A FLORA of BANDELIER NATIONAL MONUMENT

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PART II: VASCULAR PLANT COLLECTIONS

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Natural resource ranger, Ken Stephens, was essential to the successful outcome of this project. He provided encouragement and assistance throughout, and was instrumental in gaining the necessary funding for this study. His efforts enabled the researcher to concentrate on the research, and likewise provided the monument with a better product.

Budget clerk, Elaine Jacobs took a deep interest in the project and volunteered her time, over a three year period, to ensure that the research not only got done, but was done well.

SUMMARY

During the course of a two year study over 1600 specimens were collected, some 1200 of which were deposited at the Bandelier herbarium. The remaining 400, as well as over 600 duplicate collections were deposited at the Duke University herbarium. In addition, the existing Bandelier plant collection of some 600 specimens was annotated. All of the specimen label data, over 2200 individual records, was entered to the Natural Resource Management Plant Database (Bandflor.dbf) on DBASE III PLUS software. Data for specimens in the Bandelier herbarium was also converted to the NPS Museum Cataloging System/ANCS (Nhdata.dbf) on modified DBASE III PLUS software, using a program written by park volunteer Steve Bracker.

The present study has produced the first comprehensive listing of vascular plants for the monument. This listing is fully documented by the plant collection at Bandelier and includes 748 taxa, 720 species, 347 genera and 86 families. The known documented plant life for the monument has been more than doubled as a result of this study and many new records have been added to the Jemez Mountain region as well.

1988 Collections

Collecting for the 1988 field season focused primarily on the southern half of the monument. Over 600 collections were made and approximately 400 of these were added to the Bandelier herbarium. The 1988 collections are listed chronologically in the APPENDIX.

PREFACE

Dedication to Chester Arthur Thomas

To the spirit of Chester Arthur Thomas, an early custodian of Bandelier National Monument, who took an active interest in the natural history of the monument and who helped begin the effort to document the plants of Bandelier. He understood that the lands managed by the National Park Service, could not be preserved unimpaired for future generations nor interpreted in a professional manner without the foundation of baseline natural history data. His eloquent memoranda, scattered in various archival files, outlines a National Park Service philosophy so cognizant of the delicate balance between natural resource integrity and public access that one wonders why, nearly 50 years later, we still have only a fragmentary knowledge of the natural history of our parks and monuments. May the spirit of Chester Arthur Thomas prevail in the hearts and minds of those who manage our precious public lands.

Baseline Natural History Data: Nature, Purpose & Scope

Baseline natural history data documents the physical park environment at the time the data are collected and serves as a benchmark against which to measure change over time . In the present study, data were collected to document the vascular plant life of Bandelier National Monument. Park managers need accurate baseline data in order to fully understand, professionally interpret, and properly manage park resources. The collection of baseline natural history data requires long range planning by the National Park Service, where priorities and standards are set, financial committments are made, and qualified personnel are recruited. Beyond the collection of baseline data, the park staff should consult these data whenever appropriate in forming policy alternatives.

The Flora of Bandelier Project: a perspective

The Bandelier Flora project could be considered a model for plant inventory work in the National Parks. The study generated: plants collections in excess of 1600 specimens; an herbarium collection of over 1200 sheets representing nearly 750 taxa; a duplicate collection of over 1000 specimens housed at the Duke University herbarium, a computer database recording label data for 2200 unique plant collections; and an annotated checklist of vascular plants known to occur within or immediately adjacent to the monument. Nearly 40,000 acres of rugged park and adjacent lands were collected over two field seasons at a cost to the monument of just over $20,000.00.

JUSTIFICATION

Bandelier National Monument samples a unique elevational transect of the volcanic Jemez Mountains in northcentral New Mexico. The vegetation along this transect has been influenced by a variety of historic disturbances, including periodic fire, prehistoric agriculture and overgrazing by ferral burros. As New Mexico's population continues to grow, new disturbances will result. An increase in visitation to the monument, both as foot traffic in the backcountry and as vehicular traffic in Frijoles Canyon, can be expected with a high potential for detrimental effects on plant life. Developments outside the park such as Cochiti Lake can impact plant life within the monument as well. In order to adequately protect plant life within the monument from a variety of disturbances, it is necessary to first establish a documented record of what species occur, where, and in what abundance. With a good baseline of floristic data it is possible to track the immigration of an exotic species into the monument as well as to monitor populations of native species which have been adversely affected by some change in the monument's environment. This sort of information can signal the need and provide the justification for quantitative studies of an ecological nature. Habitat preferences, distribution, frequency, and phenology of rare and exotic plants, as well as of sensitive, poisonous, edible, medicinal, forage, cover or economic plants, are the sorts of information which can potentially be extracted from a good plant collection .

GEOGRAPHY

Bandelier National Monument is located in north central New Mexico, approximately 10 miles southwest of Los Alamos and 50 miles northwest of Santa Fe. Within its boundaries are some 32,000 acres of rugged canyons, mesas, and mountain slopes. Extending from the banks of the Rio Grande at 5300 ft. to the summit of Cerro Grande at 10,199, the monument samples a nearly complete transect of the volcanic Jemez Mountains.

Geology

Cerro Grande, a volcanic dome of the Tschicoma formation, lies on the southeastern perimeter of the Valle Grande. This mountain, along with many in the Jemez Mountains, was formed prior to several major volcanic eruptions in the Jemez Mountains, although additional volcanic domes have formed subsequently. At least two of the eruptions formed calderas that appear today in the heart of the Jemez as broad green valleys and prompted their first discoverers to name these mountains the Sierras de los Valles. The younger, larger caldera, Valle Grande, truncates the older, smaller caldera, Valle Toledo. Below Cerro Grande,

pyroclastic ash flow deposits of Bandelier Tuff spread out in a southeasterly direction toward the Rio Grande and are measured in thicknesses of up to 1000 ft. Near the Rio Grande, the Tuff overlies Cerros del Rio Basalts. The eastern fan of the Bandelier Tuff is referred to as the Pajarito Plateau. Much of Bandelier National Monument is located on this plateau.

Streams have formed deep erosional canyons in the Bandelier Tuff. These canyons from north to south are: Frijoles, Lummis, Alamo, Hondo, Capulin, Medio, and Sanchez. In the upper reaches of the first five canyons, erosion has exposed andesites of the Paliza Canyon Formation. These andesites are also exposed in the middle portions of Medio and Sanchez canyons. Cerros del Rio basalts are exposed in most of the canyons near the Rio Grande. In the lower part of Capulin, sediments of the Santa Fe Formation are exposed.

Soils

The soils appear quite variable depending on the substrate, elevation, rainfall, vegetation and land use patterns. While the mesa tops have been farmed in prehistoric and historic times, their major attribute appears to be topographic.

Climate

Climate is very localized within the monument depending on elevation , topographic aspect and vegetation type. Precipitation averages 16 inches a year near park headquarters and generally increases with elevation, although considerable variation is introduced by the erratic nature of thunderstorms during the summer months. Springs are normally dry and summers wet, but the pattern is not well defined. There appear to be wet and dry cycles lasting several years or more which may have far reaching consequences in terms of plant distribution and establishment. Normally a snow pack is formed during the winter months at the higher elevations, increasing stream flow considerably during the spring snow melt. Snow also falls at the lowest elevations, but usually does not persist until the next precipation event. Temperatures range generally between 0.0 F and 100.0 F during the course of the year near park headquarters, although extremes above and below this are not uncommon. Diurnal temperature differences are usually in the range of 30 F.

Plant life

The diversity of habitats created by the great variety of elevations, topographic aspects, climates and soils are populated by an equally diverse assemblage of plant life. Thus, within a

single days' march from the summit of Cerro Grande to the banks of the Rio Grande, one traverses mountain meadow, mixed conifer, pondersosa, pinyon-juniper and juniper grassland communities, along with the floristic elements found primarily in moist canyon bottoms. The flora of Bandelier National Monument, whether by design or accident, is a very representative sample of the Jemez Mountains. For this reason, the monument may well someday become as valuable for its botanical wealth as it already is for its' archeological treasures.

HISTORICAL BACKGROUND

Between 1938 and 1989, a number of collectors made significant contributions toward a plant collection for Bandelier National Monument. Their contributions are summarized below.

King, 1938,	@	2	collections
Spuhler, 1938,	@	48	collections
Sholly & Dodge, 1939,	@	28	collections
Thomas, 1939-41,	@	19	collections
Clark, 1941,	@	230	collections
Hurley, 1948,	@	56	collections
Yarnell, 1957,	@	20	collections
Foxx, 1975,	@	63	collections
Halley, 1975,	@	60	collections
Traylor, 1975,	@	2	collections
Patton, 1977,	@	1	collections
Salazar, 1983,	@	75	collections
Perkins, 1988-89,	@	17	collections
Jacobs et. al., 1986-89,	@	1,601	collections

Between 1938 and 1957, Clark and several others: Spuhler, 1938; Sholly & Dodge, 1939; Thomas, 1939; Hurley, 1948; and Yarnell, 1957, contributed collections to the Bandelier herbarium with the bulk of the specimens dating from Clark's 1941 plant inventory work. Approximately 550 specimens were present in 1957, based on a review of the old herbarium index.

From 1975-83 some 125 additional specimens were contributed by Foxx, Halley and others.

Potter and Foxx (1979), conducted a survey of the recently acquired Cerro Grande Accession and reported specimens representing some 135 species, however none of these were contributed to the Bandelier herbarium.

In 1980, Jones annotated the entire Bandelier plant collection. Some of the annotations were in doubt however, in regard to both nomenclature and specimen identification. Subsequently, Speckman inventoried the herbarium and set up another index file using the annotated names provided by Jones.

In 1983, Salazar contributed some 75 additional specimens representing about 40 species of grasses.

Foxx and Tierney (1985), published a checklist of plants of the Jemez Mountain region and cited the Bandelier herbarium as the sole source for a number of vouchers. Upon examination, it was found that some 30 species reports based on these vouchers could no longer be verified because the specimens were missing from the herbarium.

In 1986, Jacobs began the present study and made a comparison of the old herbarium index to the existing plant collection, as documented by the 1983 Speckman index. He discovered that only some 400 of the specimens collected between 1938 and 1957 were still present in the herbarium, an apparent loss of some 150 specimens. The current status of the missing specimens is under investigation. In the period since 1957 however, some 200 addition specimens had been added to the collection, bringing the total in 1986 to around 600 collections.

From 1986-1989, Jacobs collected over 1600 specimens, some 1200 of which were deposited at the Bandelier herbarium. The remaining 400, as well as over 600 duplicate collections were deposited at the Duke University herbarium. In addition, he annotated the existing Bandelier plant collection of some 600 specimens. All of the specimen label data, over 2200 individual records, was entered to the Natural Resource Management Plant Database (Bandflor.dbf) on DBASE III PLUS software. Data for specimens in the Bandelier herbarium was also converted to the NPS Museum Cataloging System/ANCS (Nhdata.dbf) on modified DBASE III PLUS software, using a program written by park volunteer Bracker.

In 1989, Jacobs compiled the first comprehensive checklist of vascular plants for the monument. This listing is fully documented by the plant collection at Bandelier and includes 748 taxa, 720 species, 347 genera and 86 families. The present study has more than doubled the known documented plant life in the monument and has added many new records to the Jemez Mountain region as well.

FACILITIES

A permanent solution to the location of the herbarium should be addressed by those concerned and timely plans submitted. Ideally, all of the biological collections would be housed in a single location and separate from the archeological collection. This would enable the museum curator to provide the archeological collection the level of protection it deserves without restricting access to the biological collections. It must be emphasized that the herbarium, while serving as a physical record

of the plants of Bandelier is also a valuable reference for resource management and researchers. Responsible curation will provide for both.

Justification for herbarium collections at NPS units

"The monument herbarium has a number and variety of uses. It will answer many visitors' questions, show visitors seasonal differences in plants otherwise unavailable to them, back up the monuments' ethnobotanical data, provide accurately named comparative material essential to correct nomenclature, facilitate the rapid break-in of new and seasonal personnel, and furnish a basic record of the botanical resources of the monument", (Richey, 1942).

Richey made these comments in an official memo to all NPS units in the southwest region in which he detailed recommended methods for building and maintaining a park herbarium. His vision of a multi-purpose plant collection located at each NPS unit is still valid; perhaps even more compelling reasons for building a park herbarium and maintaining it on site are available today. A representative plant collection provides one form of baseline data against which changes in the park environment can be measured. The plant collection is an invaluable reference for resource managers who are concerned about adverse environmental impacts in and around their park. Rare plant monitoring and exotic plant control are both facilitated when a park has a good herbarium facility. Interpretative staff can consult an authoritative source in seeking the identity of a plant and answer visitor queries in a professional manner. Researchers, whether biologists or archaeologists, will find the plant collection of immense value when they need quick answers to botanical questions related to their research. The park herbarium is both a museum and a library, providing a physical record of plant life and a facility for accessing information about it. The protection of park resources and their interpretation benefit from the kind of data provided by a good plant collection.

Cyclic Maintenance

Cyclic maintenance of the herbarium specimens is essential if the collection is to last a normal lifetime (200+ Years). At least once a year, and more often if the herbarium receives substantial use or preventative measures are disallowed, the specimens need to be examined for any evidence of insect damage. If any damage is seen, the entire contents of the infested cabinet must be fumigated as soon as possible. Fumigation may be by gas in a fumigation chamber, in a microwave oven (remove all paper clips, staples, etc. to avoid fire), or in an ultrafreeze

unit (seal specimens in plastic garbage bags). The cabinet should be fumigated as well. Preventative measures in common usage include pest strips (1/2 slap per cabinet and renew every 6 months) and moth ball crystals (20 per cabinet and renew as needed). Place the pest strip or moth balls in a small dish on the bottom shelf of each cabinet, on top of the specimens in that shelf, and rotate between the two bottom shelves every 6 months.

The organization of the specimens should be checked periodically to ensure specimens are not mis-shelved and thus unaccessible. Annotations should be allowed only by qualified personnel and any changes should not obscure earlier names. The herbarium index and databases should be updated as well. New accessions to the herbarium should be fumigated, the label data entered to the Natural Resource Plant Database (Bandflor.dbf) and the NPS Museum Cataloging System/ANCS (NHDATA.dbf) databases, and an index card prepared.

MATERIALS AND METHODS

This study documents the vascular plant life within Bandelier National Monument by assembling a representative collection of specimens and creating a computer database of botanical information.

Plant specimens were collected with several objectives in mind: (1) to fill in known gaps in the old Bandelier plant collection, including poorly represented families and habitats (2) to document each species, where feasible, with both fruiting and flowering material and by specimens documenting the range in both habitat and phenology (3) to locate species of special interest, being rare or exotic, or which occur in unique or disturbed habitats.

Specimens were pressed in the field using a standard botanical press and newspaper. Collection numbers were assigned to each plant collection and field notes corresponding to each collection number were recorded. Field notes included the following information: date of collection, collector/s, locality, elevation, habitat, and a physical description of the fresh specimen. Subsequently, this information was entered to the computer database. Additional processing of plant specimens included: rapid drying, preliminary identification, preparation of specimen and index labels, mounting, and where appropriate filing. Specimens were dried using a combination forced air/light bulb/ solar plant dryer. Specimen and index labels (100 % cotton rag, 3 x 5 inch, continuous tractor feed stock) were computer generated. Mounting was done on 100 % cotton rag (University of Californica type), herbarium paper, using an Elmers type white glue and adhesive cotton tape. For more specific instructions on the collection and preparation of plant

specimens see Benson (1979), Chapter 12.

Final species determinations were made using the The Flora of New Mexico (Martin and Hutchins, 1980) as the final authority, although the floras of adjacent states (Cronquist et. al., 1977; Kearney and Peebles, 1964; Harrington, 1954) as well as manuals on specific groups (Hitchcock, 1971) were consulted frequently to gain a consensus on the status of problem taxa.

1988 Collections

Collecting for the 1988 field season focused primarily on the southern half of the monument. Over 600 collections were made and approximately 400 of these were added to the Bandelier herbarium. The 1988 collections are listed chronologically in the APPENDIX.

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GLOSSARY

Alternate Names. Valid scientific names in current usage which reflect different taxonomic opinions about how to rank, split or combine a particular taxa.

Depauperate. A individual which is small or otherwise poorly developed in relation to other individuals of its' species, usually as a result of adverse growing conditions.

Escaped. An exotic individual which is derived from discarded seed or vegetative material, but does not readily maintain or propagate itself.

Extirpated. Individuals or populations of species which have been eliminated from a site where they previously occurred.

Habitat. The specific environment at a site where particular species might be expected to grow.

Locality. The place where a plant collection or observation is made.

Naturalized. An exotic species which readily maintains and propagates itself and thus becomes a part of the flora of a region.

Persistent. A planting of an exotic, perennial species which is long lived, often as a result of propagating itself through vegetative reproduction, and maintains itself after abandonment in the secondary growth community.

Population. A cluster of individuals of a species spatially separated from other clusters of the same species and therefore increasing the probability of intra verus inter cluster gene exchange.

Synonym. A scientific name no longer in common usage either because an earlier name has priority or because the scientific name had been applied previously to a completely different taxa.

Taxon, taxa. In a general sense any species, subspecies, variety or assemblage of these.

Weed. A plant whose virtues are not yet known.

PART II
EXPLANATION OF CHECKLIST

The data presented in the following checklist are summarized from over 2200 separate collection records. Plant species are listed alphabetically by family, genus, species and variety. The checklist is a comprehensive listing of the vascular plants documented for Bandelier National Monument. A few species listed were located just upstream of the monuments' northeast boundary and are included to represent the extirpated flora of the Frijoles Spring vicinity in White Rock Canyon. The Tsankawi and Otowi sections are included only incidentally; no systematic collection efforts were made at these disjunct sites. A total of 748 taxa are listed for the monument and inclusions/exclusions as noted. This breaks down as follows: 720 species, 347 genera, 86 families. No one is more aware than the author that these totals are not static and reflect only the current state of knowledge. **All listings are based on voucher specimens housed at the Bandelier National Monument herbarium.** Additional vouchers are also present at the Duke University herbarium.

Nomenclature

Scientific names used in this checklist are generally consistent with Martin and Hutchins (1980), except in a few instances where an alternative name has been deemed more appropriate. * INCLUDED species are in synonomy with the listed species, while * CANNOT DISTINQUISH species were not distinquishable using the available manuals and specimens. * MAY NOT BE DISTINCT FROM species are poorly defined and possibly conspecific, while * INTERGRADES WITH species suggests taxonomic confusion due to interbreeding. The taxonomic notes accompanying the checklist are not a complete review of such matters, but only information relevant to the authors' experience in compiling the plant checklist. For the purposes of this checklist, variety and subspecies are treated as equal in rank and no distinction is made. Common names are listed for each species where available, but these do not conform to any standard reference.

Habitat and Elevational Data

Habitat and elevational data listed under each species are summarized from the plant collection data and do not presume to represent the full range of habitats or elevations available to a particular species. In a few instances, the range and elevation data were modified based on the authors' undocumented field observations. Habitat descriptions are arranged in order of

increasing elevation under each species.

Occurence Data

Senstive... native plants of limited habitats and numbers of individuals.

Occasional... scattered individuals without distinct habitat preference or of disturbed sites.

Locally Abundant... large populations in specific habitats or localities.

Frequent... sizeable populations across several different habitat types.

Ubiquitous... plants occuring over an extremely broad range of habitats and elevations.

Reported occurences of plant species are based on a review of specimen data in conjunction with the authors' undocumented field observations.