

DEVELOPMENT OF NATIVE PLANT MATERIALS AND RESTORATION METHODS TO  
MITIGATE ACCELERATED SOIL EROSION IN THE PINYON-JUNIPER WOODLANDS  
OF BANDELIER NATIONAL MONUMENT

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INTRODUCTION

Piñon-juniper woodlands cover 19,000,000 hectares in the western United States. The initiation of intensive grazing by domestic livestock in the late 1800's led to extensive changes in ecosystem structure and function in these piñon-juniper woodlands of the Southwestern United States (Leopold 1924, West and Van Pelt 1987, Evans 1988, Allen 1989). Herbaceous ground cover and litter were greatly reduced, exposing increasing areas of bare soil which led to decreases in infiltration and increases in surface runoff from the typically intense, local, summer rainfall events. Thresholds were exceeded, triggering major increases in soil erosion. The reductions in grassy understories led to widespread establishment of piñon and juniper trees in former savannas and grasslands, due to decreased herbaceous competition with tree seedlings and reductions in fire frequencies. Piñon and juniper trees now dominate dense woodlands, preventing herbaceous plant re-establishment even after the removal of domestic livestock through control of site resources (and possibly allelopaths). In essence, a positive feedback cycle has been established over millions of hectares of piñon-juniper woodlands in which accelerated soil erosion and tree dominance work to keep tree interspaces largely barren and subject to further erosion.

The piñon-juniper ecosystems which cover 40% of Bandelier National Monument are representative of much of the Southwest as they display the disrupted native plant communities and accelerated soil erosion described above (Allen 1989). A soil survey of the affected piñon-juniper woodland portions of the park estimated soil erosion rates of 0.53 cm/year, or 79.3 megagrams/ha/year (35.7 tons/acre/year) (Earth Environmental Consultants 1978). Given total soil depths to bedrock ranging from 15 cm to 1 meter, the extrapolated erosion rate of 53 cm/100 years reflects the clearly unsustainable soil loss observed throughout most of this ecosystem type. In addition, the situation at Bandelier is complicated by the presence of 3000-4000 archeological sites, mostly located on piñon-juniper sites; an ongoing survey has found that over 75% of 1600 inventoried archeological sites are being damaged by erosion (Orcutt 1990). This pre-proposal outlines an approach to develop means to mitigate this serious natural and cultural resource problem which would be widely applicable in the West.

OBJECTIVES

The specific objectives of this project are to:

- 1) Develop plant materials and treatment methods to reduce the extensive sheet and gully erosion observed in Bandelier's piñon-juniper ecosystems;

- 2) Document the rates of ongoing soil erosion and patterns of historic and ongoing vegetation change in Bandelier's piñon-juniper ecosystems; and
- 3) Determine the role of various factors, including tree competition, native ungulate grazing, rainfall induced soil erosion, and frost heaving, on the maintenance of depleted herbaceous understories and bare soil surfaces in these woodlands.

#### WORK PLAN

Work plans are outlined below for two scenarios: **Level A**, the minimal level needed to continue the development of native plant materials from BAND (which only addresses portions of Objective 1); and **Level B**, a higher level which addresses all three of the objectives outlined above.

#### LEVEL A:

##### Year 1:

Continue the maintenance and evaluation of the Frijoles Mesa plant materials evaluation plot, in cooperation with the SCS Plant Materials Center at Los Lunas, NM.

##### Year 2:

Continue the maintenance and evaluation of the Frijoles Mesa plant materials evaluation plot. Begin to increase accessions which display desirable establishment characteristics.

##### Year 3:

Finish the evaluation of the Frijoles Mesa plant materials evaluation plot. Further increase accessions which display desirable establishment characteristics.

##### Year 4:

Increase the accessions which displayed desirable establishment characteristics. Institutionalize the development of a reliable source of these developed plant materials for revegetation use at BAND.

#### LEVEL B:

##### Year 1:

##### Objective 1:

**Activity 1)** Establish a number of experimental plots to test the effects of multiple combinations of treatments upon the establishment success of herbaceous plants. This work would largely be done through collaboration with the Soil Conservation Service Plant Materials Center in Los Lunas, New Mexico by extension of an existing memorandum of understanding). Treatments to be tested include combinations of: a) different types and degrees of mulching; b) varied species and genotype mixes of seeded planted materials; c) timing of seeding; d) reduction of overstory tree density by

cutting/prescribed burning/herbicide (pelletized tebuthiuron is suggested, as extensive testing of this herbicide for this purpose shows minimal environmental impacts [Whisenant and Clary 1987]); e) the effects of spatial pattern of treatments on erosion in micro-watersheds and on archeological sites; f) methods of seed application (e.g., broadcast, raked in, pelletized); and g) application of low dosages of selected plant nutrients ("fertilizers"). Treatments combinations would be tested at the wet and dry ends of the piñon-juniper zone, on two soil types, and on two slope classes (<10% and 10-40% slopes).

**Activity 2)** Continue ongoing development of native plant genotypes with desirable establishment characteristics in collaboration with the Soil Conservation Service (SCS) Plant Materials Center as outlined under Level A above.

#### Objective 2:

**Activity 1)** Establish transects to measure soil erosion, using simple, accurate, "erosion bridge" technology (requires a long level and rebar).

**Activity 2)** Collect age-structure data for piñon-juniper woodlands, to assess patterns of tree establishment, by ring counts of increment cores taken from sampled trees.

**Activity 3)** Determine changes in herbaceous plant density and species composition by collecting data along previously established permanent line transects; also establish additional permanent line transect sampling locations.

**Activity 4)** Further determine vegetation change by comparison of new and old photographs from previously emplaced, permanent photo points, and from historic photographs (such as the photos taken by Adolph Bandelier in the 1880's which were recently rediscovered).

#### Objective 3:

**Activity 1)** Initiate surveys of grazing utilization on understory plants.

**Activity 2)** Analyze the data collected in #'s 1 and 3 above to assess the effects of soil conditions and overstory density on herbaceous seedling establishment in unmanaged conditions.

**Activity 3)** Initiate a number of experimental plots to test the effects of differing tree densities and soil surface conditions on herbaceous plant establishment (to be done as part of objective 1, #1 - see above).

#### **Year 2**

The second year would collect additional data on each of the specific activities initiated the first year (listed above).

#### **Year 3**

In the third year data collection on the activities listed under Objective 2 would cease, and data analysis/interpretation and writeup of results would occur in order to complete the

project by the end of the third year. The activities under Objective 3 would continue through the third year, with data collection and analysis occurring concurrently in order to complete the project on time.

#### Year 4

The development of native plant materials would be completed in the fourth year.

The activities outlined in Objective 1 would be accomplished in collaboration with the SCS Plant Materials Center in Los Lunas, which specializes in the development of improved genotypes of native plants and establishment techniques for conservation purposes. Bandelier has had a memorandum of understanding with this Plant Materials Center since 1988, under which the development of native plant genotypes with desirable establishment characteristics has begun (Objective 1, Activity 2).

The activities outlined in Objectives 2 and 3 above would be accomplished by funding a graduate student thesis project, or by hiring a seasonal biotechnician. Contacts exist with appropriate faculty at the University of New Mexico, New Mexico State University, and Utah State University which would likely lead to the recruitment of an appropriate graduate student if funding becomes available; this is the preferred option as the quality, amount, and timing of resultant work are likely to be favorable.

#### PROPOSED BUDGET

##### Level A:

The proposed budget for the minimal development of native plant materials is: Year 1 - \$5000; Year 2 - \$7000; Year 3 - 8,000; and Year 4 - \$5000. The total cost of Level A work is estimated to be \$25,000 (see Table 1).

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Table 1: Level A, Projected Cost (X \$1000) for each Activity

| <u>OBJECTIVE:ACTIVITY</u> | <u>YEAR 1</u> | <u>YEAR 2</u> | <u>YEAR 3</u> | <u>YEAR 4</u> |
|---------------------------|---------------|---------------|---------------|---------------|
| 1: 2                      | 5             | 7             | 8             | 5             |

Total Cost = \$25,000  
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##### Level B:

The activities outlined under Objective 1 would be achieved through work performed by the SCS Plant Materials Center. Funding would be provided to the Plant Materials Center through extension of an existing memorandum of understanding between Bandelier and the Plant Materials Center. The estimated cost of Activity #1 is: year 1, \$15,000; year 2, \$5000; and year 3, \$5000 (total cost = \$25,000). The estimated cost of Activity #2 is outlined under Level A above, or \$25,000 total over 4 years.

Two potential scenarios of equal cost are outlined to achieve

Objectives 2 and 3. The first scenario involves funding a graduate student at a cost of \$10,000/year for 3 years (total cost = \$30,000), which would include data analysis and writeup of the results. The second scenario would hire a seasonal GS-7 biotechnician for three years at a cost of \$10,000/year (total cost = \$30,000); data analysis and writeup of results would be done by Bandelier's ecologist.

Thus, the total, three-year cost for the entire Level B project (Objectives 1, 2, and 3) is estimated at \$80,000 (see Table 2).

The salary of Bandelier's ecologist for time spent on project oversight, data analysis, and writeup will be contributed as cost-sharing by the park.

Table 2: Level B, Projected Cost (X \$1000) for each Activity:

| OBJECTIVE:ACTIVITY | YEAR 1 | YEAR 2 | YEAR 3 | YEAR 4 | TOTAL                 |
|--------------------|--------|--------|--------|--------|-----------------------|
| 1: 1               | 15     | 5      | 5      |        | 25                    |
| 1: 2               | 5      | 7      | 8      | 5      | 25                    |
| 2: 1-4             | 10     | 10     | 10     |        | 30                    |
| 3: 1-3             |        |        |        |        | ---                   |
|                    |        |        |        |        | Total Cost = \$80,000 |

#### PROJECT PRODUCTS

Under both Level A and Level B substantial quantities of seed would become available by the end of the project for a variety of uses from the development of selected native plant genotypes. Under Level B computerized databases would be assembled to store project data. Level B project products would include a final report for each of the three objectives outlined above, with detailed sections covering each of the nine activities.

In addition, the development of extensive collaborative activities with the SCS Plant Materials Center will facilitate additional cooperative projects with other NPS units in the region and may serve as a model for collaborative efforts with other Plant Material Centers on similar problems Servicewide.

#### PRINCIPAL PROJECT MANAGERS

This project would have two principal project managers, Dr. Craig D. Allen, Ecologist at Bandelier, and Dr. James F. Henson, Agronomist at the Los Lunas Plant Materials Center.

PJ Request (5/18/92)  
w/ Rocky

|      |    |    |    |   |
|------|----|----|----|---|
| Year | 1  | 2  | 3  | 4 |
| Amt  | 30 | 30 | 15 | 5 |

↓  
\$10 - Rocky  
5 - Green  
5 - Sec

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