

REVIEW OF NATURAL RESOURCE INVENTORY AND MONITORING AT BANDELIER

1/21/92

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This document reviews past and ongoing park monitoring programs, as well as past research that can be considered to have contributed to a resource basic inventory for Bandelier National Monument. This work is split into eight major categories: A) vegetation; B) fauna; C) water; D) weather/air quality; E) chemical contaminants; F) geology/soils; G) fire; and H) landscape/ecosystem/land use. Ongoing monitoring is so noted.

The **permanent** plots/transects/ photo points are listed. If Bandelier has a copy of the original data and/or photos this is also noted. Cited references are listed at the end of this document.

A) VEGETATION

1. Foxx and Potter (1978) established 18 permanent plots, 20 X 50 m, for which BAND received no precise locational information or field notes. These plots were generally located along Wauer's (1978-a) roughly delineated bird survey transects. These plots were established to examine the impacts of the La Mesa Fire and recorded herbaceous and woody plant compositions. Two photo stations were established at opposite corners of each of these plots. In addition, seven photo stations were established in old burn areas, again with precise locational information and resultant photographs absent from the park's records. Teralene Foxx has donated over 2000 slides from this and other studies she conducted in the park to BAND; these were recently catalogued in a computerized database (FOXPHOTO.DBF). Foxx and Potter (1978) also established two permanent plots on both Frijolito Mesa and on Cerro Grande, again associated with Wauer's bird transects and imprecisely located on a poor resolution map.

Potter and Foxx (1979-c) relocated 7 of the La Mesa Fire permanent plots and described post-fire change; twelve of these plots have been relocated and permanently marked by park staff. These (and any other plots which can be relocated) will be restudied in 1992 by Terry Foxx (with park assistance) as part followup research on the effects of the La Mesa Fire.

2. In 1984 Potter and Tierney (1985) established 20 permanent line transects and associated clip plots in the grasslands and meadows of the Cerro Grande Accession. Transect locations are described in their report, with locations marked on an air photo.

Thirty-five photos were taken of these transects when the data were collected - archival location of the photos is unknown. In 1991 we relocated 11 of these transects, and collected data on six of them. Ongoing analysis of the data indicate that there may be problems with the original data.

3. Foxx (1983) conducted a study of germinant reforestation of ponderosa pine near Ponderosa Campground that mapped the locations of seedlings in a 125 m X 250 m area. However, the park's map (in the cited report) is inadequate to relocate the field grid and planted seedlings, the grid is not permanently marked in the field, and we do not have the survival data for individual subplots that are necessary for analysis of any subsequently collected data (Teralene Foxx is not certain if she has that data anymore). It would be interesting and perhaps useful to assess the survival of the planted germinants one more time, but I do not consider it essential.

4. Three sets of permanent burro exclosures were constructed in 1975, with the first data collected in 1978 (Potter and Foxx, 1979-a). Potter (1985) recollected data from the fifteen permanent line transects within each of these sets of exclosures in 1984. Color slides taken in 1978 and 1984 are archived in the natural resources slide file. Ten of the fifteen transects in the Yapashi exclosure were re-read in 1991, with all the additional lines in all three exclosures planned for re-reading in 1992.

5. Dr. Gilbert Gonzales established 6 line transects for ground cover in the San Miguel Mesa area in 1984. These were re-read in 1985 and 1986, and soil samples taken in 1987. Bandelier currently has no data on these transects, and Gil has failed to deliver a promised manuscript with data tables (personal communication, 12/19/89). Unless we can get the information from Gil, this work will have been for naught.

6. In 1984 C. Allen established 13 photo points in the Cerro Grande montane grassland to document the condition of this grassland before management activities began. The locations of these photo points are recorded on a photo overlay in the natural resources file, and the color slides are archived in a binder. All of the flimsy aluminum stakes initially used to mark these points are in the process of being replaced with sturdy aluminum stakes that are less subject to damage from elk antler rubbing; this has been done for 9 of the points (the other four were not relocated). Completion of remarking and followup photography are planned for 1992.

7. Vegetation mapping of portions of Bandelier has been undertaken at a number of times, including Anonymous (1934), Koehler (1974), Potter and Foxx (1981), Potter (1981), Hink and Ohmart (1984), Cully (1985), Cully (1986), and Allen (1989). No permanent plots are associated with these mapping efforts. Future vegetation maps will likely be generated through computer-assisted interpretations of remote sensing data.

8) Lathja (1988) established two permanent plots in piñon-juniper woodland areas to look at nutrient cycling and plant demographic

patterns. To date only fragmentary results have been received from Kate on this work.

9. Gosz and Marks (1974) examined the reproductive status of alligator juniper in western portions of Bandelier. No permanent plots were established, although they provide a relatively detailed map of the locations of the juniper stands which they studied.

10. Koehler (1974) sampled and mapped range trends in different portions of the park, but did not establish any permanent plots.

11. Potter and Berger (1977) examined deer-burro utilization of vegetation, but did not establish any permanent plots.

12. Wauer (1978-b) indicates that a study of fungal species diversity and succession was being conducted in Bandelier by Dr. Bill Isaacs of the NM Natural Heritage Program, but I have found no information on this topic in the park.

13. Potter and Foxx (1979-b) reviewed the success of grass seeding after the La Mesa Fire, but did not establish any permanent plots.

14. Potter and Foxx (1979-c) examined the mortality and recovery of ponderosa pine after the La Mesa Fire in their permanent plots (cf. A)1.) and in additional non-permanent plots which we lack any locational information on. While they marked trees with aluminum tags, we lack the data on specific trees which would be necessary to use this study as baseline information for future monitoring of tree growth and mortality.

15. Oppenheimer (1979) examined the patterns of early revegetation after the La Mesa Fire, but did not establish any permanent plots.

16. Jones (1979) provides a barebones checklist of lichens from Bandelier that completely lacks explanatory text describing collection procedures, locations, etc. Weber (1980) made a lichen collection and considered the use of lichens for monitoring air pollution in Bandelier, but did not establish any permanent plots.

17. Tierney (1977), Potter (1981), and Hink and Ohmart (1984) studied the vegetation along the Rio Grande, but did not establish any permanent plots.

18. Barnes (1983) sampled piñon-juniper vegetation types in Bandelier and adjoining LANL lands, but did not establish permanent plots.

19. Allen (1984-a) examined tree age structures on Cerro Grande but did not establish permanent plots.

20. Tierney and Potter (1985) studied the plant ecology of felsenmeers, but did not establish any permanent plots.

21. On 8/11/88 over 100 grama grass cacti were planted in the Tsankawi section by Ken Stephens, B. and E. Jacobs, Teralene Foxx, and others. These plantings were marked with pin flags and were to have been mapped by T. Foxx, but no map was ever received by the park.

22. Jacobs and Jacobs (1988) and Jacobs (1989) made extensive plant collections and integrated previous collections into an excellent master herbarium and associated database. No permanent plots were established.

23. Allen (1989) sampled vegetation at 969 points across the Frijoles watershed, but did not establish permanent plots. However, the sample location points are located on 1:24,000 scale topographic maps, which combined with the field notes would allow approximate relocation of all points.

24. In 1976 five "permanent" vegetation line transects were established on each side of Bandelier's southern fenceline, where the fenceline isolates the tip of a mesa above Medio Canyon, creating a natural burro exclosure. Original transect establishment and data collection were done by Terry foxx, Lynn Marple, and Don Forester, as reported in Simpson (1976). In 1977 Terry Foxx and Gail Tierney revisited this site and made written observations but did not collect any data (Foxx 1977). These memos recently resurfaced, and a reconnaissance of and possible data collection at this site is planned for 1992.

25. In 1991 park seasonal biotechnician Jim McGrath established ten permanent vegetation transects in pinyon-juniper woodland portions of BAND. Each transect is 300 meters in length, permanently marked in the field, photographed, and mapped. Two transects were established on Frijoles Mesa, one near Corral Hill, three on the mesa west of the Frijoles Creek waterfalls, and four on the lower mesas west of Alamo Canyon. Data collection methods replicate those used by UNM's Long-Term Ecological Research program, with which we have begun to collaborate. Thirty-six erosion monitoring transects were established in association with these permanent vegetation transects to collect better data on rates of soil erosion.

B. FAUNA

1. Ro Wauer (1978-a) established permanent line transects to monitor bird population trends in Bandelier. Subsequent work on

these transects has been done by Wauer and Dennis (1979), Johnson (1983-a), Wauer and Johnson (1984), and Wauer (1991). In 1991 Ro donated all of his Bandelier slides (about 200) to the park; these slides are in the ecologist's office, along with copies of all of the original field data sheets.

2. In 1989 the Pajarito Ornithological Society established permanent transects in the Jemez Mts. to monitor bird population trends - one of these transects is on Bandelier in the area of the ski trail. The transect was discreetly marked with green spray paint and metal tags on the ten sample point trees. The transect has been sampled annually by POS volunteers. Bandelier has received one set of raw data from this effort, with Dr. Pat Kennedy of Colorado State University handling the processing of these data.

3. T. Johnson (1979, 1980, 1981, 1982, 1983-b, 1984, 1985, 1986, 1988) has studied bald eagles in the park since 1978. Specific roost areas have been monitored, with mapped individual roost trees.

4. Kennedy (1985, 1989) has been studying raptors in the Bandelier area throughout the 1980's. She has been monitoring a half-dozen raptor nests in the park - this work should be continued by park staff in cooperation with Kennedy (at LANL) on an annual basis.

Kennedy and D. Crowe (1991) have been conducting research on zone-tailed hawks in the Jemez Mts.; they have been working cooperatively with park staff on this project since BAND seems to be a local stronghold for this species.

5. Guthrie (1984) trapped small mammals at 11 locations in Bandelier from 1977 - 1979. While his trapping grids were not permanently marked, his methodology and sampling locations are described and/or mapped in sufficient detail in the cited reference to allow subsequent monitoring to use his results as baseline information.

6. Conley **et al** (1979) and Sivinski (1979) looked at changes in deer and elk utilization and migration in and around Bandelier, through the establishment of large numbers of permanent pellet transects, marked by rebar. Unfortunately, these transects were hard to locate even when the project was in progress, and all transects have been abandoned; no locational or other data exist in the park for these transects.

7. Jennifer Johnson and T. Johnson (1988) inventoried Upper Frijoles Canyon for spotted owls in 1988, and T. Johnson (1991) inventoried Frijoles Canyon again in 1991 for spotted owls.

8. The New Mexico Dept. of Game and Fish established pellet plots

for deer in the late 1950's and early 1960's, based upon comments found in park memos from the time. However, no information exists within the park on the locations, methods, or data associated with such plots. In recent winters NMGF has also conducted aerial sample counts of deer and elk around and sometimes in Bandelier, but the park has only fragmentary records of the results of these surveys (which are **not** comprehensive censuses). Efforts to receive complete records from NMGF indicated that it would be difficult to find the requested information, and that the data are probably not sufficient to give reliable population numbers or trends (R.Isler, personal communication). Discussions are underway with the Game and Fish Dept. to determine how we might best assess the status of Bandelier's ungulate population.

9. Arganbright (1988, 1991) studied two bat colonies in Frijoles Canyon from 1987 to 1989. The only active bat-banding in the country occurred with this work. Park interpretive ranger Chris Judson and numerous volunteers have continued to monitor these colonies since then (Judson, 1991). Chief Regional Scientist Fletcher has devised a method to count bats from a videotape, with several tapes counted from the summers of 1988 and 1989, and additional tapes from 1990 and 1991 awaiting resolution of technical problems before being counted.

10. Pippin (1978), Pippin and Nichols (1978), and Pippin and Pippin (1980, 1981, 1984-a, 1984-b) conducted an excellent collection of arthropods in the monument. This work provides reasonable baseline information on arthropod species diversity in Bandelier, with detailed information on about 40% of this collection in ANCS and dBASE ("arthro.dbf"). Unfortunately, there are no provenience data associated with 60% of the listed species, and the mounted collection has only a small fraction of the total of about 1200 species listed in Pippin and Pippin (1984-a). In addition, roughly 20% of the collected specimens were never heard from again after being sent to specialists for identification.

11. Wildlife observations have been kept for many years, and these data have been entered into a dBASE III+ file (WILDLIFE.DBF). Relatively few observations (a total of 2207 to 1989), largely consisting of the most locally common and easily observed species along with some uncommon sightings, were made and entered into this database. Bandelier's wildlife observation program has been revised to make it more productive and managerially useful, following the extremely effective wildlife observation program at Sequoia-Kings Canyon National Parks. We have established a joint wildlife observations database with LANL, and LANL is currently doing the data entry for this program.

12. Jacobi (1989) inventoried some aquatic invertebrates from Frijoles Creek, but did not establish any permanent sampling locations.

13. Occasional sampling of park streams for fish species has occurred. A 1964 park fisheries report indicates that Frijoles Creek (FC) contained brook and rainbow trout, while Capulin Creek (CC) contained only brown trout. A 1978 Dept. of Game and Fish report echoes these findings, while a 1987 Game and Fish survey above "Upper-Upper Crossing" (where the Apache Springs trail reaches FC) found only brook trout. Yet sampling of FC by regional scientist Dr. Milford Flethcher from Upper Crossing down to the horse corral between August and November of 1989 found 45 **brown** trout, 13 rainbow trout, and **zero** brook trout.

Dr. Steve Platania of UNM has conducted fish inventories of the Rio Grande (1991) and Frijoles Creek (unpublished data), with only rainbow and brook trout found in Frijoles Creek.

14. Some studies of harvester ant colonies were conducted in past years by W. Pippin, K. Spande, and D. Langley, but unfortunately the park has almost none of the data collected and maps compiled in this work. W. Pippin still has raw data that was never compiled and written up, and D. Langley apparently took the bulk of the information with him when he left the Monument several years ago with the intent of writing up a report, but it did not happen. I have encouraged Dr. Pippin to work up his data and get it to us in some sort of useable form, and have been unable to contact Langley - unfortunately it appears that this past work may have been lost.

15. Mid-winter helicopter surveys of elk and other ungulates occurred in 1990, 1991, and 1992. Maps and associated data sheets are filed in the Ecologist's office.

16. Numerous other faunal studies that lacked permanent plots are reviewed by Allen (1989), including many studies on local burros.

C. WATER

1. Purtymun and Adams (1980) and Purtymun **et al** (1980) review the geohydrology of Bandelier and part of White Rock Canyon, respectively. Christensen (1980) reviews the base flow of Frijoles Creek. These reports present baseline information which could be monitored to check for changes in such parameters as volume of flow from particlular springs.

STREAM GAUGE - FRIJOLES CREEK

1. Frijoles Creek has been gauged intermittently since 1960, but the gauging locations has changed through time. USGS established and ran a gauge from 1960-62 near Upper Crossing, moved it to

immediately above the intake or the orchard irrigation ditch in 1963, and operated this gauge from 1964-1969 and in 1978. USGS, not the park, has these flow data. USGS also has some suspended sediment data for this time period. In 1979 USGS built the current gauging station under contract with the NPS, but decided not to run this station. Thus the NPS bought the instruments necessary to operate this station, and we have hydrograph strip chart records from this station beginning with 2/11/83. These stripcharts have not been converted into flow volume data.

STREAM GAUGE - CAPULIN CREEK

1. A Parshall flume was built at Base Camp in 1983. Fragmentary stripchart records exist beginning on 9/7/83. Use of this gauge is limited by the availability of personnel in the backcountry to change stripcharts on the recorder.

WATER QUALITY MONITORING

1. Purtymun (1984) reviews water quality data for Bandelier. Water quality information has been systematically collected by park staff since 1977. Sixteen permanent water sampling locations have been established in the park, five in the upper portion of the Frijoles watershed, seven in the lower portion of Frijoles Creek, one on Alamo Creek, two on Capulin Creek, and one at Turkey Springs. The parameters collected through time have changed as experience and technology have advanced. A detailed outline of sampling protocols exists for pH and conductivity measurements; expansion of these protocols to cover all sampled parameters would be desirable. The data for all stations from 1977 to 9/10/91 has been entered into dBASE III+ files. Ken Stephens indicates that the following unmet water monitoring needs exist:

- a) monitoring of fecal coliform in park waters, which we could do if we were able to purchase the incubator and an adequate microscope;
- b) determination of the presence or absence of giardia in park waters, likely through a contract with the state; and
- c) determination of additional flow measurements on Alamo Creek, using the portable flume and pygmy flow meter that the park owns.

D. WEATHER/AIR QUALITY

WEATHER RECORDS

1. The primary weather station in the park has been moved a number of times. From 1925 to 1935 we only have intermittent precipitation data. From 1/35 - 2/78 (records sent to the National Weather Service), 12/10/84 - 4/30/85, 11/5/85 - 4/14/86, 10/1/86 - 4/27/87, and 11/2/87 - 5/8/88 weather observations were collected in the bottom of Frijoles Canyon, at about 6100 feet elevation. From 3/78 - 12/9/84, 5/1/85 - 11/4/85, 4/15/86 - 9/30/86, 4/28/86 - 11/1/86, 5/9/88 - 11/1/89 (no data from

10/20/88 -10/30/88, and RAWS data from 11/1/88 - 3/31/89) weather observations were collected at the fire tower, at about 6500 feet. From 11/2/89 to 3/31/90 the weather observations collected from a site adjacent to the entrance station, at about 6600 feet. Since 4/1/90 the weather observations have been collected from the fire tower site.

In addition, scattered weather records have taken at such places as Ponderosa Campground, Apache Springs, and most recently from the RAWS unit in the Cerro Grande Accession.

SCS SNOW COURSE

1. From 1950 through 1989 the Soil Conservation Service collected snow data from their "Sandoval Snow Course" site. This site was located just NE of Highway 4 about 0.8 miles north of the old county line boundary at UTM coordinates 3,966,700 meters north and 373,300 meters east, at about 9100' elevation. Total annual precipitation data were also collected from 1975 though 1985. Nine years of complete-year precipitation data indicated an average annual precipitation value of 26.09 inches, ranging from 21.8" to 29.5", while the fire tower et al records showed a mean value of 17.49"/year for the same years. These data are archived in the Ecologist's office. The site was abandoned by the SCS after 1989 as unneeded in their new monitoring scheme.

Note that the SCS has collected snow data at the Quemazon site along the pipeline road at the caldera rim about 3.5 miles north of the Cerro Grande summit, at about 9500'. The SCS now maintains an automated "snotel" at this site.

AIR QUALITY

1. Visibility monitoring was begun in 8/78, using a teleradiometer, and discontinued by the park in 1984. In 7/87 a new system was instituted which measures visibility from photographic slides, with interpretation of the slides and data analysis done by an independent contractor for the NPS. Seasonal visibility summaries exist. More accessible archiving of summarized data is needed.

2. Particulates have been monitored from 11/78 to the present. More accessible archiving of summarized data is needed.

3. The NADP has been monitoring wet and dry acid deposition at the fire tower weather station enclosure from 6/29/82 to the present. These data are sent to Illinois for analysis. More accessible archiving of summarized data is needed.

4. LANL monitors the deposition of tritium, also from the fire tower weather station enclosure, with results reported in their annual Environmental Surveillance results.

E. CHEMICAL CONTAMINANTS

Single soil samples indicating elevated levels of DDT were collected by the State of New Mexico from the current Frijoles Canyon picnic grounds area on 10/19/74 and 10/28/75. The NPS subsequently sampled soil, sediment, and fish in this area on 8/3/76 and 9/13/76, confirming the presence of DDT-type compounds in a number of samples. This information is contained in a memo from Dr. Fletcher to the regional Chief of Natural Resources on 11/17/76.

Extensive, ongoing sampling of the Frijoles watershed for chemical contamination has taken place since August, 1989. One sediment and one fish sample from Capulin Canyon were also been submitted for analysis. Detailed results of those samples are can be found in other reports, but in general they reveal significant levels of DDT contamination to soils, stream sediments, and fish in the area near the maintenance yard.

F. GEOLOGY/SOILS

Geology

Olinger (1972) described the geological features of lower Frijoles Canyon, but established no permanent plots.

Boden (1978) examined the stratigraphy and faulting history of the Bandelier area, but established no permanent plots.

Wells (1978) and White and Wells (1984) studied the geomorphic effects of the La Mesa Fire, establishing four "permanently" staked 1 m X 1 m "erosion contour plots" on Burnt Mesa. One of these plots was established on an archeological site. I still need to contact these researchers and field check these sites to determine if monitoring these small plots would be useful.

Dr. Steve Reneau (of LANL) has been conducting detailed studies of the fault systems of the Pajarito Plateau and of stream terraces in Frijoles Canyon in an effort to assess local seismic hazards (cf. Reneau, 1991).

Soils

Earth Environmental Consultants (1974) conducted a soil survey of the lower elevation portions of Bandelier. This was a very crude survey which collected few field data. No permanent plots were established.

Earth Environmental Consultants (1978) conducted a soil survey of the higher elevation portions of Bandelier. This too was a very crude survey which collected few field data. No permanent plots were established.

Nyan **et al** (1978) conducted a fine survey of the soils of Los Alamos County; unfortunately, Bandelier was not included in this survey.

USDA Soil Conservation Service (in press) conducted a fine survey of the soils of Sandoval County, but once again Bandelier was not surveyed as part of this work.

Freeman (1984) examined the effects of the La Mesa Fire on total soil nitrogen, but established no permanent plots.

Orcutt and Powers (1989) document the widespread impacts of erosion to archeological sites as part of the work of the Bandelier Archeological Survey. A subset of the permanently marked archeological sites should be monitored at frequent intervals (possibly every other year) to establish the magnitude and trend of the erosion damage.

Allen (1989) documented the widespread occurrence of sheet erosion across the Frijoles watershed. Although sample locations were mapped, no permanent plots were established.

G. FIRE

Forester (1976) inventoried downed woody fuel loads in the park. A map of approximate transect locations is in park files, but no permanent transects were established.

Patton (1978-a) further inventoried downed woody fuel loads in the park. A map of approximate transect locations is in park files, but no permanent transects were established.

Foxx and Potter (1978, 1984) reviewed park fire and weather records, examined the fire history of Burnt and Escobas Mesas with tree-ring analyses (cf. Robinson 1978), and documented fire effects from the La Mesa Fire and earlier fires. Figure 1 and Table 2 in Foxx and Potter (1978) show the fire history of the park prior to the La Mesa Fire. Eighteen permanent plots and a number of "permanent" line transects were established, as described above in **A)1.**, but locational information are sketchy for these line transects - T. Foxx has stated that most of them are essentially unrelocatable. I recommend monitoring a subset of the **plots** at 10-year intervals by park staff or through contract, starting in 1992.

Potter and Foxx (1979-b) examined the success of seeding grasses after the La Mesa Fire, but established no permanent plots.

Potter and Foxx (1979-c, 1984), and Potter **et al** (1982), studied the recovery and delayed mortality of pine after the La Mesa

Fire. They mapped crown cover damage classes resulting from the fire, but established no new permanent plots.

Potter and Foxx (1981) conducted a fire history of the Cerro Grande Accession based upon analysis of fire scars. Subsequent work (Allen 1984, Caprio *et al* 1988, Allen 1989) renders the conclusions of this study suspect. No permanent plots were established for this study, and my efforts to locate sampled trees in 1988 were unsuccessful.

Allen (1984-b) inventoried downed woody fuel loads in the 1977 Upper Frijoles accession to the park. A map of approximate transect locations and accompanying color slides are in park files, but no permanent transects were established.

Allen (1984-c) conducted a fire history based on analysis of fire scars adjacent to the park boundary on Sawyer Mesa. No permanent plots were established, although color slides of each sampled stump were provided to the park (not yet located in park files).

Caprio *et al* (1988) provide extensive fire history data from the Frijoles watershed. All sampled trees were mapped and can be relocated on the ground, but no permanent plots were established.

Allen (1989) analyzed the fire history data provided by Caprio *et al* (1988). This work provides the most comprehensive fire history analysis for any watershed in the Southwest to date. Additional fire scar data have been collected from the Capulin watershed within BAND as part of a larger, ongoing fire history study (Touchan, 1991).

Permanent photo stations have been established to help monitor the effects of several prescribed fires within the park. The general locations of some of these photo stations are known, but detailed locations are not recorded. Areas known to have photo stations include: Ponderosa Campground/Backgate area; Lower Falls; Upper Falls; Frijoles Canyon between Tyuonyi and Ceremonial Cave; Apache Mesa; Corral Hill; and Boundary Peak.

H. LANDSCAPE/ECOSYSTEM/LAND USE

Crow (1977) examined environmental perception in Bandelier, but established no permanent plots.

Rose (1976) used four line intercept transects at each of seven compsites to assess visitor impacts to campsite vegetation. Although these transects were not permanently marked they provide baseline information that could be used to monitor visitor impacts as Patton (1978-b) did at three of the sites.

Green (1979) developed a descriptive ecosystem model for Bandelier which was never implemented. No permanent plots were established.

Allen (1984-a) described landscape changes associated with montane grasslands in the Jemez Mts., but established no permanent plots.

Lathja (1988) established two permanent plots in piñon-juniper woodland areas to look at ecosystem nutrient cycling and plant demographic patterns - this study is ongoing. These are the only permanent plots currently to have well-documented locations and information files in the park, although Bandelier still needs to archive data from these plots.

Allen (1989) used fieldwork and mapping to assess historic landscape changes in and around Bandelier. This relatively comprehensive study reviewed local ecological literature. No permanent plots were established.

Several photo stations were established by the backcountry ranger along the Rio Grande, but documentation of precise locations and archiving of the photographs is needed.

Bandelier has a variety of aerial photographs which can be used to examine landscape characteristics through time. The photographs present in the park include:

<u>Date</u>	<u>Type</u>	<u>Scale</u>	<u>Coverage</u>
1935	Black and white	1:31,680	BNM and environs
10/15/63	Black and white	1:15,000	BNM
1975-76	Color	1:24,000	BNM environs
6/20/77	Color Infrared	1:24,000	La Mesa Fire
8/24/77	Black and white	1:6000	BNM
8/28/77	Color IR transpar.	1:6000	BNM
1981/83	Color	1:24,000	BNM and environs
9/23/82	Color Infrared	1:6000	BNM
9/24/82	Black and white	1:6000	BNM
9/85	Black and white	1:2000	major arch sites
3/18/87	Black and white	1:3000	BNM developed area
9/30/91	Color orthophotos	1:7200	BNM/LANL environs

The 9/30/91 imagery should be received during the summer of 1992, and will also be in scanned digital form, and will also have an associated 10' interval contour map in hard copy and digital formats.

A number of LANDSAT scenes which cover BAND are available from cooperating land management agencies in the area (e.g., the Santa Fe National Forest has a June 1990 scene), or from the Technology Applications Center in Albuquerque. Chief Regional Scientist Fletcher has an old (late 1970's ?) LANDSAT scene which lacks the

date and other header information but which includes Bandelier.

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