent savanna system into a woodland. Prior to, and during, occupation of pre-historic cultural sites, it is thought that the pinyon-juniper community was a savanna system with fewer, larger and more widely spaced trees. A natural fire regime prior to occupation as well as fire-ignition and fuel-wooding by pre-historic peoples, likely maintained this savanna system.

The current accelerated levels of erosion in degraded pinyon-juniper communities are unprecedented in historic times. Successful restoration efforts will help to stabilize this landscape by mitigating catastrophic erosional processes. Normal erosional and weathering processes will continue to be a part of the restored system in which cultural sites are embedded.

Floodplains

Restoration treatment of this study site could reduce the amount of sediment input to Cochiti Reservoir, but is unlikely to influence delta formation at the head of the permanent floodpool. Any changes in sediment contribution from this study site to the reservoir system are likely insignificant relative to total sediment input.

Health and Safety

Restoration treatment will improve upper watershed conditions by allowing more rain water to be captured on site thus moderating runoff to downstream areas and reducing potential flood hazard risks to backcountry users.

TES (Threatened and Endangered Species)

The proposed project area within Bandelier National Monument is adjacent to TES species habitat. Application of the overstory thinning treatment, using chainsaws, could produce enough noise to temporarily degrade TES habitat if the thinning treatment was done during sensitive time periods and in portions of the treatment watershed immediately adjacent to Frijoles Canyon. Informal consultation (and preparation of a biological assessment), between the park and the U.S. Fish and Wildlife Service, will be necessary if overstory treatment is applied during sensitive time frames (March 1st thru August 15th). Any overstory treatment applied between August 15th and March 1st will have 'no affect' and consultation will not be required.

It is proposed to treat a narrow strip of land along the rim of Frijoles Canyon prior to March 1st, the remainder of the watershed will then be treated after March 1st with a 'not likely to adversely impact' conclusion. Detailed information on T&E species of concern (i.e. biological assessment) is not presented here for protection of the listed species.

Vegetation and Soils

***overstory thinning/ slash mulching treatments**

An early spring overstory reduction timeframe is planned, with the exception noted under **TES SPECIES**. With a spring overstory treatment the green foliage can last long enough to provide critical shading and erosion control to exposed bare soil sites throughout the first post-treatment summer season. By the end of the second growing season significant herbaceous plant establishment occurs; the cured foliage which falls on the soil surface initially provides a mulching effect (moderating soil moisture and temperature) and subsequently breaks down to enhance the nutrient and organic content of the soil.

The proposed restoration treatments will modify the plant community in a manner similar to the application of prescribed fire. Mechanical thinning of the woody overstory (i.e. restoration) is comparable to the stand-thinning effects of fire; both make limited water and nutrient resources more available to the herbaceous (grass and forb) plants. Results from ongoing studies at Bandelier document a seven-fold increase in herbaceous cover after two growing seasons post-treatment. Preliminary soil moisture measurements show significant differences between treatment and control areas suggesting treated areas capture and retain more precipitation than untreated areas. These data suggest that woody overstory thinning can reduce competition for limited water and nutrient resources. In addition, slash mulch can provide a much needed protective layer over exposed soils which reduces runoff, sediment transport, and siltation while increasing infiltration, moderating soil temperature and soil moisture, redistributing soil nutrients, and providing some

protection from grazing. Combined, these treatment effects can create favorable microsites for herbaceous plant establishment and growth.

***soil surface preparation**

Successful broadcast application of native seed on exposed soil areas necessitates a soil surface preparation of light raking in order to incorporate seed into the top one-quarter to one-half inch of soil. Exposed seed that is not incorporated into the soil is either lost to predation or mortality based on results from previous experiments (Jacobs, 1995).

***introduction of native seed materials**

Locally native seed material (i.e. with origins in Bandelier and grown by the Natural Resource Conservation Service in Los Lunas, New Mexico) will be used to supplement depleted soil seed bank reserves of exposed soil areas and enhance the herbaceous response to overstory thinning. Native seed material will be applied to the treatment watershed using a raking treatment to ensure good soil-seed contact.

The addition of seed material promotes a more rapid establishment of the grass component, since assessments of existing soil seed bank reserves on degraded pinyon-juniper sites indicate the near absence of viable grass propagules. Although the seed to be applied is grown and cleaned to certified seed standards, and subsequently tested for weed content prior to application, a small percentage of weed and other crop seeds may be introduced as a result of seeding efforts. It is unlikely any weeds accidentally introduced will persist for long or inhibit the establishment of native perennials, since most are either annuals and/ or require agricultural conditions. No weeds which could be attributed to seeding efforts have been detected in ongoing studies.

***miscellaneous impacts from data collection efforts**

Data collection activities (placement of metal sample point stakes, collection of soil samples for analysis and mapping, excavation of pits for arthropod pitfall traps and soil characterization, etc.) are essential components of the proposed project, providing the scientific basis necessary to document community response to restoration treatment. Vegetation and soils information will be essential for interpreting how the whole system responds to restoration treatment, discerning differential restoration responses across the treatment watershed, and extrapolating final results to other similarly degraded sites within Bandelier. All materials for the experiment will be hauled either by person or pack stock. All pack stock will be required to stay on official park trails. The impacts from these activities to soil and vegetation resources will be minimal. All materials brought onsite for the purposes of data collection activities will remain in place for the

planned three year duration of the project. After the conclusion of the initial three year project, the park will select a subset of the original sampling design to maintain for long-term monitoring purposes; all other materials will be removed at that time. Long-term monitoring of this restoration site is an essential safe-guard in the event longer term processes, not apparent during the initial three year project, come into play and require some adjustment in restoration protocol.

Visitor Use/ Education

Normal visitor use of the project area will likely be affected by restoration activities, since a maintained trail, with moderate to low use, traverses the control and treatment watersheds. Noise from chainsaws, rakes, other handtools, and workers will be an adverse affect during data collection and treatment periods. The slash and stumps resulting from overstory reduction could be viewed as a serious aesthetic impact by some visitors.

The park trail will remain open throughout the study and will provide opportunities to experience degraded and restored landscapes. Visitors will be discouraged from leaving the trail in the immediate study area, since impacts to vegetation, sample points and equipment could potentially result.

Restoration projects at the watershed level are necessary to properly evaluate the feasibility for large scale recovery of degraded pinyon-juniper woodland systems. From an interpretive viewpoint, this project enables the park to educate the public about the potential for restoration of degraded lands. Since overstory reduction in a wilderness setting may be misconstrued, it is important for park visitors to understand the necessity for stabilizing Bandelier's degraded pinyon-juniper woodlands in order to protect threatened cultural resources. A self-guiding interpretative trail guide will be developed to allow visitors to view the restoration project area.

Water Quality

Water quality will improve because surface runoff will be moderated by an herbaceous cover, likely reducing the suspended sediment load. Increased infiltration of rainwater on site will provide opportunities for water to be cleaned while slowly percolating through soil and rock layers.

Wetlands/ Riparian Zones

Restoration treatment should enhance upper watershed conditions by increasing infiltration and soil water storage while simultaneously reducing the magnitude of silt laden runoff into riparian areas.

Wilderness

***aesthetic impacts**

The proposed restoration treatments will alter the character and feel of the current wilderness landscape. Overstory reduction will present the appearance of a fuel-wooding operation and will leave cut logs, slash and stumps on site. Construction of two ungulate exclosures will impose human structures in a wilderness setting. Placement of metal sampling points and use of other data collection equipment (i.e. for measurement of soil erosion and soil moisture) in the wilderness will impact aesthetic values.

The negative aesthetic effects of restoration treatment (i.e. cut trees and slash) treatments are relatively short-lived (i.e. 5-10 years), whereas the long-term benefits to the health and stability of the ecosystem are enormous. In addition to overstory removal impacts on aesthetic values, construction of an ungulate exclosure and installation of data sampling points in each of the two watersheds will be an additional visual impact and human intrusion in the Bandelier wilderness.

The ungulate exclosure will be dismantled and all materials removed from the wilderness at the conclusion of the project or when no longer needed in support of restoration activities. Ungulate exclosures, metal sampling stakes and other equipment used in conjunction with the study will be placed so as to minimize visibility from the official park trail.

Data collection efforts require placement of metal stakes, soil moisture probes, collection of soil samples and construction of ungulate exclosures. Data collection activities are an essential component of the proposed project, providing the scientific basis necessary to evaluate the success of restoration treatment and assess ecosystem response. Placement of sampling stakes and establishment of various research projects in the Bandelier backcountry has created an cumulative aesthetic issue. In response, the park has severely restricted casual placement of metal stakes in the backcountry, requiring all proposed research and collecting efforts to be reviewed through natural and cultural compliance procedures as well as comply with newly revised guidelines for research and collecting at Bandelier.

***disruption of solitude**

Chainsaw use will create unavoidable impacts on visitor use and wilderness values, but the timing and duration of overstory treatment has been designed to minimize these impacts. The noise will be noticeable to hikers walking through the study area on established park trails and may also be heard by hikers along the Falls trail when treatment is applied on the immediately adjacent mesa top. The total duration of chainsaw work is expected to be approximately one month with a four to six person crew.

Chainsaws were determined to be the minimum tool after consideration of 1) relative noise impacts on visitors and T&E species, 2) the feasibility and safety of using manual tools to implement overstory thinning treatment, and 3) the additional time required if manual tools (i.e. axes and hand saws) were used. Chainsaws come equipped with mufflers to suppress noise; additional noise suppression in forestry grade saws is not possible without significant loss in power.

Noise from use of chainsaws could disturb park visitors who are walking through the study site when overstory treatment is being applied. However, the impacts will be limited in duration and visitors can choose not to hike along the trail in question during the one month treatment is being applied. The visitor center will be notified of the overstory treatment schedule so that backcountry users can be notified.

In terms of noise impacts to visitor use along the Falls Trail, only the narrow strip of the treatment watershed adjacent to Frijoles Canyon is expected to generate noise of any concern; treatment of this portion of the watershed is estimated to require approximately three work days.

Visitor use of the backcountry trail segment which passes through the study area is relatively low year round, based on observations of park staff (no statistics available); visitors with concerns about the noise can choose to avoid the area for the duration of the overstory treatment (approximately one month).

Issues of practicality and safety are major considerations in the decision to use chainsaws for implementation of the overstory treatment. One-seed juniper is difficult to cut efficiently or safely using hand tools both because its growth form is very irregular and brushy, being multi-stemmed from the base, and because the wood is relatively sappy and hard. In addition, it will be impossible to flush cut stumps close to the ground and minimize the aesthetic impacts of tree removal. Finally, the use of manual tools will at least double the time that will be required to implement overstory thinning.

***philosophical considerations**

Some may feel that any intervention in a wilderness setting is unwarranted, since these areas were presumably set aside to be left alone by human intervention. Unfortunately, many areas set aside as wilderness were seriously impaired by historical land uses prior to legislative protection. Left alone, many degraded areas will not heal themselves. This appears to be the case with degraded pinyon-juniper woodlands at Bandelier. Accelerated erosional processes, if left unchecked, are expected to transform Bandelier into bedrock badlands with 100 years. NPS policy and guidelines directs park managers to restore degraded lands where

appropriate and in a manner consistent with other applicable laws and regulations.

Wildlife

Wildlife habitat and food base for a variety of species should be improved in and around restored areas with increased productivity of the herbaceous community, however little information is available to detail expected responses from individual species. A few species preferring dense, closed woodland stands of pinyon-juniper or exposed soil conditions may be negatively impacted by restoration of the treatment watershed. However, the treatment watershed will only constitute a very limited opening in a wide expanse of degraded woodland area. In order to gain more detailed information on the response of individual species, the restoration demonstration project will document the effect of restoration treatments on bird and arthropod abundance and diversity. In addition ungulate utilization of control and treatment sites will be compared using pellet count and vegetation biomass measures inside and outside of exclosures. Birds will be sampled using an avian point count method. Arthropods will be destructively sampled using pit traps with non-toxic propylene-glycol as a collection trap medium. Propylene-glycol may be slightly attractive to browsing mammals such as deer, but Material Safety Data Sheet information indicates the product has low toxicity to a range of species tested. Traps will be fitted with a camouflage cover to discourage accidental discovery and consumption of the propylene-glycol by wildlife.

Other Connected Actions

***Construction of a small greenhouse structure in the developed mesa residential area**

The restoration program at Bandelier requires a small greenhouse structure for conducting germination, soil seedbank and related experiments pertinent to restoration efforts. In addition, the greenhouse will be available for other experimental research proposed in the future. The park also has an immediate need for small scale production of native, containerized plant materials, to be used in residential and developed site landscaping efforts (i.e. concession gardens).

The greenhouse structure is reflective and will be an incremental addition to the cumulative impact of the residential area on park resources (i.e. wilderness viewshed and cultural landscape). Some negative effects on park residents might also occur if potential increases in traffic or noise in the residential area are not properly mitigated. To minimize use of the fan for summer cooling, automatic ceiling vents will be used. Heating, cooling and watering will all be automated so as to minimize the need for frequent visits during the day by staff.

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