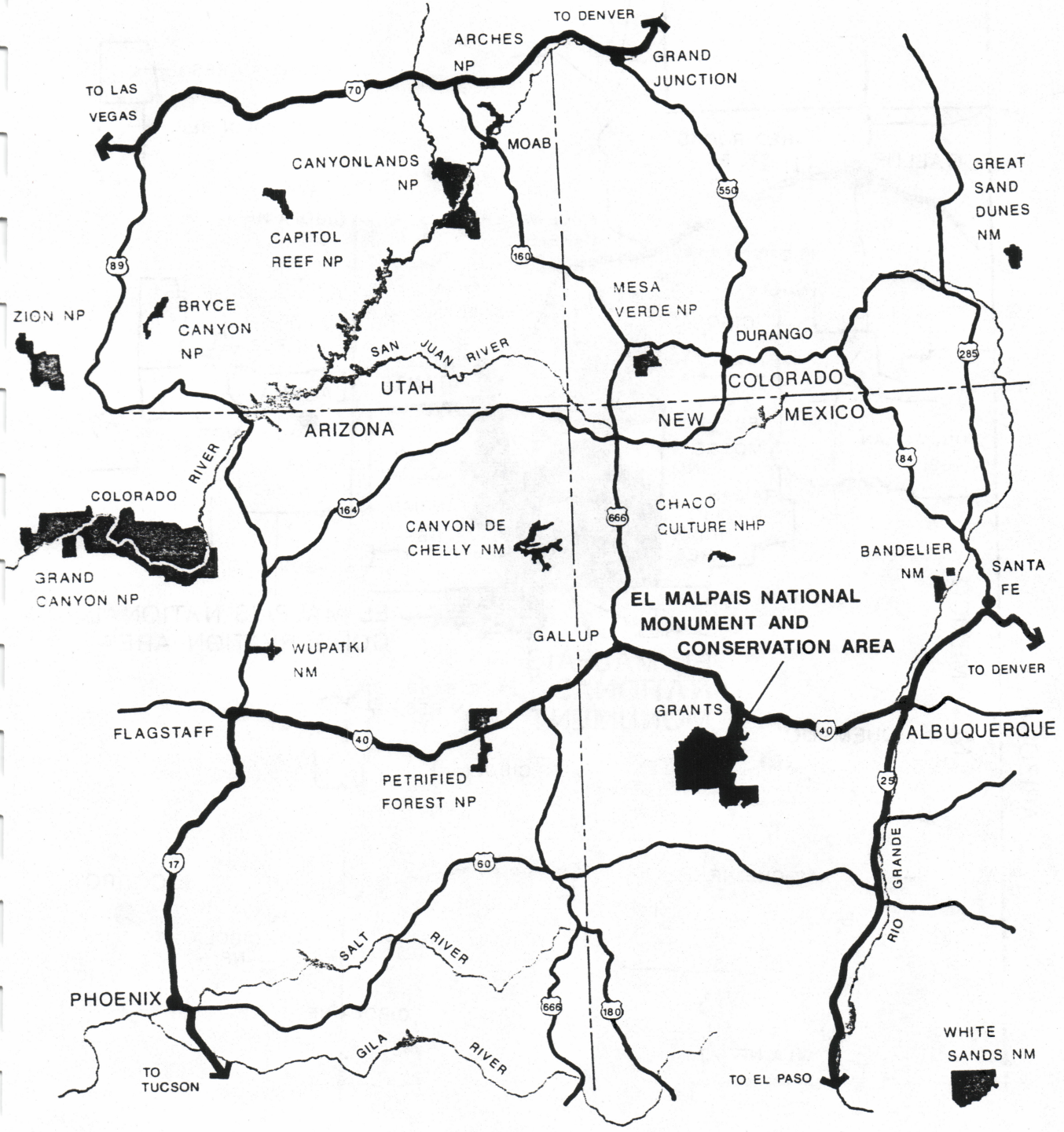
EL MALPAIS NATIONAL MONUMENT

Resource Management Plan



Prepared By: _____ 5/13/97
Resource Management Specialist — Date

Approved: _____ 5/13/97
Superintendent — Date

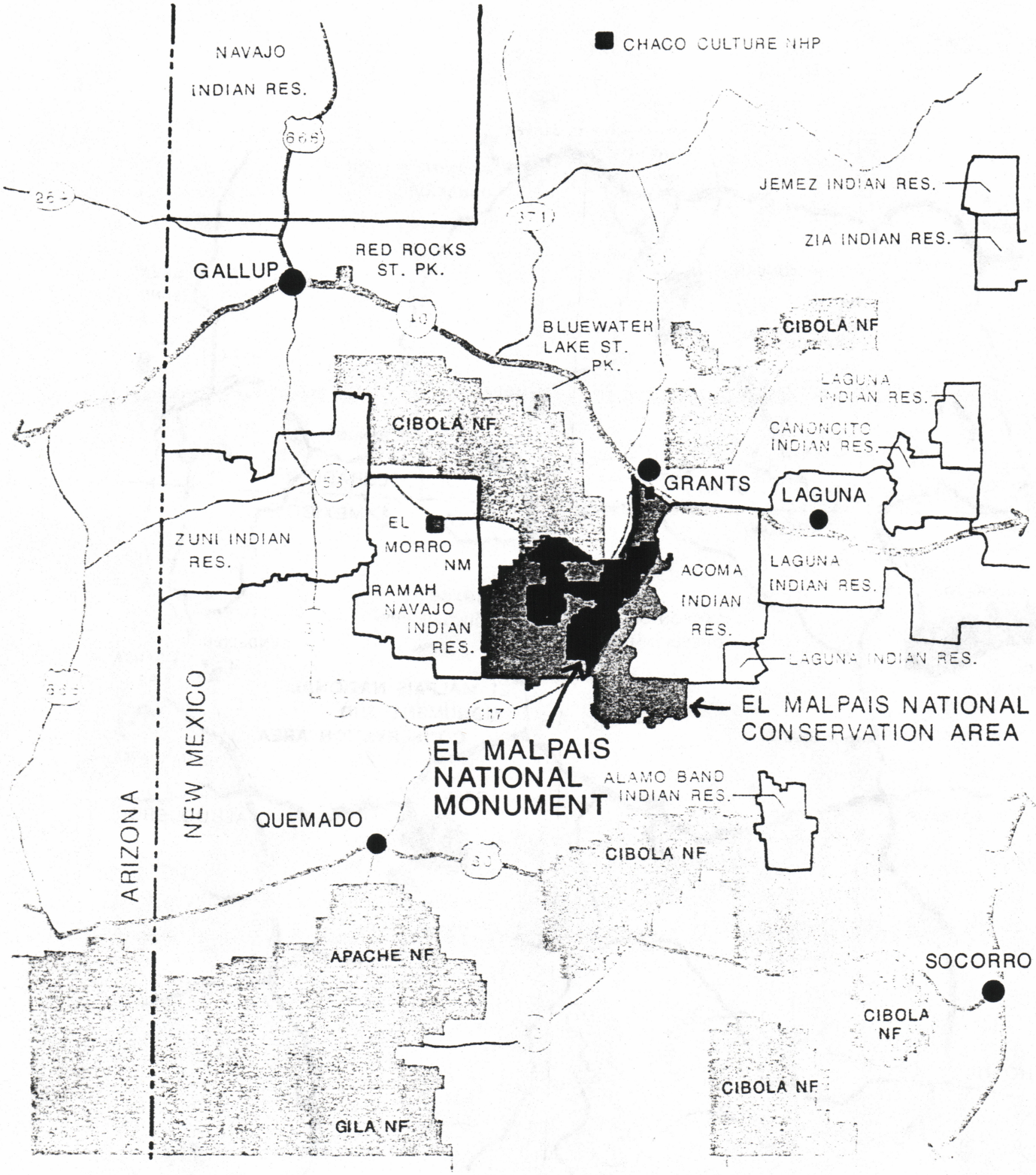


REGION

EL MALPAIS NATIONAL MONUMENT

U.S. DEPARTMENT OF THE INTERIOR / NATIONAL PARK SERVICE

DSC/JULY 1989/103/20,003



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EL MALPAIS NATIONAL MONUMENT

U.S. DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

DSC/JULY 1990/103/20,004A

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I. INTRODUCTION

This Resources Management Plan (RMP) describes, documents, and prioritizes resource management issues, problems, and actions needed to protect and enhance cultural and natural Monument resources. The RMP summarizes the purpose and values of the Monument and provides the basis for making budget requests and for measuring accomplishments against specific, documented goals and commitments. The RMP is intended for use primarily by the Monument, the Colorado Plateau Support Office, The Inter-Mountain Region, and the Washington Office staffs'; however, this plan is also a public document.

The RMP is dynamic and will be reviewed and updated annually at a minimum. This is the first comprehensive RMP completed for the Monument. Inasmuch as this document is based on the Monument's General Management Plan (GMP, 1990) and attached Environmental Assessment, no additional compliance is necessary. However, the implementation of specific projects or programs may require individual compliance review and consultation. Individual Project Statements will be revised and updated as progress, information and expertise are developed.

Project Statements make up the bulk of the document, which are prepared according to National Park Service (NPS) guidelines (NPS 77, 1991; RMP Planning Guideline, 1994). Most resource management activities conducted in the Monument are accounted for in the RMP, with the exception of some administrative activities. This Plan encompasses a range of a broad overview to specific needs and actions. Legislative mandates and management objectives are introduced. The status of each major resource type is summarized, a list of needs is identified and specific actions prescribed; funding needs and potential funding sources are identified using programming sheets, which are updated annually.

Eighteen major issues have been identified in the Monument's 1993 Statement For Management. More than 50 natural, cultural, and integrated resources project statements are included in this plan, with many more yet to be developed. All activities are prioritized within the following management strategies:

- Terminate or minimize the loss of resources/information
- Meet legal requirements
- Mitigate management and visitor caused impacts
- Mitigate external impacts
- Collect information necessary to make informed management decisions

Protecting and preventing the loss of cultural and natural resources is the prime management directive. However, some resources may be more or less sensitive/ critical than others. For this reason, some activities may shift in priority.

A wide variety of activities, including baseline inventories, long-term monitoring, resource maintenance, visitor education, management decisions, and the protection functions are integrated into this comprehensive resource management program. By describing current cultural and natural resource program/projects and proposed future program needs, this RMP serves as the Monument's primary plan for addressing

critical resource issues and problems. Additional functions of the RMP are:

- to propose specific actions, including funding and personnel required to meet the needs and problems of the resources.
- to present a multi-year program to achieve measurable progress in accomplishing the proposed actions.
- to record accomplishments and measure the effectiveness of actions through annual reviews.
- to provide a forum for an interdisciplinary approach to the Monuments' resource management issues.
- to provide the basis for subsequent action plans.

A. Park Purpose and Significance

El Malpais National Monument was established by Public Law 100-225 on December 31, 1987, for the following purposes:

> "In order to preserve for the benefit and enjoyment of present and future generations, that area in western New Mexico containing the nationally significant Grants lava flow, the Las Ventanas (Candelaria) Chacoan Outlier Archaeological Site, and other significant natural and cultural resources, there is hereby established the El Malpais National Monument..."

Mission Statement:

El Malpais preserves and protects the natural and cultural resources of the unique lava fields and associated features, and perpetuation of the ecosystem in which they are found, for the benefit of present and future generations, for traditional cultural uses and for long term scientific inquiry.

Park Purpose:

Preserve the significant natural and cultural resources associated with El Malpais lava flows and provide for the public understanding, education, and enjoyment of these resources, including wilderness resources, research and orderly scientific inquiry.

Provide for continued traditional cultural and religious practices by American Indian people, subject to legislative constraints.

Manage the areas' resources collaboratively with neighboring agencies, particularly the National Conservation Area.

To manage the Monument in compliance with the 1916 Organic Act and other laws generally associated with management of units of the National Park System and in

consultation with local Native American peoples and their cultural and religious authorities.

Significance of Park Resources:

El Malpais preserves, protects and perpetuates unparalleled examples of volcanic landforms and unique cultural features. Landforms include the finest examples of successional eruptive events, eleven volcanoes, some of the longest lava tube systems in the U.S., one of the most diverse associations of volcanic landforms. Cultural features include the Candelaria Pueblo Chacoan Outlier, archaic, Paleo-Indian and prehistoric puebloan sites, and cultural landscapes of five tribes, Spanish, Mexican, and United States exploration and settlement. The Monument provides appropriate experiences, highlighting uniqueness associated with nine major lava flows, unusual biological habitats, successional ecology, cave systems, and diverse cultural sites.

Significant specific resources continue with volcanic vents and spatter cones; numerous and extensive lava tube systems; lava caves; perennial ice caves; kipukas; lava surface features, which often display extremely stressed vegetative communities; and the dramatic lava-sandstone contact zone on its east boundary; the unusual floral habitats and associations; and the unique vertebrate and invertebrate communities and interactions.

Kipukas are usually non-lava islands completely surrounded by lava and vary from less than an acre to more that 700 acres in size. Because the lava surrounding the islands make them nearly inaccessible to domestic livestock, many kipukas appear to have experienced very little grazing. As a result, the Monument possesses islands of relatively undisturbed vegetation, which is rare in the Southwest.

The Monument consists of a complex of forested lava flows. The sources of the Monument's lava and cinder eruptions are 11 volcanic vents located within, and several outside, the Monument. The oldest flows date from half a million to over 1 million years before the present. The five recent flows are less than 250,000 years old. The most recent flow event occurred approximately 3,000 years ago. The successional ecology on these flows is producing rare specimens that are contributing valuable information on the American Southwest, and an unrealized number of other scientific interests.

B. Resource Management Goals and Objectives

El Malpais' primary resource management goals are consistent with the Monuments' Strategic Planning and the Government Performance and Results Act and include:

- preserve, understand, and protect the cultural and natural resources of the Monument within naturally functioning ecosystems, consistent with cultural resource preservation; and

- provide the means and opportunity for people to study, understand and enjoy

the resources of the Monument without compromising the resources or ethnographic values.

The Monument's resource management objectives are:

- To identify, inventory, protect, and interpret the natural resources of the Monument from an ecosystem orientation, and document critical resources for biophysical change, and modify management practices that have adverse effects on those resources based upon scientific research, assessment and monitoring, legal requirements, NPS policy, and sound management practice;

- To identify, inventory, evaluate, monitor, interpret, protect and preserve the cultural resources of the Monument in a manner consistent with scientific knowledge, legal requirements, NPS policy, and sound management practice;

- To encourage, administer, and coordinate sound scientific research of identified needs for the natural and cultural resources of the Monument;

- To identify and ensure the special protection and management of all rare, threatened and endangered species and their critical habitats, and also of unique, sensitive, and endemic plant and animal associations/communities;

- To reintroduce bighorn sheep to the Monument in cooperation with the New Mexico Department of Game and Fish, the Bureau of Land Management, and the U.S. Fish & Wildlife Service; and to identify other extirpated species for future reintroduction.

- To identify and eliminate exotic species and to prevent the introduction of new species within the Monument;

- To establish prescribed natural fire as the primary fire management strategy within the Monument. To utilize management ignited fire in those portions of the park where prescribed natural fire is not possible, due to hazardous fuels buildup, public safety, and property concerns, in a manner that simulates the natural ecosystem function of fire as determined through fire ecology/history research;

- To manage visitor use within environmental/ecosystem and social carrying capacities that promote the preservation of the Monument's natural and cultural resources;

- To preserve the Monument's wilderness resource, including its high solitude and natural quiet value;

- To secure title to the remaining private lands within the Monument boundary necessary to preserve the natural and cultural resources;

- To establish an active consultation program, and as necessary, cooperative agreements with agencies, Indian tribes, and local government to protect and maintain Monument lands and resources.

- To mitigate or minimize external threats through an active cooperative land use planning program.

- Provide natural and cultural resource information to appropriate Monument divisions to educate and facilitate management, interpretation, protection, and maintenance of these resources.

- To implement Geographic Information System (GIS) technology into operations and projects.

II. RESOURCE BASELINE INFORMATION

El Malpais National Monument is one of the more recent additions to the National Park Service system and, as a consequence, there is still a great deal of unknown information about its natural or cultural resources. National Park Service policy mandates that "natural resources be managed with a concern for fundamental ecological processes as well as for individual species and features." For this policy to be implemented, all monument management programs must be oriented toward the ecosystem as a whole rather than toward individual components.

An attempt was made during the preparation of the El Malpais National Monument General Management Plan/Environmental Assessment to compile existing resource information base source materials. Much of this material was found to be dated and not specific to the Monument. Other information that may provide a baseline for ecosystem assessment has not been searched for. Some of the information that was collected still needs to be more thoroughly investigated to determine its relevance to the Monuments' resources. In addition, relevant information, including references, need to be transferred to computer data bases. Most of the Monument land, and additional adjacent land, has been designated a National Natural Landmark.

Because very little information is available, the Monument does not meet most of the basic standards for inventory and monitoring. The Monument does have some information on biotic and abiotic elements such as geologic features, soils, vegetation, and wildlife. However, data are incomplete. Most sources have had very little inventory work and much more research is needed. Surveys or studies have not been done on water resources. There is minimal information on floodplains and wetlands. The current status of air quality is unknown. Threatened and endangered species habitat need to be identified and protected. The role and history of fire still need further investigation. Information has been gathered on vegetation and wildlife species; however, further investigations and studies are needed. Wildlife population levels and their effects on Monument ecosystems is unknown. Impacts on native plant communities and wildlife from many years of livestock grazing and logging activities are not well understood.

There is only a rudimentary understanding of the cultural resources that exist in the Monument and where they are located. Archeological survey data are severely lacking. There is also a compelling need to study how the Monuments' cultural resources fit into the context of the ancestral Puebloan peoples, the Acoma, Zuni, Laguna, Navajo and White Mountain Apache tribes, as well as into the context of

Hispanic and Anglo homesteaders and ranching. The Monument needs to be inventoried for cultural landscapes and, if appropriate, historic landscape management plans or other appropriate management tools need to be developed and implemented. A thorough understanding of the Monuments' cultural resources is essential for the effective protection, preservation, and interpretation of these resources.

Cooperation and dissemination of information among other Monument disciplines, the Bureau of Land Management (BLM), and the U.S. Forest Service (USFS) has also been lacking. The Resource Management Specialist position has only recently been filled after a very lengthy lapse. As is the case with many parks', adequate staffing and funding have not kept pace with the needs of managing resources. The other Monument Teams' (divisions) programs have been proceeding at various levels of quantity and quality without the benefit of thorough natural and cultural resources data. Of special concern are the limits that have inherently been imposed upon Management, Interpretation, Protection, and Maintenance under these circumstances.

SUMMARY TABLE OF NATURAL RESOURCES BASELINE INFORMATION

Meets, does not meet, or exceeds the
recommended minimal set of natural resources information
in Appendix A of NPS-75, the *Natural Resources Inventory and Monitoring Guideline*

INVENTORY COMPONENTS	MEETS	DOES NOT MEET	EXCEEDS
Historical Data Base		X	
Species Information		X	
Species List	X		
Biologic Surveys (Species Field Inventories)		X	
Species Distribution		X	
Vegetation Maps		X	
Cartographic Maps	X		
Soils Map	X		
Geology Map	X		
Water Resources Inventory		X	
Water Quality Data		X	
Air Quality Stations		X	
Air Quality Data		X	
Precip./Meteorological Data	X		

**New inventory components not listed in NPS-75 should be added to the table as necessary to meet individual park needs.

For a description of the inventory components see NPS-75, Appendix A.

El Malpais experiences relatively few impacts on resources in visitor use areas. Even so, based on experiences at similar units of the national park system, the Monument's resource staff is beginning to hypothesize some of the types of damage that could occur without management intervention and planning. Monitoring of visitor impacts, beginning with early establishment of baseline data, is the key to determining whether protective management is adequate and whether visitor use is impairing the very values the Monument was established to protect. The resource management staff realizes that the concepts and methodologies of visitor impact management (VIM) and limits of acceptable change (LAC) is evolving and will take advantage of these types of programs as appropriate.

The Monument's Interpretive program is challenged with multi-thematic resources. A specific interpretive prospectus has not been prepared, and staffing to develop programs, exhibits, and literature, etc., is inadequate.

Resource Protection staffing and programs are similarly inadequate. Adding to that, the geography and logistics of the Monument further inhibit regular patrols in the backcountry and the development of a monitoring program.

A. Research Program

Numerous research projects have been completed and many more are ongoing within the Monument. The Monument continues to receive requests from individuals to conduct additional research. The resource management staff identified the need to establish a list of needed research that will accomplish management objectives. A Project Statement to that effect has been developed and is included in this document. Monument specific research guidelines are being developed. Administration of a research program is lacking in all areas. The Annual Investigators' Report has been regularly completed. Listed are titles of some of the research projects that are presently underway:

Masters thesis on the Chain of Craters' Geologic History

Comparative Kipuka Ecology

Population Study of Pocket Gophers, especially in Kipukas

Doctorate on Distinguishing and Mapping Lava Flows

Study on Piñon Needle Scale

Masters Thesis on Cave Ice Formation and Dating

Bighorn Sheep Re-introduction Habitat Analysis and Plan

Cave Exploration and Mapping, Data Management

Tree Ring Analysis, Climate Chronology, Old Tree Analysis, Fire History

Writing of a Guidebook to Lava Flow Emplacement

Dating Lava Flows: General Volcanic Landforms

Lava Flow Emplacement and Characteristic Study

Cave Climate, Fire Effects on Cave Climate, and Impacts in the Six Most Heavily Visited Caves

History of Kirkland Army Air Corps Bombing Range at McCarty's Crater

Doctorate on Analysis of Bighorn Sheep Remains

Research on Indigenous Crickets

Comparative Ecology of Six Selected Caves

Piñon Pine Regeneration and Climatic Comparison

Tree Mold Lava Feature Study

B. Natural Resources - Status/Condition

1. Vegetation

The BLM completed a vegetation study of El Malpais National Monument and National Conservation Area (managed by the BLM) in 1989. Vegetation types were mapped using satellite imagery; seven major Monument vegetation zones were identified. The study is useful in general terms; however, the characteristics of the lava terrain make general, broad-scale vegetation mapping of minimal use for most resource management purposes. Additional efforts to contact the BLM regarding more recent study and applicability is necessary. A historic vegetation study will be necessary prior to any restoration efforts.

A selective vegetation inventory conducted by the University of New Mexico (1995) has brought the identified number of species of terrestrial plants within the Monument to approximately 651. The report recommended conducting intensive follow-up research in environments that may support rare or unusual plant and animal species. A comparison of this inventory with the Federal and State Threatened & Endangered (T&E) listings has been done.

El Malpais National Monument is vegetationally dominated by ponderosa pine and piñon-juniper forest, with a grass understory. Much of this plant community is maintained by periodic or recurring fire. Tree-ring dating from the fire and climate history research study provided very significant results; the Monument was identified as possessing the oldest fire scar record in the American Southwest. Some trees near Cerro Bandera have been sampled and found to have as many as 20 to 30 fire scars each. Data indicate that Monument forests experienced widespread, predominately surface fires, reoccurring on the average of every 15 years, prior to fire suppression in the early 20th century. While conducting tree-ring research, numerous Douglas fir were found that exceeded 800 years, the oldest being 1,276 years old -- most Douglas firs mature at 150 to 200 years old. Douglas fir remains have been found providing a tree-ring chronology back to 200 B.C. (2,128 years in length). Remains of a Rocky Mountain juniper have been found that date the tree at 1,888 years old when it died. This is the oldest tree to have been discovered in the American Southwest. Additional studies of old trees and their protection from loss is needed.

2. Wildlife

At the time the GMP was prepared, it was believed that the Monument supported only about 150 wildlife species. The University of New Mexico's selective vegetation and wildlife inventory identified over 300 wildlife species occurring in the Monument. Many of these previously unknown species are arthropods, including 15 that are believed to be new or undescribed species occurring only at El Malpais. In addition, melanism was found in two species of lizards. Further inventories could likely identify additional unique and rare wildlife species. It is not known what kinds of interactions wildlife species has, or are influenced by, adjacent populations or land activities.

Bighorn sheep, a New Mexico State endangered species, were extirpated from El Malpais as recently as circa 1950. This information was only recently discovered through the dating of bighorn sheep remains and oral history accounts of living Ramah Navajo hunters. The Monument needs to cooperate with the New Mexico Department of Game & Fish (NMDGF), the U.S. Fish & Wildlife Service (USFWS), and the BLM on a feasibility study of reintroducing bighorn sheep. A goal of the New Mexico Department of Game & Fish is to release sheep within the Monument in the year 2000.

A comparison between known Monument species and the Federal and State T & E lists has not been completed. No monitoring is being conducted by Monument staff at this time. A primary wildlife concern is the bat population and specific colonies found within lava tubes and caves; the concern centers around visitor use of these areas and the effects on roosting/hibernating bats, as well as human health and safety. Samples of guano and substrate cave fill tested negative for possible airborne virus's (specifically hystoplasmosis) for the one cave inhabited by the largest colony roosts. Another area of concern needing immediate attention is the potential presence of other sensitive cave fauna; however, definitive studies or inventories have not been

conducted.

3. Geology

The U.S. Department of Agriculture, Natural Resource Conservation Service completed a soil survey in 1993, which included all but about 20 acres of the Monument. This survey provided general soils information, identified their location, and included a discussion of the suitability, limitations, and management of the soils for specified uses. Monument soils are highly erosive when disturbed and not very suitable for recreation and facility development. Numerous old roads, associated with livestock grazing and logging operations, have accelerated soil erosion. There are also several old cinder pits and rock quarries that need to be reclaimed. In order to be successful, soil stabilization and reclamation techniques need to be investigated and developed.

The Monument has not been surveyed for paleontological resources, and there is potential for fossil discovery in certain formations, including Dakota sandstone, Mancos shale, San Andres limestone, and the Abo Formation. The Dakota sandstone does contain fossil plants in neighboring outcrops. Fossil tree molds have been discovered in several lava flows.

The surficial geology of the Monument is dominated by lava and cinders, but sedimentary outcrops and alluvium are also important. Volcanic events have generally been lumped together because they were not well understood. The University of New Mexico completed research to better understand the younger volcanic features. In addition, a retired geologist from the Los Alamos National Laboratory also conducting research to provide better knowledge of lava ages. The Monument currently is cooperating on a three-year lava flow emplacement and characteristic study by the U.S. Geological Survey. Additional data and research is necessary in order to gain an overall understanding of the Monument's volcanic history.

The Monument possesses hundreds of lava caves, many of which have not been surveyed, mapped, or inventoried for cave minerals, cultural resources, or scientific resources (e.g., paleo-skeletal remains, tree ring data on cave wood, etc.). The lack of cave inventory data represents a serious deficiency in the management requirements of the Monument. The local National Speleological Society (NSS) Grotto and several of their members independently have been exploring, mapping and surveying many of the lava tube caves in the Monument. An outline for a Cave Management Program that would lead to a full Cave Management Plan was presented to Grotto members in 1996 by the Monument resources staff. Grotto members will be assisting with inventory, assessments, monitoring, and public use recommendations. Individuals who have personal knowledge and documented data on caves will be providing that material to the Monument.

One of the Monuments' unique natural resources is its perennial ice caves. Although

they tend to be concentrated in the northwest corner of the Monument, they are known to occur in other areas as well. The ice caves provide a repository of paleo-climatic data that may be of considerable importance to global change research. The ice caves were used by American Indians as water sources and today have sacred value to local tribes. These caves also support very unique and fragile water-dependent plant associations and communities and provide important water sources for wildlife.

4. Hydrology

The major groundwater aquifer in the Monument is the San Andres-Glorieta. It lies about 500 feet below the surface in consolidated sedimentary rocks beneath alluvium and basalt. The Monument has very little surface water. Due to the nature of the basalt landscape, there is no apparent surface drainage system on the lava. Higher topographic areas both in and outside the Monument supply runoff from snowmelt or rain to the edges of the flows where ponding occurs. A few intermittent drainages, such as Agua Fria Creek, have been known to flow for six weeks. The Agua Fria drainage has been altered with diversion dikes, stock tanks, and visitor access facilities near El Calderon. Most all of these features seem to end in small basins along the edges of the flows. No known or obvious drainages exist that connect El Malpais to the Rio San Jose. Precipitation that does not evaporate or is not utilized by plants or animals enters the aquifer.

Permanent surface water is rarely found. There are springs just outside the Monument, but none are known to occur inside. Temporary ponds are fairly common in the El Malpais area. Most are natural, silt-bottomed depressions in the Old Basalt on the west and south sides. Tinajas (potholes) are common in sandstone outcrops throughout the Monument.

Some of the ice caves have shallow pools associated with them during the summer months. This water source is considered critical to resident wildlife; however, the full importance is not well known. Ice caves were also utilized by American Indians as a water-source. The caves continue to be important for their sacred value to people still living in the area.

Analysis performed during preparation of the GMP identified only one floodplain in the Monument in the southern part of the multi-agency center site near Grants and several ephemeral wetlands. Since that time, intermittent flows have occurred in the Agua Fria drainage at the north end of the Monument and playas and wet meadows have been identified. Additional information is needed to identify and protect floodplain and wetland resources. Truncated streams on the east side need to be evaluated.

5. Air Quality

El Malpais National Monument is designated a class II area under the 1977 Clean Air

Act (42 U.S.C. 7401 et seq.). Visual quality of the distant landscapes that form the backdrop of the major Monument features is very important to the visitor experience.

6. Wilderness

Eighty-five percent, or 97,428 acres, of El Malpais National Monument have been identified as suitable for wilderness designation (Wilderness Study Area). This figure includes potential wilderness additions of non-federal lands. These lands are managed as wilderness until such time that a final determination of status is made. A Backcountry/Wilderness Management Plan will be needed to outline specific actions and activities.

7. Grazing

The original Monument boundary was not based on resource preservation requirements or visitor use needs but, rather, on livestock grazing concerns. The boundary is very irregular, resulting in management difficulties. The Monument has approximately 157 boundary miles, of which nearly 110 miles have never been surveyed, or properly marked. That same 110 miles is presently not fenced in any way to prevent trespass by livestock. The enabling legislation of the Monument specifically allowed grazing to continue in the park until December 31, 1997; after that date, all grazing activity was to cease. A Grazing Management Plan was completed by Monument staff in 1993. An up-to-date action plan is being prepared for the eventual complete termination of grazing on Monument lands, including specific project statements, that address impact assessments, possible reseeding, exotic species control, removal of grazing improvements (e.g. stock tanks, water lines, fences, etc.).

8. Threatened and Endangered Species

There are approximately 17 threatened and endangered species known to occur and potentially occurring in the Monument. The more recent plant and animal inventories did not single out T&E species. A cross reference with current NM State and U.S. Fish & Wildlife listings has been completed. The entire Monument has not been surveyed for all possible flora and fauna, and particularly not with the intent on locating those with protected status.

9. Fire

The Monument has an approved Fire Management Plan (NPS 1992). This Plan is presently undergoing an update that will be completed in 1997. Management recognizes, on an ecological basis, the need to transition from fire suppression to a more natural process by the use of Managment Ignited Fires (MIPF) and Prescribed Natural Fires (PNF). Certain areas of the Monument will continue to be designated suppression zones in order to protect private property and public facilities.

Pre-1880 conditions of the forests, savannahs, and grasslands are considered to be the natural baseline that management will strive to replicate and dynamically maintain. The Monument has had an active MIPF program for the past five years. Future fire program operations will be directed more towards research and replicating/maintaining pre-1880 conditions as we know them. A major component of the developing Fire Management Plan is the introduction of Prescribed Natural Fire into remote areas of the Monument.

C. Natural Resources - Issues/Threats

The primary recurring issue and threat is the lack of comprehensive baseline data for all resources. Management decisions and actions must repeatedly wait for partial site specific surveys and assessments for nearly every issue, and often that information does not provide a big picture for long-term stewardship. Included with the lack of data is the need to organize a data management system. A major component of data management is developing and implementing a comprehensive Inventory and Monitoring program. Keeping up with agency and professional disciplines through technology and information sharing is insufficient.

The absence of a complete and accurate boundary survey, and posting, and fencing, perpetuates incompatable and illegal activities within the Monument. Activities include: trespass grazing, hunting/poaching, firewood cutting, archaeological site looting, vandalism, off-road-vehicle use, and unauthorized entry and activities in closed or sensitive caves.

Outside the Monument, mines, roads, powerlines, houses, and other types of development negatively affect Monument viewsheds and need to be regularly monitored for potential impacts on Monument resources. The Monument is virtually surrounded by the congressionally designated BLM National Conservation Area, except for an area of private land and USFS property at the northern boundary along State Highway 53 and an area on the east side along State Highway 117 belonging to the Acoma Pueblo.

In addition, approximately 7,987 acres of inholdings remain to be acquired within the Monument boundary, adding to management difficulties. Within the Monument, the lava margins include most of the visual evidence of human use and development. These areas have been heavily grazed and logged, and some contain roads and highways as well as overhead and buried powerlines. The Monument also has cinder mining pits, a 25-acre borrow pit, and an old sandstone quarry. None of the pits or the quarry are used today.

The Monument is receiving an increasing number of requests to conduct research and scientific study. Most of the requests have been compatible with park needs and resource protection standards. However, some requests have been suspect to

legitimacy and research ethics. Fortunately, those in the latter group were not approved and their numbers were small. The need for a sound and consistent research program guideline and standards has been identified by Monumnent staff. Until that program is developed, the Monument may be subject to abuse and the loss of resource(s) information collected by the scientific scholars.

Coordination of management actions and plans with the Acoma, Ramah Navajo, Zuni, Laguna, and White Mountain Apache Tribes was initiated early in the planning of the Monument to meet the requirements of the Monuments' enabling legislation for religious freedom and privacy requirements of American Indian people. These coordination efforts will continue and will be enhanced through an agreement being proposed in the very near future. Until then, communications and consultation will proceed as necessary on a case-by-case basis. The visiting public and area residents need to be made more aware of this special relationship and traditional associations to the Monument.

Because of the close proximity and considerable acreage of the BLM's National Conservation Area and the Cibola National Forest lands surrounding the Monument, it is necessary to closely coordinate management activities with these agencies. Common concerns of efficiency and effectiveness indicate that cooperation with these agencies regarding interpretation, fire, wilderness, natural and cultural resources, visitor safety, and law enforcement need to be strengthened.

D. Cultural Resources - Status/Condition

1. Archeology

About two percent of the Monument has been surveyed by archeologists. It is believed that there is evidence of seven human cultural periods within the Monument boundaries including:

Paleo-Indian period.....B.C. 9,000 to B.C. 5,500
Archaic period.....B.C. 5,500 to A.D. 100
Basketmaker period.....A.D. 100 to A.D. 400
Pueblo period.....A.D. 400 to A.D. 1540
Spanish period.....A.D. 1540 to A.D. 1822
Mexican period.....A.D. 1822 to A.D. 1846
United States period.....A.D. 1846 to present

Presently, there are 82 documented archeological sites in the Cultural Resource file. Documentation of archeological sites in El Malpais is a slow process with no full-time Archeologist in the Monument. Surveys are completed mainly for section 106 compliance for prescribed burn areas. There is a great need for more surveys because only a small percentage of the park has been 100% surveyed. Most of the

known information comes from a limited variety of survey sources, prescribed burn areas, reconnaissance, and assessment surveys. There have been five known, 100% surveys conducted and all culturally significant sites are flagged for prescribed burn personnel and activity avoidance. Reconnaissance surveys also yielded information but, are not as thorough because surveyor's only included known located sites. The State Highway Department conducted assessment surveys along the corridor of State Highway's 53 and 117, which border National Park lands. Other recent work includes the Candelaria Pueblo and trail assessment proposal. El Malpais has submitted data reports and staffing proposals for the Vanishing Treasures Initiative.

2. Ethnography

Ethnographic information is limited. Most of the material available was compiled by the BLM. A Traditional Indian Land Use Study of El Malpais was prepared by Barbara Holmes in 1989. The BLM, aided by volunteers, has also conducted oral history interviews on the homesteaders of El Malpais from the 1930's. These interviews are currently being transcribed and corrected and will be shared upon completion. In 1990, Neil Mangum, wrote the book In the Land of Frozen Fires. This book gives the history of El Malpais area from Native American to Anglo occupation. There were also oral history interviews with the Ramah Navajo concerning big horn sheep in the Monument area. El Malpais has been included in a multi-park Ethnographic Overview and Assessment study, along with El Morro and Petrified Forest, beginning in 1997.

3. Historic Structures

Information concerning Historic Structures in El Malpais is contained in the List of Classified Structures (LCS). The LCS is updated annually for any changes in structure status, such as damage caused naturally or by vandalism. There has never been a complete historic structure survey, inventories, or assessments in the park. Other structures in the park are identified, including those still in private ownership; however, without a proper inventory or survey, there is very little documentation.

4. Collections

Information concerning collections for El Malpais is taken from the Collections Management Report (CMR). This report is completed annually by park staff. Information in the CMR concerns the number of items in the Monument collection that have been and need to be catalogued. The collections are stored in an approved facility under lock and key, and the building is equipped with temperature and climate control. The collection currently houses items from archeology, ethnology, history, geology, and archives for El Malpais and El Morro National Monuments. The Monument does not have a Scope of Collections Statement or a Collections Management Plan.

5. Cultural Landscapes

El Malpais National Monument may be described as a potential cultural landscape (specifically, an ethnographic cultural landscape). A Traditional Indian Use Study was completed in 1989 by the BLM. An inventory and evaluation of the El Malpais landscape will confirm the type or types of cultural landscapes that exist in the Monument.

An all too common situation in many parks, particularly newer areas such as El Malpais NM, is the inadequate number of staff to properly develop and implement a comprehensive resource management program. The Resource Management Specialist position was filled in the fall of 1995, after being vacant for three plus years. The variety and amount of basic resource program planning, inventory and assessment, action plan development and implementation that is needed is overwhelming. Other park staff have assisted with resource operations, as the need arose, with only a limited effect.

The NPS Resource Professionalization Initiative and related NR-MAP/CR-MAP, and VRAP surveys have supported the identified need for a number of additional full-time employees in resources management. A position/staffing assessment was prepared several years ago however, that assessment was in need of re-evaluation based on more accurate resource programming knowledge and the workload necessary to implement individual programs. An up-dated position/staffing recommendation is included below. Monument base funding has not been increased to allow filling any number of those positions. Annual resource operations funding in the Monument is enough to basically cover the permanent resource specialist, a General Services Administration (GSA) lease vehicle and very little else. In comparison to the Monument ONPS budget, resources management is allocated only about 7% of the total. A recommendation to management is to re-evaluate the current Monument organization of human resources and funding to more equitably support resources management operations. Any seasonal employee positions are contingent upon soft project monies, of which there has been virtually none. Volunteers have sporadically provided assistance with programs but, with very little direction and consistency from season to season the past several years.

E. Cultural Resources - Issues/Threats

Little information has been gathered on the cultural resources of El Malpais. Presently, only a small number of documented sites are recorded in the Cultural Resource files. Documentation of archeological sites and structures in the Monument is a very slow process, with no full-time cultural resource staff. There have been five cultural resource surveys conducted since 1988, covering less than two-percent of the total Monument acreage.

Threats to Monument resources are believed to be many, especially since much of the Monument has not been surveyed, inventoried or documented. The unknown cultural remains, whether they are Native American, Hispanic, or Anglo, are threatened by potential pilfering and destruction by humans . These, as yet, unknown resources make it nearly impossible to manage and protect from natural and human disturbances. Pot-hunting and associated cultural resource vandalism has occurred at El Malpais for at least the past half-century. This activity has ranged from recreational pot-hunting on weekends by local residents to organized efforts involving the use of helicopters by criminals. This illegal activity is continuing. As recently as 1992, an organized pot-hunting/treasure-hunting group was arrested in the park. Any reasonable estimate of damage by livestock is incomplete.

Known cultural sites range, in time, from about B.C. 9,000 to contemporary Pueblo, Navajo, homesteading, and World War II bombing ranges. The west side of the Monument contains a proliferation of lava ring structures that are not clearly identified with any one culture, while the east side of the Monument is dominated by identified puebloan and homesteading sites. There are two Chacoan communities (A.D. 800-1350) on the National Register of Historic Places in the Monument.

Also of interest are the prehistoric trails that cross the lava flows with constructed bridges spanning the larger cracks in the lava. These trails are believed to have been used for trade routes as well as access to hunting, gathering, and ceremonial sites between the various Indian groups in the El Malpais area.

Consultation with the Native American groups that claim traditional use of the park's resources must be taken into consideration as a common courtesy and as directed by the Monument's enabling legislation. Consultation will also take place for any circumstances related to the Native American Graves and Repatriation Act (NAGPRA) and to the American Indian Religious Freedom Act (AIRFA).

The Monument has four structural homestead site remains and the prehistoric cairn Zuni-Acoma trail. Years of neglect, vandalism and natural climatic elements have caused a considerable amount of structural damage and fabric loss.

III. RESOURCES MANAGEMENT PROGRAM

A. Current Natural Resources Program and Needs

Staffing consists of one permanent full-time Resource Management Specialist with program responsibilities for both natural and cultural resources. The Monument's Management Assistant also has duties in Resource Stewardship and Partnerships relative to external affairs and some specific project coordination. The need for additional staffing to implement action plans and conduct inventory and monitoring is still a major factor in accomplishing ecological resources management. The

Monument's NR-MAP staffing assessment has identified the need for additional positions in order to properly manage and conduct resources management. It is hoped that the National Park Service Resource Professionalism Program will come to fruition in the very near future to supply the necessary funding for the new positions. Until such time, many programs and projects will be implemented behind schedule or not at all.

The following **additional full-time position/staffing needs** are based on NR/CR-MAP surveys and identified program workload:

Position	Priority	FTE
Inventory & Monitoring Specialist	1	1
Biologist	1	1
Botonist	1	1
Geologist	1	1
Cave Management Specialist	1	1
GIS/Data Management Specialist	2	1
Archeologist	1	1
Resource Interpreter	1	2
Ethnographer	2	.5
Curator/Data Management Specialist	2	.5

Base Operations National Park Service (ONPS) funding to support seasonal employees has not been available. Soft "project" monies have been the only source of funds for any temporary staff, and even that has not provided more than a couple of months of staff time. The same is true of Volunteers who have sporadically assisted with programs. In addition to the lack of funding to hire temporary employees or the ever dwindling financial support for the Volunteers In Park's, is the time consuming and inefficient reality of repeated training/orientation, and the inconsistency of method application with the seasonal or annual turnover of individuals.

The current operating program includes the development of this Resources Management Plan from which all future action plans, project statements, and needs identification will stem. As addressed throughout the narrative of this document, many projects and programs have and are being initiated or accomplished including research by investigators outside the NPS. A primary focus for the near future is to identify, organize, and prioritize the resource's needs and develop strategies to address and accomplish those needs. Most of the critical needs have already been listed in this plan, and more specifically, in the project statements. These are not all-inclusive and will be added to or revised as necessary and as they are completed.

Annual and specific reports and updates are completed and on file as required. The submission of projects for special program funding occurres as staff becomes aware of

a program and time is available for polishing and submitting a proposal. After the RMP is finalized, the Resources Management Specialist will ensure that all future project submissions are complete, up-to-date, quality documents in order to remain competitive in the evaluation process. With the full-time resources specialist on staff, the number of project submissions for the varying special emphasis programs will also increase.

B. Current Cultural Resources Program and Needs

The annual Collection Management Report shows the status of the collection is favorable and currently well managed. The collection houses archeological, historic, biological, geological and archival collections from both El Malpais and El Morro National Monuments. There is no full time curator for the Monuments' collections. Currently the position is a collateral duty, and duties are performed when there is available time to devote to the growing backlog collection. No scope of collection statement has been written that outlines procedures and appropriateness for collections.

Additional complete and comprehensive surveys and assessments are imperative for an overall understanding of the Monument and surrounding area. Cultural Landscapes, Ethnographic Resources, Archeological, and Historic site surveys and inventories have never completely been done and are critically needed. These surveys are important to understand the traditional, prehistoric, and historical use as well as to properly manage and protect the resources.

The Monuments' Resources Management Specialist is the person responsible for both natural and cultural resources. The Monuments' CR-MAP assessment has identified the need for additional full-time staff (listed with natural resources in the previous section and not all-inclusive) to adequately manage the cultural resources program. Cultural resources have been given less attention than natural resources, resulting in the lack of knowledge and data. This unbalanced program management will be remedied, and quality project statements will be submitted for special emphasis funding as staffing and time allows.

C. Summary

In summary, the most significant issues currently facing El Malpais National Monument are:

Insufficient resource management staff (natural and cultural) and funding support.

Lack of basic resource data (natural and cultural).

No complete and accurate boundary survey, marking, or fencing.

Lack of an automated/digital data base system to facilitate data storage, retrieval.

Lack of a long-term monitoring program (biotic and geophysical) to ascertain impacts to Monument resources and direct management actions.

Inadequate understanding of social science and visitor impacts.

Inadequate science/research program.

Considerable private property still needs to be negotiated for purchase.

CULTURAL RESOURCE DOCUMENTATION CHECKLIST

Place an X in the appropriate column. Leave columns blank if document is not required for the park. Remember that items in the first section, PLANNING DOCUMENTS, may also apply to natural resources. See NPS-28, Chapter 2 for description of each inventory or study.

TITLE	CURRENT AND APPROVED	INCOMPLETE; NEEDS REVISION OR UPDATING	NEEDED
Preauthorization and Authorization			
Statement of Management (SFM)	X		
Outline of Planning Requirements (OPR)		X	
General Management Plan (GMP)	X		
Development Concept Plan (DCP)	X		
Resources Management Plan (RMP)		X	
Interpretive Prospectus (IP)		X	
SERVICEWIDE INVENTORIES, LIST, CATALOGS AND REGISTERS			
Cultural Resources Bibliography (CRBIB)		X	
Cultural Sites Inventory (CSI)			X
List of Classified Structures (LCS)	X		
National Catalog of Museum Objects			X
National Register of Historic Places		X	
BASIC CULTURAL RESOURCE DOCUMENTS			
Archeological Overview and Assessment			X
Archeological Identification Studies			X
Archeological Evaluation Studies			X

CULTURAL RESOURCE DOCUMENTATION CHECKLIST

TITLE	CURRENT AND APPROVED	INCOMPLETE; NEEDS REVISION OR UPDATING	NEEDED
BASIC CULTURAL RESOURCE DOCUMENTS (cont.)			
Ethnographic Overview & Assessment			X
Ethnographic Oral Histories & Life Histories			X
Ethnographic Program			X
Historical Base Map			X
Park Administrative History			X
Scope of Collection Statement			X
SPECIAL RESOURCE STUDIES AND PLANS			
Archeological & Ethno. Collections Studies			X
Archeological Data Recovery Studies		X	
Collection Management Plan			X
Collection Storage Plan			X
Collection Condition Survey			?
Cultural Landscape Report (CLR)			X
Ethnohistory			X
Exhibit Plan			X
Historic Furnishing Report	N/A		
Historic Structure Preservation Guide (HSPG)			X
Historic Structure Report			?
Social Impact Study			X
Special History Study			X
Traditional Use Study			X

SUMMARY CHART FOR ARCHEOLOGICAL SITES

Significance		CONDITION					IMPACTS				DOCUMENTATION		
		Good	Fair	Poor	Destroyed	Unknown	Severe	Moderate	Low	Unknown	Good	Fair	Poor
National													
State & Regional													
Local													
Not Evaluated	82	49	6	15	1	11	15	6	48	13	2	19	61
TOTALS	82	49	6	15	1	11	15	6	48	13	2	19	61

SUMMARY CHART FOR STRUCTURES

Significance		CONDITION					IMPACTS				DOCUMENTATION		
		Good	Fair	Poor	Destroyed	Unknown	Severe	Moderate	Low	Unknown	Good	Fair	Poor
National	2	2							2		2		
State & Regional													
Local													
Not Evaluated	72	32	8	22		8	22	6	33	9	22	25	23
TOTALS	74	34	8	22		8	22	6	35	9	24	25	23

SUMMARY CHART FOR OBJECTS

DOCUMENTATION Form 10254 Submitted to National Catalog at Harper's Ferry	Archeology	Ethnology	History	Archives	Biology	Paleontology	Geology	TOTALS
Registration Data Only					4			4
Registration & Catalog Data	18	1	10	6	54		9	98
Total Items Cataloged	18	1	10	6	58		9	102
Backlog to be Cataloged				(1020)[1]	(2700)			(3720)
Total Collection Summary	18	1	10	(1026)	(2758)		9	(3822)

CONDITION The percentage of collection in the following categories:	Archeology	Ethnology	History	Archives	Biology	Paleontology	Geology
Excellent							
Good	100	100	100	100	100	0	100
Fair							
Poor							
Unknown							

[1] All numbers in parenthesis () are estimates.

SUMMARY CHART FOR CULTURAL LANDSCAPES

Significance		CONDITION				IMPACTS				DOCUMENTATION		
		Good	Fair	Poor	Unknown	Severe	Moderate	Low	Unknown	Good	Fair	Poor
National												
State & Regional												
Local												
Not Evaluated	1				1							
TOTALS	1[2]				1							

[2] El Malpais is considered to be one cultural landscape for the time being. No cultural resource survey has ever been done for the park.

SUMMARY CHART FOR ETHNOGRAPHIC RESOURCES

NUMBER	DOCUMENTATION LEVEL				NATIONAL REGISTER	AUTHORITY	NON-RECREATIONAL USE
	good	fair	poor	unknown			
SITES	2	19	61				
STRUCTURES	24	25	23		2L	O	
OBJECTS	(3822)						
NATURAL RESOURCES				X[3]			
ETHNOGRAPHIC LANDSCAPES				1[4]			

[3] There are no Natural Resource surveys for El Malpais at this time.

[4] For the time being the entire park is considered an Ethnographic Landscape, until a survey for the park is taken.

PERSONNEL TABLE

FY: 1997
Park: ELMA
Cluster: CPSO

TYPE OF NPS EMPLOYEE	FTEs OF RESOURCES WORK		
	Natural	Cultural	Total
Research Scientists	0.0	0.0	0.0
Resources Specialists	0.7	0.3	1.0
025 Park Rangers Res Mgmt	0.3	0.2	0.5
025 Park Rangers Res Prot	1.0	1.0	2.0
025 Park Rangers Res Interp	1.5	0.5	2.0
Maintenance Personnel	1.5	0.0	1.5
Total of RES Personnel	5.0	2.0	7.0
TOTAL PARK FTE: 14.0 PERCENT	35.7%	14.3%	50.0%

FUNDED TABLE
CULTURAL/INTEGRATED/NATURAL
FUNDED AMOUNTS
($ in thousands - by activity type)

FY: 1997
Park: ELMA
Cluster: CPSO

FUNDING SOURCE	TOTAL	RES	MIT	MON	PRO	INT	ADM
PCR1	6.00	0.00	0.00	0.00	0.00	0.00	6.00
PNR1	1.00	0.00	0.00	0.00	0.00	0.00	1.00
TOTAL	7.00	0.00	0.00	0.00	0.00	0.00	7.00

FUNDED TABLE
RESOURCE TYPE
FUNDED AMOUNTS
($ in thousands - by Resource Type)

FY: 1997-2000
Park: ELMA
Cluster: CPSO

RESOURCE TYPE	1997	1998	1999	2000	TOTAL
Cultural	6,000	0	0	0	6,000
Integrated	0	0	0	0	0
Natural	1,000	0	0	0	1,000
Subsistence	0	0	0	0	0
TOTAL	7,000	0	0	0	7,000

UNFUNDED TABLE
CULTURAL/INTEGRATED/NATURAL
UNFUNDED AMOUNTS
($ in thousands - by funding type)

FY: 1997-2000
Park: ELMA
Cluster: CPSO

FUNDING TYPE	TOTAL	RES	MIT	MON	PRO	INT	ADM
Onetime	1505.90	1207.00	32.00	0.00	221.40	0.00	45.50
Recur.	7580.61	785.00	1759.01	541.50	177.00	106.00	4212.10
TOTAL	9086.51	1992.00	1791.01	541.50	398.40	106.00	4257.60

UNFUNDED TABLE
RESOURCE TYPE
UNFUNDED AMOUNTS
($ in thousands - by Resource Type)

FY: 1-4
Park: ELMA
Cluster: CPSO

RESOURCE TYPE	1	2	3	4	TOTAL
Cultural	283,500	360,000	261,600	127,500	1,032,600
Integrated	1,722,000	1,842,000	1,527,510	424,000	5,515,510
Natural	564,400	717,000	667,000	590,000	2,538,400
Subsistence	0	0	0	0	0
TOTAL	2,569,900	2,919,000	2,456,110	1,141,500	9,086,510

Bibliography

Kirtland Demolition Bombing Range El Malpais National Monument Grants, New Mexico, May 7-21, 1994 AT-94: Comander's Ordinance Information Guide. 669th Ordnance Detachment (EODCT). , 1994.

Removal Report for the Kirtland Demolition Bombing Range Ordnance Removal Project El Malpais National Monument Grants, New Mexico. ---. , 1 July 1994.

"Affected Environment: Natural Resources." General Management Plan/Environmental Assessment Wilderness Suitability Study [Review Draft]. El Malpais National Monument. , Aug. 1989.

Aldridge, Mr., Mrs Aldridge, and Mr. Bright. "History of South Highway 57." 13 Sept. 1987.

A Classification of Forest Habitat Types of the Northern Portion of the Cibola National Forest, New Mexico. Billy G. Alexander, E. Lee Fitzhugh, Frank Ronco, et al.

Geological and Geophysical Investigations of the Zuni-Bandera Volcanic Field, New Mexico. Mark E. Ander, Grant Heiken, John Eichelberger, et al. , May 1981.

"Appendix 1. El Malpais National Monument/Sevilleta LTER: Vegetation and Wildlife Inventory Research Plan for El Malpais National Monument." Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. David C. Lightfoot, David L. Bleakly, Robert R. Parmenter, et al. , Apr. 1994.

"Appendix 10. Introduced Vascular Plant Species of El Malpais National Monument." Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. ---. , Apr. 1994.

"Appendix 11. Vascular Plant Taxa Newly Identified at El Malpais National Monument." Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. ---. , Apr. 1994.

"Appendix 12. Vascular Plant Taxa Newly Identified at El Malpais National Monument." Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. ---. , Apr. 1994.

"Appendix 13. Vegetation Inventory Plans Species Records Database." Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. ---. , Apr. 1994.

"Appendix 14. Vegetation Inventory Off-Site Plant Species Records." Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. ---. , Apr. 1994.

"Appendix 15. Vegetation Inventory Off-Site Plant Species Records." Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. ---. , Apr. 1994.

"Appendix 16. Lichen Species Substrate Records." Vegetation and Wildlife Inventory of El Malpais National Monument, Final

Report. ---. , Apr. 1994.

"Appendix 17. Vascular Plant Taxa Found at One Site." Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. ---. , Apr. 1994.

"Appendix 18. Mammal Species List for El Malpais National Monument." Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. ---. , Apr. 1994.

"Appendix 19. Bird Species List for El Malpais National Monument." Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. ---. , Apr. 1994.

"Appendix 2. Monthly and annual precipitation and temperature data for El Morro National Monument and Grants Airport." Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. ---. , Apr. 1994.

"Appendix 20. Amphibian and Reptile Species List for El Malapis National Monument." Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. ---. , Apr. 1994.

"Appendix 21. Arthropod Species List for El Malpais National Monument." Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. ---. , Apr. 1994.

"Appendix 22. Wildlife Inventory Animal Species Records Database." Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. ---. , Apr. 1994.

"Appendix 23. Wildlife Inventory Off-Site Animal Species Records." Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. ---. , Apr. 1994.

"Appendix 24. Wildlife Animal Species Sorted by Frequency of Observation." Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. ---. , Apr. 1994.

"Appendix 25. Wildlife Inventory Animal Species Sorted by Sums of Individual Counts." Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. ---. , Apr. 1994.

"Appendix 5. El Malpais Vegtation and Wildlife Inventory site names sorted by site code." Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. ---. , Apr. 1994.

"Appendix 6. Inventory Site Information Records." Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. ---. , Apr. 1994.

"Appendix 7. List of Vascular Plant Taxa of El Malpais National Monument." Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. ---. , Apr. 1994.

"Appendix 8. Annotated List of Vascular Plant Taxa of El Malpais National Monument." Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. ---. , Apr. 1994.

"Appendix 9. Cryptogram Species Listings for El Malpais National Monument and Source of Records Information." Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. ---. , Apr. 1994.

"Appendix M: Principal Lava Features in the National Monument AND Appendix N: More Detailed Information About Bandera Crater and the Bandera Lava Tube System." General Management Plan/ Environmental Assessment Wilderness Suitability Study [Review Draft]. El Malpais National Monument. , Aug. 1989.

Arbelbide, Sylvia J., Michael J. Duwe, and Sharon P. Kliwinski. "Controlling Nonfederal Mineral Development Other Than Oil and Gas in Units of the National Park System." , 1 Aug. 1989.

Bandera Crater Area Surface Feature Inventory and Trail Recommendation Photos. Author unknown.

Bandera Crater & Ice Cave: A State Park Feasibility Study. ---. , Jan. 1986.

---. "The Ecology of Fire at El Malpais." Mar. 1990.

---. "El Malpais Special Supression Plan (Albuquerque and Socorro Districts)." 16 Jan. 1976.

El Malpais National Monument Compendium: Code of Federal Regulations, Title 36, Chapter 1. ---. , 1993.

---. "Environmental Analysis Record for El Malpais Natural Area." no date.

---. "Environmental Analysis Record Number 30-010-5-44 Escalante Trail (Route) Development." no date.

---. File Folder: Threatened and Endangered Species. no date.

---. "File: Soils." no date.

---. "Fort Wingate bison move to El Malpais." New Mexico wildlife (11 May 0993):

---. "Legal Description of El Malpais National Conservation Area, El Malpais National Monument, Cebolla Wilderness Area, and West Malpais Wilderness Area." 1990.

---. "Mexican Spotted Owl Questions Answers -- ELMA." 27 Aug. 1990.

---. "Navajo Ice Cave Survey - El Malpais and Brewer's pit (data)." 1989.

---. "NM K/Ar Dates." 1990.

---. "Rare and Unique Plants Suspected of Occuring in or Near Malpais National Park." no date.

---. "Special Resources at Risk Identification and Ranking El

Malpais National Monument." 1991.

---. "Table 1 El Malpais Federal Grazing Allottees and AUM's." 1989.

---. "UTM Coords for Ice Caves." 1990.

Baker, I., and W. I. Ridley. "Field Evidence and K, Rb, Sr data bearing on the origin of the Mount Taylor Volcanic Field, New Mexico, U.S.A." Earth and Planetary Science Letters (1970):

Excursion 8A: Magmatism Associated with Lithospheric Extension: Middle to Late Cenozoic Magmatism of the Southeastern Colorado Plateau and Central Rio Grande Rift, New Mexico and Arizona. W. S. Baldridge, F. V. Perry, D. T. Vaniman, et al. , May 1989.

Baldridge, W. S., F. V. Perry, D. T. Vaniman, et al. "Middle to Late Cenozoic Magmatism of the Southeastern Colorado Plateau and Central Rio Grande Rift (New Mexico and Arizona, USA: A Model for Continental Rifting." Tectonophysics (1991):

Bandera Crater Area.

Bassett, W. A., P. F. Kerr, and O. A. Schaeffer. "Potassium-Argon Ages of Volcanic Rocks Near Grants, New Mexico." Geological Society of America Bulletin (1963):

Integrated Pest Management Guide: Southwestern Dwarf Mistletoe, Arceuthobium vaginatum subsp. cryptopodum (Engelm.) Gill, in Ponderosa Pine. Jerome S. Beatty. , Sept. 1982.

Beesley, Steve. "Fire and Ice: Being a few Words on What's Hot and What's Not in El Malpais NM." Courier (Mar. 1990):

Beta Analytic Inc. "Report of Radiocarbon Dating Analyses." 27 Aug. 1993.

Bighorn Water (potential) and remains map. 5 Dec. 1990.

Mineral Resource Potential of the El Malpais Instant Study Area and Adjacent Areas, Valencia, New Mexico. Philip R. Bigsby, and Charles H. Maxwell. , 1981.

Bleakly, David L. Flora and vegetation of El Malpais National Monument area, New Mexico. Diss. , 1994.

Boundary Map. 1990.

Brewer's Cave (Lava Tube) Valencia County - New Mexico Elevation 7,480 Feet. 1989.

Bright, John W. Oct. 1980.

Brookins, D. G., J. R. Carden, and A. William Laughlin. "Additional Note on the Isotopic Compostion of Strontium in McCartys Flow, Valencia County, New Mexico." Earth and Planetary Science Letters (1975):

Brooks, Scott, Pat O'Connell, and Duke McMullan. "Trip to Lava Roll Cave, El Malpais National Monument, 02 Jun 90." 1990.

El Malpais Natural Area Recreation Activity Plan. Bureau of Land Management. , 1973.

El Malpais Proposed Wilderness Area Final Environmental Impact Statement and Wilderness Study Report. ---. , 1981.

El Malpais Proposed Wilderness Area: US Department of the Interior Draft Environmental Impact Statement and Wilderness Study Report. ---. , 1981.

El Malpais National Conservation Area [Preliminary Draft]. ---. , Sept. 1989.

El Malpais National Conservation Area General Management Plan and Environmental Assessment [Draft] and [Final]. ---. , Apr. 1990.

Multiple-Use Management, A Plan for the Grants Lava Flows and Surrounding Areas. ---. , 1972.

Wilderness Report El Malpais Natural Area. ---. , 1980.

Carden, J. R., and A. William Laughlin. "Petrochemical Variations within the McCartys Basalt Flow, Valencia County, New Mexico." Geological Society of America Bulletin (1974):

Carlsbad Caverns/East and West, Texas and New Mexico. 1940.

Carlsbad Caverns/Guadalupe Mtns. Nat. Parks Mountain Lion Ecology Study: Home Ranges. Sept. 1984.

Cave Management Recommendations. Kent Carlton. , 8 Nov. 1988.

Carlton, Kent. "Debris Burn Plan El Malpais National Monument." 10 Dec. 1991.

El Malpais National Monument Lava Tube System Resource Inventory Report. Kent Carlton. , 8 Nov. 1988.

Carlton, Kent. "El Malpais National Monument Bandera Crater Area Surface Feature Inventory and Trail Recommendation Report." 16 Jan. 1989.

---. "Junction Cave: Hibernating Bat Inventory." 9 Jan. 1992.

---. "National Natural Landmark Nomination Evaluation Zuni Ice Cave El Malpais National Monument New Mexico." no date.

Preliminary Evaluation of the Biota of the Lava Tube Systems of El Malpais National Monument. Kent Carlton. , 8 Nov. 1988.

Species List of Plants Commonly Associated with the Lava Tube Systems of El Malpais National Monument. ---. , 8 Nov. 1988.

Untitled: Lava Tube Survey Slides. ---.

Carlton, Kent, and Christopher G. McKee. "Minerals and rock forms in lava tubes of El Malpais National Monument, Cibola County, New Mexico." Abstracts; New Mexico mineral symposium. New Mexico Geology. , 1990.

Carroll, Crista Sue. Geographic technologies and biophysical land units applied to resource management. Diss. , 1989.

Cascadden, Tracey E. "Progress Report #1 Sub-Agreement No. 5 Cooperative agreement No.1 CA-7029-1-0012 Between National Park Service, Southwest Regional Office and the University of New Mexico at Albuquerque for Geological Investigations at El Malpais National Monument." 29 Oct. 1992.

---. "Progress Report Geological Investigations at El Malpais National Monument." 30 Sept. 1993.

---. "Progress Report Geological Investigations at El Malpais National Monument." 10 Jan. 1994.

Causey, James Douglas. Geology, Geochemistry, and Lava Tubes in Quaternary Basalts, Northeastern Part of Zuni Lava Field, Valencia County New Mexico. Diss. , 1971.

Chamberlin, Richard M., Orin J. Anderson, Spencer G. Lucas, et al. "Second-day road log, from Grants to El Malpais, Fence Lake, Zuni Pueblo and Gallup." Southeastern Colorado Plateau. N.M. Bur. Mines and Miner. Resour., Socorro, NM, United States. Guidebook New Mexico Geological Society. , 1989.

Classic Cave Cibola County New Mexico. 1989.

Cleary, Dave. "Birds of Zuni, the Zuni and Chuska Mountains, and Surrounding Areas." 1988.

Condit, Christopher D., L. S. Crumpler, Jayne C. Aubele, et al. "Patterns of Volcanism Along the Southern Margin of the Colorado Plateau: The Springerville Field." Journal of Geophysical Research (1989):

Principal Aquifers and Uses of Water Between Laguna Pueblo and Gallup, Valencia and McKinley Counties, New Mexico. J. B. Cooper, and S. W. West. , 1967.

Crabbs, Carroll L., Charles H. Calisher, and Kevin M. Canestrop. "Malpais Spring virus: a new vesiculovirus from mosquitoes collected in New Mexico and evidence of infected indigenous and exotic ungulates." (1 Dec. 1988):

Crumpler, L. S. "Volcanism in the Mount Taylor Region." New Mexico Geological Society guidebook, 33rd Field Conference, Albuquerque Country II. J. A. Grambling, and S. G. Wells. , 1982.

Debruin, Ellen A. Vascular Plants and Lichens on Lava and Sandstone Substrates in Cibola County, New Mexico. Diss. , 1988.

Dellachaie, F. Chemical and Petrographic Variations in the Cerro

Colorado and Paxton Springs Basalt Flows, Valencia County, New Mexico. Diss. , 1973.

The Masau Trail: Comprehensive Management Plan [Draft]. Division of Planning/Design/Environmental Coordination, Southwest Regional Office. , Aug. 1989.

Evaluation of Rocky Mountain Bighorn Sheep Habitat In New Mexico. William C. Dunn. , Sept. 1993.

Dutton, Clarence E. "Mount Taylor and the Zuni Plateau." US Department of the Interior Annual Report (1986):

Eadie, Gregory G., and Robert F. Kaufmann. "Radiological Evaluation of the Effects of Uranium Mining and Milling Operations on Selected Ground Water Supplies in the Grants Mineral Belt, New Mexico." Health Physics (1977):

Inventory of Federal and State Endangered Threatened Animals that Occur at El Malpais, Socorro District. John C. Egbert, and Bureau of Land Management. , 1979.

El Malpais National Monument. "Annual Weather Patterns and Fuel Moisture Condition Trends, 1993." 1993.

---. "Bibliography on the Malpais." 22 July 1993.

---. "Capabilities and Interest Statement: Proposed El Malpais Core Research Area and Biogeographic Region El Malpais National Monument Grants, New Mexico." 26 Apr. 1990.

---. "Cave Resource Management Plan, El Malpais National Monument New Mexico." 7 May 1993.

---. "El Malpais National Monument New Mexico Fire Management Plan." 20 Dec. 1989.

---. "El Malpais National Monument Biological Survey Bird List." 28 Oct. 1991.

---. "El Malpais National Monument Land Protection Plan: Properties Acquired by NPS to date: 05/31/93 (and 6/24/92)." 1992.

El Malpais National Monument Threatened and Endangered Species. ---. , 1993.

---. "File: Grazing Exclosures - Proposed Sites." various dates.

---. "Folder title: Grazing Monitoring Program."

---. "Folder: Goals 1993 Resource Mgmt." 12 May 1993.

General Management Plan/Environmental Assessment Wilderness Suitability Study [Review Draft] and [Draft]. ---. , Aug. 1989.

General Management Plan/Environmental Assessment Wilderness Suitability Study [Draft]. ---. , Jan. 1990.

Statement for Management El Malpais National Monument, New Mexico. ---. , Apr. 1993.

El Malpais National Monument and Conservation Area.

El Malpais National Conservation Area and National Monument.

El Malpais National Monument. "Untitled: Grazing files." various dates.

Untitled: El Malpais Slide Collection. ---.

---. "Untitled: Weather Records." 1988.

Elston, Wolfgang, and Kenneth H. Wohletz. "Quaternary basalt fields of west-central New Mexico: McCartys pahoehoe flow, Zuni Canyon aa flow, Zuni Ice Cave, Bandera Crater, and zuni Salt Lake Maar." Geological Society of America Centennial Field Guide-Rocky Mountain Section (1987):

Fence Lake, New Mexico: National Wetlands Inventory. 1984.

Field-trip guide to the geochronology of El Malpais National Monument and the Zuni-Bandera volcanic field, New Mexico. , 1993.

Fire History of El Mapais N. M. and Adjacent Lands 1968-Present.

Water Availability and Use in the Proposed El Malpais National Monument and Grants Conservation Area. Bill Fleming, and Tom Morrison. , Feb. 1987.

Special Report: The Ice Caves Area, Valencia County, New Mexico. Forest Service, United States Department of Agriculture. , 1938.

Four Windows Cave. 1989.

Francis, Richard E., and Tod B. Williams. "Plant Community Classification of El Malpais, New Mexico." General technical report INT-U.S. Department of Agriculture, Forest Service, Intermountain Research Station. , Feb. 1989.

Frozen Mat Cave. 1994.

Gallagher, G. L. The Petrography of Ultramafic Inclusions from Bandera Crater, New Mexico. Diss. , 1973.

Gawell, M. J. Chemical and Petrographic Variations in the Cerro Negro-Cerrito Arizona Cinder Cone Chain, Valencia County, New Mexico. Diss. , 1975.

Geologic Map and Sections of the Zuni Mountains Fluorspar District, Valencia County, New Mexico. 1966.

Geologic Map of El Malpais Lava Field and Surrounding Areas, Cibola County, New Mexico. 1986.

Geologic map of the Grants quadrangle, Valencia County, New

Mexico. 1967.

Geologic map of the El Malpais Instant Study Area, Valencia County, New Mexico. 1981.

Geologic Reconnaissance of the Bandera Lava Fields Valencia Co., New Mexico. 1969.

Geological map of the Grants SE quadrangle, Valencia County, New Mexico. 1967.

Geological map of the Grants Quadrangle, Valencia County, New Mexico. 1967.

Geological Map of the Grants SE Quadrangle, Valencia County, New Mexico. 1967.

Goar, M. S. "Lava caves in New Mexico; a survey of vulcanospeleological resources." Sixth international symposium of vulcanospeleology. Geo(2). , 1991.

Geology and Ground-Water Resources of the Grants-Bluewater Area, Valencia County, New Mexico. Ellis D. Gordon. , 1946.

A 2100-Year-Long Record of Drought for West-Central New Mexico, USA. Henri D. Grissino-Mayer.

Grissino-Mayer, Henri D. "A 2129-year annual reconstruction of drought for northwestern New Mexico." Proceedings of the International Conference on Tree Rings, Environment, and Humanity: Relationships and Progress. , no date (>1994).

Progress Report: Dendrochronology and Paleoenvironmental Studies in El Malpais National Monument, New Mexico. Henri D. Grissino-Mayer. , 1992.

Progress Report: The Fire and Climate History of El Malpais National Monument, New Mexico. ---. , 15 Feb. 1993.

Progress Report: The Fire and Climate History of El Malpais National Monument, New Mexico. ---. , 20 Jan. 1994.

Grissino-Mayer, Henri D., and Thomas W. Swetnam. "Effects of Habitat Diversity on Fire Regimes in El Malpais National Monument, New Mexico." Symposium on Fire in Wilderness and Park Management: Past Lessons and Future Opportunities.

Gruener, John E. "El Malpais Lava Tubes: Analog to Lunar Lava Tubes." 1980.

Harrington, E. R. "Desert Ice Box." New Mexico Magazine (July 1940):

---. "The Origin of Ice Caves." (no dates):

Harris, Arthur H. "Fossil Evidence Bearing on Southwestern Mammalian Biogeography." Journal of Mammalogy (1990):

Bibliography on Lava Tube Caves. Russell G. Harter. , June 1971.

Harter, Russell G., and J. W. Harter. "The Geology of Lava Tube Caves." Far West Cave Management Symposium Prceedings. , Jan. 1980.

Hatheway, Allen W. Lava Tubes and Collapse Depressions. Diss. , 1971.

Hatheway, Allen W., and Alika K. Herring. "No. 152 Bandera Lava Tubes of New Mexico, and Lunar Implications." Communications of the Lunar and Planet Laboratory. , 16 Feb. 1970.

Southwest Paleoclimate and Continental Correlations. Richard H. Hevly, and T. N. V. Karlstrom. , 1970.

Hill, Carol A., and Rodney C. Ewing. "Darapskite, Na3(NO3)(SO4).H2O, a new occurrence, in Texas." Mineralogical Magazine (Dec. 1977):

Holden, Constance. "Precolumbian Trees." Science (Mar. 1992):

Mammals of the Lava Fields and Adjoining Areas in Valencia County, New Mexico. E. T. Hooper. , 14 June 1941.

Howells, B. "New Mexico's Badlands." Westways (1990):

Geology and Fuel Resources of the Southern Part of the San Juan Basin, New Mexico Part 2.-The Mount Taylor Coal Field. Charles Hunt. , 1936.

Hurley, Daniel B. 14 July 1988.

A Checklist of the Birds of El Malpais National Monument and National Conservation Area. Glen T. Hvenegaard. , 1989.

"Impacts on the Natural Environment." General Management Plan/ Environmental Assessment Wilderness Suitability Study [Review Draft]. El Malpais National Monument. , Aug. 1989.

Index to 1935 Aerial Photographs. 1935.

James, H. L. "Rivers of Fire." New Mexico Magazine (Sept. 1968):

Junction Cava (Lava Tube) Valencia County - New Mexico. 1990.

Kaufmann, Robert F., Gregory G. Eadie, and Charles R. Russell. "Effects of Uranium Mining and Milling on Ground Water in the Grants Mineral Belt, New Mexico." Ground Water (1976):

Kelly, Thomas E., and Charles B. Reynolds. "Structural Geology of the Malpais Valley, San Rafael, New Mexico." New Mexico Geological Society Fortieth Annual Field Conference, September 28-October 1, 1989: Southeastern Colorado Plateau. Orin J. Anderson, Spencer G. Lucas, David W. Love, et al. , 1989.

King, Al. "Folder: Agua Fria Creek Flooding, 3/93 by Al King." 1993.

King, Allen, and Sheri Mariger-King. "Herbacious Plants and Wildflowers Blooming at El Malpais National Monument and National Conservation Area." 1990.

Land-Use in the Ramah Area of New Mexico: An Anthropological Approach to Areal Study. John L. Landgraf. , 1954.

Geochronology of El Malpais National Monument. A. William Laughlin. , 1990.

Laughlin, A. William. "Late Cenozoic Basaltic Volcanism Along the Jemez Zone, Arizona and New Mexico." National Geographic Society Research Reports (1981):

Laughlin, A. William, M. J. Aldrich, M. E. Ander, et al. "Tectonic Setting and History of Late Cenozoic Volcanism in West-Central New Mexico." New Mexico Geological Society Guidebook, 33rd Field Conference. , 1982.

Laughlin, A. William, M. J. Aldrich, and D. T. Vaniman. "Tectonic Implications of Mid-Tertiary Dikes in West-Central New Mexico." Geology (Jan. 1983):

Laughlin, A. William, D. G. Brookins, A. M. Kudo, et al. "Chemical and strontium isotopic investigations of ultramafic inclusions and basalt, Bandera Crater, New Mexico." Geochimica et Cosmochimica Acta (1971):

Laughlin, A. William, D. G. Brookins, and J. D. Causey. "Late Cenozoic Basalts from the Bandera Lava Field, Valencia County, New Mexico." Geology Society of America Bulletin (1972):

Laughlin, A. William, D. G. Brookins, P. E. Damon, et al. "Late Cenozoic Volcanism of the Central Jemez Zone, Arizona-New Mexico." Isochron/West (1979):

Laughlin, A. William, D. G. Brookins, and J. R. Carden. "Variations in the Initial Strontium Ratios of a Single Basalt Flow." Earth and Planetary Science Letters (1972):

Field-trip Guide to the Geochronology of El Malpais National Monument and the Zuni-Bandera Volcanic Field, New Mexico. A. William Laughlin, Robert W. Charles, Kevin Reid, et al. , 1993.

Laughlin, A. William, G. K. Manzer, and J. R. Carden. "Feldspar Megacrysts in Alkali Basalts." Geological Society of America Bulletin (1974):

Laughlin, A. William, Frank V. Perry, Paul E. Damon, et al. "Geochronology of the Mount Taylor, Cebollita Mesa, and Zuni-Bandera Volcanic Fields, Cibola County, New Mexico." 1993.

Laughlin, A. William, F. V. Perry, and G. Woldegabriel. "Geochronology and geochemistry of basalts of the Zuni-Bandera volcanic field; a review and update." New Mexico Geological Society annual spring meeting. New Mexico Geology. , 1994.

Laughlin, A. William, Jane Poths, Heather A. Healey, et al. "Dating of Quaternary basalts using the cosmogenic 3He and 14C methods with implications for excess 40Ar." Geology (1994):

The Zuni Mountains, New Mexico, As a Potential Dry Hot Rock Geothermal Energy Site. A. William Laughlin, and Francis G. West. , Jan. 1976.

Lee, Willis T., and US Geological Survey. "An Ice Cave in New Mexico." The Geographical Review (Jan. 1926):

Leeman, William P. "The Isotopic Composition of Strontium in Late Cenozoic Basalts from the Basin-Range Province, Western United States." Geochimica et Cosmochimica Acta (1970):

Lightfoot, David. "Untitled: Letter and Report regarding the absence of threatened, endangered or candidate plant or animal species at the visitor center construction site." 1993.

Lightfoot, David C. "Vegetation and Wildlife Inventory of El Malpais National Monument: Semi-Annual Progress Report 2 Winter/Spring 1992." 27 May 1992.

Vegetation and Wildlife Inventory of El Malpais National Monument, Final Report. David C. Lightfoot, David L. Bleakly, Robert R. Parmenter, et al. , Apr. 1994.

Naturalist on Watch. Alton A. Lindsey. , 1983.

Lindsey, Alton A. "An Optical Effect in Chlorella Bloom in Nature." Ecology (Oct. 1949):

---. "Photographic Comparison of the Grants Malpais Vegetation 1944-1981." 1981.

---. "A Tree-trunk Squeeze-up in Lava." Science (14 Jan. 1949):

---. "A Unique Habitat for Maidenhair Spleenwort." American Fern Journal (Oct. 1945):

Untitled: Lindsey Photographic Collection. Alton A. Lindsey. , 1944-1948, 1981.

Lindsey, Alton A. "Untitled: Writings by and about Alton A. Lindsey." 1948.

---. "Vegetation and Habitats in a Southwestern Volcanic Area." Ecological Monographs (July 1951):

Potassium-Argon Ages From the Mount Taylor Volcanic Field, New Mexico. P. W. Lipman, and H. H. Mehnert. , 1980.

Basalts of the Mount Taylor Volcanic Field, New Mexico. P. W. Lipman, and R. H. Moench. , 1972.

Lummis, Charles F. "XIV. Rivers of Stone." Some Strange Corners of Our Country: The Wonderland of the Southwest. Charles F.

Lummis. , 1989.

Mabery, Ken, and Dave Kenney. "El Malpais Wilderness Suitability Study." Park Science (1991):

Mabery, Ken, and Bruce Rogers. File Folder: ELMA Minerals. 1 July 1990.

In The Land of Frozen Fires: A History of Occupation in El Malpais Country. Neil C. Mangum. , 1990.

Map Overlay A: Report and Photo Reference Map.

Map Overlay B: Lava Tube System Location and Type.

Map showing distribution, composition, and age of Cenozoic volcanic centers in Arizona and New Mexico. 1978.

Archeological Investigations in the Cerritos de Jaspe Subunit of the El Malpais Conservation Area. Michael P. Marshall. , 30 July 1993.

Maxwell, Charles H. "Bandera Crater." New Mexico Geological Society Fortieth Annual Field Conference, September 28-October 1, 1989: Southeastern Colorado Plateau. Orin J. Anderson, Spencer G. Lucas, David W. Love, et al. , 1989.

---. "El Malpais." New Mexico Geological Society Guidebook, 33rd Field Conference. , 1982.

Vascular Flora of El Morro National Monument New Mexico. D. Archibald McCallum. , 1981.

The Vegetation of the Zuni Mountain Region in Historical Perspective With Special Reference to El Morro National Monument. ---. , 1981.

Special Report: The Ice Caves Area, Valencia County, New Mexico. Milton J. McColm, J. E. Kell, Chas N. Gould, et al. , 1938.

Menzies, M. A., P. R. Kyle, M. Jones, et al. "Enriched and Depleted Source Components for Tholeiitic and Alkaline Lavas from Zuni-Bandera, New Mexico: Inferences about Intraplate Processes and Stratified Lithosphere." Journal of Geophysical Research (1991):

Menzies, Martin, and Philip Kyle. "Heterogeneous Mantle Reservoirs Tapped During Lithospheric Extension." 1989.

National Park Service, Land Resources Division. "Current and Anticipated Research at El Malpais National Monument." 21 May 1992.

Grazing Management Plan and Environmental Assessment El Malpais National Monument New Mexico [Draft]. National Park Service. , 11 Dec. 1989.

Land Protection Plan. ---. , Aug. 1990.

Lava Tube System/Location and Type-Map A & B. ---. , no date.

Lava Tube System Resource Inventory Report. ---. , Nov. 1988.

National Park Service, Land Resources Division. "Master Deed Listing: Status of Lands as of 12/31/92." 1992.

National Park Service. "NPS Global Change Plan DRAFT - 17 September 1992 The Upper Rio Grande Basin Biogeographic Area: Reading the Map of Climate Change in the Landscapes of the Semi-Arid Southwest." 17 Sept. 1992.

Navajo Ice Cave (Lava Tube) Valencia, Co., New Mexico Elevation 7450 Ft. 1989.

New Mexico's Squirrels. New Mexico Department of Game and Fish. , 1982.

New Mexico Wilderness Study Area Decisions. , Nov. 1980.

Nichols, Robert L. "Grooved Lava."

---. "McCartys Basalt Flow, Valencia County, New Mexico." Bulletin of the Geological Society of America (1946):

Pressure Ridges and Collapse Depressions on the McCartys Basalt Flow, New Mexico. Robert L. Nichols. , 1939.

Nichols, Robert L. "Squeeze-Ups."

NM 117 Alignment Study.

Biological Inventory of Selected El Malpais Lava Tubes and Fire Impact Study. Diana E. Northup.

Fire Impact Study El Malpais National Monument New Mexico. Diana E. Northup, Kenneth Ingham, and Cal Welbourn. , 27 Dec. 1993.

O'Donnell, Mary P. The Ethnozoology of the Ramah Navaho: A Justification of the Ethnozoological Approach to a Study of Total Culture. Diss. , 12 Apr. 1950.

A Checklist of the Flora of El Malpais National Monument and National Conservation Area. Cindy Ott-Jones. , 1989.

Perry, Frank V., W. Scott Baldridge, and Donald J. DePaolo. "Role of Asthenosphere and Lithosphere in the Genesis of Late Cenozoic Basaltic Rocks From the Rio Grande Rift and Adjacent Regions of the Southwestern United States." Journal of Geophysical Research (10 Aug. 1987):

"The Plan for Natural Resource and Wildlife Management." General Management Plan/Environmental Assessment Wilderness Suitability Study [Review Draft]. El Malpais National Monument. , Aug. 1989.

Preliminary geologic map of the Los Pilares quadrangle, Valencia County, New Mexico. 1977.

Proposed El Malpais Biogeographic Region.

"Proposed Monument Boundary Adjustments." General Management Plan/Environmental Assessment Wilderness Suitability Study [Review Draft]. El Malpais National Monument. , Aug. 1989.

Ramey, Rob Roy. Evolutionary Genetics and Systematics of North American Mountain Sheep: Implications for Conservation. Diss. , Aug. 1993.

Major-element variations in the Portillo, Carrizozo, and McCartys basalt fields, New Mexico. J. Renault. , 1970.

Resource Management Specialist, Wupatki-Sunset Crater. "Trip Report, May 15-18, 1989." May 1989.

Resources Management Specialist, El Malpais National Monument. "Field Inventory of the Monument's Snow cover on February 29, 1990." 1990.

Rogers, Bruce. Cave Research Foundation Field Trip to El Malpais Nat. Mon., May 10-17, 1991. 1991.

---. "Folder: Bruce Rogers' Mineral Study." 1990.

General Geology and Development of Lava Tubes in New Mexico's El Malpais National Monument. Bruce W. Rogers. , 1990.

Rogers, Bruce W. "General Geology and Development of Lava Tubes in New Mexico's El Malpais National Monument." Cave Research Foundation 1990 Annual Report. , 1990.

---. "General geology and development of lava tubes in New Mexico's El Malpais National Monument; confirming epsomite in the field by taste testing." Peacock, Norma. National Speleological Society, 1990 annual meeting, abstracts. The NSS Bulletin. , 1991.

---. "General geology and development of lava tubes in New Mexico's El Malpais National Monument." Sixth international symposium of vulcanospeleology; 1991. Geo(2). , 1991.

Rogers, Bruce. "The Sky Burned, the Earth Shook, And All The Bunny Rabbits Ran Away... Part 13." Cave Research Organisation of South Africa (June 1990):

Geologic Evaluation Grants Lava Flow, New Mexico. Robert H. Rose. , 1967.

Rosenau, Andrew J. 31 Jan. 1994.

Rosenzweig, Abraham. "Mineralogical Notes on the Uranium Deposits of the Grants and Laguna Districts." New Mexico Geological Society Guidebook of the Albuquerque County Twelfth Field Conference October 6, 7, and 8, 1961. Stuart A. Northrup. , 1961.

Hydrology of Area 62, Northern Great Plains and Rocky Mountain Coal Provinces, New Mexico and Arizona. F. E. Roybal, J. G. Wells, R. L. Gold, et al. , Apr. 1984.

Sandoval, Andrew V., and New Mexico Department of Game and Fish. "Preliminary Survey Report on the Evaluation of Historic Desert Bighorn Sheep Ranges [Final Report]." July 1979.

Soil Survey of Cibola Area, New Mexico, Parts of Cibola, McKinley, and Valencia Counties. Soil Conservation Service. , Mar. 1993.

Draft Land Protection Plan Chaco Culture National Historical Park. Southwest Regional Office, National Park Service. , Aug. 1984.

El Malpais National Monument Land Protection Plan [Draft]. Southwest Regional Office, National Park Service, and El Malpais National Monument. , May 1989.

Southwest Regional Office, National Park Service. File Folder: ELMA/GEOLOGY/Bibliographic search of GEOREF Database, using El Malpais as the keyword. June 1992.

A Report on the Survey for Threatened, Endangered, or Rare Plant Species on the Grants Malpais, Valencia County, New Mexico, with General Comments on the Vegetation. Richard Spellenberg. , 1979.

Steensen, David. 1 Dec. 1993.

Sullivan, Anne. "Roaming Bison: Elusive at El Malpais." New Mexico wildlife. Nov 1 1994 v 39 n 6, p.6 (1 Nov. 1994):

Vertebrates Assessment Along the Proposed Alignment of Highway 117 Adjacent to and Within El Malpais National Park: Preliminary Environmental Report of the Vertebrate Assessment Along the Proposed Alignment of Highway 117 Adjacent El Malpais National Park, Cibola Co., New Mexico. Robert M. Sullivan. , 9 July 1991.

Thompson, Lonnie G., Thompson Ellen Mosley, Julio L. Betancourt, et al. "Laminated ice bodies in collapsed lava tubes at El Malpais National Monument, central New Mexico." Field guide to geologic excursions in New Mexico and adjacent areas of Texas and Colorado. Univ. Tex. El Paso, Dep. Geol. Sci., El Paso, TX, United States. Bulletin New Mexico Bureau of Mines and Mineral Resources. , 1991.

A Survey Protocol for the Southwestern Willow Flycatcher (Empidonax traillii extimus). Timothy J. Tibbets, Mark K. Sogge, and Susan J. Sferra. , Apr. 1994.

Untitled: Report on the Possible Addition of the 'Perpetual Ice Cave' to El Morro National Monument. Roger W. Toll. , 1934.

A Study for the Possible Adverse Effects on Vegetation due to Air Pollutants in the Chaco Canyon National Monument, New Mexico (Concluding report). Michael Treshow. , July 1980.

Truckitt's Bat Cave & Batette Bridge. 1993.

Vegetation and Wildlife Inventory at ELMA. The University of New Mexico.

Untitled: Aerial photographs, 1935, 1955, 1966, and 1987. , 1935, 1955, 1966, 1987.

Untitled: Aerial photographs negatives. , 1935, 1956, 1966, 19??

Untitled: Aerial Photographs.

Untitled: Bighorn Sheep Bone Collection.

Untitled: Black and White Historic Photographs. , Dates unknown.

Untitled: Cave Map. no date.

Untitled: Fire History Map. 1990.

Untitled: FMU Map.

Untitled: Fossil.

Untitled: Geologic Collection.

Untitled: Oral History Tapes, Grants, New Mexico Region.

Untitled: Park Maps. no dates.

Untitled: US Geological Survey Topos with Handwritten Additions. 1990.

Untitled: Vegetation Type.

El Malpais Recreation Activity Plan. US Department of the Interior, Bureau of Land Management. , 1973.

Environmental Assessment for the Bison Management Plan: El Malpais National Conservation Area, EA No. NM-017-82 [Draft] AND Talking Points: NPS Comments on BLM's EA Proposing Bison Introduction to El Mapais NCA [Draft]. US Department of the Interior, Bureau of Land Management, Albuquerque District Office, Rio Puerco Resource Area, and National Park Service. , 1992.

Environmental Assessment for the Bison Management Plan: El Malpais National Conservation Area, EA No. NM-017-82 [Draft] AND Talking Points: NPS Comments on BLM's EA Proposing Bison Introduction to El Mapais NCA [Draft]. ---. , 1992.

A Plan for the Grants Lava Flow and Surrounding Areas. US Department of the Interior, Bureau of Land Management. , 1972.

US Fish and Wildlife Service. "Untitled: List of Special Status Species in the National Park Service Lands of New Mexico." 1993.

Various authors. "File: 117 Realignment Project." 1991.

---. "File: 1989 fires." various dates.

---. "File: Bighorn Sheep Reintroduction." various dates.

---. "File: Bison EA Project." various dates.

---. "File: Bomb File." various dates.

---. "File: Cave File." various dates.

---. "File: Fire." various dates.

---. File: Malpais - History of, etc. various dates.

---. "File: Robe Roy Ramey Study on Bighorn - Cornell University." 1993.

---. "File: University of Arizona Coop Agreement." various dates.

---. "File: University of New Mexico Coop Agreement." various dates.

---. "File: USFS Pipeline." various dates.

---. "Folder: Collection Permits Issued." various dates.

---. "Folder: Bighorn Sheep $6,000." 1993.

---. "Untitled: History Material for the Grants, NM Region." various dates.

---. "Untitled: Backcountry Management Plan Files." 1992.

Ethnobotany of the Ramah Navaho. Paul A. Vestal. , 1952.

A Proposal For: Long-Term Ecological Monitoring in the Upper Rio Grande Basin at Bandelier National Monument, El Malpais National Monument, and Pecos National Historical Park. Roy Weaver, Douglas Eury, Linda Stoll, et al. , 1993.

Further Morphometric Analyses of Mountain Sheep in Southwestern United States and Mexico: a Report to Cooperators. John D. Wehausen, and Rob R. Ramy. , Jan. 0994.

Biological Inventory of Six Lava Tubes El Malpais National Monument [Interim Report]. W. Calvin Welbourn, and Diana E. Northup. , 21 Jan. 1994.

"Wilderness Suitability Study." General Management Plan/ Environmental Assessment Wilderness Suitability Study [Review Draft]. El Malpais National Monument. , Aug. 1989.

Yeo, Herbert W. "The Ice Cave." New Mexico Highway Journal (May 1930):