PECOS

From Folsom to Fogelson:

The Cultural Resources Inventory Survey of Pecos National Historical Park

TABLE OF CONTENTS

COVER

VOLUME I

FOREWORD

ACKNOWLEDGMENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION
Genevieve N. Head, Janet D. Orcutt, and Robert P. Powers

The Need for an Archeological Inventory
Upper Pecos Valley Culture History

- Preceramic Period (11,500 B.C.-A.D. 600)
- Developmental Period (A.D. 600-1200)
- Coalition Period (A.D. 1200-1325)
- Classic Period (A.D. 1325-1600)
- Pecos Pueblo/Spanish Mission Period (A.D. 1540-1838)
  - Spanish Colonial Period (A.D. 16004821)
    - Early Colonial/Pre-Revolt (A.D. 1600-1680)
    - Pueblo Revolt (A.D. 1680-1692)
    - Late Colonial/Post-Revolt (A.D. 1692-1821)
- Early Settlement, Santa Fe Trail, Civil War Period (A.D. 1812-1880)
  - Mexican/Santa Fe Trail (A.D. 1821-1846)
  - United States Territorial (A.D. 1846-1880)
- Railroad/Tourism (A.D. 1880-1941)
- Ranching Period (A.D. 1925-1993)
- Fogelson/Monument Period (A.D. 1941-1991)

The Environment

- Topography
- Geology
- Soils
- Climate
- Flora and Fauna

Recent Impacts to the Pecos Environment

Research Objectives

Community Development
Exchange
Historic Period Investigations

Organization of the Volume

2. PREVIOUS ARCHEOLOGICAL WORK
Susan Eininger

The Beginnings of Pecos Archeology
The Kidder Years
The State Monument Era
National Park Service Projects
Recent Years
Summary

3. METHODOLOGY
Susan F. Eininger

Project Organization
Survey Methodology

Survey Areas
Survey Procedures
Cultural Resource Identification
Sites
Isolated Occurrences
Cultural Landscape Elements

Site Documentation

Site Numbering
Site Recording Forms
Site Components
Native American Artifact Documentation
Artifact Sampling
Density Count Procedures
Artifact Attribute Analyses
Euro-American Artifact Documentation
Artifact Collection
Location Information
Site Maps
Photodocumentation

Isolated Occurrence Documentation
Cultural Landscape Documentation
Data Processing and Management
Summary

4. CERAMIC CHRONOLOGY
Melissa S. Powell and Karl K. Benedict

Ceramic Typologies
Rio Grande Chronologies
Background on the Survey Chronology
The Pecos Ceramic Assemblage

- Sampling and Analytic Methods
- The Ceramic Database
- Ceramic Wares and Chronologically Sensitive Types

Dating the Pecos Survey Sites

- The Mean Ceramic Date Approach
  - South's Mean Ceramic Date Formula
  - Assumptions of Mean Ceramic Dating
  - Method
  - Mean Ceramic Date Findings
- Ceramic Probability Dating
  - Probability Assumptions
  - Method
  - Interpreting Ceramic Probabilities
  - Dating Multicomponent Sites

The Pecos Survey Chronology

- Temporal Trends
- Contemporaneity of the Early Pueblos

Conclusions
Notes

5. SITE TYPOLOGY AND ARCHITECTURE
Genevieve N. Head

Site Typology in the Upper Pecos Valley
The Effects of Mechanical Vegetation Removal on Site Interpretation
Components and Features
Classification of the Survey Sites

- Categories for the Pecos Survey Sites
- Functional Types for the Pecos Survey Sites
  - Habitations
  - Seasonal Sites
  - Special-Use Sites
  - General Artifactual Parameters of the Site Types
  - Nonstructural Feature Groups and Site Types
  - Change in Site Types through Time
  - Site Types across Space and through Time
- Summary

Description of the Survey Sites

Habitations
Communal Pueblos (100 rooms or more)
Pueblos (6-99 rooms)
Seasonal Sites
Special-use Sites

Subsistence and Social Change through Architecture

Agriculture
Expectations
Expectation Testing
Discussion
Social Integration
Expectations
Expectation Testing
Discussion

Summary and Conclusions
Notes

6. SETTLEMENT
Karl K. Benedict and Janet D. Orcutt

Characterizing Climate through the Palmer Drought Severity Index

Expectations for Site Locations

Site Types by Environment

Period 2 (A.D. 1200-1325)
Period 3 (A.D. 1325-1450)
Period 4 (A.D. 1450-1575)
Period 5 (A.D. 1575-1700)
Habitation Site Locations through Time
Seasonal Site Locations through Time
Special-use Site Locations through Time

Social Influences on Site Location

Traditional Spatial Analysis Methods
Quadrat Analysis
Nearest-Neighbor Analysis
Conclusions Regarding Traditional Spatial Analysis Methods
Simulation-based Nearest-Neighbor Analysis
Simulation Analysis Methods
Results of Simulated Nearest Neighbor Analysis
Comparison of Special-Use to Special-Use Sites
Comparison of Special-Use to Habitation Sites
Comparison of Special-Use to Seasonal Sites
Comparison of Habitation to Habitation Sites
Comparison of Habitation to Seasonal Sites
Comparison of Seasonal to Seasonal Sites
Nearest-Neighbor Summary

Site Location and Localized Soil and Resource Productivity

Potential Plant Productivity of Soils
Data Analysis
Statistical Considerations
The Models Considered in the Current Analysis
The Analysis Procedure
Analysis Results
Habitation Sites—Food Resources
Habitation Sites—Fuel Resources
Seasonal Sites—Food Resources
Seasonal Sites—Fuel Resources
Special-Use Sites—Food Resources
Special-Use Sites—Fuel Resources
Conclusions

Summary and Conclusions
Notes

7. DEMOGRAPHY
Janet D. Orcutt

Reconstructing Population

Population Estimation Methods
Estimating Population in the Pecos Area
Pecos Pueblo
Population Aggregation

Northern Rio Grande Population
Conclusions

Climate and Pecos Area Population

8. CERAMICS
Melissa S. Powell

Ceramic Research in the Northern Rio Grande Region
Methods of Ceramic Analysis
The Ceramic Assemblage

Ceramic Types
Ceramic Wares
Rio Grande Gray Ware
Pajarito White Ware
Rio Grande Glaze Ware
Historic Polychromes and Plain Ware
Plains/Apache
Other Trade Ware Ceramics
Vessel Form

Trends in Ceramic Wares

Ceramic Wares through Time
Rio Grande Gray Ware through Time
Ceramic Ware by Site Type

Functional Analyses

Functional Classes through Time
Functional Classes by Site Type

Vessel Size

Ceramic Vessel Size through Time
Vessel Size by Site Type
Vessel Size by Ceramic Type

The Organization of Ceramic Production

Direct Evidence
Indirect Evidence
Standardization and Specialization
Ceramic Resources in the Rio Grande Region
Goals of the Compositional Study
Assumptions of Compositional Analysis
The Sample for Compositional Analysis
Rio Grande Gray Ware
Pajarito White Ware
Analytic Methods
Results of Refiring
Results of Petrography
Utility Ware Temper and Paste Categories
White Ware Temper and Paste Categories
The Raw Clays
Addressing the Research Questions
Production Areas
Variation among Sites
Variation between Santa Fe Black-on-white and Galisteo Black-on-white
Comparisons to Apache and Pithouse Ceramics

Conclusions

9. LITHICS
J. David Kilby and Joseph Vasquez Cunningham

The Flaked Stone Assemblage

Regional Sources of Lithic Raw Materials
Rocky Mountains
Jemez Mountains Sources
Pedernal Chert
Other Sources in the Rocky Mountains
Basin and Range
Madera and San Andres Formations
The Rio Grande
Mount Taylor

Great Plains
Alibates Flint
Tecovas Chert
Edwards Plateau Chert
Other Sources on the Great Plains
Summary
Flaked Stone Assemblage Parameters
Raw Material Type
Size
Cortex
Platform Type
Debitage Type/Condition
Thermal Alteration
Edge Damage
Technological Type
Functional Type
Tool Classes for Analysis
The Organization of Flaked Stone Technology
Technological Organization and Raw Material
Tool Production and Raw Material
Pueblo Period Obsidian Use
Technological Organization and Settlement Patterns
Artifact Classes and Site Types
Site Types through Time

The Nonflaked Lithic Assemblage

Nonflaked Lithic Assemblage Parameters
Manos
Metates
Nonportable Grinding Features
Axes, Mauls, and Hoes
Other Nonflaked Lithic Artifacts
Population Aggregation and Grinding Intensity
Grinding Intensity and Site Types
Grinding Intensity through Time

Summary and Conclusions
Notes

VOLUME II

10. EURO-AMERICAN SITES
Jeffrey L. Boyer, James L. Moore, Natasha Williamson and Genevieve N. Head

Description of Euro-American Components

Seventeenth and Eighteenth Century Euro-American Sites

Temporal Analyses of Euro-American Artifacts

Data Collection
Dating the Euro-American Sites
Pecos National Historical Park Cultural Periods
Dating the Sites
Euro-American Sites and Cultural Periods
Spanish Colonial/Mexican/Hispanic Settlement, Santa Fe Trail, Civil War Period (A.D. 1812-1880)
Railroad/Tourism Period (A.D. 1880-1941)
Sites Tentatively Associated with Periods or Unassignable to a Period
Comparing Homestead Artifact Dates with Documentary Dates
PECO 540: Homestead D
PECO 270: Homestead A, Benigno Quintana
PECO 175: Homestead B
PECO 367: Homestead E, Pedro Ruiz
PECO 541: Homestead C, Anicieto Rivera
Summary of Analyses of Euro-American Artifacts

Review of Pecos Area Census Records

1860: The Eighth Census of the Territory of New Mexico, San Miguel County
1870: The Ninth Census of the Territory of New Mexico, San Miguel County
1880: The Tenth Census of the Territory of New Mexico, San Miguel County
1900: The Twelfth Census of the Territory of New Mexico, San Miguel County
1910: The Thirteenth Census of the Territory of New Mexico, San Miguel County
1920: The Fourteenth Census of the Territory of New Mexico, San Miguel County
Summary

An Examination of Trail and Road Segments near Pecos Pueblo

The Santa Fe Trail
Pecos Pueblo and the Santa Fe Trail
The Deterioration of Pecos Pueblo
Descriptions of the Segments Investigated
Santa Fe Trail
Colonias Road
Miscellaneous Trail Segments
Discussion of Trail Segments
Santa Fe Trail Segments
Turnoff to Kozlowski's Trading Post
Section of the Colonias Road and Associated Tracks
Miscellaneous Segments
Conclusions

Summary
Notes

11. SUMMARY AND CONCLUSIONS
Janet D. Orcutt and Genevieve N. Head

Period 0 (pre A.D. 1075) and Period 1 (A.D. 1075-1200)
Period 2 (A.D. 1200-1325)

Period 3 (A.D. 1325-1450)
Period 4 (A.D. 1450-1575)
Period 5 (A.D. 1575-1700)
Period 6 (post A.D. 1700)
Site Types

Ceramics across Site Types
Site Types and Plant Productivity

Euro-American Sites
Conclusions

APPENDIX A
Pecos Archeological Survey 1997 Site Data Form, Manual, and Glossary

APPENDIX B
Sampling Guidelines

APPENDIX C
Pecos Archeological Survey 1997 Lithic Manual/Coding Guide and Form

APPENDIX D
Pecos Archeological Survey 1997 Ceramic Inventory Form and Manual/Coding Guide

APPENDIX E
1,100 Years of Construction Wood Use in the Upper Pecos Valley

APPENDIX F
Site Number Concordance

APPENDIX G
Pecos Cultural Resources Inventory Survey Euro-American Artifact Data Base: Functional and Descriptive Data Tables

REFERENCES CITED

INDEX *(omitted from the online edition)*

LIST OF FIGURES

Chapter 1

1.1 North-central New Mexico with the location of Pecos National Historical Park
1.2 Boundary history of the Pecos Unit of Pecos National Historical Park
1.3 Locations of major prehistoric sites in the Upper Pecos Valley
1.4 Upper Pecos Valley topography
1.5 Rugged topography east of the Pecos River in the Tecolote Range, view NE

Chapter 2

2.1 Alfred Kidder in the excavations at Pecos Pueblo, ca. 1915
2.2 Kidder's 1916 stratigraphic excavations in the midden on the east slope of the Pecos mesilla
2.3 Excavations at Pecos north of South Pueblo
2.4 Excavations in preparation of stabilization in the Pecos mission convento, 1970
2.5 Gunnerson's excavations east of the Pecos church, 1970

Chapter 3

3.1 Survey areas, 1995-1997
3.2 Crew on a survey transect, spaced 10 to 15 meters apart
3.3 Site documentation in progress at PECO 142
3.4 An example of a lithic and ceramic scatter density grid square map used to delineate and select the sample units needed for artifact density counts and artifact attribute analysis

Chapter 4

4.1 Comparison of temporal frameworks for the northern Rio Grande region with the Pecos survey chronology and component frequencies
4.2 Stem-and-leaf diagram of the mean dates of the Pecos survey assemblages by decade
4.3 Stem-and-leaf diagram of the mean dates of the Pecos survey assemblages, in 20-year intervals
4.4 Histogram of the mean ceramic dates of the Pecos survey assemblages, by 50-year intervals
4.5 Bar chart of the date ranges for the Pecos ceramic types
4.6 Examples of ceramic type date ranges and normal distributions
4.7 Annual and five-decade probabilities for Glaze V
4.8 Individual ceramic type probabilities and resulting summed and normalized probability for PECO 125
4.9 Individual ceramic type probabilities and summed and normalized probability in 125-year intervals for PECO 125
4.10 Bimodal probability distribution suggesting an occupational hiatus (PECO 334)
4.11 Twenty-five year probabilities for PECO 23, PECO 30, PECO 215, and Forked Lightning (PECO 226)
4.12 Twenty-five year probabilities for Loma Lothrop (PECO 227), Shin'po (PECO 307), Dick's Ruin (PECO 434), and Arrowhead (PECO710)
4.13 Twenty-five year probabilities for Long House (PECO 402)
4.14 Early pueblo date ranges based on 25-year probabilities

Chapter 5

5.1 Possible structure at edge of a bulldozed area, PECO 108 (LA 118755) feature 13-01, view east
5.2 Cross section of a small structure exposed by a bulldozer cut, PECO 403 (LA 69302) feature 03-02, view east
5.3 Map of the Pecos Unit showing areas of vegetation removal
5.4 Example of a rock concentration, PECO 192 (LA 118795) feature 41-01, view north
5.5 Example of a grinding area, PECO 477 (LA 119034), feature 61-03, view east
5.6 Example of a small structure, PECO 245 (LA 118827), feature 03-01, view southeast
5.7 Decision tree for categorizing sites
5.8 Frequency distribution of room counts for structures with fewer than 20 rooms
5.9 Sites dated to Ceramic Period 2 (A.D. 1200-1325), showing site types
5.10 Sites dated to Ceramic Period 3 (A.D. 1325-1450), showing site types
5.11 Sites dated to Ceramic Period 4 (A.D. 1450-1575), showing site types

5.12 Sites dated to Ceramic Period 5 (A.D. 1575-1700), showing site types
5.13 Sites dated to Ceramic Period 6 (post A.D. 1700), showing site types
5.14 Pecos Pueblo north of South Pueblo (PECO 228 [LA 625])
5.15 Map of Arrowhead Pueblo (PECO 710 [LA 251])
5.16 Arrowhead Pueblo (PECO 710 [LA 251])
5.17 Map of Forked Lightning Pueblo (PECO 226 [LA 672])
5.18 Forked Lightning Pueblo (PECO 226 [LA 672])
5.19 Map of Loma Lothrop (PECO 227 [LA 277])
5.20 NE corner of Loma Lothrop (PECO 227 [LA 277]) excavated in the 1920s, view NW
5.21 Map of Shin'po (PECO 307 [LA 267])
5.22 Partially excavated room at Shin'po (PECO 307 [LA 267]) in northern room block, view SSW
5.23 Across the plaza of Shin'po (PECO 307 [LA 267])
5.24 Map of Long House (PECO 402 [LA 118967])
5.25 Long House (PECO 402 [LA 118967])
5.26 Map of Dick's Ruin (PECO 434 [LA 276])
5.27 Dick's Ruin (PECO 434 [LA 276])
5.28 Stone circle or possible tipi ring near Dick's Ruin, view NNE
5.29 Map of PECO 23 (LA 14123)
5.30 Map of PECO 30 (LA 14113)
5.31 View SE of PECO 30 (LA 14113)
5.32 Map of PECO 215 (LA 118811)
5.33 Wall at PECO 215 (LA 118811), exposed in recent road/bulldozer cut, view NNE
5.34 Ratio of rooms to kivas, through time
5.35 Kiva size through time

Chapter 6

6.1 Palmer Drought Severity Index dryness index for Period 2 (A.D. 1200-1325)
6.2 Palmer Drought Severity Index dryness index for Period 3 (A.D. 1325-1450)
6.3 Palmer Drought Severity Index dryness index for Period 4 (A.D. 1450-1575)
6.4 Palmer Drought Severity Index dryness index for Period 5 (A.D. 1575-1700)
6.5 Box plot of elevation by site type for Period 2 (A.D. 1200-1325)
6.6 Frequencies of each site type by landform types in Period 2 (A.D. 1200-1325)
6.7 Frequencies of each site type by vegetation community for Period 2 (A.D. 1200-1325)
6.8 Box plot of elevation by site type for Period 3 (A.D. 1325-1450)
6.9 Frequencies of each site type by landform types in Period 3 (A.D. 1325-1450)
6.10 Frequencies of each site type by vegetation community for Period 3 (A.D. 1325-1450)
6.11 Box plot of elevation by site type for Period 4 (A.D. 1450-1575)
6.12 Frequencies of each site type by landform types in Period 4 (A.D. 1450-1575)
6.13 Frequencies of each site type by vegetation community for Period 4 (A.D. 1450-1575)
6.14 Box plot of elevation by site type for Period 5 (A.D. 1575-1700)
6.15 Frequencies of each site type by landform types in Period 5 (A.D. 1575-1700)
6.16 Frequencies of each site type by vegetation community for Period 5 (1575-1700)
6.17 Simulation region in comparison to survey area
6.18 Frequency distribution of mean NND between habitations in Period 3 (A.D. 1325-1450)
6.19 Frequency distribution of median NND between habitations in Period 3 (A.D. 1325-1450)
6.20 Median NND p-value by period and site type comparison
6.21 Plot of observed median NND for special-use sites vs. the number of special-use sites in each period
6.22 Median observed NND between special-use sites by period
6.23 Plot of observed median NND between special-use and habitation sites vs. the number of special-use sites for each period

6.24 Plot of observed median NND between special-use and seasonal sites vs. the number of special-use sites in each period
6.25 Median observed NND between special-use and seasonal sites by period
6.26 Median observed NND between habitation sites by period
6.27 Plot of observed median NND between habitations vs. the number of habitations in each period
6.28 Median observed NND between habitations and seasonal sites by period
6.29 Plot of observed median NND between habitations and seasonal sites vs. the number of habitations in each period
6.30 Plot of observed median NND between seasonal sites vs. the number of seasonal sites in each period
6.31 Median observed NND between seasonal sites by period
6.32 Comparison of 3-km radius catchment and 100-in radius buffer area
6.33 Grain and seed productivity for Pecos National Historical Park based on soil survey data
6.34 Grain and seed potential for areas within 100-in of special-use sites
6.35 Grain and seed potential for areas more than 100 m from special-use sites
6.36 100-in buffers around habitation sites, with grain and seed potential productivity
6.37 100-in buffers around special-use sites, with grain and seed potential productivity
6.38 100-in buffers around seasonal sites, with grain and seed potential productivity

Chapter 7

7.1 Estimated number of people and occupied rooms for Pecos area habitation sites
7.2 Welker's (1997) estimates of the number of occupied rooms and population in her four time periods at Pecos Pueblo
7.3 Estimated population at Pecos Pueblo using Welker's (1997) time periods and room counts and a family size of seven people
7.4 Kidder's (1958:Figure 33a) reconstruction of Pecos Pueblo apartments
7.5 Number of rooms adjusted to time period length for several areas in the northern Rio Grande, Early Classic through Early Historic periods (Orcutt et al. 1994)
7.6 Estimated population at Pecos Pueblo, San Lazaro, San Marcos, and Arroyo Hondo

Chapter 8

8.1 Percentages of utility ware ceramic types recorded by the survey
8.2 Percentages of white ware ceramic types recorded by the survey
8.3 Percentages of identified glaze ware types recorded by the survey
8.4 Distribution of black-on-white and glaze ware sherds
8.5 Distribution of Apache ceramics
8.6 Distribution of White Mountain Red Ware sherds
8.7 Distribution of trade ware sherds
8.8 Percentages of decorated and undecorated sherds by time period
8.9 Decorated and undecorated wares by time period
8.10 Percentages of ceramic wares by site type
8.11 Percentages of ceramic wares recorded on the surface at the early pueblo sites
8.12 Percentages of ceramic functional classes by time period
8.13 Percentages of ceramic functional classes by site type
8.14 Histogram of bowl diameters
8.15 Histogram of undecorated jar diameters
8.16 Histogram of decorated jar diameters
8.17 Mean vessel size in rim diameter by time period
8.18 Locations of sites sampled for compositional analysis
8.19 Representative Black-on-white sherds submitted for compositional analysis
8.20 Clay sources sampled at Pecos National Historical Park

8.21 Total number of utility ware sherds per petrographic temper group
8.22 Summary of utility ware temper groups by site
8.23 Total number of utility ware sherds per petrographic paste group
8.24 Summary of utility ware paste groups by site
8.25 Total number of white ware sherds per petrographic temper group
8.26 Summary of white ware temper groups by site
8.27 Total number of white ware sherds per petrographic paste group
8.28 Summary of white ware paste groups by site
8.29 Percentages of local and nonlocal utility ware ceramics at the pueblos, based on petrographic results
8.30 Percentages of local and nonlocal white ware ceramics at the pueblos, based on petrographic results
8.31 Santa Fe Black-on-white petrographic temper categories
8.32 Galisteo Black-on-white petrographic temper categories

Chapter 9

9.1 New Mexico and the Southern Plains
9.2 New Mexico and important raw material sources
9.3 Specific obsidian sources in the Jemez Mountain area
9.4 Flake attributes used in debitage classification
9.5 A model of conservation and tool production strategies in relation to raw material availability and quality
9.6 Tool types for major raw materials, all sites
9.7 Raw materials for each tool type, all sites
9.8 Average volume of siltstone/quartzite per site
9.9 Average volume of local chert per site
9.10 Average volume of chalcedony per site
9.11 Average volume of obsidian per site
9.12 Average volume of nonlocal chert per site
9.13 Obsidian sources determined by Energy Dispersive X-ray Fluorescence for pueblos
9.14 Cross-section classes for ground stone
9.15 Idealized plan view and cross sections of a complex grinding feature
9.16 Complex grinding feature at PECO 301 (LA 118875)
9.17 Scatterplot comparing size of grinding area for complex grinding features with size of grinding area for complete metates
9.18 Ground stone tools
9.19 Hafted tools recorded by the survey
9.20 Cross-sections of all manos by site type
9.21 Cross-sections of manos from all sites from Periods 3, 4, and 5

Chapter 10

10.1 Seventeenth and eighteenth century sites recorded by the survey
10.2 Sites with Euro-American artifact assemblages
10.3 Sites dated to the Spanish Colonial/Mexican/Hispanic Settlement, Santa Fe Trail, Civil War Period using assemblage mean dates
10.4 Sites dated to the Railroad/Tourism Period using assemblage mean dates
10.5 Sites assigned to a period using artifact group dates
10.6 Hispanic Homesteads
10.7 PECO 540 (LA 119093), Homestead D
10.8 The northern portion of PECO 540, view SE, Pecos River in background
10.9 PECO 270 (LA 118847), Homestead A, Quintana
10.10 Overview of PECO 270 with the Forked Lightning Ranch house in background, view

NE
10.11 PECO 175 (LA 118789), Homestead B
10.12 PECO 175, southern structure, view SW
10.13 PECO 367 (LA 118934), Homestead E, Ruiz
10.14 View NW across PECO 367. Southern structure in higher vegetation
10.15 PECO 541 (LA 119094), Homestead C, Rivera
10.16 The lower portion of PECO 541, Pecos River in background, view E
10.17 Locations mentioned in census review
10.18 Santa Fe Trail route from Missouri to New Mexico
10.19 Road segments discussed in text
10.20 Historic roads derived from documentary sources

LIST OF TABLES

Chapter 3

3.1 Summary of data fields used for site recording
3.2 Site number changes due to combining previously recorded sites
3.3 Site number changes due to subdividing previously recorded sites
3.4 Artifact attribute analysis data fields
3.5 Isolated Occurrence data fields
3.6 Cultural Landscape data fields

Chapter 4

4.1 Summary of chronometric dates from Pecos National Historical Park
4.2 Date ranges for Pecos ceramic types
4.3 Ceramic mean dates for the Pecos survey sites
4.4 The Pecos survey chronology
4.5 Ceramic period assignments for the Pecos survey sites

Chapter 5

5.1 Comparison of the size of artifact scatters on sites affected by vegetation removal to those unaffected 105
5.2 Comparison of feature categories between sites affected and unaffected by vegetation removal 105
5.3 Contingency table of presence on sites of vegetation removal impacts and structures
5.4 Euro-American specific component types recorded in the field
5.5 General component types recorded in the field
5.6 Description and counts of components recorded as "other"
5.7 All nonportable features
5.8 Primary stone fabric types for structures
5.9 Primary stone fabric types for features
5.10 Primary stone construction techniques for structures
5.11 Primary stone construction techniques for features
5.12 Primary nonstone fabric types for structures
5.13 Primary nonstone fabric types for features
5.14 Primary nonstone construction techniques for structures
5.15 Primary nonstone construction techniques for features
5.16 Artifact scatters recorded in the field
5.17 Architectural categories and site types by component

5.18 Results of t-tests between number of artifact types at site types
5.19 Results of t-tests between logs of artifact density at site types
5.20 Nonstructural feature types at different site types
5.21 Cross-tabulation of site type and feature group
5.22 Site types through time
5.23 Structure types on seasonal sites
5.24 Artifact scatter types at seasonal sites
5.25 Artifact scatter types at special-use sites
5.26 Agricultural features by site type
5.27 Agricultural features by ceramic period
5.28 Kivas, measurable kiva sizes, and periods
5.29 Numbers of rooms and kivas through time
5.30 Kiva size, by period

Chapter 6

6.1 Palmer Drought Severity Index values and dryness index
6.2 Number of sites simulated for each period
6.3 Nearest-neighbor simulation results
6.4 Economic plant species and their potential uses
6.5 Area of plant productivity classes within and outside the 100-in buffer defined for habitation sites
6.6 Area of plant productivity classes within and outside the 100-in buffers defined for special-use sites
6.7 Area of plant productivity classes within and outside the 100-in buffers defined for seasonal sites
6.8 Analysis results summary, habitation sites and food resources
6.9 Observed frequencies, expected frequencies, and adjusted residuals for the localized food resource analysis for habitation sites
6.10 Analysis results summary, habitation sites and fuel resources
6.11 Observed frequencies, expected frequencies, and residuals for the localized fuel resource analysis for habitation sites
6.12 Analysis results summary, seasonal sites and food resources
6.13 Observed frequencies, expected frequencies, and residuals for the localized food resource analysis for seasonal sites
6.14 Analysis results summary, seasonal sites and fuel resources
6.15 Observed frequencies, expected frequencies, and residuals for the localized fuel resource analysis for seasonal sites
6.16 Analysis results summary, special-use sites and food resources
6.17 Observed frequencies, expected frequencies, and residuals for the localized food resource analysis for special-use sites
6.18 Analysis results summary, special-use sites and fuel resources
6.19 Observed frequencies, expected frequencies, and residuals for the localized fuel resource analysis for special-use sites

Chapter 7

7.1 Habitation sites used in population estimates
7.2 Pueblos used in population estimates
7.3 Size of the largest aggregate in each period

Chapter 8

8.1 References for ceramic type descriptions by ware

8.2 Total sherd frequencies for all ceramic types by vessel form
8.3 Shepard's (1936) findings regarding the source of manufacture for ceramics found at Forked Lightning Pueblo and Pecos Pueblo
8.4 Comparison of survey findings and Kidder's (1936) excavation data on trade ware ceramics found in the Pecos area
8.5 Total frequencies of sherds by vessel form
8.6 Comparison of sherd counts, weights, and estimated vessels by ware
8.7 Frequency of decorated and undecorated wares by time period
8.8 Frequency of utility ware types by time period
8.9 Frequencies of ceramic wares by site type
8.10 Frequencies of ceramic functional classes by time period
8.11 Frequencies of ceramic functional classes by site type
8.12 Mean vessel size in rim diameter by time period
8.13 Mean vessel size in rim diameter by site type
8.14 Mean rim diameter by ceramic type
8.15 Sites sampled for compositional analysis
8.16 Oxidized colors of the utility ware sherds by site
8.17 Oxidized colors of the white ware sherds by site
8.18 Oxidized colors of the clay samples from the Pecos area
8.19 Utility ware petrographic temper groups
8.20 Summary of utility ware temper groups by site
8.21 Utility ware petrographic paste groups
8.22 Summary of utility ware paste groups by site
8.23 Cross-tabulation of utility ware paste and temper groups
8.24 White ware petrographic temper groups
8.25 Summary of white ware temper groups by site
8.26 White ware petrographic paste groups
8.27 Summary of white ware paste groups by site
8.28 Cross-tabulation of white ware paste and temper groups
8.29 Corresponding petrographic paste groups between the utility ware and white ware ceramics

Chapter 9

9.1 Distance to major raw material sources
9.2 Flaked stone raw materials
9.3 Material types of debitage with cortex
9.4 Cortex amounts for debitage
9.5 Platform types of flaked stone
9.6 Debitage classes
9.7 Cross-tabulation of material type by debitage class
9.8 Debitage classes derived from post-field analysis
9.9 Thermal alteration for all flaked stone
9.10 Student's T-comparison of thermal alteration by thickness
9.11 Flaked stone use-wear
9.12 Student's T-comparison of item volume by edge damage
9.13 Technological types
9.14 Functional types
9.15 Projectile point classes
9.16 Tool classes derived from post-field analysis
9.17 Jemez Mountain obsidian sources
9.18 Energy Dispersive X-ray Fluorescence sources for tool types
9.19 Obsidian abundance and distance to source
9.20 ANOVA comparison of average percentage of high energy tools from site types from all

time periods
9.21 ANOVA comparison of average percentage of high energy tools from Period 2 site types
9.22 ANOVA comparison of average percentage of high energy tools from Period 3 site types
9.23 ANOVA comparison of average percentage of low energy tools from Period 5 site types
9.24 ANOVA comparison of average percentage of Class 2 debitage from Period 5 site types
9.25 Faunal and lithic comparison of Pecos Pueblo, Rowe Pueblo, and Arroyo Hondo
9.26 Cross-tabulation of mano type by material type
9.27 Cross-tabulation of mano type by cross section
9.28 Number of ground surfaces by mano type
9.29 Cross-tabulation of mano type by condition
9.30 Average sizes for complete manos by mano type
9.31 Student's T-comparison of mano type by length
9.32 Student's T-comparison of mano type by width
9.33 Cross-tabulation of metate type by material type
9.34 Cross-tabulation of metate type by cross section, all sites
9.35 Cross-tabulation of nonflaked lithic type by material type
9.36 All other nonflaked lithic artifacts
9.37 Resampling comparison of mano cross section by time periods, observed distributions displayed

Chapter 10

10.1 Euro-American components recorded in the field
10.2 European vessel forms made with native ceramics
10.3 Site numbers and descriptions of historic era sites with Euro-American artifacts
10.4 Cultural periods (Pecos Unit only) from the Cultural Landscape Overview
10.5 Assemblages with Euro-American artifact dates
10.6 Euro-American sites confidently assigned to a cultural period, based on assemblage artifact dates
10.7 Euro-American sites by cultural period, based on artifact group dates
10.8 Euro-American sites by cultural period, based on documentary, feature, or association dates
10.9 Euro-American sites that could not be assigned to a cultural period
10.10 PECO 540: OAS artifact counts by functional categories and proveniences
10.11 PECO 270: OAS artifact counts by functional category
10.12 PECO 175: OAS artifact counts by functional categories and proveniences
10.13 PECO 541/10000: OAS artifact counts by functional categories
10.14 PECO 541: OAS artifact counts by functional categories

<<< **Previous** <<< **Contents**>>> **Next** >>>

PECOS

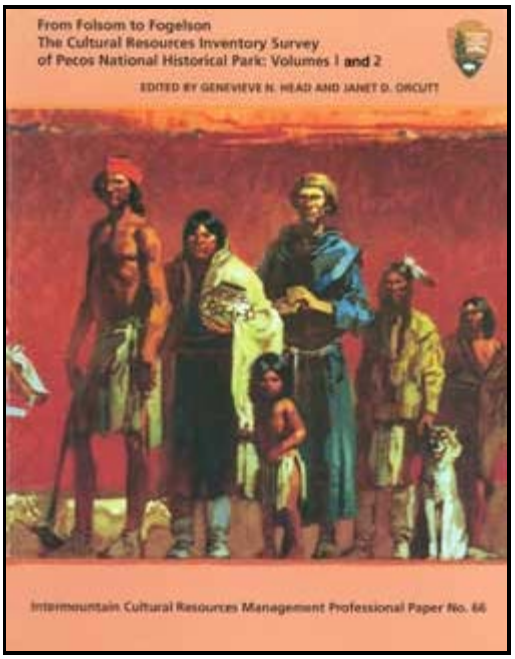
From Folsom to Fogelson:

The Cultural Resources Inventory Survey of Pecos National Historical Park

FROM FOLSOM TO FOGELSON

The Cultural Resources Inventory Survey of Pecos National Historical Park

Volumes 1 and 2



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TABLE OF CONTENTS

PECOS

From Folsom to Fogelson:

The Cultural Resources Inventory Survey of Pecos National Historical Park

FOREWORD

The people of Pecos situated their pueblo not only so they could see, but also so they could be seen. Even as a grassy mound, Pecos Pueblo is visible from almost every part of the Upper Pecos Valley and from the rim of Glorieta Mesa. Parties following the Pecos River from the Plains and runners from the villages of the Galisteo Basin would have little trouble locating the center of the Pecos community. For at least 300 years, Pecos Pueblo was the physical, economic, and political gateway to the Upper Pecos and Rio Grande Valleys. Bison meat, hides, and horn, important in Rio Grande subsistence and ceremony, passed from the plains through Pecos; obsidian from the Jemez Mountains and vibrantly painted ceramics from the heart of the pueblo world were likewise funneled to the Plains through Pecos. The village produced its own ceramics, and its warriors were feared throughout the country. In the 1540s, the people of Pecos boasted "that no one had been able to conquer them, and that they conquer whatever villages they wish" (Winship 1896:523). The Spanish entradas and European colonization disrupted the political and economic balance that kept Pecos strong. By 1840, the pueblo of Pecos lay in ruins, but travelers were impressed by its lonely beauty. Stories of the might and glory of Pecos kept its memory alive and brought the attention of early archeologists.

Adolph Bandelier performed his first archeological fieldwork at Pecos. In 1880, fresh off the train from the Midwest, Bandelier spent 10 days describing the Pecos ruins. His work brought a measure of objectivity to the legend of Pecos and laid the groundwork for future research. In 1915, Alfred V. Kidder began stratigraphic excavations at Pecos Pueblo. By systematically linking changes in pottery forms to their stratigraphic position, Kidder created a relative chronology of Rio Grande glaze ceramic types that is still used today and changed the way American archeologists worked. For the next 14 years, Pecos was the intellectual and social hub of archeological investigation in the Southwest. Though Kidder and his colleagues explored other sites in the Upper Pecos Valley, Kidder's excavations and published work focused on Pecos Pueblo. Once again Pecos had become a center, this time of scholarly inquiry.

By 1935, the standing red walls of the church and the grassy mound of the pueblo were protected as a New Mexico State Monument. In 1965, the federal government designated Pecos as a National Monument. Initially, the monument contained 60 acres surrounding the church and pueblo. The monument was small; its purpose was to preserve the church and pueblo ruins and to interpret the cultural interactions—trade, cooperation, colonization, conflict—that had occurred there between late Pueblo, Plains, and Spanish peoples. Through generous donations from Colonel E. E. Fogelson and his wife, actress Greer Garson, the monument grew to over 360 acres by the 1980s. Its interpretive focus remained the interaction between Pueblo, Plains, and Spanish—encompassing a time span of roughly 400 years.

In 1990, Pecos entered a new era. Through the donation of the northern portion of the Fogelson's Forked Lightning Ranch and authorization to administer the Civil War Battlefield

at Glorieta Pass, the monument was expanded to over 7,000 acres. Pecos National Historical Park now encompasses almost one quarter of the Upper Pecos Valley, and its cultural resources span ten millennia. From the midsection of a Folsom point discovered in the oak scrub east of the Pecos River to the Forked Lightning Ranch house and its out-buildings, the park now embraces the full course of human endeavor in the New World.

This report summarizes the results of the first systematic and contiguous inventory survey of the cultural resources at Pecos National Historical Park, both archeological and historical. The survey includes the original state and national monuments as well as the newly acquired lands surrounding them. The detached park units protecting the Glorieta Battlefields are not included in this survey. Our objective is to provide information not only on the pueblo of Pecos, but also on the villages that preceded it. We also describe the Spanish, Mexican, and American occupations that followed. Pecos Pueblo no longer stands as a solitary archeological monument, isolated in space and time. Its environs, its progenitors, and its heirs are reported upon here.

Nevertheless, the analyses in this report focus on the prehistoric puebloan era, roughly A.D. 1200 to 1600, until recent times the interval of most intense occupation in the Upper Pecos Valley. Our analyses not only provide thorough descriptions of the major sites and trends in the prehistory of the valley, but also attempt to employ innovative methods for interpreting the data. The ceramic chronology applies techniques previously used with historic ceramics and radiocarbon dates to create a replicable and explicit means for ordering prehistoric sites temporally and to determine their length of use. The chapter on settlement investigates factors that may have influenced decisions on where to place sites relative to both the physical and social landscapes. The chapter on lithics presents the first systematic consideration of lithic technology in the Upper Pecos Valley. In addition to chronological analysis of the historic sites in the park, the chapter on Euro-American sites and artifacts offers descriptions of several Hispanic homesteads or ranchos found along the banks of the Pecos River. These sites are of a time period and realm little researched by archeologists—the Territorial and early statehood eras during which New Mexico and the Southwest were incorporated into the wider commercial and cultural world.

The intent of this report is to provide professional scholars—archeologists and historians—as well as interested lay readers with a better understanding of the trends and processes that shaped Pecos. The story of Pecos has been retold countless times. We hope these volumes provide the impetus for many new stories.

Copies of this report may be obtained by contacting Anthropology Projects, National Park Service, P.O. Box 728, Santa Fe, NM 87504, (505) 988-6747 or Pecos National Historical Park, P.O. Box 418, Pecos NM, 87552, (505)757-6414. Please direct all inquiries regarding the data and background information on the project to the above numbers and addresses.

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National Park Service
Intermountain Support Office, Santa Fe
March 2002

PECOS

From Folsom to Fogelson:
The Cultural Resources Inventory Survey of Pecos National Historical Park

ACKNOWLEDGMENTS

Seven years is a long time. A great many people have been involved in the Pecos survey since its inception in 1995. Their contributions are so significant that these few paragraphs are hardly sufficient to express my gratitude.

The staff of Pecos National Historical Park have been steady and active partners in this project. Foremost, I would like to thank former Park Superintendents Linda Stoll and Duane Alire, Park Archeologist Judy Reed, and former Chief of Interpretation Ann Rasor. They helped set the project on the right track and have been unflagging in their support. The park administrative staff, Lori Roybal and Loretta Lujan, shouldered much of the administrative burden during the field portion of the project and were excellent advisors on camping and shopping in the greater Pecos area.

Facility Managers John Gibson and Vito Spinale and their staff were flexible and good humored throughout our stay at the Forked Lightning ranch house. No crew ever had better digs. Gilbert Ortiz, Joe Dalton, Christina Armijo, and George Valencia kept the house beautiful and all systems running while making us feel at home and less of a nuisance than we probably were. Gilbert and Joe also were most generous with their knowledge of the house and the ranch operations. During our field seasons, it was good to know that Chief Ranger Gary Hartley and Ranger Tim Lacy were on call 24 hours a day—luckily we never had to use any of the stretchers, oxygen, or safety floats they had on hand for us. Wildlife Ecologist Bobbi Simpson helped refine our environmental variables and was always excited about our wildlife sightings.

Special thanks are in order to the stabilization crew—Vivian Lujan, Victor Ortiz, Vicente Quintana, Junior Barela, and Rudy Armijo. Vic and Vivian have kept the church and convento standing for the last 30 years. They were always quick with a laugh, ready to share stories, and happy to explain archeological and historic features on the mesilla that occasionally we found baffling. Even though he missed the field portion of the project, Archeologist Tim Burchett has supported us throughout the write up and analysis phases. I would also like to thank the current Chief of Interpretation Wendy Lauritzen and the enthusiastic and knowledgeable staff of the Visitor Center for their interest and support—they will carry what we learned through the survey to visitors from around the world.

The field crews made the field portion of the project dynamic and memorable. The project could not have begun or been completed without Sue Einiger in her role as de facto Field Director and Chief Crew Chief—her steadiness, consideration, and wisdom kept me from more mistakes than I care to count. Sue's attention to detail taught many new crew members the right way to do fieldwork and her constant grace and gentle humor set the tone for camp life. Melissa Powell served as Lab Coordinator/GPS Maven for two seasons and then as a Crew Chief during our final season. She tackled both positions with fervor, and her critical eye kept our recording as consistent as the efforts of 33 people can possibly be.

As Crew Chiefs, Cynthia Herhahn (1995), Dan Meyer (1996), Loy Neff (1997), Melissa Powell (1997), and Ron Winters (1996, 1997) kept the crews running on schedule. They navigated the flooded river, torrential arroyos, rocky slopes, and often inscrutable archeology of Pecos with elan and saw to it that our work was done and done well. Our in-field ceramic analyses were conducted by Bill Creutz (1995, 1996), Sue Eininger (1995, 1996, 1997), Cynthia Herhahn (1995), Dan Meyer (1996), Matt Chamberlin (1997), Tom Durkin (1997), and Melissa Powell (1997). Bill Creutz was our Sherd Boy and our God of Good Temper and Paste. Bill knows the ceramics of Pecos like no one since Dr. and Mrs. Kidder, and he taught us all well. This report contains the first systematic treatment of archeological lithic materials from the Upper Pecos Valley, and it could not have been done without the in-field analyses performed by Joe Vasquez-Cunningham (1995, 1996, 1997), Jody Patterson (1995, 1996), Joe Keleher (1996), Erica Schoenberg (1997), Houston Rogers (1997), and Erin Baxter (1997). Architectural remains were recorded by Anne Goldberg (1995), Brett Hill (1995), Dan Meyer (1995), Ron Winters (1996, 1997), Dirk Hood (1996), Matt Chamberlin (1996), Loy Neff (1997), Kristen Hagenbuckle (1997), and Ben Vining (1997). The sketch maps they created transform six pages of codes and comments into a rich and understandable site record. In 1995, Eden Welker provided field and lab support and conducted historic research. She created synopses of land history for several sites and lent much appreciated cheer in the field. In 1996, Wendy Nettles shared her knowledge of historic artifacts and sites and her enthusiasm for historic archeology.

One of the most rewarding aspects of running a project like the Pecos survey is the opportunity to work with volunteers. Many thanks to Tom Windes, in his role as the VIP Coordinator, for making sure we had the paperwork right. In the field, we were ably assisted by volunteers Rolf Moore (1995), Amelia Natoli (1995), Rachel Smith (1995), Tom Durkin (1996), Berenika Byszewski (1996), Emily Shillingburg (1996), Houston Rogers (1996), Jenny Dennison (1997), Connie Howard (1997), and Jeremy Moss (1997). As always, it was a delight to work with the inspiring and unflagging Howard Newman (1997), who can out-walk crew members one-fourth his age. Julie Solometo helped out briefly in 1996 and 1997, and Shawn Penman added a bit of high technology to our recording of Pecos Pueblo in 1996, using a total station to map the pueblo structures on the mesilla.

An archeological survey crew works and travels on its stomach, and the loquacious and colorful Peter Wood kept us in Epicurean splendor during 1995 and 1996. In 1997, Paul Vigil blessed us with his good humor and great chile. We were a healthy and happy crew for three summers running because of these two men. To all the members of the field crew—this report is built upon your sore feet, scratched arms, sunburns, and laughter—thank you for your good company and hard work.

In Santa Fe, Sue Eininger's thorough background research began long before we went into the field and guaranteed we knew who had gone before us on each site. She was the major force behind the design and development of the recording forms, and she made sure we had clean data after the last field season. Many thanks to the chapter authors—Sue, Melissa Powell, Joe Vasquez-Cunningham, Jan Orcutt, Karl Benedict, David Kilby, Jeff Boyer, Jim Moore, and Natasha Williamson. They spent long hours in front of computer screens, translating the field data into new knowledge.

Tom Windes got a few of us out of the office, into the Pecos church, and on to scaffolding in the April snow to collect tree ring samples, and I thank him for his energy and enthusiasm, not to mention his summary of wood use included as Appendix E. Jake Ivey has been most generous with his encyclopedic knowledge of the Pecos Mission buildings and Franciscan architecture in general. Charlie Haecker cheerfully identified numerous Euro-American artifacts and provided insights into the Civil War era of the park.

Kate Spielmann, Winifred Creamer, and Keith Kintigh provided valuable critiques and reviews of this report. Rachel Kluender and Cynthia Herhahn worked long hours on the final GIS figures for the volume, and Nancy Lamm provided impeccable professional drafting of our old-fashioned figures. John Hanttula digitized the many photographs the survey produced. Nancy Ford worked editing miracles to bring the report to its present form. Kathleen Havill created the index. Jodi Herrera kept up with the complexities of requisitioning equipment and hiring and paying field crew and office staff. Last, but by no means least, Rose Ortiz kept the project in the black.

The project also owes much to Larry Nordby. Larry's meticulous field notes from the 1970s provided valuable lessons for interpreting the archeology at Pecos, and his personal guidance and involvement in the early stages of the project guaranteed its success. Linda Cordell has been most generous with details of her research at Rowe Pueblo and with her knowledge and enthusiasm for the archeology of the Upper Pecos Valley.

No words can capture the depth of my gratitude to Bob Powers. Bob entrusted me with a large project and as a friend has guided, prodded, and pitched in when needed. Many thanks also to Courtney White, who introduced me to Pecos and provided the support and perspective needed to see this project to its conclusion.

To all those mentioned here, and to any others I have inadvertently and regrettably omitted, my heartfelt and most sincere thanks!

Genevieve Head
Santa Fe, New Mexico
March 2002

<<< **Previous** <<< **Contents**>>> **Next** >>>

PECOS

From Folsom to Fogelson:

The Cultural Resources Inventory Survey of Pecos National Historical Park

CHAPTER 1:
Introduction

Genevieve N. Head, Janet D. Orcutt, and Robert P. Powers

Pecos Pueblo and the Upper Pecos Valley have played a long and significant role in the prehistory, history, and archeology of the American Southwest (Figure 1.1). The prominence of Pecos is reflected both by the volume of the historical and archeological literature about it and by the stature of the scholars drawn here (Bancroft 1962; Bandelier 1881, 1892; Bolton 1949; Cordell 1998; Hayes 1974; Hewett 1904; Kessell 1979; Kidder 1924, 1932, 1958; Kidder and Amsden 1931; Kidder and Shepard 1936; Schroeder and Matson 1965; Winship 1896).

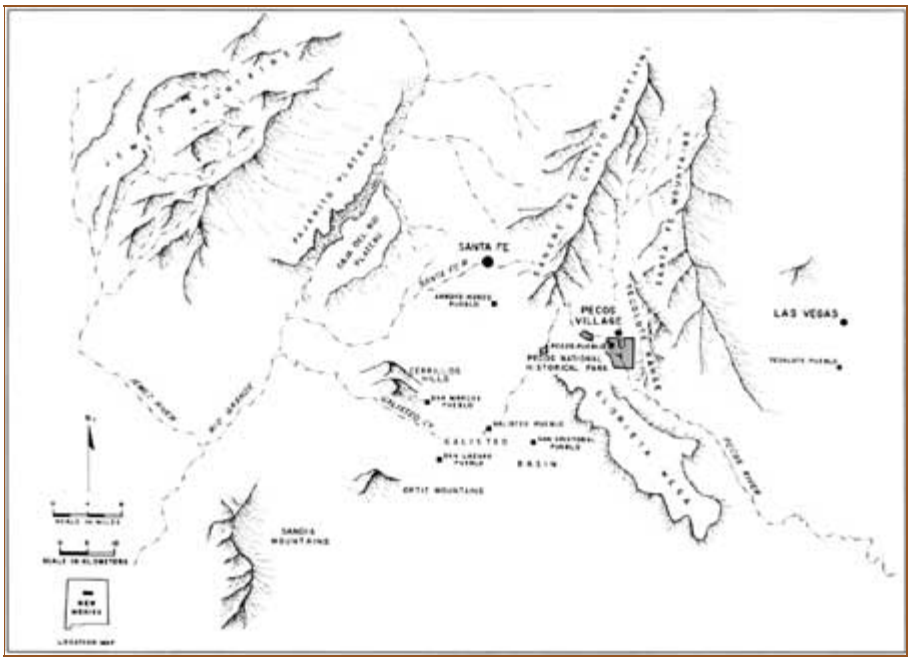


Figure 1.1. North-central New Mexico with the location of Pecos National Historical Park. *(click on image for an enlargement in a new window)*

Historians and archeologists alike have focused their efforts to a large degree on Pecos Pueblo and the nearby Spanish Mission church and convento. Kidder conducted a variety of excavations at nearby pueblos, and Cordell (1998) has recently completed a long-term study of Rowe Pueblo, but if anything these exceptions emphasize the scarcity of archeological investigation of the Upper Pecos Valley surrounding Pecos Pueblo.

This volume reports the results of a 100 percent inventory survey of the nearly 2,396 hectares (5,920 acres) of the main unit of Pecos National Historical Park. It provides the first

systematic analysis of the prehistoric and historic archeology of a large area surrounding Pecos Pueblo. Our primary goal is to describe the archeological materials found, but we also examine two aspects of prehistoric Puebloan society in the Upper Pecos Valley: (1) the development of the Pecos community and (2) exchange of material goods between Pecos and other Rio Grande Pueblos, and between Pecos and a variety of nomadic Plains groups. The emphasis of this volume is on the prehistoric Puebloan occupation of the park (A. D. 1200-1600). Sites of this affiliation are the most numerous in the project database. The historic portion of this report places the nineteenth and twentieth century Euro-American sites recorded by the survey into chronological perspective, examines economic and social change through census records, and describes and places into context the Santa Fe Trail and other circulation features within the park. This survey did not record the Spanish Mission complex, and very few sites were located that could be assigned to the Spanish Mission/Colonial period. Information for these structures and for the *entrada* and Colonial periods can be found in the recent NPS Draft Historic Structures Report (Ivey 1996).

The following sections of this chapter are intended to provide the background and context for the study. We begin by describing the need for an archeological inventory of Pecos National Historical Park. This is succeeded by descriptive summaries of the culture history and modern environment of the Upper Pecos Valley. These summaries lay the groundwork for a discussion of the project research objectives. The chapter closes with brief descriptions of the analyses performed in the following chapters.

The Need for an Archeological Inventory

It may seem obvious that the archeological resources of a national historical park as significant as Pecos should be carefully inventoried, but the need for inventory is based not only on logic but on federal law as well. Section 110(a)(2) of the National Historic Preservation Act of 1966 (as amended in 1980) directs federal agencies to "establish a program to locate, inventory, and nominate to the Secretary [of the Interior] all properties under the agency's ownership or control . . . that appear to qualify for inclusion on the National Register." An archeological inventory survey is usually necessary to identify such properties or sites.

This mandate to inventory has been strengthened recently by the National Park Service's Systemwide Archeological Inventory Program (SAIP), the purpose of which is "to conduct systematic, scientific research to locate, evaluate, and document archeological resources under National Park Service stewardship" (National Park Service 1992b:i).

While law and policy dictate that inventories be performed, almost all inventories are conducted for very specific reasons. At Pecos, impetus for an archeological survey was provided by the legislated expansion of the park in 1990, which increased the park's size by nearly 2,527 hectares (6,244 acres). The original monument, or "core area" consisting of 148 hectares (365 acres) surrounding Pecos Pueblo and the Spanish Colonial church and convento, was expanded by 2,248 hectares (5,555 acres) to include the surrounding Forked Lightning Ranch. In addition, two detached units, totaling nearly 279 hectares (689 acres), were added to preserve the Pigeon's Ranch and Cañoncito portions of the Glorieta National Battlefield (Figure 1.2).



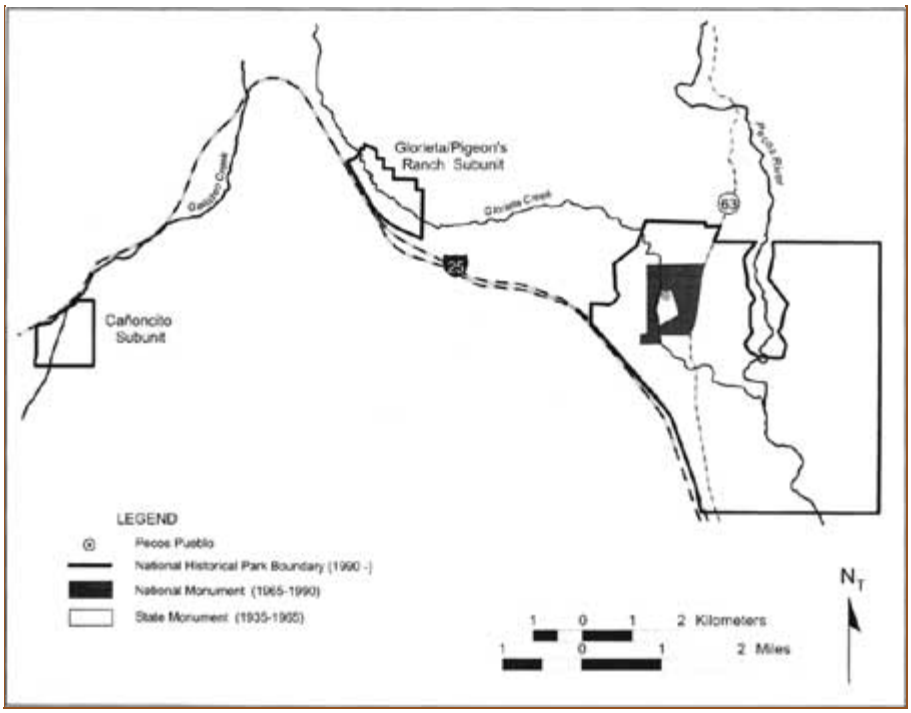


Figure 1.2. Boundary history of Pecos National Historical Park. *(click on image for an enlargement in a new window)*

Although the archeology of the original monument was relatively well known as the result of previous inventory efforts (Nordby 1992), knowledge of the nature and condition of archeological resources in the new areas was poor at best. And, even within the core monument, the results of previous surveys were unreported. Because many areas were unsurveyed, others were unreported, and information often differed in quality and consistency between areas, it became apparent that the most effective and efficient means of establishing an inventory database suitable for both management and research purposes was to inventory the entire park, including those areas previously surveyed.

The Pecos Cultural Resources Inventory Survey, referred to hereafter as the Pecos CRIS, was designed to address both management and research requirements, although the present volume focuses on the research results of the survey. The results reported here are the product of the first systematic and detailed inventory of the full range of the park's cultural resources. Design of the inventory was undertaken in 1994-1995. Fieldwork was carried out during the summers of 1995, 1996, and 1997, resulting in the identification of 629 sites within 2,396 hectares (5,920 acres). At the time of fieldwork, most of the land in the Glorieta Battlefield units was in private ownership so these units were not surveyed. Complete inventory of the Glorieta units remains a goal for the future. Two additional years (1998 and 1999) of data analysis and research produced this volume.

Upper Pecos Valley Culture History

The following discussion of the culture history of Pecos National Historical Park and the Upper Pecos Valley utilizes the Rio Grande chronological sequence developed by Wendorf and Reed (1955). This chronology is based on changes in settlement patterns, architecture, and artifacts. For this reason it differs from the ceramic chronology for the region, which uses only changes in form, composition, and decoration of ceramic vessels to define different periods. Using the Wendorf and Reed chronology helps place the culture history of Pecos in the broader context of the northern Rio Grande region. The ceramic chronology for the prehistoric sites recorded by the project is revisited in Chapter 4 of this volume. The review

of the historic period culture history is organized using the periods and themes developed for the NPS Cultural Landscape Overview of the park (Cowley et al. 1998). These two chronological constructions overlap during the early historic era (A.D. 1540-1600).

Preceramic Period (11,500 B.C.-A.D. 600)

Paleoindians were the first human occupants of the Southwest, and evidence of their presence in the Upper Pecos Valley is scant. Paleoindian economy focused on big-game hunting, targeting now-extinct large fauna, such as mastodon and *Bison antiquus.* Most Paleoindian sites in the Southwest are found around ancient lakebeds where water and game were plentiful (Judge 1973:330). Sites are generally open-air lithic scatters, recognized most easily by the presence of distinctive, well-formed projectile point types. These spear points are remarkable for their consistency in shape and size across a broad geographical area and for the high quality of the knapping techniques used to create them.

The elevation and relatively small size of the Upper Pecos Valley may have made it a marginal habitat for many species of large fauna, and hence for the Paleoindian groups dependent on them. One Clovis-like point (11,000-10,000 B.C.) was previously found in the nearby Sangre de Cristo Mountains (Nordby 1990:33; Wendorf and Miller 1959:48). Evidence for Paleoindian use of Pecos National Historical Park is limited to a single isolated Folsom point midsection (9,000-8,000 B.C.) found in the Tecolote Mountains during the present survey.

It is possible that some of the nondiagnostic lithic scatters in the valley are the result of Paleoindian activities, but until more detailed technological analyses of the lithic debitage are performed, the cultural affiliation of these assemblages will remain uncertain. The lack of Paleoindian sites also may be the product of differential exposure, as the severe erosion that has exposed many such finds in surrounding areas is not widespread in the Upper Pecos Valley (Cordell 1998).

The Archaic culture in the Southwest is defined by a broad subsistence regime including hunting of a variety of medium to small game as well as plant gathering. During the late Archaic period some groups began experimenting with horticulture (Irwin-Williams 1973), although horticultural products probably accounted for only a small portion of the diet. Sites range from open-air lithic scatters with hearths, basin metates and one-hand manos, to south facing rockshelters with deep deposits (Dick 1965; Irwin-Williams 1973). Stemmed and diagonally notched dart points and knives are diagnostic of this adaptation, as are certain patterns of raw material use.

Archaic materials from the Upper Pecos Valley and surrounding mountain areas are known from private collections (Nordby 1990:33). No positive Archaic sites were known within the park until the present survey, which recorded three Archaic site components. Further south in the Upper Pecos Valley Anschuetz (1980) reports four Late Archaic sites which contain hearths and an abundance of lithic debitage in areas surveyed near Rowe Pueblo (Cordell 1998). Lang (1977), in a survey around San Cristobal Pueblo in the Galisteo Basin, suggests the presence of two separate Archaic traditions: the Oshara, associated with the northern Southwest (Irwin-Williams 1973); and the Cochise, an arid-lands adaptation known from southern Arizona, New Mexico, and northern Mexico (Dick 1965). It is not known yet whether a similar distinction can be made among the Archaic materials from the Upper Pecos Valley.

Developmental Period (A.D. 600-1200)

During the Developmental period, sedentary habitation became more common in the northern Rio Grande region. This change in residential permanency was accompanied by increased

dependence on agriculture, especially corn *(Zea mays).* Early in the period, habitations take the form of pithouses; later, small above-ground structures are built. Around A.D. 700, the bow and small, usually corner-notched, arrow points replace the atlatl and heavy dart points of the Archaic tool-kit. Settlements are usually near water sources.

Permanent dwellings first appear in the Upper Pecos Valley during the Developmental period. Five pithouses constructed around A.D. 800-950 are the only early Developmental sites known in the area (Akins 1994; Nordby and Creutz 1993a). Very little is known about settlement in the valley between about A.D. 950 and 1200. Excavations at Rowe (Cordell 1998) and Forked Lightning (Kidder 1958) found evidence of small adobe structures dating to the eleventh and twelfth centuries, but the exact nature of these structures could not be determined due to later structures covering them. The small number of sites between A.D. 950 and 1200 suggests that after abandonment of the pithouses, the valley was not permanently inhabited, although it may have been used intermittently or seasonally by small groups. It is also possible that sites occupied during this period are simply buried deeply in areas with little erosion.

Coalition Period (A.D. 1200-1325)

The Coalition period is generally divided into Early (A.D. 1200-1250) and Late (A.D. 1250-1325) phases. It is marked by intensification of agriculture and by the coalescence of most of the population into larger pueblos. These characteristics seem to appear simultaneously in many portions of the Southwest (see Adler 1996). It is thought that much of the cultural change associated with the Coalition period is influenced by an influx of population to the Rio Grande Valley during the abandonment of the Four Corners region in the mid- to late 1200s.

During the early Coalition, at least two pueblos are present in the Upper Pecos Valley. The first, an adobe structure underlying Rowe Pueblo, is dated between A.D. 1240 and 1250 (Cordell 1998). The second site, Forked Lightning Pueblo, is dated from approximately A.D. 1225 to 1300 based on the presence of early white ware ceramics and the lack of glaze ware (Kidder 1958:42).

During the Late phase of the Coalition period (A.D. 1250-1325), the Upper Pecos Valley appears to experience a population influx, as indicated by the construction and occupation of as many as six pueblos of 50 rooms or more. In addition to continued occupation at Forked Lightning and Rowe, Black-on-white House, the structure underlying Pecos Pueblo (A.D. 1300-1425), was constructed, as were Shin'po or Hill House (PECO 307; LA 267; A.D. 1300-1350), Loma Lothrop (PECO 227; LA 277; A.D. 1315-1450), and possibly Dick's Ruin (PECO 434; LA 276; A.D. 1300-1425) (Cordell 1998; Kidder 1958:42, 47, 55-63). The locations of these pueblos are shown in Figure 1.3. The sources of the populations establishing these sites are unknown, but many may be settlers from the Rio Grande Valley attracted to the relatively cool and moist Upper Pecos Valley.



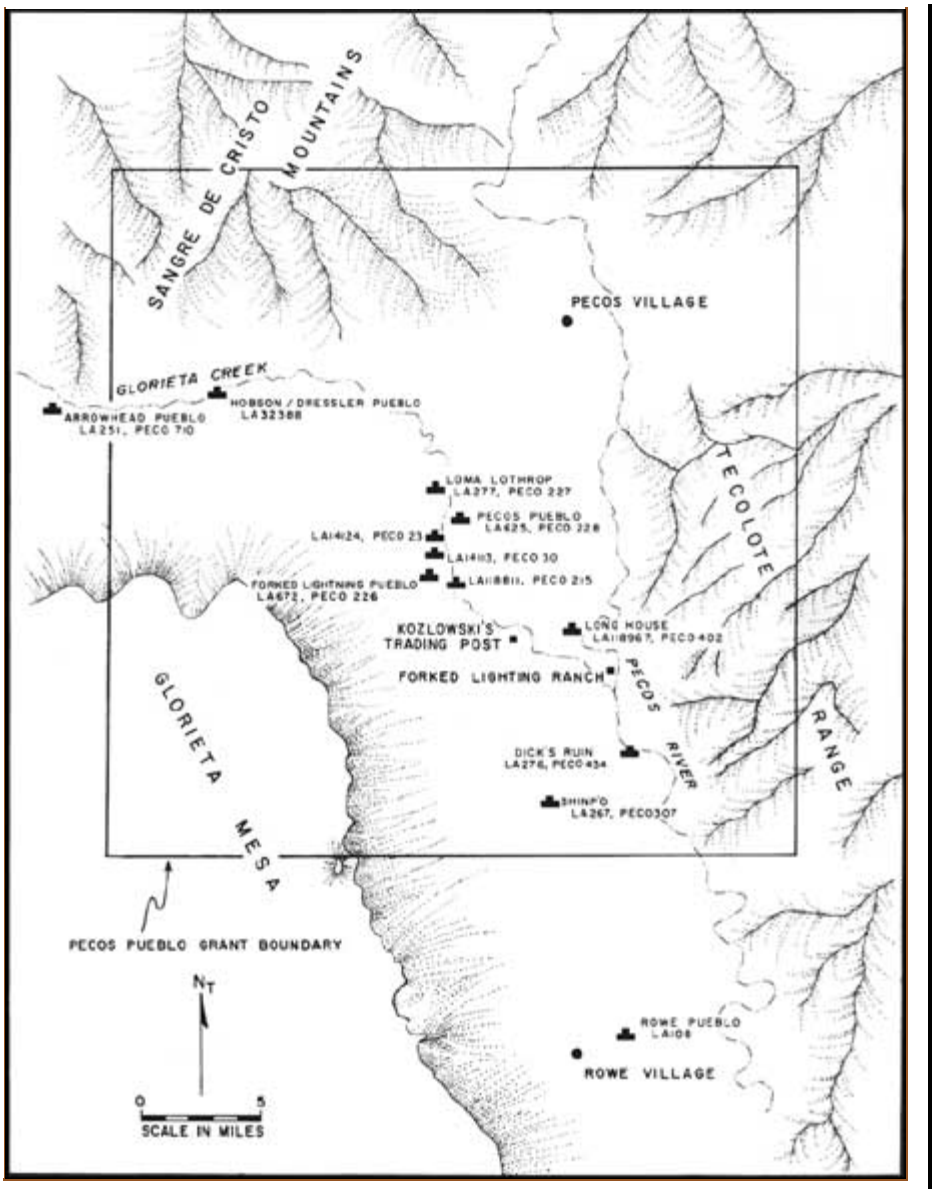


Figure 1.3. Locations of major prehistoric sites in the Upper Pecos Valley. *(click on image for an enlargement in a new window)*

It is during the Coalition period that the Southern Plains first supported farmsteads along tributaries of the Canadian River. Most of the few southwestern goods at these sites are exotic items, such as decorated ceramics, obsidian, turquoise, and shell from the Gulf of California (Lintz 1991:93). The presence of these materials on the Southern Plains suggests that reciprocal exchange between Plains and Pueblo groups involving relatively small amounts of raw materials or crafted items began at this time (Habicht-Mauche 1991:51-52; Krieger 1946).

Classic Period (A.D. 1325-1600)

The Rio Grande Classic period is divided into three phases, Early (A.D. 1325-1400), Middle (A.D. 1400-1525), and Late (A.D. 1525-1600). In the northern Rio Grande region, the Classic period is distinguished by the presence of glaze painted ceramics and very large residential structures. Researchers are now beginning to believe that during the Classic period the Rio Grande Valley was organized into a number of shifting alliances, with each community independent, yet linked to others through a complex network of economic, social, and political relations (Kessell 1979:12; Spielmann 1994; Wilcox 1981, 1984, 1991).

Exchange probably became an economic necessity for residents of both Pueblo and Plains during the Classic period, as climatic fluctuations and movement of Athapaskans into the Southern Plains, and population growth and depletion of natural resources in the Rio Grande, caused widespread subsistence stress. Pecos, as an active participant in the commerce between the Rio Grande and Plains, undoubtedly played a significant role in the development of economic networks in the northern Rio Grande Valley.

During the Early phase of the Classic period (A.D. 1325-1400) in the Upper Pecos Valley, masonry structures were built at Rowe Pueblo (LA 108; A.D. 1340-1450) and Arrowhead (PECO 710; LA 251; A.D. 1370-1450), and possibly at Hobson-Dressler (LA 32388; A.D. 1350-1400) (Cordell 1998; Holden 1955:103; National Park Service 1992a:Fig. 3). Both Arrowhead and Hobson-Dressler are located near Glorieta Pass (Figure 1.3). Structures on the Pecos mesilla were expanded, and residence continued at Loma Lothrop, but Forked Lightning Pueblo, Dick's Ruin, and Shin'po were probably no longer used as residences.

The Middle phase of the Classic period (A.D. 1400-1525) was a time of great change in the Upper Pecos Valley. A massive, four-story structure enclosing a central plaza—what we now know as the Pecos Pueblo Quadrangle—was constructed on the mesilla in about A.D. 1425 (Kidder 1958). The Hobson-Dressler site was deserted, while occupation at Rowe, Loma Lothrop, and Arrowhead persisted for a few years. By 1450, all human habitation in the valley was concentrated at Pecos Pueblo. Pecos began to produce its own glaze wares at this time.

During the Late phase of the Classic period (A.D. 1525-1600) Pecos Pueblo developed into a prosperous and influential community. It served as a center of trade and contact between the Southern Plains and Eastern Pueblos. Beginning in the early 1500s Pecos not only produced its own glaze ware, it distributed it to the Plains and other pueblos outside the Upper Pecos Valley as well (Kidder and Shepard 1936; Shepard 1942:154-155; Welker 1997:171).

Pecos Pueblo/Spanish Mission Period (A.D. 1540-1838)

To describe the historic period occupation at Pecos, the structure of this culture history now shifts to the time periods developed by the Cultural Landscape Overview (Cowley et al. 1997). These periods were developed to capture changes in the use and appearance of cultural landscapes in the Pecos area and not to split time into mutually exclusive sequential units. Some of the broader Cultural Landscape Overview periods are here subdivided using shorter periods derived from historical reconstructions for the Pecos area.

In 1540 several Pecos Indians trading at Zuni encountered the Coronado expedition. A year later, in 1541, Coronado launched his ill-fated search for Quivira from Pecos (Kessell 1979; Winship 1896). A Franciscan friar who came to New Mexico with Coronado remained at Pecos after Coronado's departure but died on the Plains continuing the fruitless search for Quiviran gold (Kessell 1979:26-27; Winship 1896:534-535).

Other Spanish expeditions passed or stopped at Pecos: the Rodriguez-Chamuscado expedition in 1581; the expedition of Antonio de Espejo in 1582; and in 1590, that of Gaspar Costaño de Sosa, who, hoping to make his fortune, entered the pueblo world by following the Pecos River north from Mexico. Meeting resistance at Pecos, the first pueblo he encountered, his soldiers stormed the mesilla and after much fighting, subdued the powerful village (Kessell 1979:31-62; Schroeder and Matson 1965). In 1598 Don Juan de Oñate arrived in the northern Rio Grande Valley with a wagon train of settlers and friars and established the first Spanish settlement near San Juan Pueblo. Oñate assigned missionaries to all the Rio Grande pueblos, but the initial missionary at Pecos lasted only three months (Kessell 1979:82). Sometime between 1617 and 1620 a Franciscan friar became a resident at Pecos, and a church was

constructed not far from the pueblo (Ivey 1996). The Spanish era in the Upper Pecos Valley had begun.

Spanish Colonial Period (A.D. 1600-1821)

The Spanish Colonial period in New Mexico can be divided into three phases: Pre-Revolt (A.D. 1600-1680), Pueblo Revolt (A.D. 1680-1692), and Post-Revolt (A.D. 1692-1821). These intervals are distinguished by differences in colonial policies regarding land and Indians and by differing magnitudes of Spanish presence. The first and last phases of Spanish occupation are separated by the Pueblo Revolt, a 12-year period during which the Spanish were forced to retreat from New Mexico.

Early Colonial/Pre-Revolt (A.D. 1600-1680)

The first eighty years of Spanish rule in northern New Spain saw the development of deep rifts between the Church and the colonial government, primarily over the use of Puebloan labor and access to its fruits. Using Puebloan labor, numerous churches were constructed, and Spanish haciendas, usually supported by tribute from the pueblos, were established under the *encomienda.*

The *encomienda* was a major element of colonial policy in northern New Mexico in the years before the Pueblo Revolt. Under this system, pueblo villages were required to provide tribute to a Spanish settler awarded an *encomienda* by the governor. In exchange, the encomendero protected the pueblo from raiding and supplied the governor with military support (Kessell 1979:99). An encomendero was usually a high ranking official in the Spanish government in New Spain, or head of an influential Spanish family. This system took valuable food and goods from the pueblos, making it harder for village residents to support their own households. At the same time, Franciscan missions were established at large pueblos to convert and Christianize the souls residing there. Missionaries used pueblo labor to build the churches and associated buildings, and the pueblos provided materials and labor to support the missions.

Evidence of the Spanish colonial occupation at Pecos is largely confined to the mission church and convento. Material manifestations of Spanish influence are the use of form-molded adobes, a variety of metal artifacts, and the appearance of new ceramic forms, such as soup plates and candle sticks.

Over the next 80 years the incremental and wearing effects of disease, drought, and tribute mounted. On August 10, 1680, the normally autonomous pueblos acted jointly and simultaneously to rid themselves of Spanish rule and oppression. During the Pueblo Revolt numerous Spanish families and friars were killed or driven from their homes and churches, and ultimately from northern New Spain. The priest from Pecos attempted to escape to Galisteo Pueblo, but was murdered just outside its walls. The friar and other Spanish citizens remaining at Pecos Pueblo were killed (Kessell 1979:228). Spanish reign over New Mexico ceased for a time (Hackett and Shelby 1970).

Pueblo Revolt (A.D. 1680-1692)

The years between the revolt and the reconquest are poorly known due to the absence of European chroniclers. The lack of major stylistic or technological change suggests that the Spanish presence (and absence) only had little effect on indigenous craft production (see also Snow 1973:56). During the years following the revolt, the Spanish settlement of Santa Fe was occupied by Tano and Tewa speaking Puebloans. El Pope, the primary instigator of the revolt, exhorted every pueblo to obliterate every vestige of Spanish occupation. Churches were burned and dismantled, and church bells, santos, crucifixes, and vestments were

destroyed. Even sheep and cattle were killed.

The revolt was a time of great upheaval in Rio Grande Pueblo society and culture. Three generations of Puebloans had grown up under the influence of the Spanish, and every aspect of Puebloan life—religious, economic, social, and political—had been affected. Disease and starvation had taken a heavy toll on pueblo populations (Kessell 1979:489-495; Levine and LaBauve 1994:36). As a result, the socioeconomic network that had previously existed in the region could not be reconstructed during the short time the Spanish were gone. Unsuccessful attempts at reconquest by the displaced colony also had a destabilizing effect on the Puebloans. When de Vargas returned to the province in 1692 he found the pueblos strongly divided (Simmons 1979:186).

At Pecos, archeological evidence of the destruction accompanying the Pueblo Revolt is limited. The massive seventeenth century church was completely razed, reportedly by Tewas, with whom the Pecos had been at odds for years (Kessell 1979:239, 241). Little but the foundations of this church have been identified archeologically. Adolph Bandelier reported seeing portions of what he believed to be the Pecos church bell on Glorieta Mesa (Bandelier 1881:99-101). The kiva in the middle of the convento may represent an act of vengeance against the Spanish religion (Hayes 1974:32), though this interpretation has recently been questioned (Ivey 1997). Otherwise there is little physical evidence to suggest that any conflagration or upheaval occurred at Pecos.

Late Colonial/Post-Revolt (A.D. 1692-1821)

In 1692, Don Diego de Vargas marched into Santa Fe and repossessed the capital. He then toured the Rio Grande, requiring and receiving the submission of each pueblo. Though his initial reception by the pueblos was quiet, the complete recolonization of New Mexico was more problematic, bloody, and time-consuming. Revolts cropped up over the following years, but this time the Spanish response was to send more settlers and soldiers. The *encomienda* was abolished, and relations between church and state became less contentious. The reconquest was successful; the Spanish foothold in northern New Spain was firm.

Pecos sided with the Spanish during the reconquest despite the presence of an anti-Spanish faction within the Pueblo (Hayes 1974:10; Kessell 1979). A new church was built inside the foundations of the earlier church, and materials from the seventeenth century convento were recycled for use in constructing a new convento on the same site (Ivey 1996; White 1996).

By the turn of the eighteenth century, Spaniards and Puebloans on the frontier faced a common foe, the Comanche. Raiding from the Southern Plains, the Comanche were less interested in trading than the Apache. As early as 1717, Pecos warriors were probably fighting side-by-side with the Spanish against the Comanche (Hayes 1974:13). Severe attacks against Pecos occurred throughout the 1700s. The pueblo's population continued to decline as warriors and farmers were killed in raids, and as smallpox ravaged the Rio Grande.

By 1773, the church at Pecos had been reduced to a visita of Santa Fe, with a priest visiting only occasionally (Adams and Chavez 1956:212; Hayes 1974:16). In 1776, Dominguez estimated the Pecos population at 269 individuals and reported that the "miserable wretches" at Pecos could not use their irrigated fields to the north and east of the pueblo because they were so frequently attacked by the Comanche. As a consequence, they resorted to wandering afar, selling their own possessions to support themselves (Adams and Chavez 1956:213).

Ultimately the reduced number of people living at Pecos Pueblo and the threat of attack produced additional consequences. After 1700, official grants of at least four square leagues of surrounding land were made to each pueblo (Simmons 1979:182). These grants were intended to provide for the safety and subsistence of the pueblos by forbidding encroachment

on Indian land under tillage. The founding of the Spanish villages of San Miguel and San Jose del Vado, along the Pecos River south and east of the Pueblo, in 1794 and 1802, respectively (Hall 1984:3-5), proved that these pueblo grants were not secure, particularly when the land was not being used intensively. In 1814, tracts of irrigated land immediately south of the Pecos Pueblo boundary were granted to families from San Miguel, and the stage was set for the alienation of Pecos Pueblo's lands (Hall 1984:17).

Early Settlement, Santa Fe Trail, Civil War Period (A.D. 1812-1880)

Mexican/Santa Fe Trail (A.D. 1821-1846)

Under the Treaty of Cordova, signed on August 24, 1821, Mexico gained independence from Spain, and New Mexico became part of Mexico. Mexican independence brought two major changes to New Mexico—more lenient land grant policies and expansion of trade (Levine et al. 1995). Mexican law and custom changed the status of Indians, making them full Mexican citizens and thereby eliminating the ward status they held under Spanish rule (Hall 1984:32). Puebloans now had the right to own and dispose of land. At Pecos, this change in status officially removed the Pueblo's right to limit use to members of the Pueblo. With a dwindling population, the residents of Pecos had not used much of their land for years. By 1825 the fertile *cienega* north of the pueblo, was largely controlled by non-Indians (Hall 1984:47).

It was not long before the villages of San Jose del Vado and San Miguel del Vado were joined by additional Spanish settlements both north and south of Pecos Pueblo. Spanish names now frame the landscape along the Pecos River—Los Trigos (Wheat), Las Ruedas (Wheels), El Gusano (The Worm) (Almaraz 1988:88; Cobos 1983). In 1825, only one baptism, one marriage, and one burial were recorded at Pecos compared to 176 baptisms, 40 marriages, and 40 burials for El Vado (Almaraz 1988:88; Kessell 1979:562; Levine and LaBauve 1994). In 1838, the last residents of Pecos left their home to join the pueblo of Jemez.

During the early years of the nineteenth century the economy of the Upper Pecos Valley remained at a subsistence level with fishing and hunting used to augment agriculture and stock raising. Land along the river was used for farming, while uplands provided grazing for goats, sheep, and cattle. Five Spanish homestead sites are located within the boundaries of Pecos National Historical Park. These sites have a period of occupation extending from 1820 to the 1930s. Many of the families may not have been residents of the Upper Pecos Valley year-round, but they tilled and grazed the land in order to retain their claims.

While the settlers, often of mixed Spanish and Indian descent, were colonizing the Pecos area, purchase of the vast Louisiana Territory by the United States brought American explorers and traders westward. In September of 1821, at the time of Mexican independence, William Becknell headed west from Missouri, creditors at his back, with visions of bounteous trade. He and his goods were welcomed warmly at Santa Fe, and the focus of Mexican frontier commerce began to shift from the merchants in Chihuahua to those in Missouri (Almaraz 1988:86; Simmons 1988:94). American wagons travelling the route that became known as the Santa Fe Trail brought cloth, clothes, jewelry, mirrors, window glass, and other luxuries and necessities. Traders headed east with buffalo robes, buckskins, blankets, gold from the Ortiz Mines, and silver Mexican reales (Simmons 1988:97).

United States Territorial (A.D. 1846-1880)

In Santa Fe, on August 15, 1846, Colonel Stephen W. Kearny, commander of the Army of the West, claimed New Mexico for the United States. The American Territorial period in New Mexico is distinguished by a growing interest in commerce and a market economy that

demanded a dependable means of transportation. Initially, Conestoga wagons filled with families and goods lumbered toward the west along the Santa Fe Trail. By 1850, long distance stagecoach routes were established to transport travelers as well as the mail.

Pigeon's Ranch, near Glorieta Pass was one stopover along the Santa Fe Trail. Alexander Pigeon (or Encher Pigeon) (Oakes and Swanson 1995:15), a French-American from St. Louis who soon changed his name to Alexander Valle (Hall 1984:149), established the stop in the early 1850s. It served as a forage and supply station for the U.S. Army in addition to providing food, entertainment, and lodging for travelers (Oakes and Swanson 1995:15-18). Today, only three adobe rooms, a mounded ruin, a well, and stone corrals remain.

In 1858 Martin Kozlowski, an immigrant from Poland who had fought Apaches with the U.S. Army in southern Arizona and New Mexico, started a ranch near a spring south of Pecos Pueblo. Travelers along the Santa Fe Trail frequented this spring and Kozlowski's Trading Post became a favorite stop for overland stages and other travelers (Kajencki 1990:47-66). Kozlowski obtained permission from Archbishop Lamy to use materials from the Pecos church to build barns and outbuildings (see Appendix E for recently collected dendrochronological in formation from Kozlowski's Trading Post).

In late 1861, General Sibley, commanding a Confederate Army force of 2,600 men, marched from Texas in an attempt to capture the western territories, and particularly, the gold fields of Colorado and California. Meeting only minor resistance, the Confederate forces moved up the Rio Grande, taking foodstuffs and supplies from villages along the way. Their march was stopped in late March of 1862 when they were engaged and ultimately defeated at Glorieta Pass by a force of Union Army regulars and Colorado volunteers (Swanson 1988).

Kozlowski's Trading Post served as the Union headquarters and hospital during the battle (Haecker 1998). The Union dead were buried "beneath the shadow of the ancient Pecos Church" (Hall 1984:116). The exact location of their original resting place is presently unknown. Pigeon's Ranch was used as the site of the Confederate field hospital and then as a burial ground. A mass grave containing Confederate dead was discovered and excavated in 1987 (Oakes 1990).

Railroad/Tourism (A.D. 1880-1941)

In 1878 the Denver and Rio Grande Railroad (D&RG) began laying track across northern New Mexico and through Glorieta Pass. The railroad had a profound effect on the economy of the territory. Lumber for cross ties was brought out of the Sangre de Cristo Mountains, and supplies were needed for work crews. The mountains surrounding Pecos came alive with lumber camps and sawmills. The Atchison, Topeka and Santa Fe (AT&SF) collected carloads of timber at Baughl's Station (or Bowll's Switch), located near the northern end of Glorieta Mesa, at the opening of Glorieta Pass.

In addition, there were rumors of mineral riches along the Pecos River. An 1881 newspaper article reported that a group of prospectors were at work in the mountains above Pecos, although few mines in the Pecos Canyon achieved steady production. The Evangeline Mine on the Pecos River north of the park produced copper laced with gold and silver, but its ores could not be exploited using the smelting techniques of the era. The mine failed but was revived in the late 1920s when processing technology changed (Glover and McCall 1988:115).

Homesteading, particularly of Hispanic sites now within the park, peaked during this interval. A gristmill was constructed on a bend in the river to serve the local residents (White and Porter 1996). There is also what appears to be an exploratory mine within the park, on the east side of the Pecos River. Created by a local Pecos man, it apparently produced no ore

(Dobie 1931:222-238; a more detailed description of this site is given in Chapter 10).

Archeologists first visited and studied Pecos Pueblo during this time. In the early 1880s Adolph Bandelier visited and mapped the pueblo and some of its associated structures (Bandelier 1881). In 1914, A. V. Kidder began stratigraphic excavations at Pecos Pueblo. These were among the first in North America and formed the basis for the Rio Grande pottery sequence as well as the Pecos Classification (Kidder 1927). With research also came preservation. In 1920, the owners of the Gross-Kelly Company, a local mercantile business, deeded 80 acres surrounding the pueblo, including the church and convento, to the Archdiocese of Santa Fe, which turned the deed over to the Museum of New Mexico and the School of American Research in Santa Fe (Kessell 1979:481; Kidder 1958:325). In 1935, Pecos became a New Mexico State Monument, and in 1965, a National Monument (Ivey 1987).

Ranching Period (A.D. 1925-1993)

By 1925, most of the homesteads and properties along the Pecos River and in the former Pecos Pueblo grant were owned by Tex Austin, an international rodeo promoter. His Forked Lightning Ranch was both a working dude ranch and a cattle operation. Guests arrived on the train and spent their time horseback riding, exploring Pecos Pueblo, and relaxing at the elegant ranch house above the confluence of the Pecos River and Glorieta Creek (1920s Forked Lightning Ranch brochure on display at Pecos National Historical Park). Austin enlarged Kozlowski's Trading Post, building corrals, sheds, barns, a tennis court, and a polo field. He went bankrupt, and in 1939, Colonel E. E. "Buddy" Fogelson purchased the Forked Lightning Ranch.

Fogelson/Monument Period (A.D. 1941-1991)

Colonel Fogelson and his wife, actress Greer Garson, raised Santa Gertrudis cattle on the ranch and spent their summers there. Some of the outbuildings constructed by Austin were torn down during their tenure. A well was dug in the Middle Pasture south of the Forked Lightning Ranch house, and additional corrals were constructed. During the 1960s, a program of vegetation clearing was undertaken to increase pastureland. Bulldozers were used to remove pinon and juniper trees in flat areas, mostly on the west side of the river (Gilbert Ortiz, personal communication 1995; see below and Chapter 5 for more details on the effects of this clearing on archeological sites). In the 1960s, the Fogelsons donated land to the newly formed Pecos National Monument. Additional land was donated in the 1980s, along with money for a monument Visitors Center. After Colonel Fogelson's death in 1987, the northern half of the ranch was sold to the R. K. Mellon Foundation, which then donated it to the National Park Service, through the Conservation Fund, in 1991.

The Environment

The Upper Pecos River Valley has been used by humans for nearly 12,000 years. It is likely that the valley has always been attractive because of its position as a natural corridor between the Great Plains and the Rio Grande Valley. Another attraction of the area is the degree of topographic, floral, and faunal diversity offered within relatively short distances.

Although it is difficult to reconstruct most aspects of prehistoric environment without a variety of detailed studies, the following discussion presents information on several aspects of the modern environment of the Upper Pecos Valley, both as a basis for understanding prehistoric and historic human adaptation to the Pecos area and as a basis for making inferences about aspects of earlier environments.

Topography

The Pecos River originates in the Sangre de Cristo Mountains and follows a narrow canyon until it reaches the modern village of Pecos, where it runs through a broad valley approximately 9.7 km (6 mi) wide and 10.5 km (6.5 mi) long. Numerous mountain streams feed the river along its route from the mountains to the Upper Pecos Valley. There are three major topographic divisions in the Pecos National Historical Park—the Pecos River Valley proper, the Tecolote Range, and Glorieta Mesa. Glorieta Mesa is outside the park. The Pecos River runs along the Tecolote Range at the eastern edge of the valley, separating the foothills from the broader expanse of valley floor west of the river. The valley floor ends abruptly at the base of Glorieta Mesa, which runs north-south and towers over the surrounding landscape (Figure 1.4).



Figure 1.4. Upper Pecos Valley topography. View SW from the east side of the Pecos River, overlooking the river, the Forked Lightning Ranch, the open valley floor, and Glorieta Mesa beyond.

The rugged Tecolote Range east of the river is dissected by numerous steep-sided drainages. These canyons flow intermittently to the west or southwest into the Pecos River. The ridges separating the drainages are narrow and flat. Elevation ranges from 2,048 m (6,720 ft) at the river to 2,304 m (7,560 ft) at the highest point in the northeastern part of the park (Figure 1.5).



Figure 1.5. Rugged topography east of the Pecos River in the Tecolote Range, view NE.

Glorieta Mesa, on the western side of the valley, dominates the landscape and separates the valley from the Galisteo Basin and the Rio Grande Valley. The mesa is outside the park, but plants, mammals, stone, minerals, and other resources were undoubtedly used by Pecos Valley residents. The base of the mesa is talus, from which steep sides, interspersed with cliffs, rise to around 2,400 m (close to 7,875 ft). Water running off the mesa's eastern slope enters Glorieta Creek, which drains the valley floor. Historically intermittent, the flow of Glorieta Creek has been continuous since the late 1960s, although the magnitude of the flow fluctuates wildly (Nordby 1990). From its origin at Glorieta Pass, the creek runs through the park from the vicinity of Pigeon's Ranch southward along the west side of the Pecos Pueblo mesilla. It eventually joins the Pecos River immediately below the Forked Lightning Ranch house.

Between the Pecos River and Glorieta Mesa the Pecos Valley is a gently sloping, undulating surface dotted with piñon and juniper and stands of ponderosa pine. Although dissected by small intermittent drainages and dotted with a few higher knolls, there are no major physiographic features. Elevation along the river is around 2,048 m (6,720 ft), and the highest point on the valley floor is a minor hill some 2,168 m (7,112 ft) in height. In addition to Glorieta Creek and the Pecos River there are five known springs within the park: Trading Post Spring (adjacent to Kozlowski's Trading Post), Mud Spring (south of Kozlowski's), Poison Spring (east of Pecos Pueblo), an unnamed spring north of Pecos Pueblo, and an unnamed spring north of Shin'po (Eininger et al. 1995).

Geology

The earliest deposits in the Pecos vicinity are Precambrian amphibolites, granites, quartzes, pegmatites, schists, and quartzites formed in the Sangre de Cristo Mountains and now present within the park as surface cobbles.

During the Mississippian period (ca. 290 million years ago), marine erosion of the earlier pre-Cambrian deposits resulted in the formation of conglomerates and sandstones that constitute the earliest sedimentary rocks in the Pecos area (Nordby 1990:9). Other limestones and sedimentary rocks are represented in the Magdalena group and the Madera formation of Pennsylvanian age. The Sangre de Cristo formation, which covers the Pecos River Valley floor, was created during periods of occasional submergence followed by complete

withdrawal of the sea.

The Yeso formation, consisting of red sandstones and siltstones, and gray limestone beds, was deposited on top of the Sangre de Cristo formation during the Permian, a period of dry climatic conditions. These bright red deposits show up in the Pecos area only on the steep slopes of Glorieta Mesa. Two later episodes deposited layers of gray sandstone (Glorieta sandstone) and gray limestone (San Andres formation) on Glorieta Mesa. The Bernal formation, a deposit of maroon sandstone and siltstone beds, is exposed by erosion on portions of Glorieta Mesa. In the drainages in the valley, the Bernal formation is associated with thin gypsum beds.

During the Triassic, major uplifting formed the Tecolote Range and raised the northern scarp of Glorieta Mesa (Nordby 1990:14). These episodes were followed by deposition of Santa Rosa sandstone, which is light tan in color and has a fairly restricted distribution. The Pecos River has completely eroded the valley's Mesozoic rocks, and as a result either of uplifting or downcutting, the river's course, which is still marked by cobbles, has clearly moved eastward.

Many of these deposits contain materials that proved useful to the prehistoric inhabitants of Pecos. Quartzite and other rocks of Precambrian age were utilized for grinding tools and hammer stones, while the later Magdalena deposits provided cherts and chalcedonies for flaked stone tools as well as sandstone slabs for architecture.

In more recent Quaternary times, alternating episodes of erosion and alluviation have created the characteristic riverine terraces, as well as the erosion responsible for formation of the Pecos mesilla. The arkosic sandstone that caps the mesilla is fractured and breaks away in blocks and most likely provided much of the building stone used at masonry sites. The shale eroding on the mesilla probably also provided the adobe for building and possibly clay for making pots (Nordby 1990:15).

Soils

Several soil types are present in the park. According to Spielmann (199la: Map 2), only two of these, a fine sandy loam (Manzano or Mb), and an undulating soil association known as the Vibo-Ribera (or VB) are suitable for cultivation.

The fine sandy loams occur on fans and floodplains and are deep and well thinned with slopes up to 3 percent. These soils have slow permeability, and available water capacity, referring to the soil's ability to hold water for use by plants, is high. Runoff is medium; water erosion hazard is moderate, although hazard of blowing wind is high (Hilley et al. 1981:24).

The Vibo-Ribera association soils occur on fans with slopes from 1 to 9 percent. They are moderately permeable with a high available water capacity, medium runoff, moderate water erosion, and a high hazard of blowing wind. Ribera soils are on the higher slopes, from 5 to 9 percent, and have moderate permeability and water capacity, medium runoff, moderate erosion, and a high wind hazard (Hilley et al. 1981:40). The VB association is appropriate for dry farming (Spielmann 1991a: 102).

According to Spielmann (1991a: 102-104), most of the VB and fine sandy loam soils occur to the north, northwest, and northeast of Pecos Pueblo. There are also areas of Vibo-Ribera soils 2 km (1.2 mi) southeast of the pueblo. The majority of the fine sand loam soils are a minimum of 2 km (1.2 mi) northeast of Pecos Pueblo, in the vicinity of the town of Pecos. Spielmann (1991a) measured approximately 175 hectares (432 acres) of potentially irrigable land and 465 hectares (1,149 acres) of land that could have been dry farmed by the population at Pecos Pueblo within these soil units. In addition, there are more Vibo-Ribera soils farther south that probably could have been farmed that she did not include in her

estimates.

Climate

Of the many different aspects of climate, those most important to Pecos agriculturalists were moisture and temperature. The timing of moisture availability affects crop growth and also the productivity of wild plants and animals. Temperature affects germination and maturation of crops, and the length of the frost-free season is especially important to successful corn maturation.

The Pecos area averages between 40 and 50 cm (16 and 20 inches) of precipitation annually. About three-quarters of this moisture comes between late spring and early fall, with about one-third falling during the summer monsoons in July and August. In the winter the Pecos Valley receives anywhere from 25 to 89 cm (10 to 35 inches) of snow. The Pecos River is fed by mountain snow melt, which means that irrigation agriculture is affected by winter snowfall and precipitation that feeds the river during the spring and summer.

The growing season in the Pecos area averages 127 days, which is marginal for corn agriculture. Spielmann (1991a: 116) estimates that it falls below 120 days, the minimum needed for corn, one out of every three years. In addition, frosts are more common in late spring than early fall, and they are usually more harmful than frosts late in the growing season. As Snow (1991:73) states, "If prehistoric growing season length at elevations above 6,000 feet was highly variable, as it is today in northern New Mexico and adjacent areas, relying on a mature maize crop from one year to the next would have been an undependable strategy."

Even with a shortened growing season, the inhabitants of Pecos most likely harvested green corn, which would not provide seed for the following year, but would supply short-term calories and food for storage (Snow 1991:73). In Snow's (1991:75) view, the probable inability of peripheral populations, especially those above 6,000 feet, to produce seed corn would have limited their "agricultural independence."

Certain aspects of prehistoric climate are critical to understanding how the agricultural subsistence system might have functioned and the problems that farmers may have faced. The Palmer Drought Severity Index (PDSI) is one way to estimate climatic stress on agriculture (Rose et al. 1982). PDSI is an index of meteorological drought and it is calculated using estimates of potential evapotranspiration. Retrodiction of PDSI backward to time intervals without climatic records is based on tree-ring indices, and is, as best as possible, a measure of the moisture available to plants during the growing season. The June PDSI for the Santa Fe area tree-ring index, which includes samples from Glorieta Mesa, covers the years A.D. 883 to 1988 and is the most appropriate record for the Pecos area. Analyses of these values reveal quite variable conditions over time and are discussed in Chapter 6.

Another important aspect of prehistoric climate is the timing of rainfall during the growing season. In her research on corn growth, Spielmann (1991a: 109) found "that the most severe damage is experienced if stress occurs during the tasselling/silking stage. Moisture stress at this time can reduce grain yield by as much as 50%." Typically, the Santa Fe-Pecos area gets summer monsoons during the same time that corn is in the tasselling/silking stage. Unfortunately, the June PDSI does not provide information on the monsoon season, which begins in July.

Based on tree-ring reconstructions of prehistoric climate, Dean (1996:40) has very recently identified two patterns of precipitation, one characteristic of the "northwestern two thirds of the Southwest" the other of the "southeastern third of the region," that are strikingly similar to the present day. The southeastern pattern, which includes the Santa Fe-Pecos area, is

dominated by a unimodal, summer-dominant regime (Dean 1996:Figure 4), while the northwestern pattern is a bimodal, summer-winter regime. The patterns are separated by a sinuous transition zone that winds through Arizona and New Mexico.

This geographic division was stable for over 500 years, then, between A.D. 1250 and 1450, "the long term pattern broke down into chaotic distributions of three or four principal components that exhibit no logical geographic patterning" (Dean 1996:43). The southeastern group, which includes Santa Fe-Pecos, remained stable. The northwestern group, however gave way to a variable mixture of rainfall regimes" (Dean 1996:44).

Within the northwestern regime area, the combination of high population densities, falling water tables, floodplain erosion, and severely depressed annual rainfall between A.D. 1275 and 1300 (the "Great Drought") resulted in the virtual abandonment of the San Juan drainage as a place of residence for agricultural societies. Population shifted to the south and east into the Little Colorado Valley, the Mogollon Highlands, and the Rio Grande drainage.

Because the Rio Grande Valley maintained its summer-dominant pattern during the 200 years of precipitation chaos in the northwestern regime area, it appears to have become highly attractive for late thirteenth and early fourteenth century settlement.

Flora and Fauna

The Upper Pecos Valley falls within the Upper Sonoran Life Zone (Bailey 1913), but other zones are accessible within short distances of the park. Rodriguez-Bejarno's (1993) vegetation map shows that most of the park is dominated by piñon-juniper. Along the Pecos River, riparian vegetation, such as cottonwood, willow, and reeds, is predominant. At higher elevations, oak, pinon, and juniper woodlands give way to ponderosa pine, Douglas fir, and aspen forests. Above the treeline, in the Sangre de Cristo Mountains north of the valley, grassland meadows predominate (Cordell 1998).

Within the park, the present vegetation is a reflection of many years of use for ranching and grazing. During the 1960s piñon and juniper were bulldozed in order to increase the amount of grass available for grazing (see below and Chapter 5). Today's landscape probably does not reflect prehistoric vegetation, which undoubtedly changed through time as trees were cut for building and firewood, and fields were cleared to grow corn.

Archeological evidence for the presence and potential use of certain plant species is available from excavations at Rowe Ruin (Cordell 1998:61). Most of the edible wild plant remains identified at Rowe are common disturbance species, such as pigweed (Amaranthus sp.), goosefoot (Chenopodium sp.), and purslane (Portulaca sp.). The Rowe excavations also revealed remains of tansy mustard, several cacti, Indian ricegrass, dropseed, juniper seeds, piñon nuts, and American plum. Wild tobacco (Nicotiana rustica) and wood from juniper, piñon, oak, and willow are nonfood items found at Rowe.

There is, and probably was, a diversity of fauna in the area. Parmenter and Lightfoot (1994) identify 24 different mammals, seven reptiles, and two amphibians within the park. They also found 189 arthropods. Historically, larger game animals, such as bighorn sheep, elk, mule deer, and pronghorn were found in the area.

A separate inventory of birds (Mukai 1989) has identified 109 species, of which 24 are year-round residents. There are fish in the river, most notably rainbow and brown trout, but both are introduced species. Fishes native to the river probably included "white sucker, long-nosed dace, and possibly the fathead chub, fathead minnow, Rio Grande chub, and Rio Grande cutthroat" (Eininger 1995:7).

Faunal remains from Rowe Ruin include the common species found at most prehistoric pueblos in the Southwest, but the percentage of large game is much higher at Rowe than other contemporaneous pueblos outside the valley (e.g., 39.3 percent vs. 18.5 percent at Tijeras Pueblo), and it appears that meat was a greater part of the Rowe diet than we might expect for Pueblo agriculturalists (Cordell 1998:62-63). Turkey bone also was found at Rowe, but Cordell did not find any dung or eggshells that might indicate they were raised there (Cordell 1998:64). Turkeys were bred and raised at Arroyo Hondo and Tijeras Pueblo, and probably at other prehistoric pueblos in the northern Rio Grande.

Recent Impacts to the Pecos Environment

Modern vegetation cover rarely reflects prehistoric conditions, and this is especially true in the Upper Pecos Valley. During the 1950s and 1960s, large bulldozers were used to clear piñon and juniper from portions of the valley. The fact of this clearing was known when the Pecos survey was begun, though its extent and effect were not well understood. Steps were taken during site recording to acknowledge and track vegetation removal, and in Chapter 5 this information is used to give a more detailed analysis of the effects of clearing on surface archaeological features. To summarize the results of that analysis: artifact scatters on affected sites are larger than those on unaffected sites, reflecting the horizontal movement of materials by bulldozer blades and treads; structures are less likely to occur on affected sites; and all nonportable features are more likely to be described with ambiguous terms on affected sites. The implications of these findings for interpretation are difficult to assess. They serve as a caveat emptor, and the reader must take vegetation removal impacts into consideration when appraising the project results.

Research Objectives

Based on the project research design (Head 1997a), data recovered by the survey are used to address research questions pertinent to both the prehistoric and historic periods in the Upper Pecos Valley. For the prehistoric and early historic period (ending at 1700) two problems related to the development of large sedentary villages are examined. The first issue concentrates on the development of the Pecos community, while the second examines the nature of exchange relationships between Pecos, other Rio Grande pueblos, and nomadic Plains groups.

Community Development

The prehistoric Pecos community evolved over a period of seven centuries from a small cluster of pithouses to a single large aggregated pueblo. In order to understand the changes that accompanied this transformation, our research focuses on aspects of community development, specifically: population growth and aggregation, agricultural intensification, and settlement.

Aggregation occurred in many portions of the northern Southwest during the thirteenth and fourteenth centuries (Adams 1991; Adler 1996; Kintigh 1985; Powers and Orcutt 1999; Reid 1989). A variety of theories have been proposed to explain the formation of large villages throughout the Southwest. Kidder (1924) put forth the need for defense as one of the earliest theories of aggregation, a theme that has been echoed recently (Haas and Creamer 1993, 1996). Other current explanatory models have involved minimization of conflict over resources (Hunter-Anderson 1979), population growth and environmental degradation (Kohler 1989; Orcutt et al. 1990), adaptation to climatic variability, particularly rainfall (Dean et al. 1985; Plog 1983; Plog et al. 1988), technological specialization, particularly agricultural intensification (Hill and Trierweiler 1986), and organization and legitimization of access to good quality arable land (Adler 1990, 1992). All of these discussions of population

aggregation address aspects of population density, the nature of the resources being utilized, the technology used to exploit them, and methods of social integration (Cordell et al. 1994).

We begin our examination of the development of the Pecos community by investigating three aspects of the process of aggregation: (1) changes in the location, number, size, and structure of Puebloan sites; (2) the measurement of population aggregation within each time period; and (3) based on these data, estimations of population over time to determine whether the observed rate of growth is indicative of local population growth or migration from surrounding areas.

Changes in subsistence were clearly an important part of the development of the Pecos community. Agricultural intensification is frequently seen as a correlate of aggregation (Kohler 1989), and we examine whether it occurred with the formation of Pecos Pueblo. Four measures of agricultural intensification are evaluated: (1) increased investment in agricultural features; (2) change in ceramic vessel size through time as an indicator of greater reliance on agricultural products; (3) site location in relation to plant productivity; and (4) grinding intensity as measured by change in the shape, size, and degree of wear shown by manos.

Settlement patterns are closely related to subsistence. We expect that the distribution of prehistoric sites across the Pecos landscape changed over time as a consequence of aggregation and increasing dependence on agriculture. Three aspects of these changes are examined: (1) the relationship of sites to key natural resources and landscape features; (2) the relationships of sites to other sites of the same type as a means of inferring the degree of cooperation or competition among sites; (3) the relationship among different site types as a means of inferring change in subsistence patterns.

Exchange

It has long been recognized that Pecos Pueblo played a pivotal role in the exchange of a variety of subsistence and craft items. Kidder and Shepard (1936) identified the presence of nonlocal trade ware ceramics at Pecos. These nonlocal ceramics were manufactured by Puebloan groups in the Rio Grande Valley and eastern Arizona, then traded to Pecos. Likewise, obsidian from the Jemez Mountains occurs in substantial quantities in Pecos Pueblo deposits, again apparently as the result of exchange with other Rio Grande pueblos.

Complementing trade with the Rio Grande Valley and other Puebloans, exchange also occurred between Pecos and a variety of nomadic groups from the southern Plains. This trade is thought to begin in the late prehistoric period (ca. A.D. 1450) and likely involved the exchange of meat and hides from the Plains for corn, pottery, and obsidian from Pecos (Kessell 1979; Kidder 1932; Spielmann 1991a). Spielmann (1983, 1991a) has argued that the relationship between Pecos and other pueblos on the eastern edge of the Rio Grande Valley was mutualistic in that it provided resources each needed on a regular basis.

Two topics on Pecos exchange are investigated using the survey data: (1) information on the organization of production of utility and white ware ceramics; and, (2) identification of the quantity, geographic distribution, temporal duration, and sources of nonlocal lithic materials present at Pecos.

Historic Period Investigations

By the close of the eighteenth century, the Pecos Pueblo social and political organization, subsistence economy, settlement, and exchange systems were irrevocably changed as a result of Spanish colonization. Although Pecos Pueblo was not abandoned until 1838, archeological remains of the nineteenth and twentieth centuries are almost exclusively of Spanish or American (referred to collectively as Euro-American) cultural affiliation and reflect a new

and different pattern of human use of the Upper Pecos Valley. The occupation of most of these sites occurred after the emergence of Mexico and the United States as independent nation-states. Although the Pecos Valley is initially on the far frontier of each of these political and economic systems, interaction with them is increasingly significant and crucial to understanding local settlement and subsistence.

The discussion of the Euro-American materials recorded by the Pecos survey has three objectives: (1) to provide accurate and replicable dates for the nineteenth and twentieth century sites through examination of the artifact data collected in the field; (2) to examine how the settlement and subsistence economy changed over time through consideration of census records pertaining to the area; and (3) to describe remains of the Santa Fe Trail within the park and to consider the effect it had on the subsistence economy of the Upper Pecos Valley.

Organization of the Volume

The chapters that follow furnish the setting and background for the project, then present the data gathered by the survey and apply that data to the research topics presented above.

In Chapter 2, Susan Eininger summarizes the history of archeological investigation at Pecos National Historical Park and in the Upper Pecos Valley. Archeological excavations, surveys, ancillary studies, and historical research conducted over the last 100 years are discussed.

Chapter 3, also by Susan Eininger, describes the inventory survey methodology and organization. Survey logistics, procedural definitions, data collection objectives, recording techniques, and artifact sampling procedures are presented and discussed.

In Chapter 4, Melissa Powell and Karl Benedict use ceramic types with known production spans to date the Pecos survey sites. Ceramic mean dating and ceramic probability data are the primary methods used to construct a seven-period chronology. The classification of sites into these temporal divisions provides a chronological framework for many of the analyses performed in subsequent chapters of the report.

In Chapter 5, Genevieve N. Head groups the sites recorded by the survey into three types using site architectural characteristics. Habitation, seasonal, and special use categories are created based on the presence or absence of structures and the number of feature types present on sites. In this same chapter, Head provides descriptions of the habitation sites in the park and examines the effects of aggregation on subsistence and society through changes in agricultural features and kivas.

In Chapter 6, Karl Benedict and Janet D. Orcutt describe the locations of different site types utilizing several environmental variables and nearest-neighbor analyses. Expectations for site locations are derived in part from changes in climate that affected agricultural productivity and are measured using the PDSI.

In Chapter 7 Janet D. Orcutt uses the survey data to reconstruct the number of people in the Pecos area during the Puebloan occupation. The survey data do not inform well on the development of Pecos Pueblo so other data are used to reconstruct its population. The population fluctuations in the Pecos area are compared to those in the larger Rio Grande area.

In Chapter 8, Melissa Powell assesses how increasing aggregation and changes in regional interaction at Pecos affect ceramic technology through time. Her chapter focuses on the cultural, temporal, and spatial variability in the survey ceramic assemblages. She investigates the functional content of ceramic assemblages as evidence for the intensification of agriculture. Finally, using petrographic and compositional data for utility and white ware

ceramics, she evaluates evidence for the organization of pottery production at Pecos.

In Chapter 9, David Kilby and Joseph V. Cunningham contribute the first systematic analysis of lithic materials in the Upper Pecos Valley. Using chipped and ground stone data, they evaluate expectations for activities at different site types. An X-ray fluorescence study identifies obsidian sources for the large pueblos at Pecos. The authors also examine other chipped stone raw material sources to better understand interactions with Plains groups. Analysis of the survey manos is used to examine postulated increases in grinding activity.

In Chapter 10, Jeffrey L. Boyer, James L. Moore, Natasha Williamson, and Genevieve N. Head place the historic sites recorded by the survey into chronological perspective and provide details on census records and the Santa Fe Trail. In the first portion of the chapter, Boyer and Williamson use mean dates derived from field recorded artifact information to place the sites into the themes and landscapes presented earlier and derived from the Cultural Landscape Overview of the park (Cowley et al. 1997). In the second portion of the chapter, Williamson provides insight into changes in the life of the Upper Pecos Valley as revealed through a review of census records from the late nineteenth and early twentieth centuries. In the final portion of the chapter, Moore describes the ruts of the Santa Fe Trail that are still visible within the park, as well as several other circulation features discovered during survey. He places each in context through comparison with historic maps and documents.

Finally, in Chapter 11, Janet D. Orcutt and Genevieve N. Head review the conclusions of the previous chapters and integrate the results to provide a summary of the survey findings.

<<< Previous <<< Contents>>> Next >>>

PECOS

From Folsom to Fogelson:

The Cultural Resources Inventory Survey of Pecos National Historical Park

CHAPTER 2:

Previous Archeological Work

Susan Eininger

The written history of Pecos Pueblo is a long one by Southwest standards. For more than 400 years, its topographic setting, visual prominence, and cultural diversity have been of interest to both the casual and purposeful visitor in the Upper Pecos Valley. Early Spanish explorers and missionaries (Bandelier 1881; Hull 1916; Schroeder and Matson 1965; Winship 1896), and later military personnel and westward travelers (Abert 1848; Adams and Chavez 1956; Drumm 1982; Emory 1848; Gregg 1969; James 1962) included observations of Native American and early Euro-American settlements in their journal entries and reports. These accounts, together with the physical prominence of the pueblo, stimulated archeological interest in the area and provided a historical basis for reconstructing the pueblo's culture history.

The history of archeological investigation at Pecos National Historical Park spans a period of more than one hundred years, beginning in the late 1800s. As a result of its long and diverse archeological history, a wide variety of archeological projects—mapping, excavation, testing, reconnaissance survey, systematic survey, architectural documentation, and resource specific analytical studies—have been conducted at the park. These investigations have ranged in scope from site-specific to regionwide, reflecting changing trends in archeological methodology and in later years, changing National Park Service management concerns.

The vast majority of archeological work, particularly in the early years, was concentrated in the "core area" of the park (see Figure 1.2) focusing on Pecos Pueblo's extensive architectural remains and midden deposits. In contrast, investigations of land surrounding the pueblo were few and far between and targeted only the most prominent pueblo sites. It is only in more recent years that the peripheral areas of the park have become the subject of more intensive archeological investigation.

This chapter presents an overview of the previous archeological work conducted within the Upper Pecos Valley, summarizing the activities and accomplishments and overall contribution to our present-day understanding of Pecos' culture history. The cumulative results of these investigations formed the foundation for the design of the Pecos Cultural Resource Inventory Survey and provide the framework for its subsequent analyses and conclusions.

The Beginnings of Pecos Archeology

Adolph Bandelier, renowned Southwestern archeologist and ethnologist, conducted the first systematic archeological investigation of the Upper Pecos Valley in 1880. Although his visit to Pecos was brief, Bandelier's observations resulted in the compilation of detailed notes, plan views, and cross sections of the Pecos Pueblo and Mission complex as well as general descriptions of several other sites scattered across the valley (Bandelier 1881, 1892). As with

other archeological studies of this time period, Bandelier's work was largely descriptive, documenting site setting, layout, size, construction method, and features. Drawing on his field observations and the results of his historical and ethnographic research, Bandelier was the first to propose a formal classification of the Pecos area culture sequence (1881:104-125). As the first archeologist to formally investigate the Upper Pecos Valley, Bandelier is credited with putting Pecos Pueblo on the "archeological map." His documentation efforts resulted in the preservation of significant, now irretrievable, archeological data, and his findings served as a starting point for the subsequent development of broader regional chronologies.

Building on Bandelier's ethnohistorical and archeological findings and recognizing the importance of preserving Pecos Pueblo's fragile history, Edgar Hewett continued the investigation of Upper Pecos Valley archeology in the early 1900s. In his 1904 American Anthropologist article, Hewett draws on the results of his own archeological observations and ethnographic research, as well as F. W. Hodge's ethnographic notes from the late 1890s in defining a site typology for the Upper Pecos Valley and proposing a regional Puebloan culture sequence (Hewett 1904:426-439).

Recognizing the significance of aggregation—which has continued to be an important topic in Pecos archeological research—Hewett noted that according to Jemez tradition, "Ton-ch-un" or Rowe Pueblo, located roughly 6.4 km (4 mi) south of Pecos Pueblo, was the last of seven or eight "outlying villages in Pecos territory to be abandoned as the process of concentration went on" (Hewett 1904:433). Hewett attributed population aggregation to defensive needs and noted resulting changes in the Pecos population's social, linguistic, and ceremonial life. Although his interpretations were only briefly summarized and preliminary in nature, Hewett's work helped define chronological development, site variability, and cultural change within the Pecos Valley. Within the context of turn-of-the-century Southwest archeology, Hewett, like Bandelier, demonstrated a "precocious interest in Southwestern chronology and made some fairly accurate guesses about [the] sequences there" (Willey and Sabloff 1980:51).

The Kidder Years

Coinciding with methodological changes in the field of archeology during the first half of the twentieth century, stratigraphic excavation and chronological classification characterize the next phase of archeological investigation in the Upper Pecos Valley. Stratigraphic excavation was introduced to the Southwest by Nels C. Nelson in the Galisteo Basin, 23 km (14 mi) southwest of Pecos Pueblo (Nelson 1914). Following Nelson's lead, A. V. Kidder used stratigraphic excavation techniques to pursue his archeological investigation of Upper Pecos Valley sites. Attracted by the deep, ceramic-rich midden deposits and long occupation of Pecos Pueblo, Kidder intended to use the stratigraphic findings to develop a local ceramic typology, site chronology, and ultimately an understanding of the Rio Grande Valley Puebloan culture sequence.

Between 1915 and 1929, Kidder, under the auspices of the Phillips Academy of Andover, Massachusetts, conducted ten seasons of field excavation within what is now Pecos National Historical Park (Kidder 1916a, 1916b, 1917a, 1917b, 1920, 1921, 1922, 1924, 1925, 1926a, 1926b, 1932, 1951, 1958). Under his direction, 12-15 percent of the Pecos Pueblo site area was excavated. Midden deposits up to 6 m (20 ft) deep, a few hundred rooms, 21 kivas, more than a thousand burials, and "literally millions of sherds" (Kidder 1932:4), stone, bone, shell, and textile artifacts were uncovered in the course of the excavation (Hooton 1930; Kidder 1958) (Figures 2.1 and 2.2).





Figure 2.1. Alfred Kidder in the excavations at Pecos Pueblo, ca. 1915. View south, mission church in left background. Photo courtesy Museum of New Mexico, negative number 12943.



Figure 2.2. Kidder's 1916 stratigraphic excavations in the midden on the east slope of the Pecos mesila—"face of Text X, showing bottom (?) three cuts in place." Photo courtesy of Archives, Laboratory of Anthropology, Museum of Indian Arts and Culture, Santa Fe, Negative number 435, Kidder-Pecos Collection.

Using field provenience data and post-field ceramic attribute analyses, Kidder identified changes in vessel form and technology within a chronological context. His systematic analysis and innovative interpretation resulted in the classification of the local pottery types (Kidder 1932; Kidder and Amsden 1931; Kidder and Kidder 1917; Kidder and Shepard 1936), providing a chronological framework for reconstructing Pecos Pueblo's cultural history and serving as a "base for departure" in the development of a more regional Rio Grande glaze pottery typology (Mera 1933:2).

Supplemental to Kidder's interpretation of Pecos' ceramic typology and equally significant to the advancement of Southwest archeology, Anna Shepard, in affiliation with the Laboratory

of Anthropology, conducted technological analysis of the Kidder excavation ceramics (Bishop 1991:52). The large size of Pecos Pueblo's ceramic assemblage, Kidder's newly established typology, and the pueblo's continuous occupation provided an excellent opportunity for a ceramic technology study. With the intent of recreating the history of pottery making at Pecos Pueblo and focusing on glaze ware ceramics, Shepard recorded technological characteristics, such as shaping, finishing, and firing, and used petrographic analysis to determine the types and proportions of materials—clay, pigment, and most importantly, temper—used in ceramic production.

Shepard's work exemplified early efforts at merging scientific methodology and archeological analysis (Willey and Sabloff 1980:157). Her analyses resulted in the identification of several type-specific technological features supporting and refining Kidder's ceramic typology, and of even greater significance, her petrographic analysis enabled her to compare Pecos ceramic materials with known source areas in the Upper Rio Grande. As a result, Shepard identified both local and nonlocal ceramic types in the assemblage and noted changes in the types and proportions of imported wares over time (Kidder and Shepard 1936). Like many archeological studies of that time period, chronology building and typology classification were the original motivation for her analysis. In the process, however, Shepard opened a new avenue of study, using ceramic production and trade as a tool in the reconstruction of Southwest Puebloan culture history.

The skeletal remains resulting from Kidder's excavations were another focus of scientific study. "No less than 1938 burials came to light at Pecos" (Kidder 1958:279) and from these, the skeletal remains of almost 1,000 individuals were examined documenting age, sex, bone, cranial, and pathological observations (Hooton 1930). By tallying the number of burials per ceramic period and mean annual death rate, Hooton estimated a total population of 50,000 over the course of the pueblo's occupation. He does acknowledge that this number seems "impossibly high" (Hooton 1930:342), in part due to some incorrect assumptions; however, the pattern of increase and decline reflected by his numbers shows significant growth during the Glaze II period (A.D. 1400-1450) (Hooton 1930:349), as would be expected in association with pueblo growth during a period of aggregation.

In addition to the artifact and skeletal studies, Kidder included architectural remains in his classificatory and chronological analyses. Based on his understanding of the local ceramic sequence and his observations of the newly exposed architecture, Kidder identified several spatially and chronologically distinct architectural features within the pueblo. Beneath the prominent North Pueblo or Quadrangle at the north end of the mesilla, he recognized the remains of several early, pre-Glaze architectural features including a "sizeable pueblo" (Kidder 1958:55) (Figure 2.3). Using the associated black-on-white ceramic assemblages as temporal indicators, Kidder dated these features between A.D. 1200 and 1315, pushing back the previously assumed beginning occupation of A.D. 1400 an additional 200 or so years.



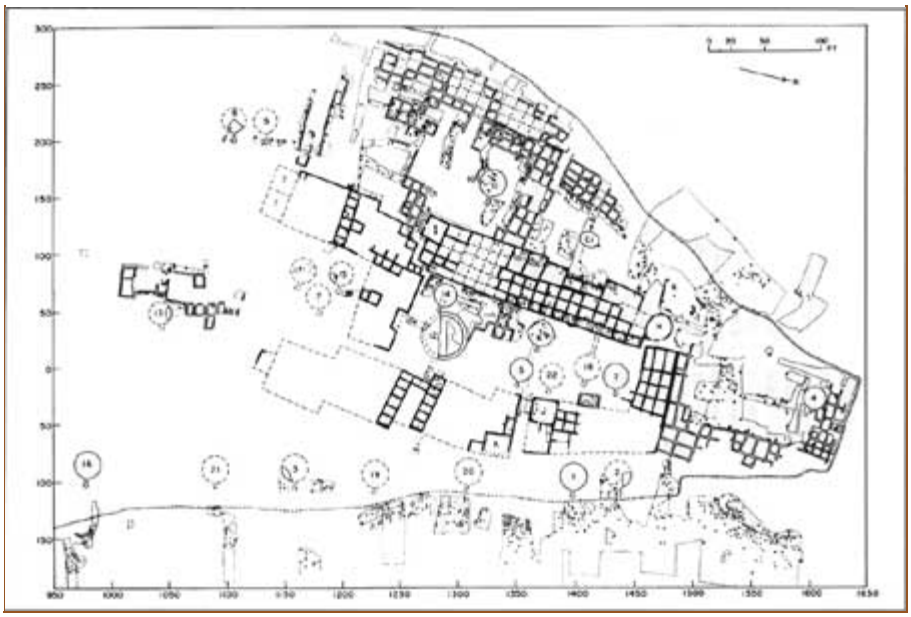


Figure 2.3. "Excavations at Pecos north of South Pueblo. Heavy lines indicate late Quadrangle; lighter lines, earlier ruins, all covered by later refuse. Trenches indicated by wavy lines, burials by dots" (Kidder 1958:Figure 20). @copy;Robert S. Peabody Museum of Archeology, Phillips Academy, Andover, Massachusetts. All rights reserved. *(click on image for an enlargement in a new window)*

As part of the excavation recording, Kidder documented architectural attributes (construction technique, materials, layout, etc.) and used this data in conjunction with information gleaned from the historic records to reconstruct the pueblo's architectural growth and development. Although much of the early architecture was left unexcavated, Kidder did observe some significant differences between early and late architectural styles. Prior to the 1400s, Pecos architecture appeared to be the result of unplanned, sporadic building episodes characterized by periods of remodeling and additions. In contrast, the layout of the later architecture suggests single-episode construction according to a preconceived design. Kidder (1958:63) bases his conclusion on the comparison of the "straggling one-story [Glaze III] community" to the "compact, four sided" post-1400 Quadrangle, interpreting this change as a necessary response to population aggregation and the growing need for defense during the later Puebloan periods (Figure 2.3).

Kidder's investigations also touched on what has become another ongoing research concern at Pecos—the extent of Plains influence, interaction, and trade at the Pueblo. Kidder uncovered an "abundance...of certain artifacts of eastern derivation," most of which were found in association with Glaze V (A.D. 1500-1700) and later deposits (Kidder 1958:313). These findings, the absence of Plains artifacts at pueblo sites farther west, and historic documentation of Plains presence (Harrington 1916; Hull 1916; Winship 1896), led Kidder to conclude that Pecos Pueblo served as a thriving trade center for Pueblo-Plains exchange. Subsequent work by Shepard documenting nonlocal pottery types in the Pecos assemblage supported Kidder's premise of the pueblo's role as "middleman" between the northern Rio Grande pueblos and eastern Plains tribes (Kidder and Shepard 1936).

Given the state of Southwestern archeology during the first half of the twentieth century, Kidder's investigations at Pecos Pueblo and mission were groundbreaking in both extent and methodology. Kidder's approach toward excavation, data recording, analysis, synthesis, and publication set new standards in the field of archeology. His synthesis established the framework for reconstructing Upper Pecos Valley culture history and broader Southwestern regional studies, and more importantly, his concerns with the "need for system, for clearer

definitions, and for synthesis" (Woodbury 1973:39) pioneered the advancement of archeology into the professional discipline it is today.

Concurrent with Kidder's investigations at Pecos Pueblo and following his stratigraphic methodology, several ancillary excavations were conducted at other large multiroom pueblo sites in and near the park. Four sites were investigated: Loma Lothrop, northwest of the mesilla; Dick's Ruin in the southern portion of the park; Rowe Pueblo, south of the park near the present day village of Rowe; and Forked Lightning Pueblo, several hundred meters west of Pecos Pueblo (see Figure 1.3). Although the work performed and resulting documentation varied from project to project, these excavations, collectively and individually, confirmed the presence of large, dispersed pre-1400 pueblo communities occurring within the Pecos Valley prior to Pecos Pueblo aggregation.

The excavations at Loma Lothrop and Dick's Ruin are poorly documented. Scheick (1989) attributes the Loma Lothrop work to Sam Lothrop in 1926; however, field note references to this work (Kidder 1920; Vaillant 1915) suggest earlier excavation. Dick's Ruin was excavated in 1926 by H. D. Skinner of Otago University, New Zealand in association with the Phillips Academy. Fifteen rooms and one corner kiva of the C-shaped coursed adobe pueblo were exposed (Kidder 1958:47).

In 1917, Carl Guthe excavated Rowe Pueblo hoping to gain an understanding of the earlier "Black on White culture" represented at the site (Cordell 1998; Guthe 1917). Although only a portion of the pueblo was excavated—the south plaza and the adjacent roomblocks—substantial architectural and artifact data were collected, and three distinct building episodes were defined (Cordell 1998; Guthe 1917). Kidder investigated Forked Lightning Pueblo, another early black-on-white site (Kidder 1958:5-46) (see Figure 1.3). Between 1926 and 1929, he excavated portions of the pueblo's deep midden deposits and extensive mounds. Kidder (1958) noted the same rambling, unplanned construction design seen at the nearby "Black-on-white House" on the mesilla. Based on Forked Lightning's pottery types, he assigned a date range of A.D. 1225-1300, an occupation interval that ended slightly earlier than the final occupation dates at nearby Loma Lothrop, Dick's Ruin, and Rowe Pueblo.

The Kidder years also saw the beginnings of a ruins preservation program. Unlike the ongoing archeological investigations, the focus of the preservation work was the Spanish, rather than Puebloan, architecture. In 1915, during Kidder's first field season, Jesse Nusbaum directed the stabilization of the eighteenth century church at the south end of the mesilla. Concrete wall supports were installed and various wall repairs were conducted (Ivey 1996; Nordby et al. 1975:2). Excavation in support of the stabilization work exposed lower interior walls and foundations and over one hundred burials beneath the church floor (Hooton 1930:12). Nusbaum left no records other than a few photographs of the church architecture and a map depicting the church and convento plan view (Nordby et al. 1975:2). As the only documentation of this work, the photos provide a crucial glimpse of the 1915 prestabilized church, and the map is an important key for "deciphering the entangled mass of multiple layers of use and reuse" throughout the convento (Ivey 1996:6-6).

Several years later, in 1925, Kidder conducted additional excavations in the church convento area, opening a few test pits and trenches (Ivey 1996). Under Kidder's direction, Susan Vaillant excavated a trench just west of the church. Several burials and a segment of the church facade were exposed in the process (Hayes 1974:xii).

The State Monument Era

Following the conclusion of the Kidder excavations, archeological activity within the Upper Pecos Valley took on a more sporadic character with focus temporarily shifting away from

the mesilla. Texas Technological College, under the direction of William Holden, began excavating Arrowhead Ruin, a roughly 100-room pueblo located north-northwest of Pecos Pueblo within the present-day Glorieta Battlefield Subunit (see Figures 1.2 and 1.3). Over the course of six field seasons, between 1933 and 1948, the college field school excavated a total of 79 rooms and one kiva (Holden 1955). Upon completion of the excavation, the kiva and several of the rooms were restored and stabilized. Based on tree-ring dates and ceramic types, Jane Holden (1955:103) assigned an occupation period of A.D. 1370-1450, slightly later than the other early pueblos identified in the valley. She (1955:113) suggests that occupants of the site may have originated from Pecos Pueblo and "leisurely" returned there after a time at Arrowhead Ruin.

Some time concurrent with the Arrowhead excavations, H. P. Mera investigated Shin'po, LA 267 (also known as Hill House), a small pueblo south-southeast of Pecos Pueblo (see Figure 1.3). Mera's investigation established the presence of another early preaggregation pueblo in the valley but generated little additional information. The only documentation associated with his work is a very brief site description written on a 1939 Laboratory of Anthropology site card. Recent observations at the site noted previous excavation in at least two of Shin'po's rooms (Head 1997a), but whether or not this work can be attributed to Mera's investigation is unknown.

With the establishment of the Pecos State Monument in 1935 and in anticipation of the four hundredth anniversary commemoration of Coronado's entrada, the mesilla again became the focus of intense archeological activity. An extensive government-supported excavation and stabilization project was conducted under the combined efforts of Edwin Ferdon, John Corbett, J. W. Hendron, and William Witkind (Metzger 1990b). Unlike Kidder's research oriented investigations, the goal of this work was "ruins display and vessel acquisition" (Nordby 1990). Over a three-year period, between 1938 and 1940, the defensive wall and approximately 100 rooms in the northern portion of the South Pueblo were excavated, mapped, and stabilized; Kiva 16 was re-excavated and reconstructed; a portion of the convento was excavated, the entire convento mapped; and the eighteenth century church was stabilized (Corbett 1939; Hendron 1939; Nordby et al. 1975; Witkind 1940).

Confined by the time constraints imposed by the upcoming Cuarto Centennial and using a large untrained labor force, huge quantities of dirt were hastily removed and numerous architectural features exposed and stabilized. Although field notes, photographs, daily logs, and maps were compiled, a final report was never completed. It has only been in recent years, due to the efforts of James Ivey, National Park Service research historian, that the records have been interpreted and the full extent of the work has come to light (Ivey 1996). Nonetheless, given the vast quantities of cultural fill and architecture exposed by the project, the available documentation represents an unfortunately incomplete record of the work performed.

The years following the Cuarto Centennial were relatively quiet with only a few archeological investigations conducted on park lands between the early-1940s and mid-1960s. Three separate excavations were documented during this period. Unlike most of the earlier excavations, these projects were limited in scope and duration and focused on smaller, more varied sites peripheral to the mesilla.

In 1956, Stanley Stubbs and Bruce Ellis, in affiliation with the Laboratory of Anthropology, excavated portions of the Lost Church, the first of the "four churches of Pecos" (Hayes 1974:19). The Lost Church, also known as the Ortiz Church (Ivey 1996), had been described and mapped by Bandelier in 1880 (Bandelier 1881:88) and remapped and tested by Kidder in 1925 (Ivey 1996:3-1). Despite these previous efforts, additional mapping and testing were proposed in order "to prepare a more accurate ground plan...and to determine if possible the

age of construction and use" (Stubbs et al. 1957:68).

Based on their historical research and excavation findings, Stubbs et al. (1957:85) propose a construction date during "the first two decades of the 1600s," the earliest period of mission architecture represented in the park. They also concluded that the church was never completed, its materials salvaged for later construction on the mesilla 300 m (984 ft) south. Recent investigations (Ivey 1996:3-13) have confirmed this supposition, identifying yellow adobe bricks originally associated with the Lost Church construction in later walls of the South Pueblo.

In association with the Lost Church excavation, Stubbs et al. (1957) excavated a suspected shrine a short distance to the northeast. The shrine lacked the characteristic architecture and elevated setting of other Pecos shrines; however, its artifact assemblage was comparable to shrine objects identified in the course of the Kidder excavations (Kidder 1932). Given the shrine's location near the church, Stubbs et al. (1957:91) proposed that it might have been established to counter the influence of the newly imposed church upon the native Pecos population.

In 1963, a salvage excavation project was conducted along the proposed route for Interstate 25 (I-25) to the south of the monument (Wood 1963, 1973). This was one of the first of many archeological projects conducted in the vicinity of the park in response to New Mexico State Highway improvement projects (Alexander 1964; Gaunt 1998; Lent 1992; Maxwell 1985; Moore 1992; Moore et al. 1991; Oakes 1990, 1991, 1995; Willmer 1993; Zamora 1990) and growing government concern with mitigating development impacts on cultural resources. Four sites were excavated prior to I-25 construction, exposing three single room structures and a lithic and ceramic scatter. One of the sites, LA 6846, falls within present-day Pecos National Historical Park boundaries.

Wood's excavations represent one of the first efforts to investigate small site architecture and settlement in the vicinity of Pecos Pueblo. He notes that all three structures were similar in architectural style with sparsely associated artifacts suggestive of short-term occupation (Wood 1963:31). Temporal affiliations ranged from the late fifteenth to the early eighteenth century. Based on his findings, Wood supported Kidder's assumptions concerning Pecos Pueblo aggregation by suggesting these three small structures represent seasonally occupied field houses used by the occupants of Pecos Pueblo.

National Park Service Projects

In 1965, the establishment of Pecos National Monument triggered a renewed interest in site display, interpretation, and ruins preservation. As a result, archeological activities shifted back to the most visitor-accessible and architecturally prominent sites on the mesilla (Hayes 1970; Matlock 1974; Metzger 1990b; Nordby 1990; Nordby et al. 1975; Pinkley 1968; White 1993). The mission complex, because of its substantial architecture and need for preservation, became the primary focus of this government-funded work.

With stabilization as the motivating force, the "topical direction of Pecos archeology [changed] from Puebloan studies to historical and Euro-american ones" (Nordby 1990:23). This shifting emphasis between the prehistoric Puebloan components and the Spanish-Pueblo contact period components characterizes much of the history of archeological investigation at Pecos. Church and convento excavations prerequisite to stabilization were conducted by the National Park Service under the direction of Jean Pinkley and Alden Hayes from 1966-1969 and 1969-1970, respectively (Figure 2.4). The scope of work for the church and convento excavation and stabilization was extensive, and in retrospect, overwhelming. Funding and scheduling needs were greatly underestimated given the area and architecture involved (Ivey

1996; Nordby et al. 1975). Pinkley's efforts to complete the proposed work were further complicated by inconsistencies in the previous records and by her misconceptions concerning the extent of previous work. The convento had not been completely excavated as she had assumed and required considerably more excavation time than had been anticipated (Ivey 1996). As a result, Pinkley's goal of interpreting the various convento construction episodes was never realized, project documentation was sparse and poorly organized, and the project's contributions to the archeological record were limited.



Figure 2.4. Excavations in preparation of stabilization in the Pecos mission convento, 1970. Pecos National Historical Park.

Despite these problems, extensive portions of the mission complex were excavated and stabilized, and several significant discoveries were made. Pinkley's excavations in the eighteenth century church uncovered the remains of an earlier seventeenth century church foundation. This discovery verified the presence of a fourth church at Pecos (Hayes 1974) and resolved the long recognized discrepancy between the historical record and on-the-ground archeological observations (Ivey 1996). Three new features—a kiva, a tower, and a post-Pueblo revolt root cellar—were identified within the convento (Nordby 1990). The kiva was the most intriguing find, stimulating a variety of suppositions explaining its location within the mission complex. Hayes (1974) concluded that the kiva was an attempt by the Pueblo people to "resanctify the scene" following the Pueblo Revolt (Nordby 1990:24). Based on recent investigations at Pecos and other Franciscan missions in northern New Spain, Ivey (1997) asserts that this kiva was constructed by (or for) the Franciscans early in their tenure at Pecos to facilitate Indian conversions.

Excavation activities were also extended to other Spanish Colonial structures adjacent to the mission complex—the first time secular Spanish remains were investigated in the park. In 1970, Hayes excavated to the west of the mission complex. He focused his efforts on the Estancia, consisting of two components: the "Presidio" (also known as the "Corrales" or "Compound") and the "Casas Reales" (also referred to as the "Convento Annex" or "Casa") (Ivey 1996:5-15). As a result of this work, Hayes (1974) theorized that the "Casas Reales" represented eighteenth century secular housing and the "Presidio" was used for garrisoning the troops. Subsequent to the publication of Hayes' *The Four Churches of Pecos* (1974), archeomagnetic sampling from one of the Casas Reales rooms indicated a seventeenth century pre-Revolt occupation. Since that time, additional dating and archeological

investigation have confirmed an early seventeenth century affiliation (Ivey 1996).

Following the excavations, extensive stabilization efforts were conducted under the direction of Roland Richert and Frank Wilson, and park archeologist Gary Matlock (Nordby et al. 1975). As a result of the 1969-1974 stabilization efforts, portions of the South Pueblo, the defensive wall, the seventeenth century church foundation, the eighteenth century church, the convento, the Estancia, Square Ruin, the Lost Church, and a number of kivas were stabilized (Ivey 1996; Nordby et al. 1975). Subfloor testing was conducted in some of the South Pueblo rooms prior to stabilization, confirming the presence of earlier, underlying construction and room remodeling (Nordby 1990). As part of the final report, Matlock compiled room-by-room and area-by-area descriptions of the stabilization work, including brief summaries of the previous work episodes and available archeological and architectural data (Nordby et al. 1975). The quality and detail of this information and its relevance to the interpretation of Pecos' architectural and culture history is highly variable.

During the same period, along a more research-oriented vein, James Gunnerson of the University of Nebraska conducted reconnaissance survey and test excavations in search of Apache sites near Pecos Pueblo (Gunnerson 1969b; 1970a, 1970b; Gunnerson and Gunnerson 1970). Although numerous other archeologists had wandered park lands in search of site remains, Gunnerson was the first to incorporate reconnaissance survey of park lands into his project design. This shift in emphasis, from site-specific excavation to broader area investigations, reflects changing trends in archeological research and increasing recognition of survey methodology and surface recording as a valid investigative approach.

Over the course of three seasons, Gunnerson identified several Apache sites based on the presence of micaceous Apache sherds and circular rock features. Nine Apachean locales were identified within the monument area (Gunnerson 1969b, Gunnerson and Gunnerson 1970), although another version of Gunnerson's site map shows as many as 23 different locales in the vicinity of the Pueblo. A few sites were also identified on Forked Lightning Ranch lands, but other than mentioning one rock ring above the Pecos River, Gunnerson's research was focused on sites within the monument.

Gunnerson's investigation of "Area C" east of the church is of particular interest (Figure 2.5). Excavations uncovered the remains of a burned, pole and clay daub dome-roofed structure in association with Puebloan and Apache ceramics (Gunnerson 1970b; Gunnerson and Gunnerson 1970). Comparison of the structural remains with other Jicarilla Apache pole and earth structures (Gunnerson and Gunnerson 1970:4), the presence of Ocate Micaceous ceramics, and historical accounts of Apache camps in the vicinity of Pecos Pueblo led the Gunnersons to conclude probable Apachean affiliation.

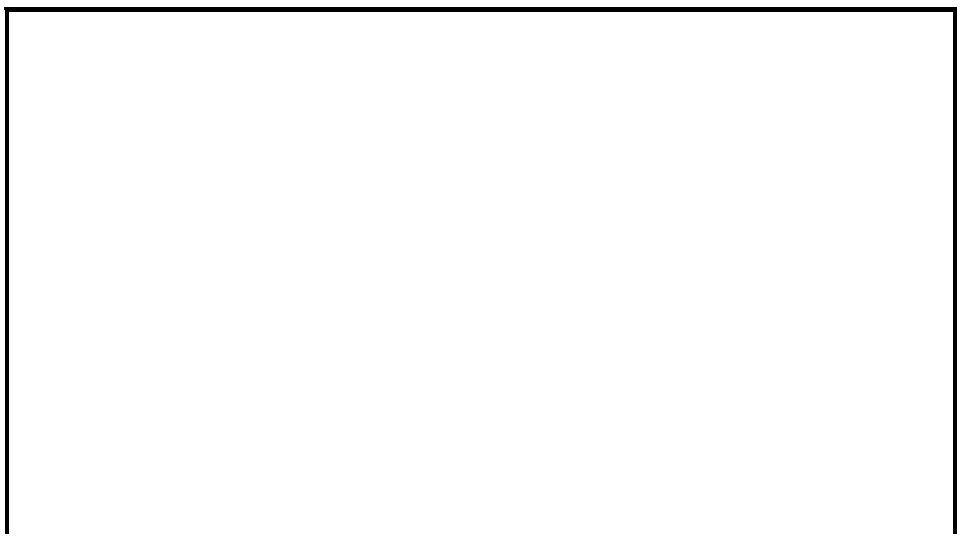




Figure 2.5. Gunnerson's excavations east of the Pecos church, 1970. Pecos National Historical Park.

Gunnerson also excavated a few nearby Christian burials and a Puebloan shrine to the northeast. Referring to ethnographic research, he noted the possibility of eight Puebloan shrines in the monument area (Gunnerson 1970a:33). The Pecos Cultural Resource Inventory Survey documented eight shrines within the park, though only three within the monument area.

In 1971, another reconnaissance survey was conducted within the park focusing on the petroglyphs and pictographs, a largely unstudied resource up until this time. Robert Lentz and Eugene Varela, both seasonal rangers at the park, conducted reconnaissance survey among the bedrock outcrops and talus boulders north of Pecos Pueblo (Lentz 1971). They recorded 45 petroglyph panels and 33 grinding surfaces, compiling locational maps and detailed sketches of the individual panels. Lentz's report is largely descriptive summarizing the types, condition, and locations of the petroglyphs and grinding features. He does note patterns in the occurrence of certain motif types and an apparent association between petroglyph locations and a nearby mesilla shrine (Lentz 1971; Nordby 1990).

Privately owned ranch lands surrounding the monument remained relatively uninvestigated, their archeological sites largely unknown, until the mid-1970s. This situation changed dramatically with the initiation of two concurrent but separate research projects, both focusing on the cultural resources of Forked Lightning Ranch lands. In 1975 and 1976, Dietrich Fliedner, a German geographer, conducted a one-man reconnaissance survey of both ranch and monument lands. Fliedner's goal was to collect data in support of his "theory of society in space and time" using the Pecos Pueblo population as one of his study groups (Fliedner 1981). His wanderings across the park resulted in the identification of more than 1,300 sites, many of which were partially collected. The resulting collection, grab samples of ceramics and a small number of flaked lithics, is curated at the National Park Service in Santa Fe. Unfortunately, Fliedner neither described his field methodology, nor provided any site specific data in his final report. He did compile a hand-drafted map of the site locations, but without associated site records, the map is of limited utility.

During this same time, the National Park Service began its first systematic cultural resource survey of the monument and portions of the surrounding Forked Lightning Ranch lands. The

primary goal of this project was to obtain much-needed information concerning "small site archeology" in the park and Upper Pecos Valley area (Nordby 1993). Under the direction of National Park Service archeologist Larry Nordby, the survey sought to document the types, distribution, and relationship of these sites to each other, Pecos Pueblo, and the surrounding landscape. After recording a small number of monument area sites in 1975, Nordby developed a standardized recording format designed to capture archeological, environmental, and management data. In response to the anticipated continuous, low density artifact scatter across the park's landscape, sites were defined based on the presence of features rather than on the limits of artifact distribution (Nordby 1993).

A total of 125 core monument sites and 88 Forked Lightning Ranch sites was recorded over the course of the survey (Nordby 1992, 1993). Archaic, Puebloan, Plains, and Euro-American sites were identified. Recorded structures ranged in size from one to more than 100 rooms, although one to five room structures were most common. A wide variety of features were noted, including petroglyph panels, isolated wall segments, bedrock mortars, cairns, fire-cracked rock, hearths, and rockshelters.

Despite extensive research and the completion of several information-filled chapters (Nordby 1990), the survey report was never finished. In lieu of this, a brief management report and summary of survey findings were compiled (Nordby 1992, 1993). Although the full research potential of this project was never realized, as the first systematic cultural resource survey at Pecos, it made a significant contribution to our understanding of the park's cultural resources. The documentation of more than 200 sites broadened management's perception of the resource, improved the existing site database, and provided baseline data which assisted design of the current inventory survey.

During the years following the survey, in the late 1970s and early 1980s, three pit structures were discovered in the park (Nordby and Creutz 1993a). Despite numerous archeological investigations, this was the first evidence of Developmental Period sites on park lands. All three pithouses were identified as a result of subsurface excavations: the Sewer Line Site (PECO 207) and the Propane Tank Site (PECO 61) were discovered during construction activities associated with park facilities development, and Hoagland's Haven (PECO 53) was located during test excavations of an overlying two-room surface structure. The Sewer Line Site and Hoagland's Haven pithouses were 100 percent excavated, but only a quarter of the Propane Tank Site pithouse was exposed (Nordby and Creutz 1993a). Tree-ring dates from Hoagland's Haven and archeomagnetic dates from the Sewer Line Site indicate occupation dates ranging between A.D. 800 and 850. Nordby and Creutz (1993a) suggest these pithouses may represent a portion of a larger pithouse village. Subsequent magnetometer tests (Korsmo 1983) noted anomalies in the area, but the results are inconclusive. In support of the supposition, it is interesting to note that a fourth pithouse was identified in the same general area during 1994 mitigation excavations associated with proposed facilities construction (Akins 1994:16-21). Two more pithouses were located during excavation of the common grave for the 2,000 individuals reburied at Pecos in 1999 (Judy Reed, personal communication 2001).

Prior to the Nordby and Creutz pithouse excavations, the earliest occupation in the park was thought to date circa A.D. 1100, suggested by early ceramic assemblages at Forked Lightning Ruin. Discovery of the pithouses pushed the occupation dates back another 200 to 300 years. The presence of Alibates flint in the pithouse assemblages also raises the possibility of earlier Pecos-Plains contact than had been previously thought (Nordby and Creutz 1993a). Other than the above-mentioned pithouses, archeological evidence representative of the Developmental Period is very limited, and the intensity and extent of pithouse occupation within the Pecos Valley is still largely unknown.

Several other test excavations were conducted within the monument area during the late 1970s and early 1980s. These include testing at Square Ruin (LA 14081)—a large pentagonal shaped masonry structure west of the Spanish Estancia, South Pueblo, and the seventeenth century church midden (McKenna 1986; Nordby 1976a, 1976b, 1976c, 1983a, 1983b; Nordby and Creutz 1993b; Nordby and Matlock 1972, 1975). Motivated by differing research, stabilization, and/or mitigation concerns, the scope and results of these projects vary widely. The 1982-1983 Square Ruin excavation was the most exploratory, although research questions concerning cultural affiliation and site function were largely unanswered. The discovery of an early pit structure—either a Developmental pithouse or a Coalition kiva—did little to clarify the affiliation and will require additional excavation.

The most significant work conducted within the Upper Pecos Valley during this period was at Rowe Pueblo, south of the park. Relatively untouched since Guthe's 1917 excavations, the pueblo was once again the focus of extensive archeological investigation. Testing, excavation, and survey (intensive and reconnaissance) were conducted within and adjacent to the pueblo through the cooperative efforts of the University of New Mexico, New Mexico State University, and the National Park Service (Anschuetz 1980; Cordell 1998; Morrison 1987; Wait 1981; Wait and Nordby 1979).

Initial testing and excavation conducted in 1977, 1978, and 1980 were designed to identify population origins, span of occupation, relationship to other early pueblos in the valley, and the role of trade in the pueblo's development (Wait 1981). The results of tree-ring dating, ceramic analyses, and architectural observations led to the conclusion that all three plazas postdate the thirteenth century. Although the final form of the dwelling implies it was carefully designed, the complex stratigraphy suggests earlier periods of remodeling and unplanned building. Wait (1981) proposes a relatively short occupation span of 70 to 100 years dating around A.D. 1330 to 1400. Cordell (1998) notes that despite the dendrochronological and archeomagnetic findings, a pre-1300 occupation of the site is possible, as suggested by underlying adobe walls and use surfaces in the southern portion of the site.

Fieldwork at Rowe resumed in 1983 and 1984, and included additional excavation, detailed site mapping, and proton magnetometer survey (Cordell 1998). Research continued to focus on temporal, settlement, and trade issues, in addition to searching for indications of agricultural intensification and evidence of restricted access to certain artifact types indicative of the existence of local site hierarchies (Cordell 1998:202). Cordell (1998) identified six construction episodes within the pueblo with an occupation span of A.D. 1250-1425. Based on interpretations of the pueblo stratigraphy, masonry style, ceramic assemblage, and burial population, Cordell attributes the pueblo's establishment to local, rather than immigrant, populations. Aggregation at the site may "have begun as early as the 1240s or 1250s for the adobe ruins but certainly in the 1340s and 1350s for the masonry structures" (Cordell 1998:89). There was no evidence of agricultural intensification or restricted access to certain ceramic types at the pueblo, nor did the site assemblage indicate interaction between Rowe Pueblo and Plains groups to the east.

In addition to the on-site investigations, two archeological surveys were conducted in the pueblo vicinity to determine the extent of occupation and diversity of site types in the surrounding Pecos Valley. In 1980, a systematic archeological survey was conducted within a 3 km^2 (1.2 mi^2) area immediately adjacent to the pueblo (Anschuetz 1980; Cordell 1998). In 1984, transect and reconnaissance surveys focused on an 87 km^2 (33.6 mi^2) area north and northwest of Rowe Pueblo, investigating a total of 6 km^2 (2.3 mi^2) (Cordell 1998; Morrison 1987). Portions of the later survey area included some of the Forked Lightning Ranch lands that have since become part of Pecos National Historical Park.

A total of 71 sites, ranging from late Archaic to nineteenth century Euro-American, was identified as a result of the surveys. The documentation of several late Archaic sites was a significant addition to the previously meager Upper Pecos Valley Archaic database. Obsidian samples were collected from a number of sites in lieu of, or as an alternative to, ceramic dating. The resulting obsidian hydration dates vary widely, in some cases spanning several thousand years within a single site (Cordell 1998). Whether or not these broad date ranges reflect actual site occupation, patterns of reuse, or problems inherent to the obsidian dating technique is unclear (Head 1997a:26).

Recent Years

Since the completion of the Rowe project field work, many of the archeological investigations in the Upper Pecos Valley have been motivated by compliance with cultural resource protection laws. State highway improvement projects, local residential development, and park facilities construction have triggered a variety of small survey and excavation projects within and adjacent to park lands. In addition, stabilization work and historic research have prompted several small National Park Service projects within the park.

The proposed improvement of portions of State Road 50 has resulted in various phases of archeological survey, testing, and excavation prior to project clearance. Eighteen sites including Puebloan, unknown Native American, and nineteenth and twentieth century Euro-American remains were identified along roughly 9.7 km (6 mi) of NM 50 between Glorieta and Pecos (Maxwell 1985; Moore 1992; Zamora 1990). Some of these sites lie within the Pecos National Historical Park Pigeon's Ranch Unit.

Twelve sites were tested to determine the nature and extent of subsurface remains (Moore et al. 1991; Oakes 1991, 1995). Archeological findings at the Native American sites were "compatible with the expected land-use patterns of the region during the Pueblo period" (Oakes 1991:65) and were consistent with the site types identified during the previous National Park Service survey (Nordby 1992, 1993). Investigation of the historic sites, however, opened up a different chapter of Pecos Valley history—the Civil War and nineteenth century Euro-American settlement.

Two historic sites, Pigeon's Ranch and the Glorieta Battlefield, became the focus of intensive site investigation (Oakes 1995). Both sites are now within the Pigeon's Ranch Unit of the park. Excavation and archival research were conducted by the Office of Archeological Studies in 1986 and 1989 (Oakes 1995). As a result of the testing project at Pigeon's Ranch, several historic features were encountered, including a well dating to the 1850s, remains of an 1880s saloon, and a house foundation, cellar, and gas pump locale dating from the 1920s through 1950s. The ranch history, architectural chronology, and layout were reconstructed from both archeological and archival evidence.

No subsurface features were located in association with the Glorieta Battle during the highway right-of-way testing (Oakes 1995), although a Confederate mass burial was found on private land nearby, southeast of Pigeon's Ranch (Oakes 1990). The burial, originally discovered by the landowner during house construction, was excavated in 1987 by the Office of Archeological Studies with volunteer time. Thirty-one individuals and numerous associated artifacts were uncovered during the excavation. The human remains were submitted for skeletal, DNA, bone tissue, and parasitological analyses prior to reburial at an alternate site. Archival research was conducted to gather information on the battle and its participants with hopes of being able to identify the individuals buried within the mass grave (Oakes 1990).

Another highway right-of-way survey and testing project was conducted along a five-mile

stretch of NM 63 bisecting the park west of the former monument area (Gaunt 1998; Lent 1992; Willmer 1993). Sixteen sites, ranging in affiliation from Archaic to recent historic, were identified (Lent 1992; Willmer 1993). Ten of these sites, including a portion of the Santa Fe Trail, were tested prior to project clearance (Gaunt 1998). The methods used in the investigation of the Santa Fe Trail segment are of particular interest. Electromagnetic soil conductivity testing was used to map the trail route in areas where ruts were no longer visible (Gaunt 1998). As a result, a previously unidentified section of trail was located. To supplement the electromagnetic testing, mechanical trenching was conducted across two trail segments allowing for the examination of their soil profiles. Soil anomalies coinciding with the rut alignments were detected in both trenches confirming the trail locations (Gaunt 1998).

Other small-scale archeological investigations were conducted by the National Park Service within the park during the late 1980s and early 1990s. In an effort to update his 1976 survey, Nordby created a more detailed site recording format and began transferring the original site data onto the newly revised form. Between 1988 and 1993, he made periodic visits to the park, revisiting previously recorded sites and collecting additional data. This effort resulted in the data transfer or re-recording of 40 monument area sites.

A small acreage survey along the proposed south boundary fence line recorded four new sites in 1992 (Metzger 1992). Three parcels of land proposed for facility development were surveyed in 1993, resulting in the identification of four Native American sites and numerous Euro-American historic features (Eininger 1994). Subsequent to the 1993 survey, additional surface recording and subsurface testing were conducted at one of the proposed facility locations. Mapping, surface collection, augering, and test excavations were conducted southwest of the convento across the anticipated construction zone (Akins 1994). Although no subsurface deposits or features were found within the proposed construction area, a pithouse was encountered within a test pit outside the impact area. As mentioned above, this pithouse is located in the vicinity of the three other previously excavated pithouses (Nordby and Creutz 1993a) and like the others, is situated roughly 1 m (3.3 ft) below ground level with no associated surface remains.

Stabilization projects continued to be an integral part of the cultural resource program at the park, addressing preservation needs at the mission complex and North and South Pueblos. Beginning in the early 1990s, under the direction of park archeologist Todd Metzger, the park's stabilization standards were revised. Although stabilization maintenance of exposed structural remains was still the primary goal, detailed architectural documentation and stabilization recording were incorporated into the preservation process. This new emphasis on documentation was based on the premise that architectural remains are an archeological data source with research potential, and as a result, the architectural data as well as structural fabric need to be preserved (Metzger 1990b).

Observations concerning original wall fabric, construction methods, architectural details, and previous work were recorded on a room-by-room, wall-by-wall basis (Metzger 1990a; White 1993, 1994). Construction material samples were collected, material source areas identified, and ancillary studies of mortar and adobe including grain-size, trace element, pollen, and macrobotanical analyses were conducted (Ivey 1996; White 1993, 1996).

Based on the careful field observations and the results of these analyses, several distinctive material types and construction patterns were identified within the church and convento. Although the presence of different adobe types—"red" and "black"—had been previously documented by Hayes (1974), a total of nine adobe and eight mortar types was identified within the mission complex as a result of this recent documentation process (White 1996). These types were further defined and interpreted based on information gleaned from the field observations, lab results, archeomagnetic dating, historical documentation, and previous

excavation findings (Ivey 1998; White 1996). The resulting typology was placed within a chronological framework and provided a useful tool for determining construction sequence and determining structural and cultural development of the mission complex (White 1996).

This investigation of the mission complex mortar types was part of a larger multiyear research project concerning the park's Spanish Colonial resources. The results of this work are compiled in a draft "Historic Structures Report" (Ivey 1996) and represent the first comprehensive study of Pecos National Historical Park's Spanish Colonial architecture. Its significance and contribution to the park's culture history lies not only in the quantity of information contained within its pages but also in Ivey's extensive efforts to re-evaluate and interpret the findings of previous studies, the vast majority of which have "never been published or discussed in detail anywhere" (Ivey 1996:7).

Two other thematic cultural resource studies recently undertaken at the park include an ethnographic overview (Levine et al. 1994) and a cultural landscape overview (Cowley et al. 1998). The purpose of the ethnographic study was to consult with the "culturally diverse communities traditionally associated with Pecos National Historical Park" (Levine et al. 1994:1-1). As a result of consultations with Jemez Pueblo, Cochiti Pueblo, Santo Domingo Pueblo, Plains Apache, Comanche, Jicarilla Apache, and the town of Pecos, information concerning the cultural associations and traditional uses of the lands and sites within the park was collected. The cultural landscape overview (Cowley et al. 1998) examined the interactions and effect of cultural and natural forces on the landscapes within the park. Using a combination of fieldwork and archival research, cultural history themes and features extending from pre-Contact times to the present-day were delineated.

Contemporaneous with these various park projects and the multiyear Cultural Resources Inventory Survey (CRIS), numerous small archeological investigations were conducted within the surrounding Pecos Valley in response to private, community, and utility development projects. Many of these surveys resulted in negative findings, largely a result of the size, location, and previous disturbance of the proposed project areas. Others identified a variety of new sites, both Native American and Euro-American, typical of the findings of the previous projects discussed above (Fredine 1998; Futch 1995; Kramer et al. 1997; Martinez 1995; McGraw 1997; Swan 1997; Townsend 1997, 1998; Williamson 1995). One notable exception was the recording of a grid garden system at the base of Glorieta Mesa (McGraw 1997). Only a small number of agricultural features have been recorded within the Upper Pecos Valley despite intensive Pueblo settlement. McGraw (1997:22) notes the significance of this finding, citing the Rowe survey (Morrison 1987) as the only other investigation to record a grid garden system in the Pecos area (see Chapter 5 for a discussion of agricultural features located by the Pecos CRIS).

Historical Euro-American resources were the focus of two recent site-specific studies in the park. In 1995, a grist mill site along the Pecos River across from the Forked Lightning Ranch house was test excavated, and the remaining millstones were retrieved for curation at the park. The site, identified as the Cattanach Mill, was dated to the early 1900s. Although the excavation confirmed the location of the mill, the almost complete lack of associated architectural remains on the site was unexpected. The mill apparently had been dismantled in 1925 and the associated debris either hauled off, burned, or washed away by subsequent flooding of the Pecos River (White and Porter 1996).

Investigations were also conducted at Camp Lewis, the site of the Union Army encampment during the 1862 Civil War Battle of Glorieta Pass. Historic documentation placed the campsite adjacent to the Santa Fe Trail and Kozlowski's Stage Stop, however its exact location and spatial extent were unknown. A variety of field methods were implemented to determine the camp's location: conventional ground survey, metal detector transects, shovel

testing, proton magnetometer survey, black-and-white and infrared aerial photography interpretation, and archival research. As a result of these efforts, camp boundaries were interpreted, based on artifact distribution and the location of several man-made anomalies (Haecker 1998).

Most recently, roughly 300 dendrochronological samples were collected from several park sites: Kozlowski's Trading Post, the North and South Pueblos, the eighteenth century mission, and three Hispanic ranches. The results of this study are reported in Appendix E of this report. Kozlowski's Trading Post samples dated mostly to the early 1900s. Despite historic documentation noting the use of Pecos Pueblo beams in the building construction, the earliest dates were in the late 1800s. Only a few reliable dates were generated for the other sites due to the preponderance of juniper in the sample collection. One corral post at PECO 541 dated to 1542, suggesting salvaging from the mesilla. Of the 120 samples taken at the North and South Pueblos, four North Pueblo samples date to the 1400s and one South Pueblo sample dates to 1542. Church samples reveal several date clusters in the 1500s, 1600s, 1706, 1880s and park repair in the 1930s.

One final investigation involving Pecos Pueblo that warrants mention is a recently completed dissertation concerning pueblo aggregation by Eden Welker (1997). Using Pecos Pueblo and San Marcos Pueblo data, Welker's goal is to "compare and contrast the maintenance of aggregation at [the] two communities" (Welker 1997:1). Her study includes extensive examination of Pecos Pueblo's previous excavations, architectural layout, population, agricultural practices, ceramic production, and trade relations. Focusing on economic factors, Welker questions the reliability of agriculture and confirms the importance of trade in maintaining the viability of Pecos Pueblo's aggregated community (Welker 1997).

Summary

The history of archeological research at Pecos National Historical Park is as varied and rich as the archeological remains which have been their focus. Over the course of the last hundred years, numerous archeologists and researchers have been drawn to the Pecos Valley, lured by the accumulated remains of several hundred years of continuous occupation and the mosaic of cultures represented. As this chapter has demonstrated, the park's multicultural past and diversity of archeological remains are the backdrop for many significant archeological findings.

The majority of archeological work at Pecos National Historical Park has focused on Pecos Pueblo and Mission—the most visibly prominent and archeologically rich of the park cultural resources. A wide variety of investigations have been conducted at this site including excavation, survey, artifact analysis, architectural documentation, archival research, and stabilization. Although the emphasis of the work has alternately focused on Puebloan and Spanish remains, pueblo development, community aggregation, Pueblo-Plains relations, the role of trade, and Spanish settlement have been recurring themes throughout much of this work.

In contrast to Pecos Pueblo's prominence in the archeological record, areas of the park beyond the mesilla have received little attention. The earlier habitations, special-use sites, and numerous campsites that characterize the surrounding area have been largely overlooked in favor of the larger, permanent habitation sites. Although a few previous investigations ventured beyond the walls of the Pueblo and Mission, recognizing the importance of small site archeology, the surrounding landscape was, until recent years, largely understudied and little known. The intent of the Pecos Cultural Resource Inventory Survey is to address this void in the archeological record, broaden our understanding of Upper Pecos Valley intrasite and intersite dynamics, and contribute to the reconstruction of the diverse culture history of

this prominent gateway in the American Southwest.

<<< Previous <<< Contents>>> Next >>>

peco/cris/chap2.htm
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PECOS

From Folsom to Fogelson:

The Cultural Resources Inventory Survey of Pecos National Historical Park

CHAPTER 3:
Methodology

Susan Eininger

The methodology of the Pecos National Historical Park Cultural Resources Inventory Survey (CRIS) was designed with two goals in mind: (1) to provide the National Park Service with updated information with which to manage the park's unique cultural resources; and (2) to compile and interpret archeological data concerning the prehistory and history of Pecos National Historical Park within the greater Pecos Valley. In support of this, a wide variety of recording tasks and data fields was identified for incorporation into the survey design. As with any cultural resource survey, it was essential to design a methodology that would maximize meaningful data collection, achieve the stated goals, and operate efficiently and effectively within the time, money, and resources allotted for project completion.

The project methodology evolved into its final format over the course of several years, building on the successes and failures of previous National Park Service cultural resource surveys, the 1994 Pecos pilot survey, and the first year of this multiyear survey. Portions of the recording format were adapted from the recently completed archeological inventory of Bandelier National Monument (Powers and Orcutt 1999). Other elements were based on standard Southwest survey methodology and the data requirements of the statewide New Mexico Cultural Resource Inventory System (NMCRIS) and the National Park Service Archeological Sites Management Information System (ASMIS). Aspects of the Euro-American artifact analyses were adapted from procedures used by the Museum of New Mexico Office of Archaeological Studies (Boyer et al. 1994). Despite the incorporation of these other program elements into the project methodology, the overall recording format was designed to address management and research concerns specific to Pecos National Historical Park cultural resources.

Various aspects of the project design have been discussed in earlier National Park Service reports. The survey's theoretical approach and proposed work plan is presented in the project research design (Head 1997a). Post-field season progress reports summarize project organization, logistics, methods, and annual fieldwork accomplishments (Cunningham and Eininger 1998; Eininger 1996; Head 1997b). Guidelines concerning recording procedures, data fields, and project terminology are presented in the annual field manuals (available through National Park Service, Santa Fe). The following discussion presents a general overview of the Pecos CRIS methodology—its project organization, survey procedures, and documentation processes.

Project Organization

The Pecos CRIS was funded by the National Park Service and conducted as a joint effort between Pecos National Historical Park and the Intermountain Support Office-Santa Fe (IMSF). The project was implemented under the direction of Genevieve Head, IMSF

archeologist, in consultation with Todd Metzger and Judy Reed, successive Pecos National Historical Park archeologists, and Linda Stoll and Duane Alire, successive Pecos National Historical Park superintendents. Except for the few IMSF archeologists assigned to the project, the survey crew and support staff consisted of seasonal park hires and volunteers.

Survey efforts encompassed approximately 23 weeks of field time over a three-year period (May through August, 1995, 1996, and 1997) with roughly a third of the total project acreage surveyed per season. All cultural resource documentation—site, isolated occurrence (10), artifact attribute, and cultural landscape data—was recorded during the in-field portion of the survey project. Data entry and editing were conducted in the fall following the end of each field season. Database compilation, data analysis, report preparation, and finalization of all project-related documentation were conducted over a four-year period following completion of the fieldwork, between September 1997 and September 2001.

Project staff, depending on the field season, included 15-18 people, although short-term volunteers and concurrent special projects sometimes temporarily increased that number. Survey personnel included the project director, lab archeologist, historic archeologist (during the 1996 field season), 3-4 crew chiefs, 10-12 survey crew members, and a camp cook. During the first two years of the project, the survey staff was organized into three field crews. Each crew consisted of a crew chief, two paid crew members, and a volunteer. In 1997, a fourth crew was added. To offset the cost of the additional crew, crew organization was changed to include one crew chief, one paid crew member, one student intern, and one volunteer. Despite this last season change in field organization, the experience of the eight returning crew members helped maintain consistency with the previous seasons' work and reduce the learning curve at the start of the new season.

To expedite site documentation and ensure consistent data quality, individual crew members were assigned specific site recording tasks. Each crew included a lithicist responsible for lithic analysis and recording, a ceramicist responsible for ceramic analysis and recording, and a mapper/architectural specialist responsible for site mapping, location information, and when applicable, architectural documentation. As the fourth crew member, the volunteer assumed the role of crew photographer and assisted in the full range of recording tasks as needed; their responsibilities varying depending on the complexity of the site. The historic archeologist, hired for the 1996 field season, was responsible for recording all the Euro American sites encountered that year. For the remainder of the project, various crew members shared the Euro-American site recording responsibilities. All crew members participated in general recording tasks; however, final recording decisions and site form completion were ultimately the responsibility of the individual crew chiefs. The laboratory archeologist was responsible for reviewing all completed documentation prior to data entry, tracking and maintaining the site record files, ensuring that all sites were recorded on the season's master map, logging collected artifacts, and downloading Global Positioning System (GPS) data files. The lab archeologist also served as liaison between the field crews, the park, and the Santa Fe office.

Due to the size and layout of the park (see Figures 1.2 and 1.3), logistical concerns were relatively minor for a survey of this size. All survey areas west of the Pecos River (approximately 1,332 hectares [3,291 acres]) were easily accessible by either paved or dirt road, and/or a short hike. Commuting time to these survey areas rarely exceeded 20 minutes. Logistics east of the river (about 1,064 hectares [2,629 acres]) were more demanding, however. Fluctuating river levels and the scarcity of road access often resulted in more than an hour of hiking time to reach many of the survey areas. In addition, the dissected terrain, steep slopes, and thick vegetation were physically and logistically more demanding than the open, rolling terrain west of the river. Despite the challenging terrain, the number of acres surveyed per crew-day was comparable if not higher east of the river due to lower site

density, smaller sites, and less time intensive site recording demands.

The Forked Lightning Ranch house served as the field office and base camp during the field work portions of the project. The field office provided a work center and clearinghouse for all outgoing and incoming data, artifacts, and supplies. Ranch house facilities were also used for camp activities with a nearby tent camp providing sleeping space.

At the close of each field season, project operations were transferred to National Park Service offices in Santa Fe. Each season's site and 10 data were entered into a Microsoft Access 97 database program. Once all fieldwork was completed, a master database was created by merging the three seasons' databases. This database forms the basis for all statistical analyses and summary discussions presented in this final report. Upon completion of the project, all artifacts, site records, maps, photos, and supporting documentation will be curated and archived at Pecos National Historical Park.

As part of the project planning, a preliminary literature search was conducted to identify previous archeological research within or immediately adjacent to Pecos National Historical Park. National Park Service, U.S. Forest Service, and New Mexico State Archeological Records Management Systems (ARMS) files were checked for site records and cultural resource reports concerning Pecos National Historical Park and the surrounding area. A reference file of all previously recorded site records, a cultural resource bibliography, and a baseline map (1:24,000 U.S. Geological Survey [USGS] map enlarged) showing the locations of all previously recorded sites were compiled.

To prepare for the cultural resource inventory, a pilot survey was conducted in the fall of 1994 (Eininger et al. 1995). Nine areas were surveyed for a total of 103 hectares (254 acres). Two of these areas were located within proposed park development zones. The remaining seven were placed judgmentally, their locations chosen in an effort to sample the anticipated range of environmental and cultural resources found within the park. Forty-three sites and 15 IOs were identified. Twenty-one of the sites were recorded using the proposed Pecos CRIS recording format. The remaining 22 sites were described in field notes and on project maps, but due to time constraints were not formally recorded. All of the pilot sites were subsequently re-recorded during the Pecos CRIS.

The pilot survey proved to be extremely helpful in project planning. It provided project staff with the chance to familiarize themselves with the logistical and topographic demands of the park and enabled them to test and modify the proposed recording format prior to initiation of the full-scale survey. As a result, the project methodology required very little change over the course of the multiyear inventory. The only exceptions to this were the changes required for artifact sampling and GPS recording, neither of which were included in the original pilot survey design.

Survey Methodology

The Pecos Cultural Resources Inventory Survey was designed as a 100 percent survey of park lands—2,675 hectares (6,610 acres) including land from the Forked Lightning Ranch, the original National Monument, and the detached Pigeon's Ranch and Cañoncito Units (see Figure 1.1). Subsequent management decisions in 1996 eliminated the Pigeon's Ranch and Cañoncito Units (279 hectares [689 acres]) from the survey design reducing the survey area to 2,396 hectares (5,920 acres).

Survey Areas

For management purposes, the project area was divided into three topographic and

management zones: (1) the "core area" consisting of 148 hectares (365 acres) surrounding and including the mesilla and the original Pecos National Monument; (2) the Forked Lightning Ranch east of the Pecos River, consisting of approximately 1,064 hectares (2,629 acres) along the Tecolote Foothills; and (3) the Forked Lightning Ranch west of the River, totaling 1,185 hectares (2,927 acres) of level to gently sloping terrain surrounding the "core area" (see Figures 1.2 and 1.3). Each of these areas was in turn subdivided into smaller, more manageable survey units of 16-170 hectares (40-420 acres) each, depending on the terrain, site density, and logistical considerations. Figure 3.1 shows the configuration of these survey units and their distribution across park lands.

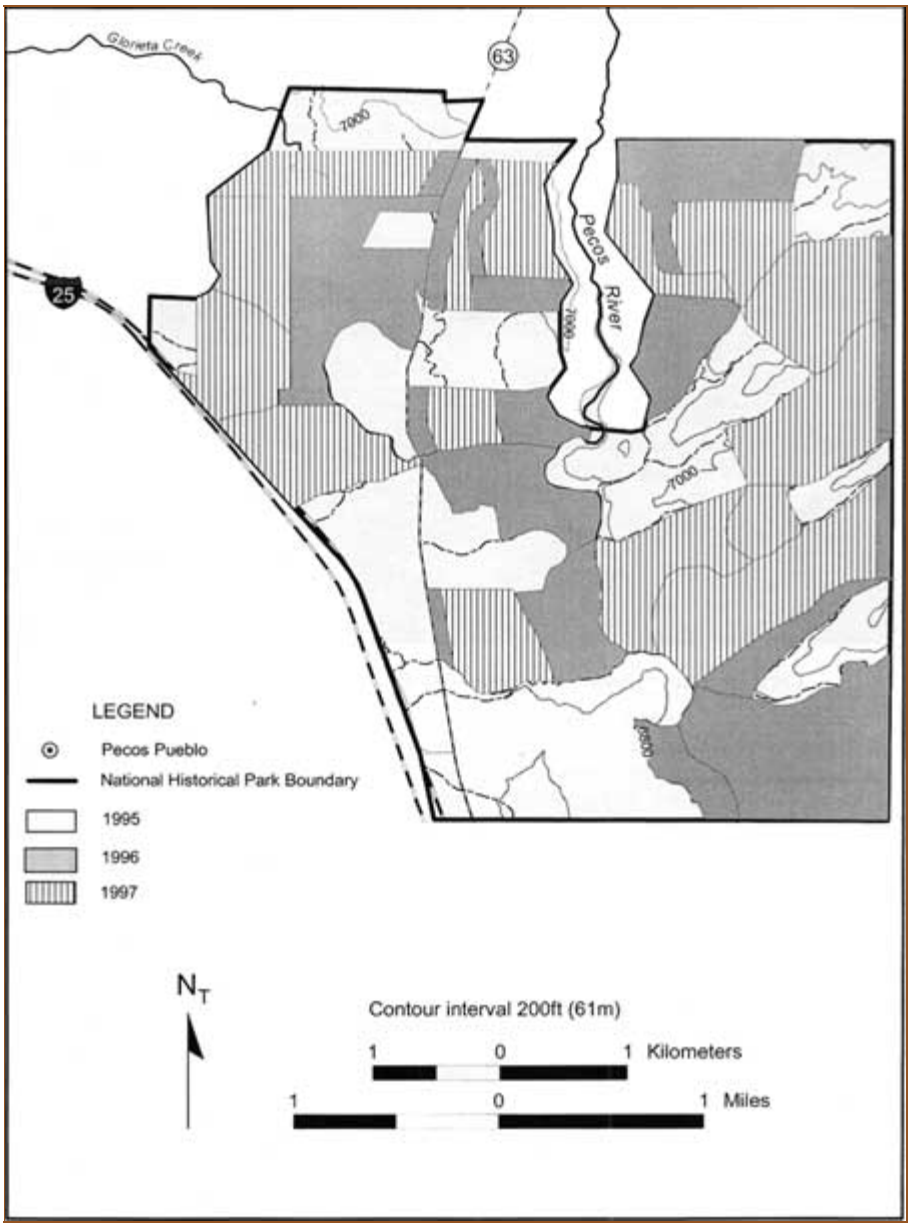


Figure 3.1. Survey areas, 1995-1997. *(click on image for an enlargement in a new window)*

As a 100 percent inventory, there was no need to develop a formal sampling strategy to select the areas to be surveyed. During the first season, survey areas were scattered across all three zones of the park. The intent was to examine as much of the topographic and cultural variability as possible, using the information to better anticipate and plan the subsequent seasons work. This strategy also enabled the crews to vary their routine over the course of the

summer and divide up the workload more equitably.

Survey areas were defined in much the same way during the following years' work, although in a few instances certain areas were given priority based on specific park needs. By the third year of the project, survey areas were simply based on what was left. Individual survey area boundaries were defined using natural and man-made linear features (e.g., fence lines, roads, drainages), or judgmentally selected compass bearings marked on-the-ground with temporary flag lines. Area locations were plotted on 1:3000 aerial photos and USGS topographic maps. Survey area acreage was calculated at the end of each field season using either manual planimeter or computer-generated measurements.

Survey Procedures

Survey areas were investigated by walking parallel transects with crew members spaced 10-15 meters apart (Figure 3.2). With a four-person crew, a single survey sweep covered an area roughly 60 m (200 ft) across. The orientation of the sweep was chosen to provide the most efficient coverage. In steeper terrain, transects were typically walked on contour, while in level areas, they were oriented along compass bearings or linear features such as roads, fence lines, or drainages.



Figure 3.2. Crew on a survey transect, spaced 10 to 15 meters apart. View north-northeast.

Transects were marked using temporary flag lines. During the initial sweep, the person on the outside edge marked his/her line with colored pinflags. Once the sweep was completed, the crew turned around and began a new transect using the other side of the newly laid flag line to guide the next sweep. As the crew proceeded forward, the flag line was pulled and another flag line established along the "new" outside edge. This procedure was repeated back and forth across the landscape until examination of the survey area was completed. Although the use of flag lines required one crew member to rewalk the line in order to remove the previously-laid flags, it helped ensure consistent parallel spacing and eliminate the possibility of gaps in coverage that can occur when relying solely on compass orientation.

Cultural Resource Identification

When cultural remains or anomalies in the natural landscape were noted, crew members stopped to investigate the area in question for additional artifacts or evidence of human use. Individual artifacts, artifact concentrations, and/or features were flagged (Figure 3.3) and the distribution, extent, and nature of the cultural remains determined. For the purposes of the survey, cultural remains were classified as either sites, IOs, or cultural landscape elements. A total of 629 sites, 479 IOs, and 118 cultural landscape elements was recorded.



Figure 3.3. Site documentation in progress at PECO 142 (LA 118780).

Sites

Sites were defined by one or more cultural features and/or by artifact scatters containing six or more artifacts situated within a spatially discrete area. All prehistoric and historic cultural remains meeting these criteria and predating 1945 were recorded as sites.

Site boundaries were defined by the extent of artifacts and/or features on the landscape. In some areas of the park, however, continuous low density artifact scatters made the application of these criteria somewhat problematic. Sites within these areas were typically not as spatially distinct, and as a result, boundaries were often based on decreases in artifact density, rather than the actual extent of artifact distribution.

This was especially true in the "core area" which was characterized by a continuous, though sometimes sporadic scatter of features and artifacts. Earlier park surveys (Nordby 1990, 1992, 1993) in anticipation of the difficulties associated with defining sites within continuous scatter areas, focused on the distribution of features rather than artifacts in determining site boundaries. Because the Pecos CRIS inventory used an artifact-based recording strategy, many previously recorded site boundaries were expanded to include the surrounding artifacts. In some cases, several adjacent previously recorded sites were re-recorded as a single site due to an encompassing, continuous scatter of artifacts.

In addition to these considerations, site boundaries were also influenced by logistical concerns. In a few instances, the cumbersome requirements of recording a seemingly endless artifact scatter warranted splitting the scatter into two (or more) contiguous sites to allow for more manageable recording. Artifact density decreases, topographic breaks, and/or man-made features typically formed the basis of these subdivisions.

Isolated Occurrences

As a rule of thumb, IOs are cultural resources that do not meet the minimum site criteria. For the purposes of the Pecos CRIS, IOs were defined as: (1) isolated diagnostic or museum quality artifacts, such as complete projectile points, axes, or historic bottles; (2) artifact scatters with fewer than six artifacts; (3) artifact scatters with more than six artifacts if they are the result of a single activity, such as a pot drop or core reduction area, or if they are located in an area lacking contextual integrity, such as in a stream channel or bulldozer backdirt pile; (4) an isolated feature (no associated artifacts) or isolated feature of questionable cultural origin (e.g., a vague rock alignment); and (5) possible raw material source areas. As with sites, the temporal criteria for IOs was pre-1945.

Cultural Landscape Elements

Cultural landscape elements (CLs) were used to record many of the modern (post-1945) features within the park. Features such as roads, fence lines, corrals, water catchments, vegetation anomalies, and trash dumps were included in this classification. Given the recent acquisition of the Forked Lightning Ranch, CL recording was crucial to the documentation of prepark ranching activities. Other linear features, such as trails or roads of unknown temporal affiliation were also recorded as CLs. Because of their linear configuration and extent, these resources were more effectively documented using the landscape-oriented CL forms rather than the project site forms which were designed to capture more spatially discrete information.

Site Documentation

As mentioned above, the site recording format was designed to capture both management- and research-oriented information. Cultural resource data were recorded using computer encoded and descriptive text fields. Data collection was based on a hierarchical approach, recording site and component level data as well as individual structure, feature, scatter, and artifact attributes. Attributes were selected to address research questions pertaining to site formation, function, chronology, cultural affiliation, and demography. Management data dealing with site significance, condition, and preservation concerns were also recorded. Table 3.1 provides a summary of the range of data fields included on the site form.

In addition to the park-specific data needs, data requirements for the statewide NMCRIS and the National Park Service ASMIS were incorporated into the recording format. There were instances, however, where the project data requirements were more detailed or finely defined than the broad classifications included in these regionwide databases. In these cases, field values were designed to meet the project-specific data needs and later converted into a format compatible with the other data systems.

To maximize consistency in the recording process and site information collected, recording manuals were compiled with explanations of the numerous data fields, standards for applying recording procedures, and definitions and encoding equivalents of any applicable terminology. Copies of the 1997 recording manuals for cans, glass, and nails and miscellaneous historic artifacts are available from the National Park Service, Santa Fe. Recording guides for site data, sampling, lithics, and ceramics are included as Appendices A-D. The reader is referred to these documents for a discussion of the various data fields and the guidelines for their application.

Table 3.1. Summary of data fields used for site recording.

REGISTRATION DATA: PECO #, Laboratory of Anthropology (LA) #, site name, Park unit, Survey area #, Management unit, Recorders, Date, Recording time

LOCATIONAL DATA: State, County, Quad, Aerial photo, UTMs, GPS status, Meridian, Legal location, Location summary

SITE DESCRIPTION: Component #, Cultural affiliation, Date, Confidence, Component type, Site summary, Site size, Area, Criteria, Subsurface potential

FEATURES: Type, #, Size, Extent, Shape, Wall height, Number of courses, Mound height, Depth, Rooms visible, Rooms estimated, Construction, Fabric, Association, Stability, Comments, Room size, Agricultural feature/field size/slope/aspect

REFUSE SCATTERS: Type, #, Dimensions, Depth, Stability, Comments

SAMPLING: Feature, Sample #, Type, Representation, Dimensions, Area, Comments

DENSITY GRID (if applicable): Feature, Density datum location, Grid size, Square #, Sample #, Counts (Flaked, Nonflaked, Ceramics, Euro-American), % Ground visibility, Comments

RESOURCE MANAGEMENT DATA: Condition, Threat, % intact, % surface visibility, Soil pedestal height, Channel/Gully depth, % Sheet wash, Impacts

SITE EVALUATION: National Register recommendation, Criteria, Basis, Significance, Research potential, Dating potential, Interpretive potential, Site visibility, Site access

MANAGEMENT RECOMMENDATIONS: Recommendations, Comments

ENVIRONMENTAL DATA: Physiographic zone, Landform, Elevation, Aspect, Slope, Soil, Deposition, Vegetation zone, Nearest water/direction/distance, Permanent water/direction/distance

PHOTOGRAPHS: Roll #, Exposure #, Intermountain Cultural Resource Center (ICRC) #, View, Subject COLLECTIONS: Field Specimen (FS) #, Artifact code, Component #, Feature, Sample #, Description

ASSEMBLAGE CHECKLIST: Debitage, Flaked tools, Diagnostic points, Ground stone, Nonlocal lithics, Tool manufacturing items, Prehistoric diagnostic ceramics, Other prehistoric ceramics, Historic diagnostic ceramics, Other historic ceramics, Diagnostic glass, Other glass, Diagnostic metal, Other metal, Architectural stone, Burned adobe, Fire-cracked rock/burned caliche

ASSEMBLAGE SIZE: Lithic artifacts, Prehistoric ceramics, Historic artifacts, Total assemblage

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One to two days were set aside at the start of each field season to orient crew members to the project recording format and field methodology. Field manuals were updated as needed, incorporating minor changes and additions identified over the course of the fieldwork. Once completed, site forms were reviewed by the lab archeologist to help ensure adherence to the guidelines and consistent application between crews.

Overall, there was little modification to the site recording format over the course of the

project. In a few instances, definitions were clarified, additional values were added to the list of encoding options, or procedures were streamlined to allow for more efficient recording. As previously indicated, the only substantial changes in recording procedure involved GPS data collection and artifact sampling. The methodologies for both these activities are described in their respective sections below.

Site Numbering

Each recorded site was assigned a park-specific PECO site number based on the numbering system established during the 1975-1976 cultural resource survey (Nordby 1990, 1992, 1993). A total of 485 new PECO numbers (PECO 233-720) and 144 previous site numbers was assigned over the course of the survey. All site forms, maps, photos, and related documentation are cross-referenced using the designated PECO number. Aluminum site stakes marking individual site locations were stamped with a "P" followed by the designated PECO number (i.e., P720). Sites were subsequently assigned Laboratory of Anthropology (LA) site numbers, although for National Park Service purposes the PECO number is considered the primary site designator. The LA numbers do not appear on the Pecos CRIS site stakes. Appendix F gives a concordance of PECO numbers and LA numbers.

As a rule, previously recorded sites with existing PECO and/or LA numbers were rerecorded using their original site numbers. There were exceptions to this, however, due to differences in recording strategies between the present and previous projects. There were situations where several adjacent previously recorded sites were redefined as a single site. In these instances, only one of the previously assigned site numbers was reused although in a few cases, a totally new number was assigned. There were also instances where a previously recorded site was reinterpreted and as a result, divided into several smaller sites. The original site number was maintained at one of the subdivided sites, while the others were assigned new number designations. Tables 3.2 and 3.3 summarize these site number revisions. For tracking purposes, number changes were noted in the Previous Investigations section of the site data form, previous site markers were left in place, and a master site log was maintained noting the disposition of all previously assigned PECO site numbers.

Table 3.2. Site number changes due to combining previously recorded sites.

Site Number	Site Numbers Subsumed within That Site
PECO 10	PECO 225
PECO 32	PECO 27, 28, 31, 33, 34
PECO 48	PECO 79, 80, 85
PECO 60	PECO 59
PECO 81	PECO 82
PECO 101	PECO 216, 217 and LA 85507, 85508
PECO 107	LA 32241
PECO 144	PECO 149, 150, 170
PECO 148	PECO 153, 156
PECO 151	PECO 152, 154, 155, part of 157
PECO 157	PECO 158, 180
PECO 219	PECO 210
PECO 220	PECO 161

PECO 226	PECO 73, 74, 75, 77, 78, 87, 88, 89
PECO 247a	PECO 132
PECO 282a	PECO 106
PECO 335a	PECO 51, 52, 54, 63
PECO 403a	PECO 141
PECO 458a	PECO 171
PECO 494a	PECO 164

[a]Re-recorded using newly assigned PECO number.

Table 3.3. Site number changes due to subdividing previously recorded sites.

Previous Number	Re-recorded as:
PECO 138	PECO 138, 592, 595, 596, 597, 598, 599, 630, 631, 632, and 633
LA 69301	PECO 504 (LA 69301) and 505
LA 85502	PECO 290 (LA 85502) and 292
LA 85503	PECO 293 (LA 85503) and 269

Site Recording Forms

The primary site recording tool was the Site Data Form which includes basic location, descriptive, management, and environmental data (Appendix A). Supplemental forms were used as needed to document the various artifact classes represented in the site assemblages. These artifact-specific forms enabled attribute recording of flaked and nonflaked lithics, ceramics, glass, cans, nails, and miscellaneous Euro-American artifacts. All artifact analyses were conducted on site as part of the in-field recording procedures. This non-collection approach was adopted to minimize the need for collecting and curating large numbers of artifacts and to help ensure minimal disruption of site integrity and artifact provenience as a result of project activities.

Site Components

Sites were interpreted and documented using a component-based recording system—a "component" being an intrasite grouping of temporally and/or culturally related remains. Given the long and varied history of the Upper Pecos Valley and the occurrence of multicultural site areas, the component-based system provided the means for sorting culturally and temporally associated intrasite and intersite data. Sites with structures, features, and/or scatters that appeared to be the result of a single occupation or use period were recorded as single component sites. Multi-component sites were recorded when it was possible to attribute the site remains to two or more distinct occupations or cultural periods. Of the 678 components recorded, 582 were identified within single component sites and 96 in multi-component sites.

Components were assigned a type designation and cultural affiliation to enable preliminary sorting of site data. Component type was based on the most prominent feature of the component group. Cultural affiliation was determined by the presence (or absence) of culturally and/or temporally diagnostic artifacts and features. Depending on the site

assemblage and the diagnostic information available, cultural affiliation assignments varied from the broad generic categories of "Native American" or "Euro-American," to more specific associations, such as "Archaic," "Puebloan," "Plains," or "Hispanic." Date ranges were assigned whenever possible using temporally diagnostic information present within the component's artifact and feature assemblage. As with the cultural classifications, temporal assignments ranged from very broad all-encompassing dates spanning several hundred years to narrow time spans of 10-30 years depending on the diagnostics present and their associated period of manufacture.

Puebloan ceramic typologies established for the Upper Pecos Valley and the northern Rio Grande cultures served as the primary dating tools at Native American sites. Towards this purpose, a ceramic typology field manual (available through National Park Service, Santa Fe) was compiled, assembling information from various published and unpublished regional ceramic references. The manual formed the basis of the field classifications and chronological assignments and helped promote consistency between crews. At aceramic and pre-ceramic sites, projectile points were sometimes used for determining cultural and temporal affiliations. Projectile point dating was complicated, however, by the lack of a well-established point typology for the area and by the possibility for reuse and curation of early points at later sites.

Euro-American site dates were based on the identification of artifacts and/or features with time-sensitive attributes. As a result, manufacturing techniques, materials, and stylistic designs associated with recognized periods of manufacture were recorded. To maximize field recordation and ensure recognition of historic diagnostic attributes, the majority of Euro-American sites were recorded in 1996 while the historic archeologist was on staff. Historic artifact field guides and a reference library established at the project office helped provide information for determining artifact chronologies. In a few instances, field recording was supplemented with review of quit-claim deeds, land titles, cemetery rolls, and journal descriptions (Welker 1995). A few local residents and ranch employees were interviewed for information on the more recent ranch features.

A variety of factors, including the number and type of diagnostics present (e.g., ceramics, projectile points, Euro-American artifacts), the confidence with which the diagnostics were dated, the range and/or overlap of the dates identified within the assemblage, and the complexity of the site as a whole were considered in making in-field temporal assignments. During the research phase of the project, site chronologies were re-examined using a variety of computer-based statistical programs (see Chapter 4, this volume). This work was performed in-house with the exception of the Euro-American artifact analysis which was conducted by the Museum of New Mexico-Office of Archaeological Studies, Santa Fe, New Mexico (OAS) (see Chapter 10, this volume).

Native American Artifact Documentation

As a primary source of cultural, temporal, technological, and functional data, artifact documentation comprised a significant part of the site recording process. The documentation focused on two separate but complementary recording tasks: (1) the inventory and attribute analysis of the individual artifacts and (2) the density count and composition of the assemblages as a whole. Artifact attribute analyses were designed to provide data for determining artifact function, technology, and temporal range while density data were designed to provide intrasite artifact distribution and frequency. The data collected as a result of both these processes were used to reconstruct site function, duration of occupation, chronology, and settlement patterns.

Artifact Sampling

Artifact inventory procedures were adapted from the Bandelier National Monument archeological survey (Powers and Orcutt 1999). Sampling strategies were designed to ensure representation of artifact assemblage variability and statistically valid comparative data (McKenna and Powers 1986). Preserving site integrity and maintaining artifact provenience were also of primary concern. To minimize sampling logistical demands, attribute analysis data and density grid counts were derived from the same sample units, whenever possible. Lithics and ceramics were inventoried separately within the selected units; their differing technologies, functions, and frequencies requiring separate sampling strategies and analytical approaches (see Appendix B).

Ceramic assemblages with fewer than 200 ceramics and lithic assemblages with fewer than 40 flaked lithics were 100 percent inventoried with all artifacts included for attribute analyses. The artifact density data at these sites—the lithic and ceramic counts and scatter area—were recorded in conjunction with the artifact analysis and did not require any additional sampling procedures. Lithic scatters with 41-100 flaked lithics, were sampled by randomly selecting 30-40 artifacts from the total lithic assemblage. In these instances, the density data was again accomplished by the same procedures used to document the analytical sample. Nonflaked lithics, which were characteristically few in number, were 100 percent inventoried at all sites regardless of quantity, and therefore not addressed in the sampling design.

At larger scatters, exceeding the 200 ceramic or 100 flaked lithic limit, representative artifact samples were selected for both the attribute analyses and the density count documentation. Density count samples were designed to include 10-15 percent of the total scatter area. Artifact attribute analysis was based on a sampling of roughly 200 ceramics and/or 100 flaked lithics (from which 30-40 lithics were randomly selected) per scatter. Assuming these numbers represented at least one percent of the total assemblage (i.e., no more than 20,000 sherds and/or 10,000 lithics), no additional samples were taken. If additional samples were needed to meet the 1 percent goal for attribute analyses, a second sample of 200 sherds and/or 100 lithics was selected. Due to time constraints, a maximum of 400 sherds (2 samples) and 300 lithics (3 samples) was analyzed per scatter.

To simplify the logistics involved in completing the attribute analyses and density counts, sample areas were designed to meet the size requirements of both procedures. For most sites this was achieved by gridding off the scatter area and selecting a stratified random sample of grid squares. The goal of this methodology was to compile spatially representative samples that could be used to reflect overall scatter composition (Appendix B).

The implementation of the grid system and the identification of sample units across the sites proved to be one of the most logistically challenging tasks of the project. As a result, the implementation of the grid system and artifact selection process underwent substantial modification during the early stages of the survey. More streamlined methods adapted to the dispersed scatters characteristic of the Pecos area were developed. Under the revised system, the datum and the primary grid axis were judgmentally placed along the main axis of the scatter. The scatter area was mapped in relation to the axis, and a grid system of equally sized, individually numbered squares was superimposed on the plan view (Figure 3.4). Depending on the size of the scatter, grid squares ranged in size from 0.5 x 0.5 m to 11 x 11 m (1.6 x 1.6 ft to 36 x 36 ft). The maximum sample unit size of 11 x 11 m (36 x 36 ft) was established to minimize the displacement of artifacts upon redistribution.



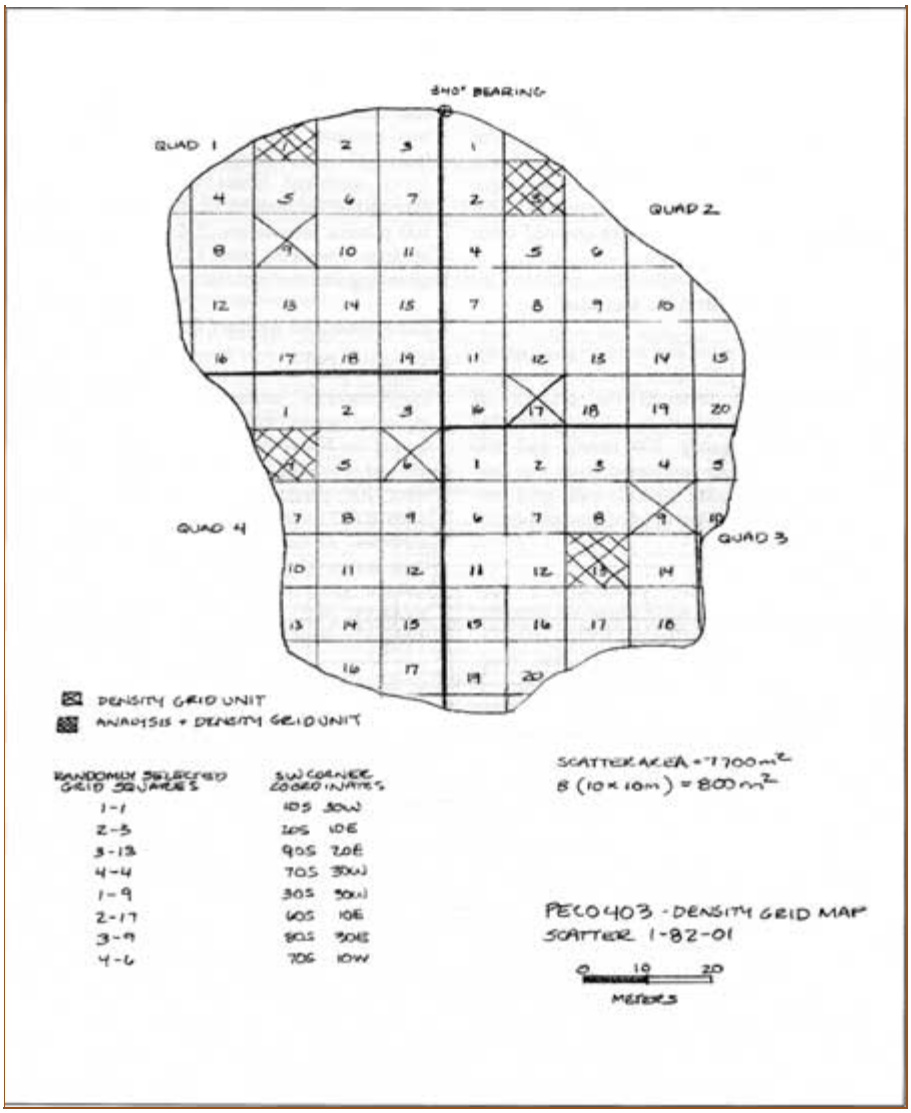


Figure 3.4. An example of a lithic and ceramic scatter density grid square map used to delineate and select the sample units needed for artifact density counts and artifact attribute analysis. *(click on image for an enlargement in a new window)*

The plan view grid was then divided into four equal-sized quadrants and grid squares were randomly selected, an equal number of grid units per quadrant. Using location coordinates derived from the map datum, the selected units were identified and marked on the ground. Depending on the area involved and crew preference, sample units were laid out encompassing the entire grid square or as circular dog-leash areas within the grid square interior. Typically 8-12 units were selected to meet the 10-15 percent sample required for the density count. These same grid units were also used to provide the artifact sample for attribute analyses, although at some of the more dispersed scatters artifacts from additional units were analyzed to meet the required 200 ceramic or 100 lithic sample size requirements.

It was within the discretion of the ceramic or lithic analyst to select additional judgmental samples if he/she felt the grid square sampling did not effectively capture all the site diversity or functionally important artifact locations. Depending on the intent of the additional sampling, units were randomly or judgmentally selected. There were only a few instances at the larger more complex sites where this type of supplemental sampling was implemented. Judgmental samples were also used to record "items of interest" that fell outside of the selected sample boundaries. This included high input lithic tools, ground stone, unique artifact types, cores, worked sherds, and unusual ceramic types.

Despite successes in streamlining the grid square procedures, implementation at the larger dispersed artifact scatters continued to be a time consuming task. Re-evaluation of the procedure because of scheduling concerns in 1996 resulted in the decision to eliminate grid square sampling of large nonstructural artifact scatters. As a result, grid square mapping was discontinued, and density data was no longer collected at these scatters. Sample units needed to generate the artifacts required for the artifact attribute analyses were derived from judgmentally placed sample units rather than randomly selected grid squares. The judgmental units were placed in areas that, based on on-site observation, best represented the scatter assemblage and variability and would provide the required number of artifacts needed for attribute analyses.

Density Count Procedures

Once the grid square units were selected and defined on-the-ground, artifacts within individual units were collected. Provenience was maintained by careful labeling and handling of the sample unit bags and by returning all artifacts to their original unit locations. All artifacts in a grid unit were counted. Ceramics, flaked lithics, nonflaked lithics, and when applicable, Euro-American artifacts were tallied. Counts were recorded on the Density Grid Form included in the site form packet (Appendix B). Disturbance factors and ground visibility conditions likely to influence the counts were also noted. Artifacts were returned to their respective units upon completion of the recording procedures. Over the course of the project, 91 scatters representing 71 sites were sampled using the grid square methodology. As a result, over 44,000 artifacts were counted from more than 900 grid units.

Artifact Attribute Analyses

Selected grid units were also used to generate the 200 ceramics and 100 lithics needed for artifact attribute analyses, although the practice of collecting each grid unit in its entirety precluded the selection of exactly 200 sherds and 100 lithics. Artifacts were assembled from the individual grid units noting their specific grid provenience for redistribution upon completion of analysis.

Attribute analysis procedures were designed to address a wide range of ceramic, flaked lithic, and nonflaked lithic artifacts. Various descriptive, technological, and functional data fields were selected in support of the anticipated research goals. These attributes are summarized by artifact type in Table 3.4 below. Chapters 8 and 9 include respective discussions of the specific ceramic and lithic attributes and the results of their subsequent analysis.

Ceramics were analyzed and sorted by type and vessel form. Counts, weights, rim counts, and when possible, rim diameter, were noted. Over the course of the survey, 631 ceramic samples were analyzed. As a result, more than 30,000 sherds representing 586 artifact scatters and 487 sites were analyzed. Most samples (n=541) were the result of 100 percent inventory of their associated ceramic assemblages. Eighty-five represent sampling of larger artifact assemblages and five samples are the result of efforts to document items of interest outside the established sample areas.

Lithic documentation included descriptive information, such as material, condition, artifact size, evidence of thermal alteration, and use wear. Technological and functional types were also determined. A total of 865 lithic samples was analyzed representing 694 lithic scatters from 587 sites. Over 21,000 flaked lithics and 1,145 nonflaked lithics were recorded. More than half of the samples (n=524) are the result of 100 percent inventories, 216 represent sampling of larger scatters, and 125 are the result of recording items of interest.

Euro-American Artifact Documentation

On-site artifact attribute analyses were conducted at Euro-American artifact scatters although the recording procedures were less formally defined than at the Native American sites. At smaller scatters and whenever feasible, Euro-American scatters were 100 percent inventoried and all artifacts counted and recorded for descriptive and diagnostic attributes. At the larger, high density scatters and trash dumps where 100 percent inventory was unrealistic given the logistical constraints, artifact inventory and attribute analysis focused on temporally diagnostic artifacts only.

Sampling procedures were determined based on assemblage size and distribution, the types of artifact present, and the potential for recording diagnostic attributes. Judgmental samples were selected, focusing on diagnostic artifacts and items of interest, rather than on random samples of the assemblage. Artifacts were selected for analysis at the discretion of the analyst. The condition of the artifact, the certainty with which the diagnostic attributes could be identified, and the number of other diagnostics available for analysis often influenced artifact inclusion in the judgmental sample (see discussion of field recording in Chapter 10).

As a result of the survey, over 5,000 Euro-American artifacts were analyzed. This includes artifacts from 78 Euro-American artifact samples at 37 sites. Forty-five of these samples were the result of 100 percent inventory. The remaining 33 were judgmentally selected samples of a larger assemblage. As a result of this analysis, 54 can inventories, 64 glass inventories, 57 miscellaneous artifact inventories, and 15 nail inventories were completed. Research findings derived from the resulting database are presented in Chapter 10.

Table 3.4. Artifact attribute analysis data fields.

CERAMIC INVENTORY FORM
Sample Data: Feature sampled, Sample #, Sample type, Dimensions, # of Pickup, # of Analyzed, Assemblage summary, Dates, Confidence.
Ceramic Data: Group #, Ceramic type, Form, Count, Weight, # of Rims, Vessel estimate, Comments.
Rim Sherd Data: Group #, Diameter, # of sherds, % of rim, Comments.
LITHIC INVENTORY FORM
Sample Data: Feature sampled, Sample #, Sample type, Dimensions, # of Pickup, # of Analyzed, # of nonflaked lithics, # of other flaked lithics, Assemblage Summary.
Flaked Stone Data: Artifact #, Material, Color, Cortex, Platform, Item Condition, Heat Alteration, Use-wear, Technological Type, Functional Type, Length, Width, Thickness, Comments.
Nonflaked Lithic/Ground Stone Data: Artifact #, Material, Nonflaked lithic type, Condition, Length, Width, Thickness, Cross section, # of surfaces, Comments.
GLASS INVENTORY FORM
Sample Data: Feature sampled, Sample #, Sample type, Dimensions, # in sample, # of other, Dates, Assemblage summary.

Glass Data: Group #, Count, Color, Type, Function, Makers Technique, Label, Base, Finish, Lid, Seam, Dates, Comments.

CAN INVENTORY FORM

Sample Data: Feature sampled, Sample #, Sample type, Dimensions, # in sample, # of other, Dates, Assemblage summary.

Can Data: Group #, Count, Function, Material, Part, Seam, Seal, Open, Diameter, Height, Width, Thickness, Label, Dates, Comments.

MISCELLANEOUS HISTORIC ARTIFACT INVENTORY FORM

Sample Data: Feature Sampled, Sample #, Sample type, Dimensions, # in sample, # of other, Dates, Assemblage, Summary.

Nail Data: Group #, Count, Class, Function, Length, Dates, Comments.
GLASS Miscellaneous Artifact Data: Group #, Count, Class, Function, Brand/Comments, Dates.

Artifact Collection

As a result of the project's in-field analysis procedures, only a limited number of artifacts were collected over the course of the project. The resulting collection includes diagnostic projectile points, unique or "museum quality" artifacts, and representative artifacts and raw material samples (such as clay and stone) that were incorporated into the survey type collection. In a few instances, unidentified artifact types were collected in order to consult with other analysts on a more definitive artifact classification.

Artifact-specific collection data were recorded on individual artifact collection tags, collated in the project's field specimen log, and catalogued using the National Park Service Automated National Cataloging System Plus (ANCS+). A total of 506 collections from 200 different sites is entered in the project database. Although many of the collected sites averaged one or two collections each, as many as 52 collections were taken at Forked Lightning Ruin, PECO 226. Projectile points comprise the overwhelming majority of collected materials (n = 349). Sherds, lithic tools, lithic material types, diagnostic Euro-American artifacts, worked bone, shell, and clay samples are also included in the collection.

Location Information

Site location information was documented using three different field recording methods: (1) site boundaries were plotted on the USGS 7.5' Pecos, New Mexico Quadrangle topographic map (enlarged to 1:12000); (2) site boundaries and datum locations were plotted on 1992 1:6000 aerial photos (enlarged to 1:3000); and (3) GPS Universal Transverse Mercator (UTM) data were collected for all site datums and for boundaries on roughly a third of the sites. All GPS readings were taken using the World Geodetic System 1984 (WGS 84) coordinate system. Datum and boundary locations were also documented on the individual site sketch maps, and brief narratives describing site locations were included on the site recording forms. Township-Range locations were extrapolated from USGS topographic maps with field-plotted site locations.

The procedures used for compiling GPS locational data evolved over the course of the survey in response to various base station problems, the acquisition of new equipment, and

increasing technical expertise. The initial approach was to have a separate GPS recording crew responsible for all of the GPS data collection. Once a survey area was completed, the GPS crew revisited the area and recorded point files at each site datum using a Trimble Pathfinder Basic Plus™ unit. To ensure a certain standard of accuracy, each point file consisted of at least 180 readings (approximately three minutes of recording time) and required data from a minimum of four satellite stations.

Prior to the second field season, new GeoExplorer II GPS units were acquired to provide one unit per survey crew. As a result, GPS data were collected during the initial recording of the site, eliminating the need to revisit the site at a later date. Crews were also able to record GPS data for IO locations. During the 1995 field season, UTM locations for IOs were taken off the 1927 7.5' USGS topographic sheet and reprojected to WGS-84. During the third and final field season, GPS recording procedures were expanded to include line files documenting individual site boundaries.

GPS logs were maintained manually and submitted to the lab archeologist with the recorded data files on a daily basis. Differential corrections were made within a day or two of field data recording using simultaneous observations collected by the National Park Service's Albuquerque base station. For the few times when the Albuquerque National Park Service base station data were unavailable, data were obtained from the New Mexico Engineering Research Institute base station, also in Albuquerque, or from the Mesa Verde National Park base station in southern Colorado.

Based on the manufacturer's specifications (Trimble Navigation Limited 1994:1-4), GPS locational data were expected to be accurate within 2-5 m (6.6-16.4 ft). To monitor accuracy, each crew took daily readings of established brass caps. These readings were subsequently compared with known UTM coordinates for those caps. The brass cap readings and the re-recording of a number of site datum locations indicated that most of the evaluated GPS locations were within 1 m (3.3 ft) of accuracy. UTM data generated by the GPS files were entered into the site database and transferred to the site recording forms. In addition, as part of the post-field analysis and final report preparation, the GPS data were converted to a Geographic Information System (GIS) application for mapping and analysis.

Site Maps

Intrasite locational information was provided on individual site sketch maps included in the site form packet. Scaled plan views were created for all recorded sites using compass, tape, and/or pacing. In a few instances where extensive site size and heavy vegetation cover limited line of sight and prohibited efficient ground measurements, aerial photos were used to help project the site area. Individual site sketch maps depicted the location and extent of site stakes, all site features, scatters, sample areas, photo points, and collected artifacts. Topographic features, pertinent vegetation, modern features, impact areas, and other items of interest were also located.

Instrument maps were completed at seven of the larger sites in the park: Pecos Pueblo, the Estancia, Loma Lothrop, Arrowhead, Forked Lightning, Shin'po, and Dick's Ruin. With the exception of Pecos Pueblo, which was mapped by Shawn Penman from the University of New Mexico, the instrument mapping was incorporated into the standard site recording process. Mapping instrumentation varied depending on available equipment, but included an alidade, theodolite, electronic distance measurer (EDM), optical transit, and laser transit.

Photodocumentation

Black-and-white photos were taken of each site. At a minimum, photodocumentation

included site stake location and general site setting. Specific features and additional viewpoints were taken as needed. Color slides were also taken focusing mostly on survey methodology and representative site features for use in the park's interpretive library. Photo information was logged on project photo record forms and cross-referenced on the associated site form. All prints, negatives, photo CDs, slides, and photo logs resulting from the survey are archived at the park.

Isolated Occurrence Documentation

In comparison to site documentation, IOs were recorded on a much more abbreviated scale. Due to their limited research potential, extensive recording was not warranted. A single page Isolated Occurrence Form and associated recording manual were designed to document general location, environmental, administrative, and archeological data. IO data fields are based on the design of the Site Data Forms. Table 3.5, presents a summary of these recorded data fields.

IO locations were plotted on both USGS topographic quadrangles and project aerial photos. UTM data were generated manually from 1927 7.5' USGS topographic sheets during the first year of the project and from GPS point files in the later two years. In situ artifacts and features were sketched and/or photographed at the discretion of the crew chief. IO artifact collection was guided by the same principles established for site artifact collection.

Cultural Landscape Documentation

CLs were recorded on a single page form using a loosely defined narrative-based format. Unlike the site and IO data which were designed for data entry and immediate research and management use, the CL field recording was considered the first of a multistage documentation process and was therefore more preliminary in design. The intent was to identify and briefly describe all CL features encountered in the course of the survey and, in effect, to flag these resources for future documentation and research.

Table 3.5. Isolated Occurrence data fields.

REGISTRATION DATA: IO #, Park unit, Survey area #, Management unit, Recorders, Date.

DESCRIPTION: Culture, Date, Confidence, Artifact/Feature type, Dimensions, Description.

LOCATIONAL DATA: State, County, Quad, Aerial photo, UTMs, GPS status, Meridian, Legal location, Location summary.

ENVIRONMENTAL DATA: Physiographic zone, Landform, Elevation, Aspect, Slope, Soil, Vegetation zone.

COLLECTIONS: Field Specimen (FS) #, Artifact code, Description.

PHOTOGRAPHS: Roll #, Exposure #, Intermountain Cultural Resource Center (ICRC) #, View, Subject.

Unlike archeological sites and IOs, which tend to be location-specific, the CLs require a broader regional perspective encompassing land use patterns and the surrounding

environment. As a result, Pecos Cultural Resources Inventory Survey (CRIS) strategies did not always allow for thorough recording of the CLs, especially for those with extensive linear dimensions or poorly defined boundaries. General location, environmental and administrative data similar to sites and IOs were recorded but narrative text rather than encoded information was used to provide descriptive information. Table 3.6 presents a summary of these recorded data fields. All CL locations were plotted on USGS topographic quadrangles and aerial photographs to the extent they were defined and in some instances, GPS data points were collected.

Data Processing and Management

Upon completion of the fieldwork, all recorded data were entered into a Microsoft® Access 97 relational database. As part of the data editing process, database files were screen checked against the hard copy site forms for entry errors and inconsistencies in data values. The three seasons' files were merged into a master database and edited again for noticeable inconsistencies or errors affecting compatibility and sorting of data. In compliance with state and National Park Service cultural resource programs, site data were transferred into the NMCRIS and National Park Service ASMIS document formats and submitted to the respective agencies.

Table 3.6. Cultural Landscape data fields.

REGISTRATION DATA: CL #, Park unit, Survey area #, Management unit, Recorders, Date, Recording time.

LOCATIONAL DATA: State, County, Quad, Aerial photo, UTMs, GPS Status, Meridian, Legal locations.

ENVIRONMENTAL DATA: Physiographic zone, Landform, Elevation, Aspect, Slope, Vegetation zone, Soil.

LANDSCAPE INFORMATION: Theme/Period, Landscape feature type, Subtype, Description, Size, Orientation, Shape/Pattern, Material, Plant species, Associated features, Comments.

PHOTOGRAPHS: Roll #, Exposure #, Intermountain Cultural Resource Center (ICRC) #, View, Subject.

All project data and documentation are archived at Pecos National Historical Park. This includes original recording forms, all photodocumentation, maps, supporting documents, and computerized data. As previously mentioned, artifacts have been catalogued in ANCS+ and are curated at the park.

Summary

The Pecos CRIS survey provided the unique opportunity to systematically investigate Pecos National Historical Park lands for evidence of prehistoric and historic occupations. While most of the previous investigations focused on Pecos Pueblo and the lands immediately adjacent, the Pecos CRIS adopted a broader focus encompassing more distant park lands away from the pueblo. The goal of the survey was to collect and interpret the cultural resource findings in a way that would be meaningful to managers, researchers, affiliated communities, and visitors alike. Building on the knowledge gained from previous

archeological and management studies, Pecos CRIS methods were designed to maximize the quality and quantity of the data collected while operating within the project budget and scheduling requirements. As a result, priorities were established and compromises were made, hopefully without impacting the overall project goals.

Three seasons of field survey resulted in the examination of more than 2,396 hectares (5,920 acres) and recorded 629 sites, 479 IOs, and 118 CLs. A wide variety of site, feature and artifact data were collected. Artifact assemblages, because of their functional and chronological data potential, were a primary focus of the survey. Artifact attribute analyses and scatter density determinations comprised a significant portion of the on-site recording time. The data generated by these procedures and the numerous other recorded data fields document and, in effect, help preserve the numerous cultural resources encountered by the survey and provide the foundation for the research and analyses presented in the following pages.

<<< Previous <<< Contents >>> Next >>>

peco/cris/chap3.htm
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PECOS

From Folsom to Fogelson:
The Cultural Resources Inventory Survey of Pecos National Historical Park

CHAPTER 4:
CERAMIC CHRONOLOGY

Melissa S. Powell and Karl K. Benedict

> *In the Rio Grande, as in other parts of the Southwest, pottery has proved, on preliminary reconnaissance, to be the most serviceable single criterion; the general ceramic history of the region has been worked out by strategic excavation. It remains to examine all the ruins in the area and, using pottery as our criterion, to rank them in proper chronological order.*
>
> Alfred Vincent Kidder, *The Pottery of Pecos*

Chronology is the foundation upon which all other archeological inference is based. Implicit in Kidder's stated objective of 70 years ago is the recognition that the archeologist must successfully control time before more explanatory research goals may be addressed. Knowledge of the timing and relative sequence of events in the past is critical to understanding the causes of those events, as well as the relationships between them.

This chapter presents a temporal framework for the occupation of pre- and protohistoric Puebloan sites within Pecos National Historical Park, based on ceramic data recorded by the Pecos survey. While historic Puebloan poly-chrome ceramics are used in construction of the site chronology in this chapter, other types of historic artifacts and documentary sources were not considered in assigning sites to time periods. The historic era chronology is treated explicitly in Chapter 10 (see also Ivey 1996 for a structural history of the Pecos mission).

Following a brief discussion of traditional northern Rio Grande chronologies and known chronometric dates from the park for the ancestral Puebloan period, the chapter describes the construction of a Pecos ceramic chronology that is independent of other cultural traits. Ceramic mean dating and ceramic probability dating are the primary methods used to partition time, with the best results achieved using the probability approach.

The purpose of the dating project is to date individual sites in an objective, consistent, and replicable manner. A related goal is to use ceramic data to classify Pecos sites into useful and appropriate temporal divisions in order to provide a structure in this report for monitoring change through time in variables such as settlement, lithics, and architecture. A distinction is drawn between the culture history of the Pecos area and the survey project chronology as a temporal classification method based solely on surface ceramic data. The chronology outlined here serves as a baseline for research questions framed in subsequent sections of the report.

Ceramic Typologies

In the American Southwest, concern with chronology can be traced to Kidder's systematic study of ceramics and stratigraphy at Pecos Pueblo (Kidder 1924; Kidder and Amsden 1931; Kidder and Shepard 1936), modeled after Nelson's (1914) stratigraphic excavations at nearby

Pueblo San Cristobal. Kidder found that the forms and design styles of ceramics changed through time, providing a method for dating ceramic types relative to one another based on their vertical placement in the stratigraphy. Other early research on the ceramics and chronology of Pecos includes work by Amsden (Kidder and Amsden 1931) and by Shepard (1936, 1942), who described the Pecos pottery types and noted their relative occurrence in the stratified middens of Forked Lightning and Pecos Pueblos. Mera's (1933, 1934, 1935) regional syntheses were also instrumental in defining ceramic types and in establishing a cultural, spatial, and temporal sequence for the Rio Grande region.

When linked to the tree-ring record in the 1930s, pottery was recognized by archeologists as an even more sensitive indicator of the age of prehistoric sites. Ceramics found in association with dateable wood permitted more tightly controlled dates to be assigned to pottery types (Breternitz 1966; Smiley 1951; Smiley et al. 1953). Relying on the principle of cross-dating, other sites where these ceramic types were found could be fitted into the known temporal sequence.

Early Southwestern ceramic researchers recognized the value of decorated ceramic types as time markers, a function that they continue to fulfill today. Types are viewed simply as tools for achieving chronological goals and are not considered emic categories. Although the traditional ceramic types encompass much variation, they are still in wide use by archeologists working in the region. In contrast to other areas of the Southwest, ceramic types in the northern Rio Grande are defined on the basis of a combination of technological attributes—primarily paste and temper—with far less attention paid to particular design styles. Fortunately for this project, identifying ceramic types using technological characteristics works well for even the small sherds typically found on survey.

Rio Grande Chronologies

The Pecos Classification, the earliest chronology for the Southwest, was a product of the first Pecos Conference held in 1927 at Kidder's Pecos field camp. Despite its name and origin, however, the Pecos Classification (Kidder 1927) is no longer a valid temporal scheme for either Pecos or for the northern Rio Grande culture area. Researchers working in the area today follow Wendorf and Reed (1955), who proposed revisions to the original chronology to bring it more in line with the known prehistory of the northern Rio Grande region, which does not mirror the cultural sequence of areas farther west (Figure 4.1). In particular, Pecos does not have the time depth that Kidder originally sought when he began research at Pecos Pueblo. The Pecos Classification temporal designations of Basketmaker, Pueblo I and II were subsequently found to be absent, and therefore, inappropriate descriptions of cultural patterns at Pecos.



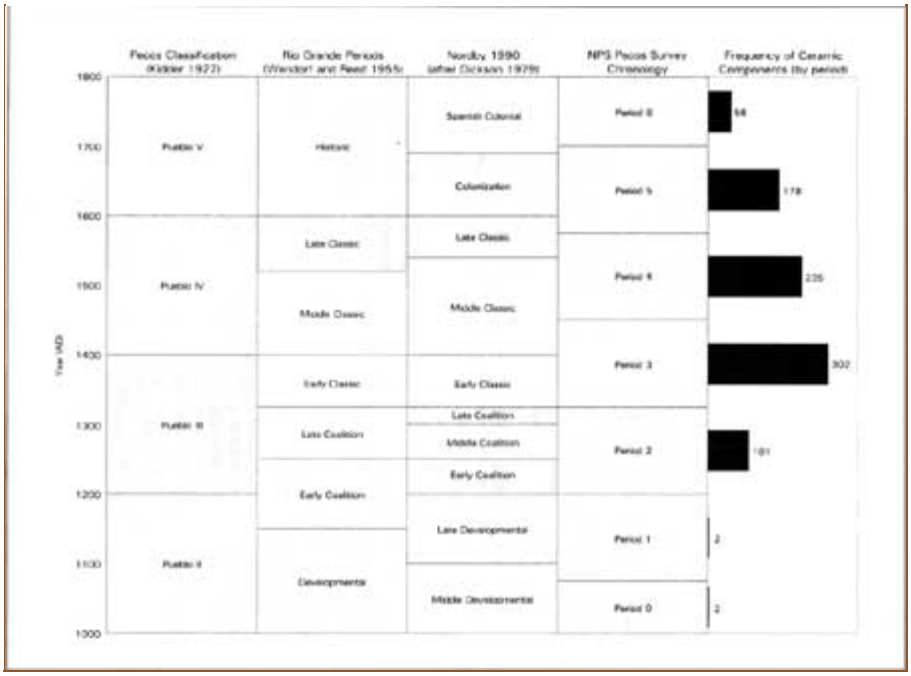


Figure 4.1. Comparison of temporal framworks for the northern Rio Grande region with the Pecos survey chronology and component frequencies. *(click on image for an enlargement in a new window)*

The Wendorf and Reed (1955) chronology identifies five major temporal periods, based on changes in settlement patterns, architecture, and artifacts: Preceramic, Developmental, Coalition, Classic, and Historic. Dickson (1979) later subdivided Wendorf and Reed's temporal periods based on survey work in the Galisteo Basin. An abbreviated summary of the Pecos culture history is discussed below. The chronology developed in this chapter does not encompass the Preceramic period (11,500 B.C.-A.D. 600). However, survey finds including an isolated Folsom point midsection in the Tecolote Range of the park attest to Paleoindian use of the Pecos landscape. (See Chapter 9, for more information on the Preceramic period.)

The early Developmental period in the northern Rio Grande area (A.D. 600-1200) is represented at Pecos by the presence of at least one small pithouse village beginning in A.D. 800. Ground-disturbing activities at Pecos National Historical Park in recent decades encountered three pithouses (PECO 53, 61, 207) approximately 1 m (3.3 ft) below ground with no surface indications of their presence (Nordby 1981; Nordby and Creutz 1993a). A fourth pithouse was located in the vicinity during later testing for a new maintenance building (Akins 1994:16-21). Indications of two other possible pithouses were noted in 1999 (Judy Reed, personal communication 1999).

Chronometric dates for the excavated pit houses establish occupation around A.D. 800-850 (Table 4.1). Archeomagnetic samples from the Sewerline Site (PECO 207) processed by Robert DuBois of the University of Oklahoma date to A.D. 840 ± 40. Three tree-ring dates were also obtained from PECO 207, with one cutting date of A.D. 801 (Robinson and Cameron 1991). Tree-ring dates from PECO 53 (Hoagland's Haven) indicate that the wood was cut in the years A.D. 832 and 841 (Nordby and Creutz 1993a). These sites are the only documented early Developmental period sites within the park.

When considering the pithouses and the next known occupation at the oldest black-on-white pueblos, there seems to be a hiatus in occupation in the Upper Pecos Valley between A.D. 900 and 1000. No sites definitely date to this time period. However, excavations at Rowe (Cordell 1998) and at Forked Lightning (Kidder 1958) revealed small, underlying adobe

structures that could possibly date to the eleventh century. The nature of these occupations is difficult to define since the adobe structures have been severely disturbed by the later, overlying pueblos.

Visibility may be a factor in explaining the apparent absence of sites from this time period, since earlier sites may be differentially affected by greater deposition. If structures at this time were built of adobe, walls may have melted and may be difficult if not impossible to recognize on the surface. Rather than projecting culture forward or backward in time, however, it may be that structural sites from this time period simply do not exist. Settlement patterns at this time could have been more mobile, with intermittent or seasonal use of the valley, although we would expect to see some ceramic evidence if people were present.

Later Developmental period occupations in the northern Rio Grande region include above ground structures and small pueblos with kivas. The ceramic hallmark of the late Developmental period is Kwahe'e Black-on-white, which dates to ca. A.D. 1050-1250 (McKenna and Miles 1991). Identified in part by the use of iron paint, Kwahe'e Black-on-white is easily distinguished from later Rio Grande White Ware types decorated with organic pigments. Only 15 sherds of Kwahe'e Black-on-white were recorded by the Pecos survey, perhaps signaling a relative absence of human settlement in the Pecos Valley during this time period. Excavations at Arroyo Hondo and Rowe pueblos have encountered a similar lack of Kwahe'e Black-on-white ceramics (Cordell 1998; Habicht-Mauche 1993). Elsewhere in the northern Rio Grande area, the Bandelier archeological survey (Powers and Orcutt 1999) recorded 1,101 Kwahe'e Black-on-white sherds, indicating greater occupation on the Pajarito Plateau at this time.

Table 4.1. Summary of chronometric dates from Pecos National Historical Park.

Site	Earliest Cutting Date	Latest Date	N	Method	Comments
Sewerline Site PECO 207 (LA 118808)	801	801 840 ± 40	3	Dendro Archeomag	
Hoagland's Haven PECO 53 (LA 14154)	832	841	17	Dendro	1 date cluster
Forked Lightning Pueblo PECO 226 (LA 672)	-	1148	8	Dendro	No in-site provenience. 904 is the earliest noncutting date.
Arrowhead Pueblo PECO 710 (LA 251)	1370	1392	60	Dendro	2 date clusters.
Pecos Pueblo PECO 228 (LA 625)	1299	1695	99	Dendro	4 date clusters

All dates are A.D. References: Nordby and Creutz 1993a; Robinson and Cameron 1991; Robinson et al. 1973; Smiley 1951; Smiley et al. 1953; Stallings 1933, 1937.

Note. See Appendix E for a summary of tree-ring dates collected in 1998 from Pecos Pueblo, the Pecos Church, and Kozlowski's Trading Post by Thomas Windes.

Forked Lightning, a coursed adobe pueblo with over a hundred rooms, has eight published tree-ring dates that fall between A.D. 904 and 1148, all from unprovenienced contexts (Table 4.1) (Robinson et al. 1973; Smiley et al. 1953). With one exception, the dates are *vv*, meaning that it is impossible to estimate the distance between the last ring and the true outside of the wood (Robinson et al. 1973:5). Because the dates reported by Smiley et al. (1953) were obtained from charcoal fragments, Kidder (1958:42) felt that these were unreliable and "almost certainly too early." This observation is borne out by the ceramics found on site, the predominant type being Santa Fe Black-on-white, which has a traditionally accepted beginning date of around A.D. 1175-1200. The lack of substantial numbers of Kwahe'e Black-on-white ceramics would also appear to indicate that the site was not founded before A.D. 1175. However, Kidder's excavations and the survey noted the presence of basket-impressed sherds, both utility and black-on-white ware, which tend to be associated with early proveniences (i.e., the Late Developmental period, A.D. 1000-1200) in the northern Rio Grande region.

Major settlement of the Pecos area began during Wendorf and Reed's Coalition period. In the northern Rio Grande area, the Coalition period (A.D. 1200-1325), particularly the latter part, has been widely characterized as a time of demographic upheaval. Migrants from the Colorado Plateau are thought to have pushed southward in search of favorable environmental conditions, spurred by more severe environmental fluctuations and by the "Great Drought" of A.D. 1275-1300 (Cordell 1989; Crown et al. 1996; Dean 1996; Rose et al. 1981). The presence of more sites in a previously sparsely settled landscape is the primary evidence for an influx of population to the Rio Grande Valley during the Coalition period (Stuart and Gauthier 1981). Nonetheless, clear indicators of migrant populations are unknown. Similarity of Rio Grande White Ware ceramic designs to Mesa Verde ceramic design styles is often mentioned (Collins 1975; Lang 1984; Mera 1935; Wendorf and Reed 1955), but this is more often a matter of casual speculation than systematic analysis.

During the Coalition period in the northern Rio Grande region, masonry and jacal roomblock structures are common. Kivas exhibit a variety of forms; round and square kivas are present, in both subterranean and within-roomblock locations. The initial appearance of agricultural features is proposed for this period (Cordell 1989; Woosley 1986). A diversification of ceramic types is noted, with a shift from mineral to organic paints. Santa Fe Black-on-white is considered diagnostic. The best evidence for settlement during the early Coalition period in the Pecos area comes from Forked Lightning Pueblo and from an adobe structure underlying Rowe Pueblo, dated to A.D. 1240-1250. During the later Coalition period, as many as six pueblos of 50 rooms or more are known from the Upper Pecos Valley. In addition to Forked Lightning Pueblo and Rowe Pueblo, Black-on-white House, Shin'po, Loma Lothrop, and Dick's Ruin appear to have been inhabited at this time.

The Rio Grande Classic period (A.D. 1325-1600) is a time of population aggregation and the establishment of large-scale residential communities. Construction of multiroom and multi-storied pueblos surrounding central plazas, along with a more intensive commitment to agriculture, are indicative of increasing population size and sedentism. The increase in settlement size and shift towards aggregation is thought to be accompanied by heightened regional interaction and trade (Snow 1982; Wilcox 1991). Rio Grande Glaze Ware pottery predominates, sometimes hypothesized to have been made in imitation of western pueblo glaze ware ceramics such as St. Johns and Heshotauthla polychromes from the White Mountain Red Ware series of the Cibola area (Habicht-Mauche 1995; Spielmann 1998).

In the Upper Pecos Valley, Rowe Pueblo, Pecos Pueblo, and Loma Lothrop continue to be

active communities during the Classic period. The sites of Arrowhead Pueblo and nearby Hobson-Dressler (not located within the present park boundaries) were founded during the early Classic period.

Arrowhead Pueblo is the most securely dated structure in the Upper Pecos Valley. A 100+ room masonry pueblo, the site was excavated in the 1930s and 1940s by W. C. Holden. A series of 60 tree-ring dates from the site cluster at A.D. 1370, the probable date of initial construction (Table 4.1) (Robinson et al. 1973:9). The large number of consistent cutting dates provides strong support that roof beams for the pueblo were cut during the nongrowing season, most likely between the fall of A.D. 1370 and the spring of A.D. 1371 (Thomas Windes, personal communication 1998). A later building episode is reflected in beams from a D-shaped corner kiva, apparently added to the pueblo around A.D. 1390 (Robinson et al. 1973:9).

However, an incongruence exists between the Arrowhead Pueblo tree-ring dates and the commonly accepted production span for the ceramic types recorded during excavation (Holden 1955). While the production interval of Glaze I (A.D. 1315-1425) spans the Arrowhead Pueblo tree-ring date range (A.D. 1370-1390), the presence of substantial quantities of supposedly earlier, Santa Fe Black-on-white ceramics (A.D. 1175-1350) is more difficult to reconcile. It is possible that Santa Fe Black-on-white was produced later than A.D. 1350, or alternately the tree-ring dates might reflect later construction or remodeling of structures built prior to A.D. 1350.

Given the large sample and the reliability of the tree-ring dates from Arrowhead Pueblo, it is most likely that Santa Fe Black-on-white was produced later in the Pecos area than is normally assumed. Tree-ring and archeomagnetic dates from Arroyo Hondo Pueblo in the Galisteo Basin (Habicht-Mauche 1993) provide additional evidence that Santa Fe Black-on-white vessels were produced in the northern Rio Grande region until around A.D. 1425, extending the known production span of the type to a total of 250 years.

Pecos Pueblo was founded by around A.D. 1400, as an aggregate community integrating population from the earlier, dispersed pueblos of the Pecos Valley. Given the longevity of Pecos Pueblo, it is not surprising that the 99 tree-ring dates from various contexts at the site range from A.D. 1300-1700 (Table 4.1) (Robinson et al. 1973:26-29). Clusters of cutting dates from several rooms suggest discrete construction episodes in A.D. 1433, 1434, 1501, and 1513 (Smiley et al. 1953) but represent only a portion of the 600-year time span Pecos Pueblo was occupied. Discrepancies in dates from the Pecos Pueblo proveniences (Robinson et al. 1973:29) indicate mixed deposits or reuse of old wood, throwing some doubt on the reliability of individual dates from the site. Windes (Appendix E) reports four new tree-ring dates in the A.D. 1400s for North Pueblo and one additional date of A.D. 1542 from South Pueblo.

Rio Grande Glaze Ware ceramics continued to be produced until about A.D. 1700, when locally made historic polychromes replaced the glazes. While the Puebloan historic polychromes are used in construction of the site chronology in this chapter, the Euro-American ceramics that appear shortly thereafter are not. Other types of historic artifacts and documentary sources were not considered in assigning sites to time periods. With the exception of the indigenous polychrome ceramics at the Euro-American homesteads, Pecos historic components are excluded here.

Background on the Survey Chronology

Based on the project research design (Head 1997a), the first step in the chronological analysis was to locate existing, comparative ceramic assemblages from securely dated, excavated

contexts in the northern Rio Grande region. Following Orcutt's (1999a) approach to the Bandelier ceramic chronology, it was thought that this independent data might allow the Pecos assemblages to be assigned to more precise temporal periods through multiple regression analyses such as those employed by Kohler and Blinman (1987).

However, the search for ceramic assemblages from Pecos or contemporary assemblages from the northern Rio Grande area with associated absolute dates was not successful, because the relationship between existing collections of ceramics and the few absolute dates was often unclear. Many of the ceramic collections are poorly provenienced, and due to sampling methods and collection culling, are not complete assemblages. Further complicating the situation, the available tree-ring dates are often noncutting dates and come from sites with multiple occupations. Clearly, more excavations aimed at recovering complete assemblages from well-dated contexts are needed for a similar study to be successful in the Pecos area.

The Pecos Ceramic Assemblage

Sampling and Analytic Methods

As described in the methodology section of the report (Chapter 3), a noncollection approach to research was followed on this project. Sites were recorded by analyzing artifacts in the field. Typically, all ceramic artifacts within a scatter were inventoried, except in those instances (n=85) when more than 200 sherds were present. In such cases, the analyst set out stratified random sample grids until 400 sherds or 1 percent of the total estimated sherds in the scatter were recorded (whichever was less). This sampling procedure was adopted with two goals in mind: to gain representative data on the overall scatter assemblage and to collect information on artifact density.

To obtain the most accurate dates possible for each site, the field recorders grouped the sherds analyzed at each site by ceramic type, according to descriptions provided in the ceramic field manual (available through National Park Service, Santa Fe). This method enables comparison of proportions of the different ceramic types in each assemblage. Since chronology was emphasized as a major goal in the project research design, ceramic types rather than other ceramic attributes such as temper or design styles were recorded. The ceramic type approach has the added advantage of comparability with previously published data. Preliminary judgmental dates were assigned by analysts in the field, using a simple method of bracketing the earliest and latest ceramic types present.

A potential source of inconsistency that should be acknowledged is the multiple ceramic analysts who participated in the project. During three seasons of work, eight different ceramicists classified and recorded ceramics in the field. Descriptions for distinguishing ceramic types were clear, and training and communication between analysts was high. However, any application of the ceramic type approach must recognize possible differences in the way sherds are classified by individuals.

The Ceramic Database

The resulting database consists of 631 ceramic samples from 487 sites with ceramics. Of the 631 total samples, 541 consist of the entire scatter, 85 are smaller samples of the entire assemblage, and five are samples of diagnostic or unusual items outside the established sample area. Aside from the five "items of interest" samples, all of the samples were treated equally as representative samples in construction of the chronology. The reader is referred to Chapter 3 for a more detailed discussion of the survey sampling strategy.

The nature of the Pecos ceramic assemblages presents some problems for dating sites. The

prevalence of small surface assemblages with few diagnostic items lessened confidence in the date assignments for small assemblages in all of the methods discussed in this chapter. In fact, 27 percent (n=170) of the 631 ceramic assemblages have five or fewer dateable sherds. This pattern of small assemblage sizes is due in part to a disturbed landscape, since modern bulldozing was a common practice at Pecos that displaced sites and artifacts. (See discussion of vegetation removal, Chapter 5.) Prior visitation at many sites resulted in surface collection of ceramics. In addition, historic use of the Pecos landscape almost certainly impacted prehistoric sites. Finally, 23 percent of the Pecos sites (n=142) have no ceramics.

Aside from later landscape disturbance, the function of the prehistoric sites in question probably contributes more to the small size of the surface ceramic assemblages. The project site typology (Chapter 5), determined primarily by the presence or absence of architectural features, classified 600 of the Pecos sites as seasonal or special-use. Such sites were probably used only on a short-term or intermittent basis. Seasonal and special-use sites would be expected to have smaller artifact assemblages than full-time habitation sites, which may account for some of this patterning.

The large quantity of unidentifiable glaze ware sherds found at Pecos sites also restricts the ceramic sample available for dating. Since the glaze ware sequence in the northern Rio Grande is distinguished largely on the basis of rim form, following Mera (1933), most glaze ware body sherds are not temporally diagnostic. In some cases, particular design elements or the quality of the glaze paint itself permits positive identification. However, 65 percent (n=5,957) of the glaze ware sherds encountered by the survey could not be identified by type. In small assemblages, body sherds could sometimes be matched stylistically or physically with dateable rim forms. In assemblages where multiple rim types were present, this was impossible.

Ceramic Wares and Chronologically Sensitive Types

The major ceramic types found within the park boundaries may be discussed under the broader heading of wares. A ware is defined as "a class of pottery whose members share similar technology, fabric, and surface treatment" (Rice 1987:484). Wares at Pecos include Rio Grande Gray Ware (Colton 1953), Pajarito White Ware (Cordell 1998; Habicht-Mauche 1993), Rio Grande Glaze Ware (Mera 1933, 1935), historic polychromes (Batkin 1987; Harlow 1973), and Apachean ceramics (Gunnerson 1968, 1969a). Within each ware, ceramic "types" are recognized as a "consistent association of attributes" (Rice 1987:484), including characteristic paste and tempers. Ceramic type classifications in the field followed published descriptions listed in Table 8.2. Table 4.2 provides the best available date ranges for the temporally diagnostic ceramic types, organized by ware. Most date intervals are derived from tree-ring information that brackets the earliest and latest contexts in which these ceramics are found. These temporally diagnostic types are the only ceramics used in the chronological analyses described in the remainder of the chapter.

The currently accepted tree-ring date ranges for the Rio Grande Glaze Ware types (see Table 8.2) (Eighth Southwestern Ceramic Seminar 1966; McKenna and Miles 1991; Mera 1933, 1935; Nordby 1990; Warren and Snow 1976) imply a measure of precision that simply may not exist for the ceramic types from the northern Rio Grande. Snow (1982, 1989, 1997) has suggested various revised date ranges that subsume the individual glaze ware types into early, middle, and late variants. While Snow feels that these larger groupings are better estimates of dates for the glaze ware sequence, sufficient new data have not yet accumulated to allow us to revise the long-standing glaze ware sequence for the northern Rio Grande region as a whole. Spielmann (personal communication 2000) has noted that Snow's (1997) dates may have some validity for the Salinas area. Until northern Rio Grande researchers with recent ceramic information from tightly controlled excavated contexts pool their data, it is difficult

to evaluate which dates are most in need of revision.

Table 4.2. Date ranges for Pecos ceramic types.

Type Name	Start Date	End Date	Median
PAJARITO WHITE WARE[a]			
Kwahe'e Black-on-white	1050	1250	1150
Chupadero Black-on-white	1175	1540	1358
Santa Fe Black-on-white	1175	1350	1263
Pindi Black-on-white	1300	1350	1325
Galisteo Black-on-white	1300	1400	1350
Rowe Black-on-white	1300	1425	1363
Jemez Black-on-white	1300	1750	1525
Wiyo Black-on-white	1300	1400	1350
Biscuit A	1375	1450	1413
Biscuit B	1400	1550	1475
RIO GRANDE GLAZE WARE[b]			
Glaze I Agua Fria Glaze-on-red	1315	1425	1370
Glaze I	1325	1425	1375
Cieneguilla Glaze-on-yellow			
Sanchez Glaze-on-red, Glaze-on-yellow, Glaze polychrome			
Glaze I San Clemente Glaze polychrome	1315	1425	1370
Glaze II	1400	1450	1425
Largo Glaze-on-red, Glaze-on-yellow, Glaze polychrome			
Medio Glaze polychrome			
Glaze III Espinosa Glaze polychrome	1425	1490	1458
Glaze IV San Lazaro Glaze polychrome	1475	1515	1495
Glaze V Pecos Glaze polychrome	1515	1700	1608
Glaze V Puaray Glaze polychrome	1515	1650	1583
Glaze VI Kotyiti Glaze-on-red, Glaze-on-yellow, Glaze polychrome	1625	1700	1663
POLYCHROMES[c]			
Sakona Polychrome	1580	1700	1640
Tewa Polychrome	1650	1750	1700
Tewa Black-on-red	1650	1760	1705
Pojoaque Polychrome	1690	1800	1745
Ogapoge Polychrome	1720	1760	1740

a

Data from Breternitz 1966; Habicht-Mauche 1993; McKenna and Miles 1991; Smiley et al. 1953; Stubbs and Stallings 1953.

[b]Data from Eighth Southwestern Ceramic Seminar 1966; Mera 1933, 1935; Nordby 1990; Warren and Snow 1976.

[c]Data from Batkin 1987; Harlow 1973.

The survey did not elect to group the individual glaze ware types into early, middle, and date variants as has been proposed by Snow (1997). The sequence of individual Glaze I through Glaze VI types appearing in successive stratigraphic levels continues to hold validity for Pecos (Kidder and Shepard 1936). It is certainly acknowledged that a great deal of work must be undertaken to refine the dating of the glaze ware types, mainly through the development of more secure dates derived from excavation. However, that was not the aim of the present survey, and the date ranges used in this chapter reflect the best available and most commonly-used glaze ware dates at the time the survey was undertaken.

Dating the Pecos Survey Sites

The second half of this chapter describes the specific methods used to date the Pecos survey sites. The project goals required sites to be dated individually, and assigned to a nonoverlapping sequence of time periods in order to track changes through time. The first approach discussed is mean ceramic dating, which provides valuable information about the temporal ordering of sites relative to one another. This section is followed by a discussion of probabilistic ceramic dating, the method that was ultimately used in the construction of a chronology for the Pecos survey.

The Mean Ceramic Date Approach

Mean ceramic dates are one approach to dating surface assemblages relative to one another. This simple statistical technique was used to determine the chronological placement of each Pecos assemblage, based on the relative frequencies of ceramic types with known date ranges (Table 4.2). First devised by South (1977) and tested using known production spans for Euro-American historic artifacts, mean ceramic dates have been used by other researchers to date pre-historic Southwestern ceramic assemblages (Christenson 1994; Goetze and Mills 1993; Kincaid et al. 1983; Mills 1988; Upham and Bockley 1989; Van Dyke 1997). In essence, the mean ceramic date formula creates a relative seriation of ceramic assemblages. One major advantage is that results are replicable and objective. Significantly, results are generally comparable to those generated by more complex methods of multivariate analysis, including multi-dimensional scaling (Mills 1988).

South's Mean Ceramic Date Formula

For each Pecos assemblage, the mean ceramic date was computed by multiplying the estimated median production date of each ceramic type by the frequency of that type, calculating the sum of the products of all types, and dividing by the total number of dated sherds in the assemblage (South 1977). For comparative purposes, several mean ceramic dates were calculated for the Pecos data, substituting sherd counts and sherd weights for measures of frequency, with both measures providing results that are close (most within 10 years). However, sherd counts proved easier to work with and seemed to provide more consistent results, so are used here. (Chapter 8 contains details of other ceramic attributes recorded by the survey, not used in the chronological analysis.)

Assumptions of Mean Ceramic Dating

Mean ceramic dating necessarily relies on several assumptions common to all seriations. First, breakage of pottery is assumed to occur soon after a ceramic type is first produced and is considered to occur in the same proportion as use. Mean ceramic dating also assumes that the frequency of a ceramic type can be approximated using a unimodal curve. As applied here, the mean ceramic date method equates type production spans with site occupation spans. Use of mean ceramic dates implies that the currently accepted date range for each ceramic type is a reasonable estimate of when the ceramics at a site were actually used.

A key consideration in the application of the mean ceramic date formula is which ceramic types to include. In most cases utility ware ceramics were not used for assigning sites to time periods because their assumed 400-year interval of production adds little to the refinement of the chronology. Omitting utility wares from the analysis also controls for some of the possible functional differences between sites. While changing styles of decorated ceramics have demonstrated chronological value, changes in utility wares are more likely to be influenced by functional constraints.

Method

A mean ceramic date was calculated for all Pecos assemblages having more than five dateable sherds. In similar analyses, Goetz and Mills (1993) and Christenson (1994) found that mean ceramic dates derived from only 5-10 dateable sherds closely approximate the mean ceramic date calculated using larger sample sizes, and significantly, the mean ceramic dates generated from independent tree-ring dates. Since many of the Pecos ceramic assemblages are small, a cut off of five sherds was chosen as a reasonable compromise between the need to obtain reliable mean ceramic dates and the desire to include as many sites as possible in the analysis.

Some Pecos sites have previous collections, and in these instances sample sizes were increased by analyzing those ceramic collections using the survey methodology. Ceramics collected by Kidder from surface contexts and curated by the Robert S. Peabody Museum of Archaeology at the Phillips Academy in Andover, Massachusetts, were included in this fashion. Surface collections by Fliedner (1981) and by Nordby (1990), currently stored at the National Park Service IMSF, that could be matched to known Pecos sites, were also reanalyzed using the present survey's recording format.

Mean Ceramic Date Findings

Mean ceramic dates for the Pecos sites (Table 4.3) were evaluated using descriptive and exploratory statistics in order to note patterning in the data. Figures 4.2 and 4.3 are stem-and-leaf diagrams of the mean ceramic dates assigned to each Pecos survey assemblage, ordered by decade and by two-decade intervals, respectively. Figure 4.4 presents the data as a histogram, organized by 50-year intervals. There is no strong overall directional trend in the data, although the patterning becomes clearer with large time groups, as seen in Figure 4.3, with each line representing two decades. Several suggestive natural breaks indicate relatively fewer sites between A.D. 1320-1330, during the A.D. 1500s, and after A.D. 1710.

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177 3333
176
175 5
174 46
173
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```
172
171 08
170 055555
169 09
168 5
167 4448
166 134
165 35
164 012669
163 000013489
162 3447
161 233
160 335588888888
159 49
158 29
157 467
156 2
155 5
154 35
153 3499
152 24499
151 122556689
150 34568
149 5559
148 2389
147 00266
146 0002467899
145 012234459
144 12345678899
143 012234459
142 14566777889
141 3456898
140 033569
139 0003344678
138 02259
137 0012356689
136 044667899
135 00012459
134 15679
133 16699
132 08
```

```
131 1555
130 144679
129 19
128 011367888
127 88
126 33
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Note: This figure provides a visual picture of the distribution of the mean dates as well as actual date values. It is read by combining the stem value on the left (decade) with leaf values on the right (individual years). For example, the bottom line of the diagram represents the decade A.D. 1260, with two mean dates of 1263 from two sites. Decades with no mean dates (1760) lack leaf values.

Figure 4.2. Stem-and-leaf diagram of the mean dates of the Pecos survey assemblages by decade.

```
176 3333
174 465
172
170 05555508
168 509
166 1344448
164 01266935
162 3447000013489
160 335588888888233
158 2949
156 2467
154 355
152 244993499
150 34568122556689
148 23895559
146 0002467889900266
144 1234567889924888889
142 14566777889012234459
140 0335693456889
138 0222590003344678
136 0446678990012356689
134 1567900012459
132 0816699
130 1446791555
```

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128 01136788819
126 3388
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Note: This figure provides a visual picture of the distribution of mean dates. It is read by combining the stem value on the left (decades in 20-year intervals) with leaf values on the right (individual years). For example, the bottom line of the diagram represents the interval between 1260 and 1279, with two mean dates of 1263 and two mean dates of 1278. Each leaf value is a mean date from one site. Some resolution is lost by compressing dates into 20-year intervals; refer to Figure 1 for actual date values. Intervals with no mean dates lack leaf values.

Figure 4.3. Stem-and-leaf diagram of the mean dates of the Pecos survey assemblages, in 20-year intervals.

Table 4.3. Ceramic mean dates for the Pecos survey sites.

PECO Site No.	Component	Mean Date (A. D.)	PECO Site No.	Component	Mean Date (A. D.)	PECO Site No.	Component	Mean Date (A. D.)
4	1	1448	101	1	1460	252	1	1608
6	1	1350	103	1	1449	261	1	1519
8	1	1503	108	1	1594	265	1	1421
9	1	1382	109	1	1555	266	1	1431
10	1	1529	112	1	1603	274	1	1744
12	1	1403	115	1	1539	277	1	1773
13	1	1460	119	1	1773	279	1	1469
15	1	1638	120	1	1442	286	1	1674
16	1	1543	125	1	1685	293	1	1403
17	1	1470	126	1	1427	294	1	1341
20	1	1441	127	1	1468	301	1 / 2	1464
21	1	1539	129	1	1504	305	1	1488
22	1	1369	136	1	1396	307	1	1352
22	1	1705	138	1	1470	315	1	1389
23	1	1433	139	1	1516	316	1	1350
24	1	1315	144	1	1630	321	1	1624
25	1	1299	151	1	1746	322	1	1425
26	1	1304	157	1	1495	323	1	1400
30	1	1283	160	1	1414	331	1	1524
32	1	1315	163	1	1495	332	1	1306
35	1	1382	192	1	1390	333	1	1633
38	1	1287	193	1	1424	334	1	1483
40	1	1291	193	1	1512	335	1	1278
45	1	1705	196	1	1418	336	1	1653
48	1	1288	197	1	1366	337	1	1630
49	1	1512	201	1	1355	338	1	1434

50	1	1518	202	1	1369	343	1	1495
55	1	1631	203	1	1718	345	1	1608
57	1	1589	204	1	1346	349	1	1370
58	1	1378	213	1	1468	353	1	1608
60	1	1263	215	1	1281	362	1	1375
60	1	1699	218	1	1655	363	1	1398
61	1	1286	219	1	1415	366	1	1641
64	1	1646	220	1	1413	368	1	1613
71	1	1336	221	1	1508	369	1	1773
76	1	1280	223	1	1454	375	1	1605
81	1	1278	224	1	1426	377	1	1613
91	1	1623	226	1	1301	378	1	1627
92	1	1366	227	1	1405	382	1	1755
93	1	1364	228	1	1577	383	1	1630
94	1	1379	235	1	1649	391	1	1432
96	1	1331	238	1	1705	402	1	1416
97	1	1439	244	1	1664	403	1	1674
98	1	1373	245	1	1281	406	1	1710
99	1	1390	247	1	1574	406	1	1506
100	1	1515	251	1	1476	407	1	1516

PECO Site No.	Component	Mean Date (A. D.)	PECO Site No.	Component	Mean Date (A. D.)	PECO Site No.	Component	Mean Date (A. D.)
422	1	1674	531	1	1458	672	1	1678
434	1	1336	532	1	1634	677	1	1599
436	1	1443	538	1	1661	679	1	1462
437	1	1489	547	1	1458	680	1	1445
440	1	1705	550	1	1385	681	1	1427
444	1	1608	552	1	1482	683	1	1418
445	1	1428	554	1	1608	686	1	1469
451	1	1467	555	1	1367	687	1	1630
452	1	1339	562	1	1370	688	1	1603
454	1	1449	565	1	1347	695	1	1458
460	1	1315	568	1	1390	696	1	1460
461	1	1459	569	1	1263	697	1	1545
462	1	1427	577	1	1307	700	1	1382
463	1	1476	578	1	1288	701	1	1448
464	1	1529	579	1	1288	702	1	1394
465	1	1533	580	1	1311	708	1	1409
467	1	1499	581	1	1349	709	1	1524
468	1	1428	584	1	1452	710	1	1309
469	1	1360	588	1	1380	713	1	1624

473	1	1444	589	1	1394	714	1	1432
474	1	1466	590	1	1429			
476	1	1562	592	1	1371			
488	1	1458	594	1	1376			
490	1	1397	595	1	1350			
491	1	1406	596	1	1426			
492	1	1393	601	1	1419			
493	1	1351	602	1	1612			
494	1	1345	606	1	1705			
496	1	1582	608	1	1434			
497	1	1364; 1640	611	1	1515			
498	1	1663	613	1	1608			
499	1	1505	614	1	1605			
503	1	1690	616	1	1339			
506	1	1773	625	1	1534			
507	1	1700	631	1	1435			
510	1	1430	632	1	1368			
518	1	1642	639	1	1458			
519	1	1639	640	1	1646			
521	1	1376	649	1	1393			
522	1	1446	658	1	1608			
524	1	1372	660	1	1608			
525	1	1447	661	1	1511			
526	1	1576	663	1	1354			
527	1	1320	664	1	1359			
528	1	1304	668	1	1328			
529	1	1472	670	1	1522			



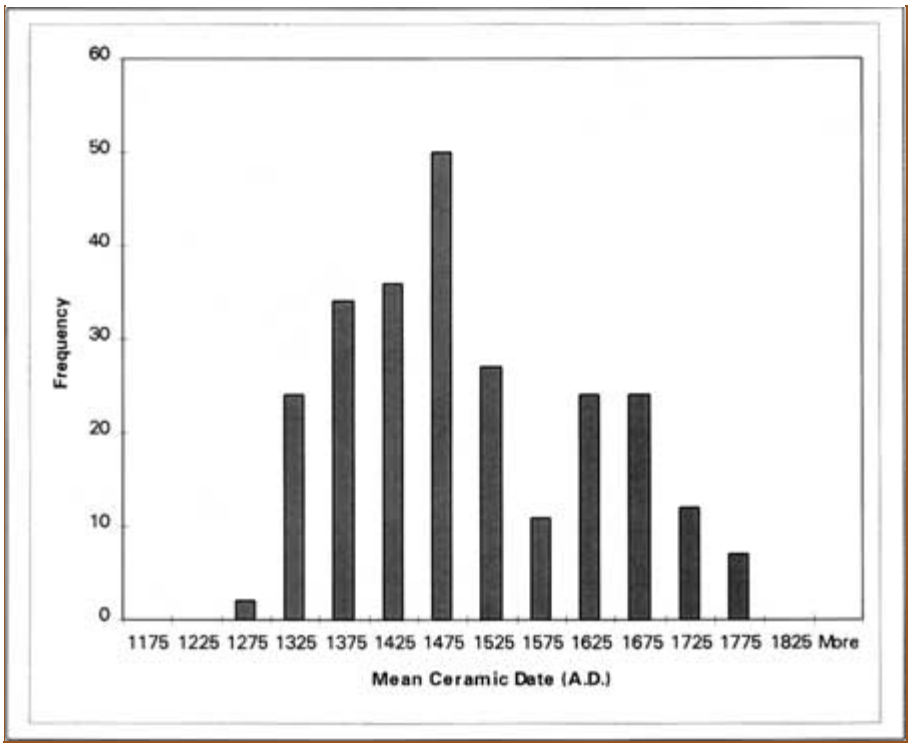


Figure 4.4. Histogram of the mean ceramic dates of the Pecos survey assemblages, by 50-year intervals. *(click on image for an enlargement in a new window)*

None of the mean ceramic dates precede the traditionally defined Coalition period, with the earliest dates occurring at A.D. 1263. Although the mean ceramic dates span a total of 510 years, the majority of the dates cluster in the fourteenth and fifteenth centuries. The densest part of the plots, suggesting the most intensive occupation, occurs from about A.D. 1340 to 1470. However, the single highest frequency of dates is in the A.D. 1600-1610 range (Figure 4.2). The plots reveal a relative lack of sites dated to the A.D. 1500s, with a resurgence of dates by A.D. 1600. Another notable gap occurs between A.D. 1718 and 1744.

Unfortunately, independent absolute dates are not available to test the accuracy of the Pecos survey mean ceramic dates. While Arrowhead Pueblo does have tree-ring dates, there is a mismatch between ceramics and tree-ring dates due to the probable later production of Santa Fe Black-on-white, discussed earlier in the chapter. The few unreliable noncutting dates from Forked Lightning Pueblo also do not coincide with the ceramic mean date from that site. However, in an independent test of the mean ceramic date method elsewhere in the Southwest, Christenson (1994) found that mean ceramic dates calculated from a sample of Kayenta ceramic types in northeastern Arizona provided results that were nearly as accurate as dendrochronology.

Ceramic Probability Dating

As single calendar year dates, mean ceramic dates do not address such complex issues as duration of occupation or the possible abandonment and reuse of sites. For this reason, a multivariate approach was desired that would create a seriation that could take into account the duration of site use reflected in ceramic assemblage composition. In response to these problems, probabilistic ceramic dating was used to seriate the Pecos survey sites. This method was found to be much more effective than mean dating for creating replicable and objective temporal assignments for the sites.

Ceramic probability dating is an alternate method of seriation developed in order to partition

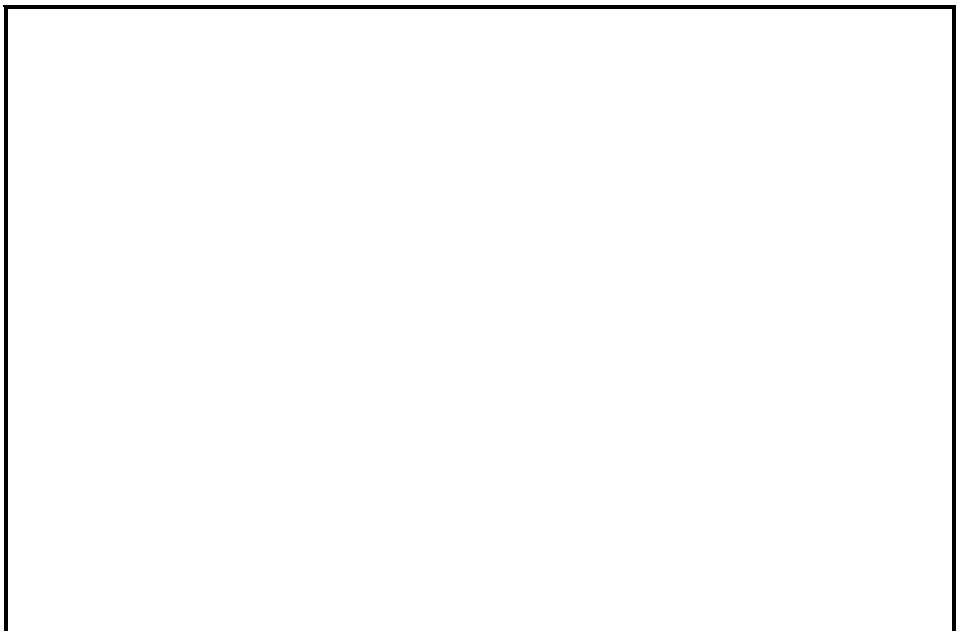
time into manageable analytic divisions, drawing on previous work by Benedict (1996). Similar statistical approaches have been suggested for use with ceramics by Christenson (1994) and by Steponaitis and Kintigh (1993) for historic artifacts. These similar statistical methods for dating sites were encountered after the analysis was complete and were not used in the development of the probability method discussed here. As applied in this report, probabilistic dating is an approach originally devised to combine a series of radiocarbon dates from a site (Benedict 1996). It was applied here to the multiple ceramic types found in an assemblage. Probabilistic dating has utility as both a statistical and graphical technique. Although individual probability graphs were created for each of the Pecos sites, the method was more useful as a statistical technique in the goal of assigning a relative chronological placement to each of the sites.

Probability Assumptions

As with mean ceramic dating, a major assumption in the probability method used here is that the production of each ceramic type approximates a unimodal, symmetric curve. In this model, a ceramic type is expected to exhibit a gradual increase in quantity, reach a modal peak, and then decline through time. The statistical assumption of symmetry and unimodality is not unique to the approach adopted here, but is inherent to most traditional archeological seriations. In one case study, Ambler (1983) constructed frequency distributions for Kayenta ceramic types that demonstrated that most had normal, bell-shaped curves. However—as in any seriation method—this may not be a truly accurate model for all ceramics, because some ceramic types were probably more rapidly adopted or abandoned than others. Nonetheless, like the battleship-shaped curves used to create traditional seriations, unimodal normal curves have demonstrated utility for representing changing styles through time.

Method

A probability distribution was created for each ceramic type using known production spans derived from tree-ring dates from the northern Rio Grande region (Figure 4.5).[1] For this analysis, probability distributions were calculated using a normal distribution with a mean estimated from the median of the ceramic date range and a standard deviation estimated from the ceramic date range divided by four. This estimate of the standard deviation is based upon an assumption that the ceramic date range encompasses roughly 95 percent (±2SD) of the actual time span for a particular ceramic type. The approximated normal distribution for several ceramic types may be seen in Figure 4.6.



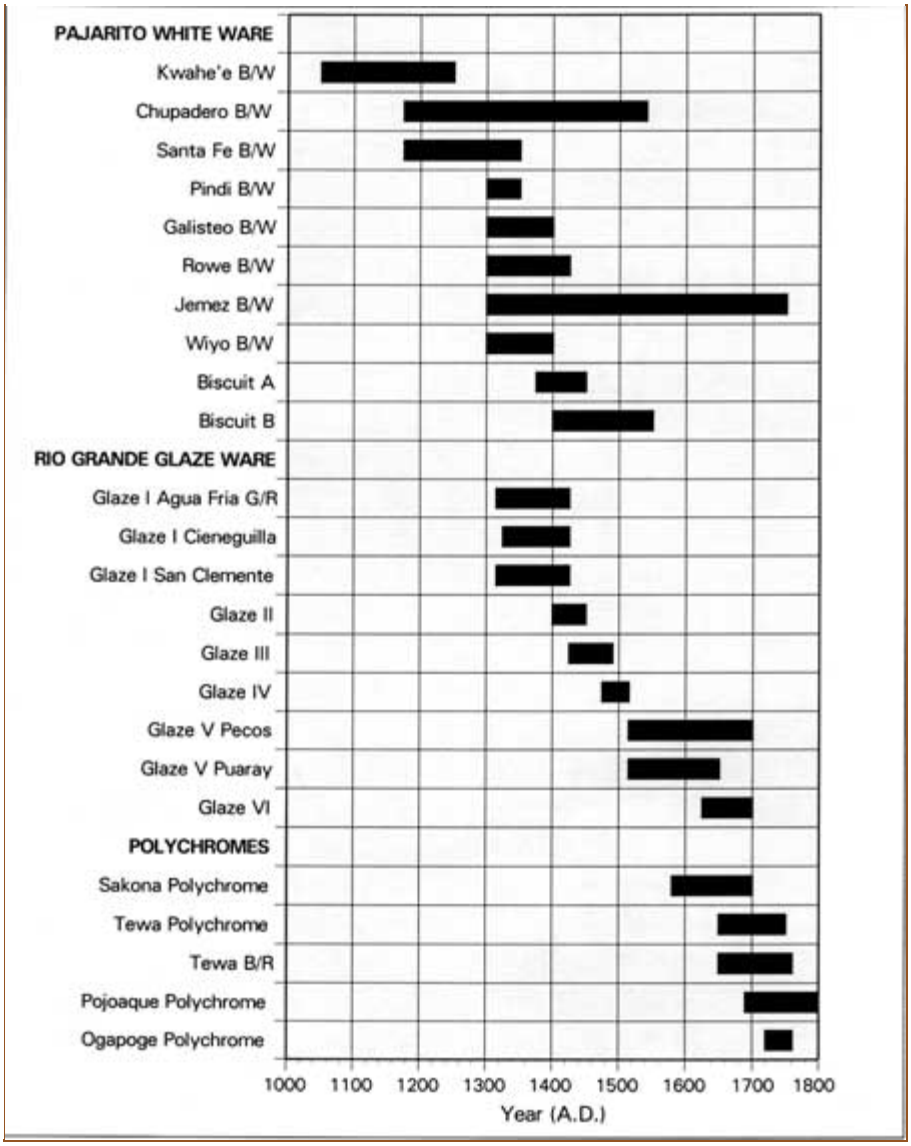


Figure 4.5. Bar chart of the date ranges for the Pecos ceramic types. *(click on image for an enlargement in a new window)*

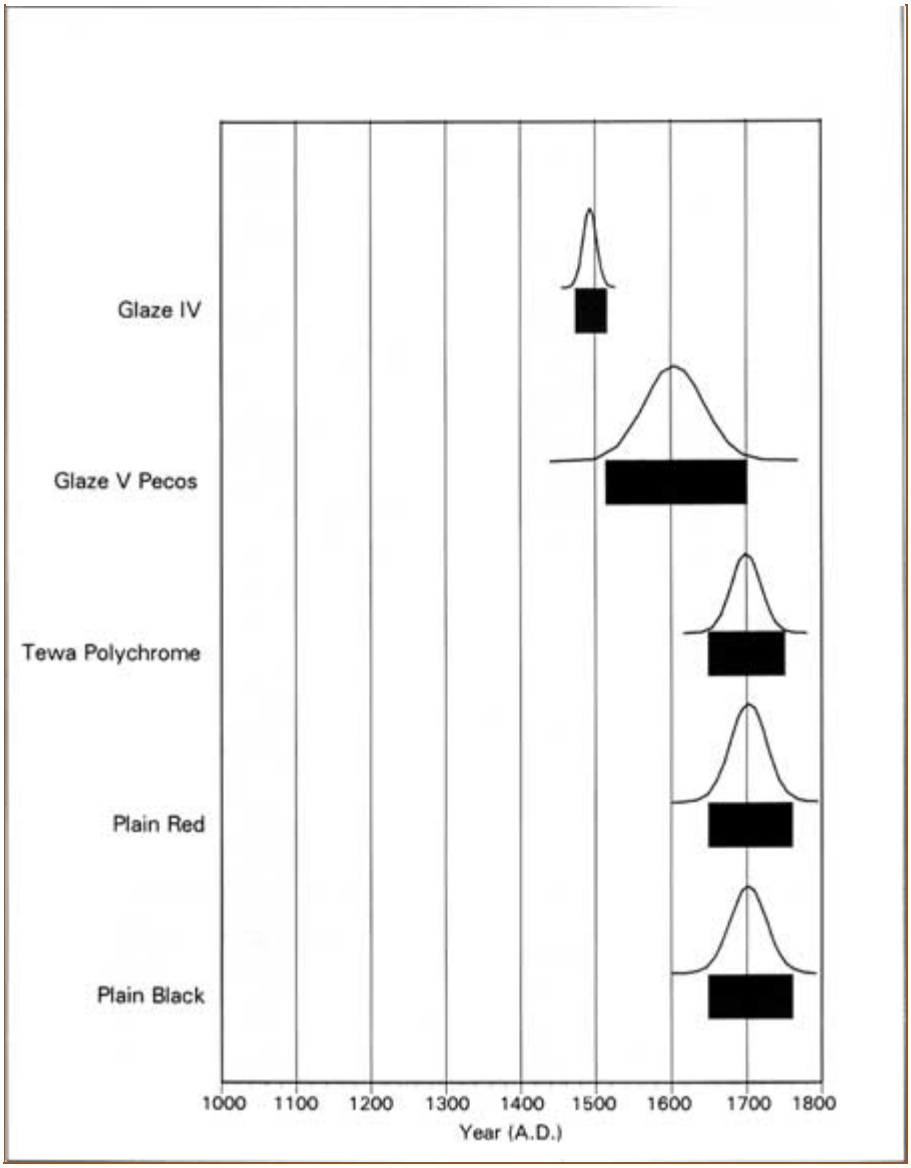


Figure 4.6. Examples of ceramic type date ranges and normal distributions. *(click on image for an enlargement in a new window)*

In this method, all of the discrete probability distributions for the ceramic types from a single assemblage are combined and weighted by the frequency of the type in the assemblage. In effect, the procedure treats each sherd as an individual probability distribution and merges all of the probability distributions in the assemblage to produce a composite probability curve for the assemblage as a whole. Figures 4.5 and 4.6 provide an important illustration of the influence of ceramic date ranges on the probability distributions. While short duration ceramic types like Glaze IV allow for differentiation between relatively short spans of time, longer duration ceramic types like Glaze V allow for effective differentiation only between longer periods.

The overall Pecos survey project goals called for segmenting the prehistoric occupation of Pecos into discrete time periods and classifying sites into these periods for analysis. Thus, the next step in constructing the chronology involved segmenting the overall probability distribution for each assemblage by setting specific time intervals for calculation of the probabilities. For purposes of illustration only, Figure 4.7 demonstrates how the annual probabilities of the normal distribution for one ceramic type, Glaze V, may be aggregated into summed probabilities for 50-year intervals. (However, the analysis itself used 125-year

intervals, as discussed below.) In a similar example at the site level (PECO 125), Figure 4.8 displays the individual ceramic type probabilities along with the summed and normalized (so that it sums to 1) probability distribution in 50-year intervals.

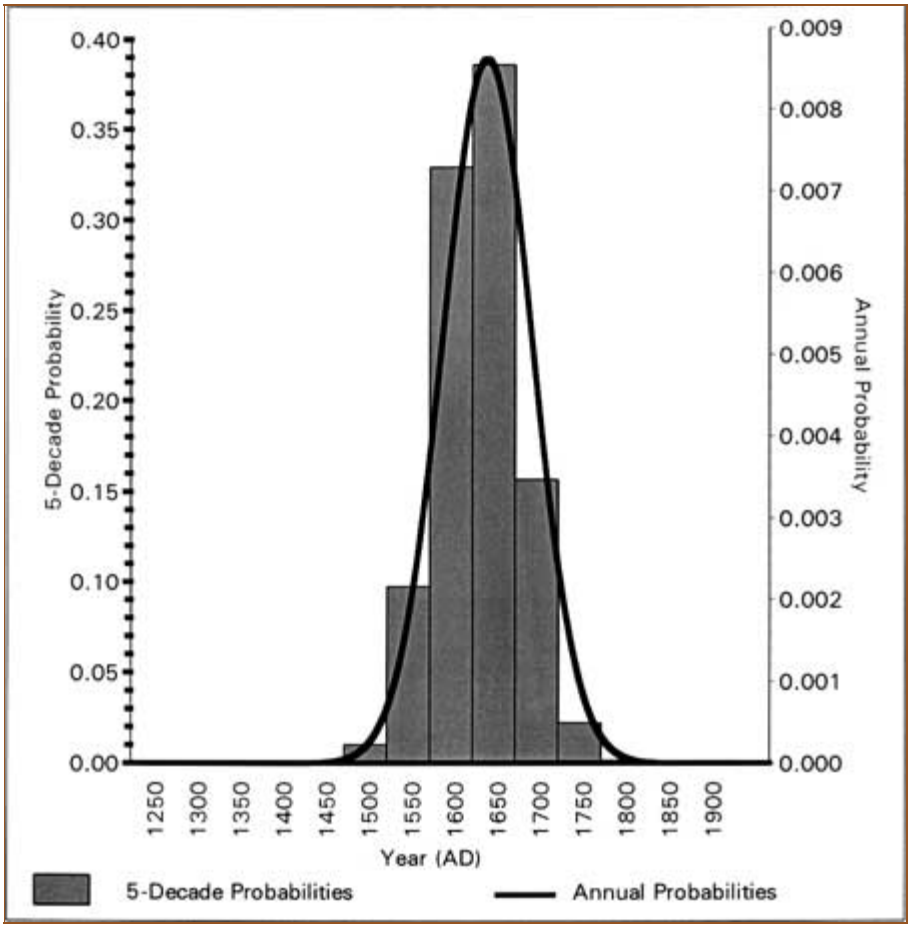


Figure 4.7. Annual and five-decade probabilities for Glaze V. *(click on image for an enlargement in a new window)*

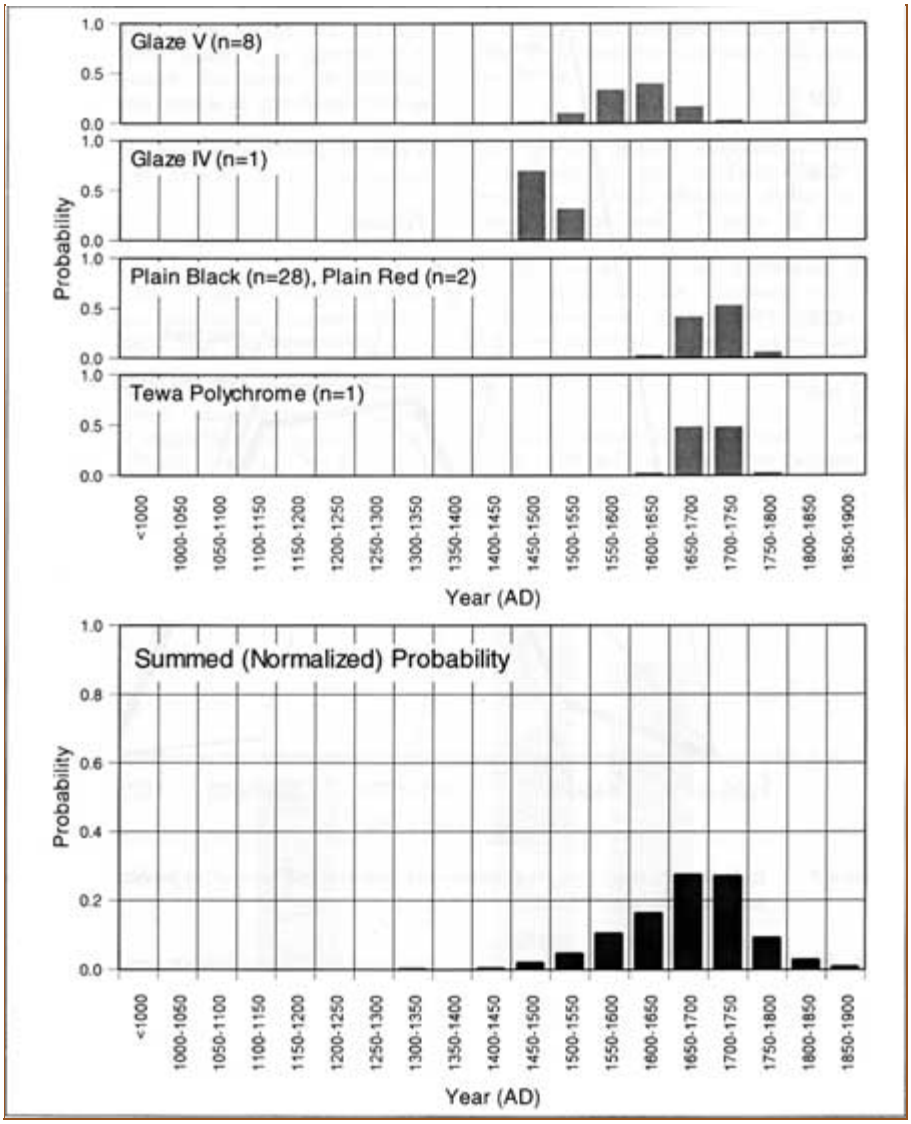


Figure 4.8. Individual ceramic type probabilities and resulting summed and normalized probability for PECO 125. *(click on image for an enlargement in a new window)*

Appropriate time intervals for this method are necessarily determined by the researcher's goals. For the Pecos sites, several increment ranges were tried, including 25, 50, 100, and 125 year spans. Due to the wide scope of the survey project, the nature of the small yet long-duration surface ceramic assemblages; and the broad research questions posed in Chapter 1, intervals of 125 years were selected as the most appropriate temporal divisions for this particular dating project. Although shorter temporal resolution is certainly desirable, the extended production spans of many of the decorated ceramics, including types such as Santa Fe Black-on-white, preclude assignment of more restricted date ranges to each site. Indeed, many of the subjective, preliminary dates assigned to sites in the field spanned almost the entire Puebloan occupational sequence at Pecos. Given the long duration of occupation at many sites, 125-year divisions were chosen as the most useful and meaningful analytical units for addressing the research questions of this survey.

In order to integrate the project classification with chronologies developed by other researchers working in the northern Rio Grande region, the widely used A.D. 1325 transition date between the Coalition and Classic periods was maintained. In a further consideration, temporal periods of equal length were determined to be most useful for controlling for the

variable of time in other analyses, including the population estimates presented in Chapter 7. The resulting chronological intervals are best regarded as convenient units that subdivide sites temporally for this project.

Combining all of the ceramic types from an assemblage into a single summed and normalized probability distribution is accomplished through application of the normal probability density function over a range of dates (125 years in this case).[2] This yields a discrete probability for each interval within the distribution. Summing and normalizing the assemblage distribution in this way provides a summary probability of occupation for each time period. The interval probability—or graphically, the area under the normalized curve for each interval—may be interpreted as the relative statistical likelihood that a site was occupied during a given time period. Figure 4.9 is an example of the individual ceramic type probabilities from one site (PECO 125) with the resulting, combined distribution, in bold.

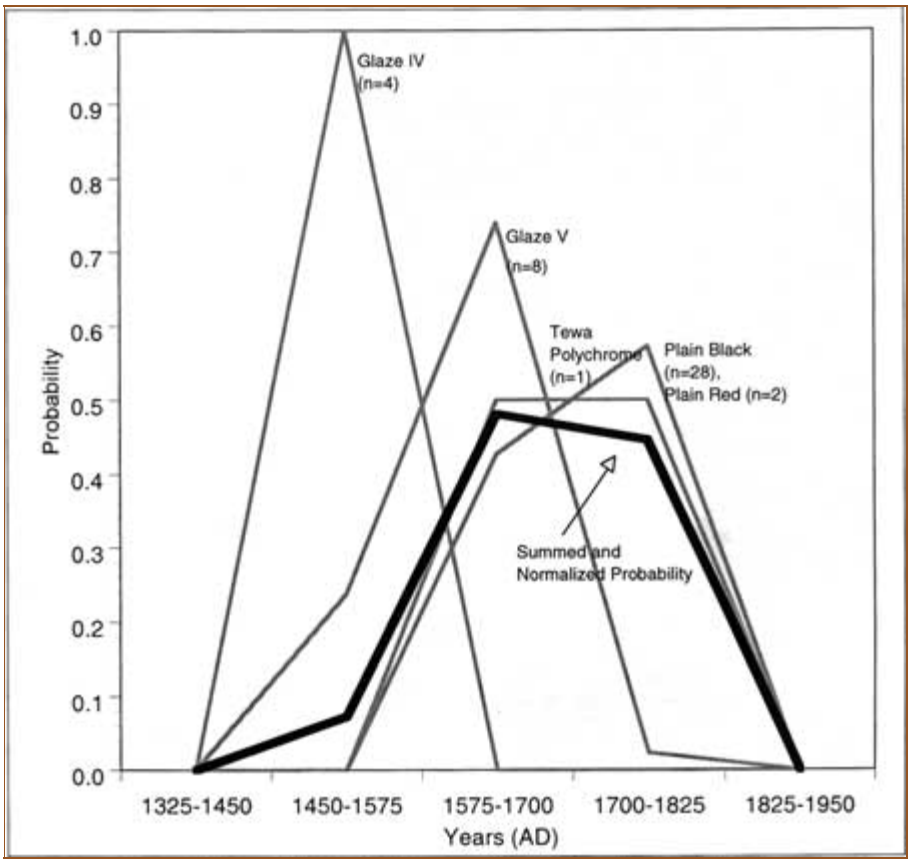


Figure 4.9. Individual ceramic type probabilities and summed and normalized probability in 125-year intervals for PECO 125. *(click on image for an enlargement in a new window)*

Examination of the discrete probability distributions for a number of sites suggested that a threshold value of .20 would be appropriate for including a particular period in the interval of potential occupation, while not excluding sites with apparent long occupations. The definition of this threshold value has the effect of removing periods with a very small likelihood of occupation (<.20) from the total range assigned to a given site (in effect excluding the tails of the distribution). While this value is low for a single period, when summed over a sequence of periods, a reasonable level of confidence for the combined time span can be achieved. By using the .20 cutoff, sites were assigned to one or more temporal periods.

Interpreting Ceramic Probabilities

In the probability approach, sites that were occupied for long periods of time tend to have broader distributions, as their total summed and normalized probability for occupation (1.0) is spread out over a greater range. For long-duration sites, the likelihood of occupation during any one period is relatively small. Summed over several periods, the confidence is greater that the site was occupied at some time during that larger interval. In contrast, sites with short, restricted occupations display peaked distributions and have greater probabilities for a single time period. This pattern is a function of the ceramic types found at a particular site. For example, as seen in Figure 4.9 for PECO 125, a short duration ceramic type such as Glaze IV displays a narrow, peaked distribution, while a type with a longer production interval, Glaze V, is depicted by a broader and flatter distribution. In addition, infrequent ceramic types in an assemblage—such as Glaze IV in this example—do not contribute significantly to the combined probability distribution and may not be reflected in the final period assignments.

Dating Multicomponent Sites

Significantly, the probability approach can identify and date sites that have mixed deposits, meaning that more than one occupational component is represented by the surface artifacts. This ability contrasts with other types of seriation in which multiple components are lumped together into a single range of dates. Depicted graphically (Figure 4.10), the ceramic probability distribution for multicomponent sites exhibits marked bimodality, allowing the discrete occupations to be assigned to defined time periods. The establishment of a threshold level (.20) places the occupation hiatus below the cutoff for assigning a component to a particular time period.

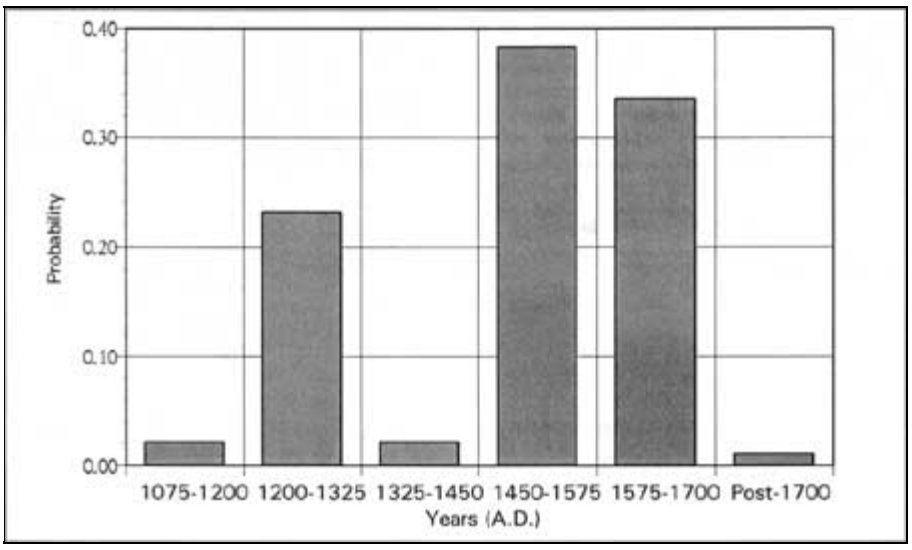


Figure 4.10. Bimodal probability distribution suggesting an occupational hiatus (PECO 334).

Thirty-three Pecos sites were found to have more than one ceramic component as indicated by the probability data (see Table 4.5). Four of these 33 sites were identified in the field as dual-component sites. Thirteen of the sites were recorded as single component sites with two date ranges and an intervening hiatus assigned in the field for the ceramic types. For the remaining sites, the probability method was able to determine possible gaps in site occupation that were not readily observable in the field.

Another advantage of the probability method is that small numbers of outlying ceramics that

do not fit with the overall assemblage, including intrusive artifacts or possible heirloom vessels, have such small probability values in the combined distributions that they will not be misclassified as a separate component by this method.

Future work could refine the method described here by documenting the actual frequency distribution of each ceramic type. The development of empirical (as opposed to theoretical) probability distributions for the ceramic types would allow for an improved fit of the probability model to the archeological assemblages under consideration. A detailed literature search of excavation notes from relevant sites might determine actual percentages of ceramic types in successive stratigraphic levels, allowing the timing of each ceramic type to be more fully understood.

The Pecos Survey Chronology

The Pecos ceramic chronology, based on the probability analysis, is presented in Table 4.4, with seven resulting time periods (Periods 0 through 6). Table 4.5 provides the period assignments for each site. Structured at the component level, the chronology incorporates 477 field components from 473 sites. As defined by the survey, a component is an intrasite grouping of temporally and/or culturally related remains. A "1" in the columns for Pecos periods 0 through 6 indicates that, according to the probability data, the site component has an interval probability greater than .20 and was likely occupied during that time period.

A confidence rating was given to all date assignments. Sites with a confidence rating of "2" are considered securely dated within the context of the survey data. These sites have five or more dateable sherds and the time period assignments are based solely on the probability data. Confidence code "1" is used for those sites dated with lower confidence. This category includes sites with fewer than five diagnostic sherds and sites that could only be dated on the basis of utility ware ceramics or nondiagnostic glaze ware body sherds, using the probability approach. Confidence level 1 sites also include components with fewer than five sherds recorded by the survey that could be dated using information from previous research or from curated collections (not probability data). The evidence for dates at confidence 1 sites is meager, but it was felt that the attempt to date these sites was warranted, rather than dismiss them out of hand. A total of 268 components is considered securely dated; 209 components are assigned low confidence dates.

Table 4.4. The Pecos survey chronology.

Ceramic Period	Dates (A.D.)	Number of Components	Percent
0	Pre-1075	2	0.2
1	1075-1200	2	0.2
2	1200-1325	101	11.5
3	1325-1450	302	34.4
4	1450-1575	235	26.8
5	1575-1700	178	20.3
6	Post-1700	58	6.6
Total		878	100.0

Note. The chronology incorporates 477 site components, some of which date to more than one time period. Period 0 was created to include known chronometric dates from the Pecos pithouse sites.

Table 4.5. Ceramic period assignments for the Pecos survey sites.

Key: Refer to text for a detailed description of how sites were assigned to periods and how confidence codes were determined. A "1" in columns P0-P6 signifies that the site was likely occupied during that period. Confidence ratings: 1 = low; 2 = high. Ceramic periods (all A.D.): P0 = pre-1075; P1 = 1075-1200; P2 = 1200-1325; P3 = 1325-1450; P4 = 1450-1575; P5 = 1575-1700; P6 = post-1700.

PECO Site No.	Comp.	Culture	P0	P1	P2	P3	P4	P5	P6	Confidence
4	1	Puebloan	—	—	—	1	1	—	—	2
5	1	Puebloan	—	—	—	—	1	—	—	1
6	1	Puebloan	—	—	—	1	1	—	—	2
7	1	Puebloan	—	—	1	1	—	—	—	1
8	1	Puebloan	—	—	—	1	—	—	—	2
9	1	Puebloan	—	—	—	1	—	—	—	2
10	1	Puebloan	—	—	—	1	—	—	—	2
11	1	Puebloan	—	—	—	1	1	1	—	1
12	1	Puebloan	—	—	1	1	—	1	—	2
13	1	Puebloan	—	—	—	1	1	—	—	2
14	1	Puebloan	—	—	—	—	1	—	—	2
15	1	Puebloan	—	—	—	—	1	1	1	2
16	1	Puebloan	—	—	—	1	1	1	—	2
17	1	Puebloan	—	—	—	1	—	—	—	2
20	1	Puebloan	—	—	—	1	1	—	—	2
21	1	Puebloan	—	—	—	1	1	1	—	2
22	1	Puebloan	—	—	—	1	—	—	1	2
23	1	Puebloan	—	—	1	1	—	—	1	2
24	1	Puebloan	—	1	1	1	—	—	—	2
25	1	Puebloan	—	—	1	1	—	—	—	2
26	1	Puebloan	—	—	1	1	—	—	—	2
29	1	Puebloan	—	—	—	1	—	1	1	2
30	1	Puebloan	—	—	1	1	—	—	—	2
32	1	Puebloan	—	—	1	1	—	—	—	2
35	1	Uknown	—	—	1	1	—	—	—	2
38	1	Puebloan	—	—	1	1	—	—	—	2
40	1	Puebloan	—	—	1	1	—	—	—	2
41	1	Puebloan	—	—	1	—	—	1	—	1
42	1	Puebloan	—	—	1	—	—	—	—	1
43	1	Puebloan	—	—	1	1	1	—	—	1
45	1	Puebloan	—	—	—	—	—	1	1	2
48	1	Puebloan	—	—	1	1	—	—	—	2
49	1	Puebloan	—	—	—	—	1	—	—	2

50	1	Puebloan	—	—	—	—	1	1	—	2
53	1	Puebloan/Euro-Am.	—	—	—	—	1	1	—	2
53	2	Basketmaker	1	—	—	—	—	—	—	2
55	1	Puebloan	—	—	—	—	1	1	1	2
57	1	Puebloan	—	—	—	—	1	1	—	2
58	1	Puebloan	—	—	1	—	—	1	—	2
60	1	Puebloan	—	—	1	—	—	1	—	2
61	1	Puebloan	—	—	1	1	—	—	—	2
61	2	Basketmaker	1	—	—	—	—	—	—	2
64	1	Euro-American	—	—	—	—	1	1	—	2
65	1	Puebloan	—	—	—	—	1	1	—	1
71	1	Puebloan	—	—	1	1	—	—	—	2
76	1	Puebloan	—	—	1	1	—	—	—	2
81	1	Puebloan	—	—	1	—	—	—	—	2
86	1	Puebloan	—	—	1	1	—	—	—	1
91	1	Puebloan	—	—	—	1	—	1	1	2
92	1	Puebloan	—	—	—	1	—	—	—	2
93	1	Puebloan	—	—	1	1	—	—	—	2
94	1	Puebloan	—	—	—	1	—	—	—	2
96	1	Puebloan	—	—	1	1	—	—	—	2
97	1	Puebloan	—	—	—	1	—	—	—	2
98	1	Puebloan	—	—	—	1	—	—	—	2
99	1	Puebloan	—	—	—	1	—	—	—	2
100	1	Puebloan	—	—	—	1	1	1	—	2
101	1	Puebloan	—	—	—	1	1	—	—	2
103	1	Puebloan	—	—	—	1	1	—	—	2
104	1	Puebloan	—	—	—	1	—	—	—	2
107	1	Puebloan	—	—	—	—	—	1	1	1
108	1	Puebloan	—	—	—	—	1	1	—	2
109	1	Puebloan	—	—	—	1	—	—	1	2
111	1	Puebloan	—	—	—	1	—	—	—	1
112	1	Puebloan	—	—	—	—	1	1	—	2
115	1	Puebloan	—	—	—	—	1	1	—	2
117	1	Puebloan	—	—	—	1	1	—	—	1
118	1	Puebloan	—	—	—	1	—	—	—	1
119	1	Puebloan	—	—	—	1	—	1	1	2
120	1	Puebloan	—	—	—	1	1	—	—	2
121	1	Puebloan	—	—	—	—	1	1	—	1
123	1	Puebloan	—	—	—	1	—	—	—	1
124	1	Puebloan	—	—	—	1	1	1	—	1
125	1	Puebloan	—	—	—	—	—	1	1	2
126	1	Puebloan	—	—	—	1	1	—	—	2
127	1	Puebloan	—	—	—	1	1	1	—	2

128	1	Puebloan	—	—	—	—	1	—	—	1
129	1	Puebloan	—	—	—	1	1	1	—	2
130	1	Puebloan	—	—	—	—	1	1	1	1
133	1	Puebloan	—	—	—	1	—	—	—	1
134	1	Puebloan	—	—	1	—	—	—	—	1
136	1	Puebloan	—	—	—	1	1	—	—	2
138	1	Puebloan	—	—	—	1	1	1	—	2
139	1	Puebloan	—	—	—	1	—	1	—	2
140	1	Puebloan	—	—	—	1	—	—	—	1
144	1	Puebloan	—	—	—	—	—	1	1	2
146	1	Puebloan	—	—	—	1	—	—	—	1
148	1	Puebloan	—	—	—	—	1	1	—	1
151	1	Puebloan	—	—	—	—	—	1	1	2
157	1	Puebloan	—	—	—	—	1	—	—	2
160	1	Puebloan	—	—	1	1	1	—	—	2
163	1	Puebloan	—	—	—	—	1	—	—	2
165	1	Puebloan	—	—	—	1	1	—	—	1
172	1	Puebloan	—	—	—	—	1	1	—	1
175	1	Hispanic	—	—	—	—	—	1	1	1
179	1	Puebloan	—	—	—	—	1	1	—	1
190	1	Puebloan	—	—	—	1	—	1	1	1
191	1	Puebloan	—	—	—	1	1	—	—	1
192	1	Puebloan	—	—	—	1	—	—	—	2
193	1	Puebloan	—	—	—	1	1	—	—	2
193	2	Puebloan	—	—	—	1	1	1	—	2
195	1	Puebloan	—	—	—	1	—	—	—	1
196	1	Puebloan	—	—	—	1	1	—	—	2
197	1	Puebloan	—	—	—	1	—	—	—	2
200	1	Puebloan/Apachean	—	—	—	—	1	—	—	1
201	1	Puebloan	—	—	—	1	—	—	—	2
202	1	Puebloan	—	—	—	1	—	—	—	2
203	1	Puebloan	—	—	—	—	—	1	1	2
204	1	Puebloan	—	—	1	1	—	—	—	2
206	1	Puebloan	—	—	1	1	—	—	—	1
212	1	Puebloan	—	—	—	1	1	—	—	1
213	1	Puebloan	—	—	—	1	1	1	—	2
215	1	Puebloan	—	—	1	1	—	—	—	2
218	1	Puebloan	—	—	—	—	1	1	—	2
219	1	Puebloan	—	—	—	1	1	—	—	2
220	1	Puebloan	—	—	—	1	1	—	—	2
221	1	Puebloan	—	—	—	1	1	—	—	2
222	1	Puebloan	—	—	—	1	1	—	—	1
223	1	Puebloan	—	—	—	1	1	—	—	2
224	1	Puebloan	—	—	—	1	1	—	—	2

226	1	Puebloan	—	—	1	1	—	—	—	2
227	1	Puebloan	—	—	—	1	—	—	—	2
228	1	Puebloan	—	—	—	1	1	1	—	2
229	1	Puebloan	—	—	—	1	—	—	—	1
230	1	Puebloan	—	—	—	1	1	—	—	1
233	1	Puebloan	—	—	—	1	1	—	—	1
235	1	Puebloan	—	—	—	—	1	1	—	2
238	1	Puebloan	—	—	—	—	—	1	1	2
242	1	Puebloan	—	—	—	—	—	—	1	1
243	1	Puebloan	—	—	—	—	1	1	—	2
244	1	Puebloan	—	—	—	—	—	1	1	2
245	1	Puebloan	—	—	1	1	—	—	—	2
246	1	Puebloan	—	—	—	1	—	1	—	2
247	1	Puebloan	—	—	—	—	1	1	—	2
248	1	Puebloan	—	—	—	—	—	1	1	1
251	1	Puebloan	—	—	—	1	—	1	—	2
252	1	Puebloan	—	—	—	—	1	1	—	2
254	1	Puebloan	—	—	—	1	1	1	—	1
259	1	Puebloan	—	—	—	—	1	1	—	1
260	1	Puebloan	—	—	—	1	1	—	—	1
261	1	Puebloan	—	—	—	—	1	1	—	2
262	1	Puebloan	—	—	—	1	—	—	—	1
263	1	Puebloan	—	—	1	1	—	—	—	1
264	1	Puebloan	—	—	—	1	—	—	—	1
265	1	Puebloan	—	—	—	1	1	—	—	2
266	1	Puebloan	—	—	1	—	1	—	—	2
267	1	Puebloan	—	—	1	—	—	—	—	1
268	1	Puebloan	—	—	1	1	—	—	—	1
269	1	Puebloan	—	—	1	1	—	—	—	1
270	1	Spanish	—	—	—	—	—	1	1	1
272	1	Puebloan	—	—	—	—	—	1	—	1
274	1	Puebloan	—	—	—	—	—	1	1	2
275	1	Puebloan	—	—	—	—	1	1	—	1
277	1	Puebloan	—	—	—	—	—	1	1	2
279	1	Puebloan	—	—	—	—	1	—	—	2
280	1	Puebloan	—	—	—	—	1	1	—	2
281	1	Puebloan	—	—	1	—	—	—	—	1
282	1	Puebloan	—	—	—	—	—	1	1	1
283	1	Puebloan	—	—	—	—	1	1	—	1
284	1	Puebloan	—	—	1	—	—	1	1	1
285	1	Puebloan	—	—	1	1	—	—	—	1
286	1	Puebloan	—	—	—	—	1	1	1	2
289	1	Puebloan	—	—	—	1	1	—	—	1
290	1	Puebloan	—	—	—	1	—	—	—	1

291	1	Puebloan	—	—	1	1	—	—	—	1
292	1	Puebloan	—	—	—	—	—	1	1	2
293	1	Puebloan	—	—	1	—	1	—	—	2
294	1	Puebloan	—	—	1	1	—	—	—	2
297	1	Puebloan	—	—	—	1	—	—	—	2
298	1	Puebloan	—	—	—	1	—	—	—	1
299	1	Puebloan	—	—	1	—	1	—	—	1
300	1	Puebloan	—	—	—	1	1	—	—	1
301	1	Puebloan	—	—	—	1	1	1	—	2
301	2	Plains?	—	—	—	—	1	—	—	2
303	1	Puebloan	—	—	—	1	—	1	1	1
305	1	Puebloan	—	—	—	—	1	—	—	2
307	1	Puebloan	—	—	—	1	—	—	—	2
308	1	Puebloan	—	—	—	—	1	—	—	1
310	1	Puebloan	—	—	1	1	—	—	—	1
311	1	Puebloan	—	—	—	—	1	—	—	1
312	1	Puebloan	—	—	1	1	1	—	—	1
313	1	Puebloan	—	—	—	1	1	—	—	2
315	1	Puebloan	—	—	—	1	—	—	—	2
316	1	Puebloan	—	—	—	1	—	—	—	2
317	1	Puebloan	—	—	—	1	—	—	—	1
318	1	Puebloan	—	—	1	—	—	—	—	1
319	1	Puebloan	—	—	—	—	—	1	—	1
321	1	Puebloan	—	—	—	—	1	1	—	2
322	1	Puebloan	—	—	—	1	—	—	—	2
323	1	Puebloan	—	—	1	1	1	—	—	2
325	1	Puebloan	—	—	—	1	—	—	—	1
326	1	Puebloan	—	—	1	—	—	—	—	1
327	1	Puebloan	—	—	—	1	—	—	—	1
331	1	Puebloan	—	—	—	—	—	1	—	2
332	1	Puebloan	—	—	1	1	—	—	—	2
333	1	Puebloan	—	—	—	—	1	1	—	2
334	1	Puebloan	—	—	1	—	1	1	—	2
335	1	Puebloan	—	—	1	—	—	—	—	2
336	1	Puebloan	—	—	—	—	1	1	—	2
337	1	Puebloan	—	—	—	—	—	1	—	2
338	1	Puebloan	—	—	1	1	1	—	—	2
343	1	Puebloan	—	—	—	—	1	—	—	2
344	1	Puebloan	—	—	—	1	1	—	—	1
345	1	Puebloan	—	—	—	—	1	1	—	2
347	1	Puebloan	—	—	1	1	—	—	—	1
348	1	Puebloan	—	—	1	—	1	1	—	1
349	1	Puebloan	—	—	1	1	1	—	—	2
351	1	Puebloan	—	—	—	1	1	—	—	1

352	1	Puebloan	—	—	1	1	—	—	—	1
353	1	Puebloan	—	—	—	—	1	1	—	2
354	1	Puebloan	—	—	1	1	—	—	—	1
355	1	Puebloan	—	—	1	1	1	—	—	1
357	1	Puebloan	—	—	—	—	1	1	—	2
358	1	Puebloan	—	—	—	1	1	1	—	1
359	1	Puebloan	—	—	—	1	1	—	—	1
360	1	Puebloan	—	—	1	1	—	—	—	1
362	1	Puebloan	—	—	—	1	—	—	—	2
363	1	Puebloan	—	—	—	1	—	—	—	2
364	1	Puebloan	—	—	1	1	—	—	—	1
365	1	Puebloan	—	—	—	—	1	1	—	1
366	1	Puebloan	—	—	—	—	—	1	1	2
368	1	Puebloan	—	—	—	1	—	1	1	2
369	1	Puebloan	—	—	—	—	—	1	1	2
373	1	Puebloan	—	—	—	—	—	1	1	1
375	1	Puebloan	—	—	—	—	1	1	—	2
376	1	Puebloan	—	—	—	—	—	1	1	1
377	1	Puebloan	—	—	—	—	1	1	—	2
378	1	Puebloan	—	—	—	—	1	1	—	2
380	1	Puebloan	—	—	—	—	1	1	—	1
381	1	Puebloan	—	—	—	1	—	—	—	1
382	1	Puebloan	—	—	—	—	—	1	1	2
383	1	Puebloan	—	—	—	—	—	1	—	2
384	1	Puebloan	—	—	—	1	—	—	—	1
385	1	Puebloan	—	—	1	1	—	—	—	1
386	1	Puebloan	—	—	—	1	—	—	—	1
387	1	Puebloan	—	—	—	1	—	—	—	1
388	1	Puebloan	—	—	—	1	—	—	—	1
390	1	Puebloan	—	—	—	1	1	1	—	1
391	1	Puebloan	—	—	—	—	1	—	—	2
392	1	Puebloan	—	—	—	1	—	—	—	1
394	1	Puebloan	—	—	—	—	—	1	1	1
398	1	Puebloan	—	—	1	—	—	1	—	1
399	1	Puebloan	—	—	—	—	1	1	—	1
400	1	Puebloan	—	—	—	1	—	—	—	1
402	1	Puebloan	—	—	—	1	1	—	—	2
403	1	Puebloan	—	—	—	—	—	1	1	2
404	1	Puebloan	—	—	—	—	1	—	—	1
405	1	Puebloan	—	—	—	—	1	—	—	1
406	1	Puebloan	—	—	—	—	1	1	1	2
407	1	Puebloan	—	—	—	—	1	—	—	2
422	1	Puebloan	—	—	—	—	—	1	1	2
430	1	Puebloan	—	—	—	1	1	—	—	1

432	1	Puebloan	—	—	—	1	1	1	—	1
433	1	Puebloan	—	—	1	1	—	—	—	1
434	1	Puebloan	—	—	1	1	—	—	—	2
435	1	Puebloan	—	—	—	1	1	1	—	1
436	1	Puebloan	—	—	—	1	—	—	—	2
437	1	Puebloan	—	—	—	1	1	—	—	2
438	1	Puebloan	—	—	—	1	1	1	—	1
440	1	Puebloan	—	—	—	—	—	1	1	2
441	1	Puebloan	—	1	—	—	—	—	—	2
442	1	Puebloan	—	—	—	—	—	1	1	1
443	1	Puebloan	—	—	—	1	1	—	—	1
444	1	Puebloan	—	—	—	—	1	1	—	2
445	1	Puebloan	—	—	—	1	1	—	—	2
448	1	Puebloan	—	—	—	1	1	—	—	1
449	1	Puebloan	—	—	—	1	—	—	—	1
450	1	Puebloan	—	—	1	—	1	—	—	1
451	1	Puebloan	—	—	—	1	1	—	—	2
452	1	Puebloan	—	—	1	1	—	—	—	2
453	1	Puebloan	—	—	—	1	1	—	—	1
454	1	Puebloan	—	—	1	1	1	—	—	1
457	1	Puebloan	—	—	—	1	1	1	—	1
458	1	Puebloan	—	—	—	—	—	1	1	1
460	1	Puebloan	—	—	1	1	—	—	—	2
461	1	Puebloan	—	—	—	1	—	1	—	2
462	1	Puebloan	—	—	—	1	1	—	—	2
463	1	Puebloan	—	—	—	1	1	—	—	2
464	1	Puebloan	—	—	—	—	1	—	—	2
465	1	Puebloan	—	—	—	1	1	—	—	2
466	1	Puebloan	—	—	—	1	—	—	—	1
467	1	Puebloan	—	—	—	1	1	1	—	2
468	1	Puebloan	—	—	—	1	—	—	—	2
469	1	Puebloan	—	—	—	1	—	1	—	2
470	1	Puebloan	—	—	1	1	—	—	—	1
471	1	Puebloan	—	—	1	—	—	—	—	1
472	1	Puebloan	—	—	—	1	1	—	—	1
473	1	Puebloan	—	—	—	1	1	—	—	2
474	1	Puebloan	—	—	—	1	1	—	—	2
476	1	Puebloan	—	—	—	—	1	1	—	2
479	1	Puebloan	—	—	—	—	—	1	1	1
482	1	Puebloan	—	—	1	1	—	—	—	1
488	1	Puebloan	—	—	—	1	1	—	—	2
489	1	Puebloan	—	—	—	—	1	—	—	1
490	1	Puebloan	—	—	—	1	—	—	—	2
491	1	Puebloan	—	—	—	1	1	1	—	2

492	1	Puebloan	—	—	—	1	1	—	—	2
493	1	Puebloan	—	—	1	1	—	—	—	2
494	1	Puebloan	—	—	1	1	—	—	—	2
496	1	Puebloan	—	—	—	1	1	1	—	2
497	1	Puebloan	—	—	—	1	—	—	—	2
498	1	Puebloan	—	—	—	1	—	1	—	2
499	1	Puebloan	—	—	—	—	1	—	—	2
500	1	Puebloan	—	—	—	1	1	1	—	1
501	1	Puebloan	—	—	1	1	—	—	—	1
503	1	Puebloan	—	—	—	—	—	1	1	1
505	1	Puebloan	—	—	1	1	—	—	—	1
506	1	Puebloan	—	—	—	—	—	1	1	2
507	1	Puebloan	—	—	—	—	—	1	1	2
508	1	Puebloan	—	—	1	1	1	—	—	1
509	1	Puebloan	—	—	1	1	1	—	—	1
510	1	Puebloan	—	—	—	1	1	—	—	2
511	1	Puebloan	—	—	—	—	1	1	1	1
513	1	Puebloan	—	—	—	1	—	—	—	1
515	1	Puebloan	—	—	—	—	—	—	1	1
516	1	Puebloan	—	—	—	1	1	1	—	1
518	1	Puebloan	—	—	—	—	—	1	1	2
519	1	Puebloan	—	—	—	—	—	1	—	2
521	1	Puebloan	—	—	—	1	—	—	—	2
522	1	Puebloan	—	—	—	1	1	—	—	2
524	1	Puebloan	—	—	—	1	—	—	—	2
525	1	Puebloan	—	—	—	1	1	—	—	2
526	1	Puebloan	—	—	—	—	1	1	—	2
527	1	Puebloan	—	—	1	1	—	—	—	2
528	1	Puebloan	—	—	1	1	—	—	—	2
529	1	Puebloan	—	—	—	1	1	—	—	2
530	1	Puebloan	—	—	—	1	1	—	—	1
531	1	Puebloan	—	—	—	1	1	—	—	2
532	1	Puebloan	—	—	—	—	—	1	—	2
533	1	Puebloan	—	—	—	1	1	—	—	1
534	1	Puebloan	—	—	—	1	—	—	—	1
536	1	Puebloan	—	—	1	1	—	—	—	1
537	1	Puebloan	—	—	—	—	1	1	—	1
538	1	Puebloan	—	—	—	—	—	1	—	2
539	1	Puebloan	—	—	—	1	1	—	—	1
540	1	Hispanic	—	—	—	—	—	1	1	2
546	1	Puebloan	—	—	—	1	—	1	1	1
547	1	Puebloan	—	—	—	1	1	—	—	2
549	1	Puebloan	—	—	—	1	—	1	1	1
550	1	Puebloan	—	—	—	1	—	—	—	2

551	1	Puebloan	—	—	—	1	—	1	1	1
552	1	Puebloan	—	—	—	1	1	—	—	2
554	1	Puebloan	—	—	—	—	1	1	—	2
555	1	Puebloan	—	—	—	1	—	—	—	2
558	1	Puebloan	—	—	—	1	—	1	—	1
559	1	Puebloan	—	—	—	1	—	1	—	2
560	2	Puebloan	—	—	—	—	1	—	—	1
561	1	Puebloan	—	—	—	1	—	—	—	1
562	1	Puebloan	—	—	—	1	—	—	—	2
563	1	Puebloan	—	—	1	1	—	—	—	1
565	1	Puebloan	—	—	1	1	—	—	—	2
566	1	Puebloan	—	—	—	1	1	1	—	1
567	1	Puebloan	—	—	—	1	1	—	—	2
568	1	Puebloan	—	—	—	1	1	—	—	2
569	1	Puebloan	—	—	1	—	—	—	—	2
570	1	Puebloan	—	—	—	—	1	—	—	1
571	1	Puebloan	—	—	1	—	—	—	—	1
573	1	Puebloan	—	—	—	1	1	1	—	1
574	1	Puebloan	—	—	—	1	1	—	—	1
576	1	Puebloan	—	—	—	1	—	—	—	1
577	1	Puebloan	—	—	1	1	—	—	—	2
578	1	Puebloan	—	—	1	1	—	—	—	2
579	1	Puebloan	—	—	1	1	—	—	—	2
580	1	Puebloan	—	—	1	1	—	—	—	2
581	1	Puebloan	—	—	1	1	—	—	—	2
582	1	Puebloan	—	—	1	—	—	—	—	1
583	1	Puebloan	—	—	—	1	1	—	—	2
584	1	Puebloan	—	—	—	1	1	—	—	2
585	1	Puebloan	—	—	—	1	—	—	—	1
587	1	Puebloan	—	—	—	1	—	—	—	1
588	1	Puebloan	—	—	—	1	—	—	—	2
589	1	Puebloan	—	—	—	1	—	—	—	2
590	1	Puebloan	—	—	—	1	1	—	—	2
591	1	Puebloan	—	—	—	—	1	—	—	1
592	1	Puebloan	—	—	1	1	1	—	—	2
594	1	Puebloan	—	—	—	1	—	—	—	2
595	1	Puebloan	—	—	—	1	—	—	—	2
596	1	Puebloan	—	—	—	1	1	—	—	2
598	1	Puebloan	—	—	—	1	1	—	—	1
599	1	Puebloan	—	—	—	1	1	—	—	1
601	1	Puebloan	—	—	—	1	1	—	—	2
602	1	Puebloan	—	—	—	—	1	1	1	2
603	1	Puebloan	—	—	—	1	1	—	—	1
604	1	Puebloan	—	—	—	1	—	—	—	1

605	1	Puebloan	—	—	1	1	—	—	—	1
606	1	Puebloan	—	—	—	—	—	1	1	2
607	1	Puebloan	—	—	1	1	—	—	—	1
608	1	Puebloan	—	—	—	1	1	—	—	2
609	1	Puebloan	—	—	1	1	—	—	—	1
610	1	Puebloan	—	—	—	—	1	—	—	1
611	1	Puebloan	—	—	—	1	1	—	—	2
612	1	Puebloan	—	—	—	—	—	1	1	1
613	1	Puebloan	—	—	—	—	1	1	—	2
614	1	Puebloan	—	—	—	—	1	1	—	2
616	1	Puebloan	—	—	1	1	—	1	—	2
617	1	Puebloan	—	—	—	1	—	—	—	1
618	1	Puebloan	—	—	—	—	1	—	—	1
621	1	Puebloan	—	—	—	1	1	—	—	1
623	1	Puebloan	—	—	—	1	1	1	—	1
624	1	Puebloan	—	—	—	1	1	1	1	1
625	1	Puebloan	—	—	—	—	1	1	—	2
626	1	Puebloan	—	—	—	1	1	1	—	1
629	1	Puebloan	—	—	—	1	—	—	—	1
630	1	Puebloan	—	—	—	1	—	—	—	1
631	1	Puebloan	—	—	—	1	1	—	—	2
632	1	Puebloan	—	—	—	1	—	—	—	2
634	1	Puebloan	—	—	—	1	1	—	—	1
635	1	Puebloan	—	—	—	—	1	1	—	2
638	1	Puebloan	—	—	—	1	1	1	—	1
639	1	Puebloan	—	—	—	1	1	—	—	2
640	1	Puebloan	—	—	—	—	—	1	—	2
641	1	Puebloan	—	—	—	—	1	1	—	1
642	1	Puebloan	—	—	—	1	1	—	—	1
643	1	Puebloan	—	—	—	—	1	—	—	1
644	1	Puebloan	—	—	—	1	1	1	—	1
645	1	Puebloan	—	—	—	1	—	—	—	1
646	1	Puebloan	—	—	—	1	—	1	1	1
649	1	Puebloan	—	—	—	1	—	—	—	2
653	1	Puebloan	—	—	—	—	1	1	—	1
656	1	Puebloan	—	—	—	1	—	—	—	1
657	1	Puebloan	—	—	—	1	1	1	—	1
658	1	Puebloan	—	—	—	—	1	1	—	2
660	1	Puebloan	—	—	—	—	1	1	—	2
661	1	Puebloan	—	—	—	1	1	1	—	2
662	1	Puebloan	—	—	1	1	—	—	—	1
663	1	Puebloan	—	—	—	1	—	1	—	2
664	1	Puebloan	—	—	—	1	—	—	—	2
665	1	Puebloan	—	—	—	1	—	—	—	1

666	1	Puebloan	—	—	—	1	1	—	—	1
667	1	Puebloan	—	—	—	—	1	—	—	1
668	1	Puebloan	—	—	1	1	—	—	—	2
669	1	Puebloan	—	—	—	1	1	—	—	1
670	1	Puebloan	—	—	—	—	1	1	—	2
671	1	Puebloan	—	—	—	1	1	1	—	1
672	1	Puebloan	—	—	—	—	—	1	1	1
676	1	Puebloan	—	—	—	—	1	1	—	1
677	1	Puebloan	—	—	—	—	1	1	—	2
679	1	Puebloan	—	—	—	1	—	1	—	2
680	1	Puebloan	—	—	—	—	1	—	—	2
681	1	Puebloan	—	—	—	1	—	—	—	2
682	1	Puebloan	—	—	—	1	1	—	—	1
683	1	Puebloan	—	—	—	1	1	—	—	2
684	1	Puebloan	—	—	—	—	1	1	—	1
685	1	Puebloan	—	—	—	1	—	—	—	1
686	1	Puebloan	—	—	—	1	—	—	—	2
687	1	Puebloan	—	—	—	—	1	1	—	2
688	1	Puebloan	—	—	—	—	1	1	—	2
689	1	Puebloan	—	—	—	1	1	—	—	1
690	1	Puebloan	—	—	—	—	—	1	—	2
692	1	Puebloan	—	—	—	—	1	1	—	1
693	1	Puebloan	—	—	—	—	1	1	—	1
694	1	Puebloan	—	—	—	—	1	1	—	2
695	1	Puebloan	—	—	—	1	1	—	—	2
696	1	Puebloan	—	—	—	1	1	—	—	2
697	1	Puebloan	—	—	—	1	1	1	—	2
698	1	Puebloan	—	—	—	—	1	1	—	2
699	1	Puebloan	—	—	—	1	1	—	—	2
700	1	Puebloan	—	—	1	1	—	—	—	2
701	1	Puebloan	—	—	—	1	—	—	—	2
702	1	Puebloan	—	—	—	1	—	—	—	2
703	1	Puebloan	—	—	—	1	—	—	—	1
704	1	Puebloan	—	—	—	—	1	—	—	1
705	1	Puebloan	—	—	—	1	1	—	—	1
706	1	Puebloan	—	—	—	1	—	—	—	1
707	1	Puebloan	—	—	—	—	1	1	—	1
708	1	Puebloan	—	—	1	1	—	—	—	2
709	1	Puebloan	—	—	—	1	1	1	—	2
710	1	Puebloan	—	—	1	1	—	—	—	2
711	1	Puebloan	—	—	—	—	1	1	—	1
712	1	Puebloan	—	—	—	—	1	1	—	1
713	1	Puebloan	—	—	—	1	—	1	—	2
714	1	Puebloan	—	—	—	1	1	—	—	2

715	1	Puebloan	—	—	—	1	—	—	—	1
716	1	Puebloan	—	—	—	1	—	—	—	1
717	1	Puebloan	—	—	—	1	1	—	—	1
718	1	Puebloan	—	—	1	1	—	—	—	1

Temporal Trends

Figure 4.1 presents a temporal comparison of the traditional northern Rio Grande culture historical frameworks and the Pecos survey chronology. The bar chart on the right side of the figure represents the number of Pecos ceramic components dated to each survey time period. The large increase in ceramic components between Period 1 and Period 2 (from 2 to 101) may reflect an influx of population to the Pecos area after A.D. 1200, an issue addressed in greater detail by Orcutt in Chapter 7. Between Period 2 and Period 3, the number of ceramic components at Pecos continues to increase threefold, from 101 to 302, indicating greater settlement during A.D. 1325-1450. The trend toward settlement aggregation at Pecos Pueblo beginning around A.D. 1400 almost certainly accounts for the drop in ceramic site components from 302 to 235 by Period 4 (A.D. 1450-1575). The decline in the number of sites continues in Period 5 (A.D. 1575-1700), diminishing to 178 ceramic site components. By Period 6 (after A.D. 1700), the number of Pecos Puebloan ceramic components declines even further to 58. These demographic and settlement trends are pursued further in Chapters 6 and 7.

Contemporaneity of the Early Pueblos

Probabilistic ceramic dating was used to conduct a more fine-grained assessment of the contemporaneity of the pueblos antecedent to Pecos Pueblo in order to understand the timing of each in relation to the others. Using the project site typology (Chapter 5), only those sites classified as pueblos (>6 rooms) or communal pueblos (>99 rooms) were used in this analysis. Pecos Pueblo, founded later, was excluded. A locational map of the pueblos may be found in Figure 1.3.

For the contemporaneity analysis, 25-year divisions were used instead of the 125-year intervals used to define the overall project chronology. Although the probabilities for each 25-year division became diminishingly small, the small sample (n=9) made it feasible to graphically examine each of the sites of interest (Figures 4.11, 4.12, and 4.13). A bar graph of the date ranges of the early pueblos calculated from the probability data also facilitates an assessment of contemporaneity (Figure 4.14).



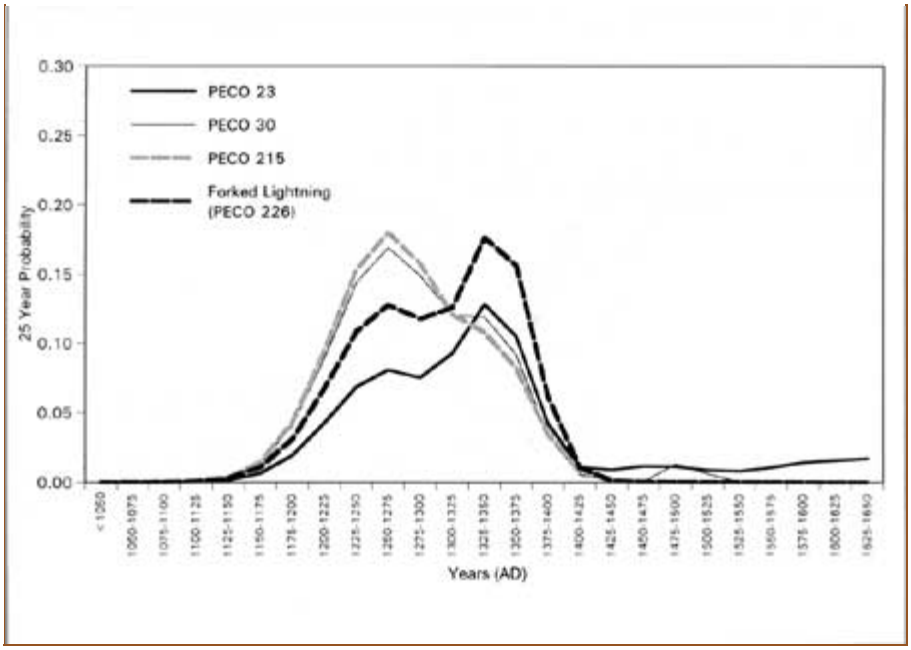


Figure 4.11. Twenty-five year probabilities for PECO 23, PECO 30, PECO 215, and Forked Lightning (PECO 226). *(click on image for an enlargement in a new window)*

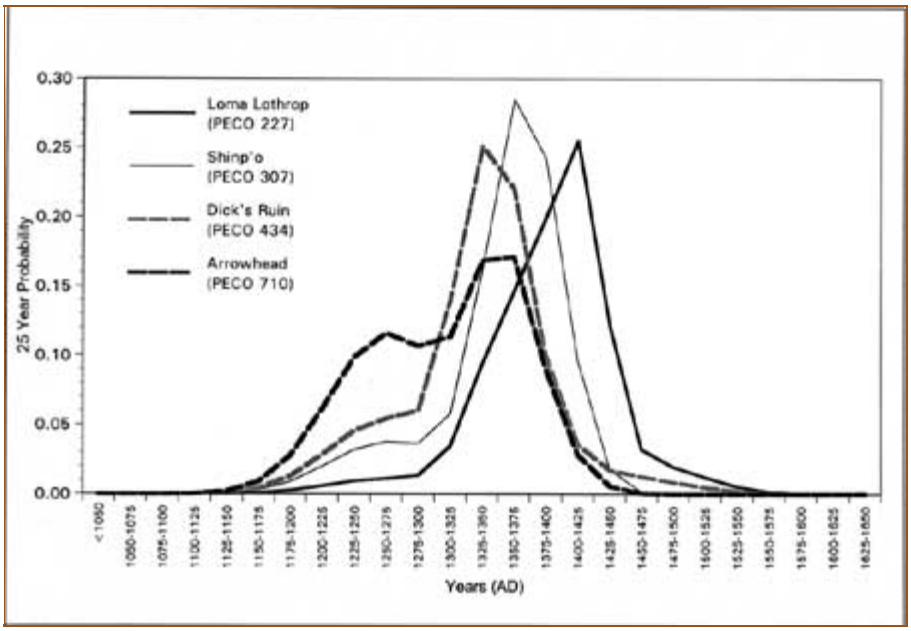


Figure 4.12. Twenty-five year probabilities for Loma Lothrop (PECO 227), Shin'po (PECO 307), Dick's Ruin (PECO 434), and Arrowhead (PECO 710). *(click on image for an enlargement in a new window)*

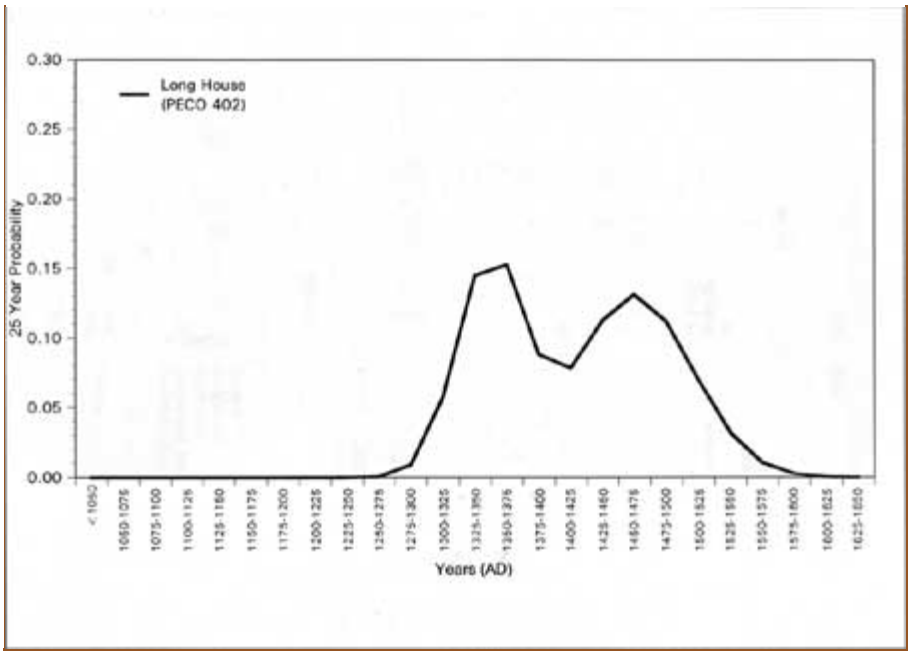


Figure 4.13. Twenty-five year probabilities for Long House (PECO 402). *(click on image for an enlargement in a new window)*

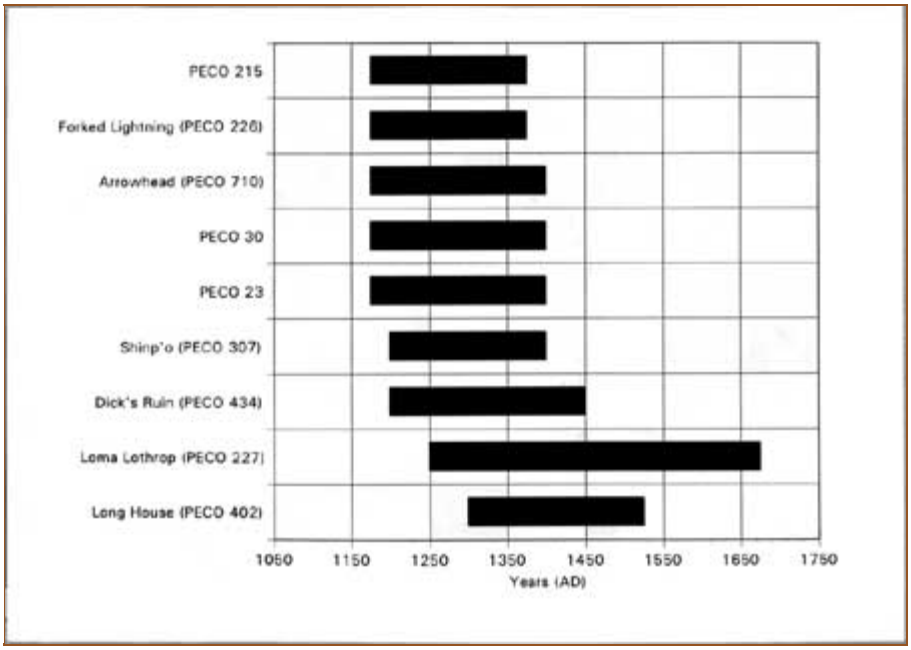


Figure 4.14. Early pueblo data ranges based on 25-year probabilities. *(click on image for an enlargement in a new window)*

Although Forked Lightning (PECO 226) is typically regarded as the earliest pueblo in the Upper Pecos Valley, the probability data reveal that two small, unnamed pueblos (PECO 215 and PECO 30) were most likely contemporaneous with Forked Lightning Pueblo (Figure 4.11). Located in the same general area of the park, these small pueblos are an architectural rarity within the Pecos Valley. Most structural sites recorded by the survey have only 1-2 estimated rooms. While wall alignments are not very apparent on the surface of PECO 215 and PECO 30, they are estimated to have 16 rooms and 45 rooms, respectively, based on extent of architectural rubble.

PECO 23, an unnamed pueblo with an estimated 10 rooms, displays a probability distribution which resembles that of Forked Lightning Pueblo. Radiocarbon dates from Rowe Pueblo that place initial occupation around A.D. 1250 (Cordell 1998) suggest that it was likely in use at the same time as Forked Lightning. In Kidder's estimation, Black-on-white House, underlying the extensive midden of the north terrace of Pecos Pueblo, was also contemporaneous with Forked Lightning Pueblo.

Forked Lightning Pueblo and PECO 215 were apparently the earliest pueblos to be abandoned, by at least the middle of the fourteenth century. According to the probability data, all of the other pueblos—including Dick's Ruin (PECO 434), Loma Lothrop (PECO 227), and Shin'po (PECO 307)—were still in use at the time of Forked Lightning Pueblo's abandonment (Figure 4.12). Due to sparse remaining surface ceramics, Arrowhead Pueblo (PECO 710) is showing up in these plots earlier than is probably correct. Dick's Ruin continues to be occupied into the A.D. 1400s, outlasting six of the other early pueblos, although simultaneous occupation continued at Loma Lothrop, and probably at Arrowhead Pueblo as well. A surprising finding indicated by the probability data is the length of time that Loma Lothrop continued to be used—well into the seventeenth century. Use of the site appears to have continued on a lesser scale at this time, perhaps in a seasonal or special-use capacity (see Chapter 5).

Dick's Ruin and Shin'po exhibit overall ceramic probability distributions that mirror one another, although Dick's Ruin was apparently established slightly earlier and occupied longer. While Dick's Pueblo is a completely black-on-white site, Shin'po has traces of early glaze ware. However, the very small ceramic assemblage from Shin'po limits further inferences about its timing in comparison to the other pueblos.

Long House (PECO 402, estimated 46 rooms) (Figure 4.13) has a probability distribution that is unlike any of the other pueblos. Showing a slightly bimodal distribution, the probability figures indicate that the site was initially settled by the A.D. 1300s and was contemporary with Dick's, Shin'po, Loma Lothrop, and probably Arrowhead Pueblo. It is significant that Long House is the only pueblo besides Pecos Pueblo that is dated to survey Period 4 (A.D. 1450-1575).

Conclusions

This chapter has incorporated two primary methods for assigning relative chronological placement to the Pecos survey sites. Mean ceramic dates provide a useful relative sequence of sites through time and are a rapid method for identifying temporal trends in a large dataset. Ceramic probability dating was found to have greater potential for chronology building using hundreds of surface ceramic assemblages. In contrast to traditional archeological seriations and to methods such as mean ceramic dating, the probability method estimates site occupation ranges at a defined threshold level, taking into account the presence and relative frequency of multiple ceramic types. A significant advantage of the probabilistic approach is that it uses replicable and objective criteria for assigning sites to time periods defined by the researcher, thereby allowing comparison with standard chronologies and with other assemblages.

A fine-grained assessment of the contemporaneity and sequence of occupation of the early pueblos was conducted. Ceramic probability dating takes strides towards understanding the timing of these little-known but important sites.

Future work should continue to refine the probabilistic method and the chronology developed here by taking into account the unique trajectory of individual ceramic types, rather than treating each as an idealized normal distribution. More ceramics found in well-dated

excavated contexts—ideally from short-term, single-component sites—are of course our best means for further improving the Pecos chronology.

Notes

1. While the probability distributions used in this analysis were generated in SPSS ver. 8.5, any program that can generate probabilities for segments of defined distributions (i.e., the normal distribution) may be used. Previously, probabilities have been calculated in Microsoft Excel, MathCAD Professional, and Mathematica ver.3.0

2. The formula for the normal probability density function is as follows:

$$Z = \frac{1}{\sigma\sqrt{2\pi}} e^{-\frac{1}{2}[(Y-\mu)/\sigma]^2}$$

Z = Height of curve at Y, given :

μ = Mean of Distribution

σ = Standard Deviation of Distribution

<<< Previous <<< Contents >>> Next >>>

PECOS

From Folsom to Fogelson:
The Cultural Resources Inventory Survey of Pecos National Historical Park

CHAPTER 5:
SITE TYPOLOGY AND ARCHITECTURE

Genevieve N. Head

As long as archeologists have worked in the American Southwest they have sought to reduce the variability of the sites and materials they found in order to more easily make sense of past human behavior. The purpose of this chapter is to categorize the numerous descriptive feature types used by the Pecos survey into a small number of site types that reflect where people lived, farmed, and pursued other subsistence activities. This typology is used in other chapters of this volume to estimate prehistoric population in the valley and to assess change through time in material acquisition, trade, and land use. A brief review of how previous researchers in the Pecos area categorized sites is followed by a consideration of the effects of recent vegetation clearing on the nature of surface remains in the park. This is followed by descriptions of the site components and features recorded by the survey. The survey sites are then grouped according to the presence/absence and character of nonportable features. These groups are placed into three functional site types and expectations for the kinds of activities that occurred at these types are given. The density of artifacts and the number of artifact classes on sites in each of these types are compared in order to examine the artifactual parameters of this classification defined by nonportable features. Additional discussions of the artifactual characteristics of these functional site types are given in Powell's chapter on ceramics (Chapter 8) and Kilby and Cunningham's chapter on lithics (Chapter 9). Descriptions of the survey sites follow, ordered by site type. The last section of this chapter briefly assesses how the formation of Pecos Pueblo affected subsistence and social life in the Upper Pecos Valley by considering two specific feature groups—agricultural features and kivas.

Site Typology in the Upper Pecos Valley

Adolph Bandelier (1881) was the first scholar to work in the Upper Pecos Valley, and his observations from 1880 are characteristically astute and accurate. He did not provide a standard ordering of the sites he recorded however. This may be explained by the fact that Bandelier was only in the area for a very few days (making his extensive measurements and observations all that more impressive) and that Pecos was his very first archeological work in the Southwest.

In 1904 Edgar Hewett categorized the sites in the Upper Pecos Valley into three classes based on size and morphology (Hewett 1904). Pecos Pueblo is the only member of his first class, Class I. His second class includes "several ruins of smaller communal houses" (1904:432) generally with 200-300 rooms, built around a plaza, often with two stories. Also included in Class II are smaller similarly built structures of 10-50 rooms without a plaza. He also noted that Class II sites are generally older than Pecos Pueblo. Hewett's Class III sites consist of rock shelters "of a very primitive type." Although he describes these as numerous in the Pecos area, subsequent investigations, including this survey, have found relatively few rock shelters.

In his 1924 "Introduction to Southwestern Archaeology," A. V. Kidder provides a classification of sites for the Rio Grande area in general (Kidder 1924:84-87). This classification is based primarily on ceramic change, which is not surprising given Kidder's research interests in ceramic chronology. After mentioning an early "pre-Pueblo type" of small settlements that were at that time not yet described, Kidder identifies a stage of single story "small houses" with 3-50 rooms accompanied by black-on-white and corrugated pottery. These are followed by much larger pueblos built around plazas containing kivas. These structures are often at least two stories high. Kidder offers Rowe Pueblo and the early structure under Pecos Pueblo as examples of this stage of architecture. These structures are

accompanied by black-on-white ceramics and by early red ware with white exterior decoration—probably White Mountain Red Ware. Kidder's scheme moves to glaze ware, and he notes that with the advent of glaze paint the "ruins become larger, more compact in floor plan, and fewer in number" (1924:86). With the use of red paint on glaze ware came the concentration of settlement in the Rio Grande area into a few large pueblos, such as Pecos Pueblo.

These classificatory schemes focus on the larger "communal houses" of the valley. Kidder classifies sites with three rooms but puts them in the same category as those with up to 50 rooms. These classifications also contain a unilinear evolutionary perspective of complexity, with the smaller houses always assumed to precede the larger. In the 1960s and 1970s, Southwestern archeologists became interested in the smaller sites and settlement systems in general (see articles in Ward 1978). With the shift in Americanist archeology toward more concern for systemic processes, archeologists began to pay more attention to small nonhabitation structures and sites without any architecture at all. Chronological refinements also demonstrated that the less complex sites found throughout the region were not necessarily earlier than the large pueblos but often played different roles in a contemporaneous settlement system.

In the Upper Pecos Valley work done by Larry Nordby for the National Park Service exemplifies this change in interests. In a research design developed for the survey of the original Pecos National Monument, Nordby creates a site typology that divides multiroom pueblos into three groupings based on number of rooms and morphology, similar to those of Hewett and Kidder. Nordby's typology also includes circular rings possibly representing tipis or wickiups, water control structures, pueblo shrines, pithouses and field houses. This typology was apparently preliminary in nature, since it accompanied notes for the research design for the survey (notes on file, National Park Service, Santa Fe), and the reports produced later do not mention it at all. It demonstrated a greater interest in subsistence and land use than is found in the earlier typologies and did not assume that smaller sites necessarily preceded larger ones.

Survey work done near Rowe Pueblo (Cordell 1998) by the University of New Mexico (UNM) field school was performed with the purpose of determining the kinds of sites surrounding Rowe Pueblo, particularly agricultural fields and lithic procurement areas. The types of sites defined by the Rowe survey include lithic and ceramic scatters, agricultural features, lithic quarry/workshops, and three separate structure classes divided by number of rooms—single room, two to five rooms, and greater than five rooms (Cordell 1998:203, Table 26). These groupings are similar to some of the component types identified by the Pecos survey.

The Effects of Mechanical Vegetation Removal on Site Interpretation

One issue that must be considered before any discussion of surface remains at Pecos National Historical Park is the impact of the widespread mechanical removal of piñon and juniper trees. After the livestock boom of the late nineteenth century and the overgrazing and fire suppression that occurred in its wake, grasslands in the Western United States were rapidly encroached by woody shrubs and trees (Bahre 1991, 1995:256; Dick-Peddie 1993:88). During the 1950s and 1960s federal land management agencies encouraged ranchers throughout the Southwest to use mechanical means to remove trees, such as piñon and juniper, decreasing woodlands and increasing grasslands for cattle forage (Bahre 1995:247).

Ninety-five percent of the land that is presently the Pecos Unit of Pecos National Historical Park was formerly part of the Forked Lightning Ranch. Bulldozers were used on the Forked Lightning to clear trees from large portions of the gently rolling plains of the Pecos Valley on the west side of the river (Gilbert Ortiz, former foreman Forked Lightning Ranch, personal communication 1995; Bernie Quintana, machine operator, personal communication 2000). This work was done with bulldozers alone, not by chaining.[1] After uprooting, the cleared trees (and any soil or brush brought up or dragged along with them) were pushed into arroyo heads or into large piles. Many of these piles, especially those in open areas, were subsequently burned.

The fact of this clearing was known when the Pecos survey was begun, though its extent and effect were not well understood. Two things were done in site recording to acknowledge and track vegetation removal. First, the survey recording system used several categories for structures and features designed to encapsulate uncertain function. The category of "possible structure" was used to capture ambiguous features "that suggest a structure location (rubble,

debris, and/or mound areas) but the nature, extent, and condition of the remains make this a questionable assignment" (Appendix A, Glossary). Figure 5.1 shows a possible structure at the edge of a bulldozed area. The category "unknown structure" was used to designate structures of indeterminate size or nature. The entire feature group "unknown rock features" can record features whose functions were not obvious due to disturbance. None of these recording categories were used exclusively for features disturbed by vegetation removal however. Second, vegetation removal is included as a type of site impact and was recorded on each site where its effects were observed. Survey crews used the presence of brush or dirt piles and obvious scrape marks from bulldozer buckets or treads as indicators of mechanical vegetation removal.



Figure 5.1. Possible structure at edge of a bulldozed area, PECO 108 (LA 118755) feature 13-01, view east.

Information collected by the survey will be used to examine the effects of bulldozing on the surface character of archeological sites by comparing sites where vegetation removal was recorded as an impact to sites where it was not recorded. The null hypothesis is that there are no statistically significant differences between sites impacted by vegetation removal and those that were not. This examination is by necessity limited to information collected by the survey, not all of which was intended to directly capture the effects of mechanical clearing. The following is far from an exhaustive study of the effects of heavy machinery on cultural resources in Pecos National Historical Park.

Common sense leads one to conclude that just driving a caterpillar tractor across the artifact scatters and concentrations of rock that characterize surface sites at Pecos would practically obliterate them. Figure 5.2 shows an example of extreme bulldozer damage to a structure. Most archeologists would shudder to imagine what might happen to sites when the buckets of those tractors were used to dislodge and uproot trees. It might thus be expected (1) that there are no or very few sites of any sort within cleared areas of the park. Previous studies of the effects of vegetation clearing have measured the horizontal displacement of surface artifacts and show an average amount of movement as great as 52 cm (20 inches) (Wildesen 1982:56-59). Scatters on sites with removal impacts are therefore (2) expected to be more extensive than scatters on nonimpacted sites because the blade and treads of a bulldozer would spread soil and artifacts. Very little has been reported regarding the effects of clearing on nonportable surface features. Bulldozing would disrupt rock alignments and possibly bury portions of surface features, making them more difficult to specifically characterize. Thus it is expected (3) that there are more features in the "unknown rock features" group recorded on impacted sites. Bulldozing would knock down or consolidate structural walls and truncate structural mounds, making them unrecognizable. It is therefore expected (4) that there are fewer impacted sites with structures and (5) that any structures on impacted sites will be "possible structures" or "unknown structures."



Figure 5.2. Cross section of a small structure exposed by a bulldozer cut, PECO 403 (LA 69302) feature 03-02, view east.

A first step in getting a handle on the extent of clearing activities within Pecos National Historical Park is approximating how much of the park area is affected. Figure 5.3 is a map of the Pecos Unit of the park showing cleared areas, sites where vegetation removal was recorded as an impact, and those where it was not.[2] In reference to the first expectation outlined above, that there would be no archeological sites in cleared areas, it is apparent from Figure 5.3 that the impact of clearing was quite variable. Though many of the cleared areas have fewer archeological sites than uncleared areas, they are by no means devoid of sites. Some cleared areas are even ringed by archeological sites, most of which are impacted by vegetation removal.

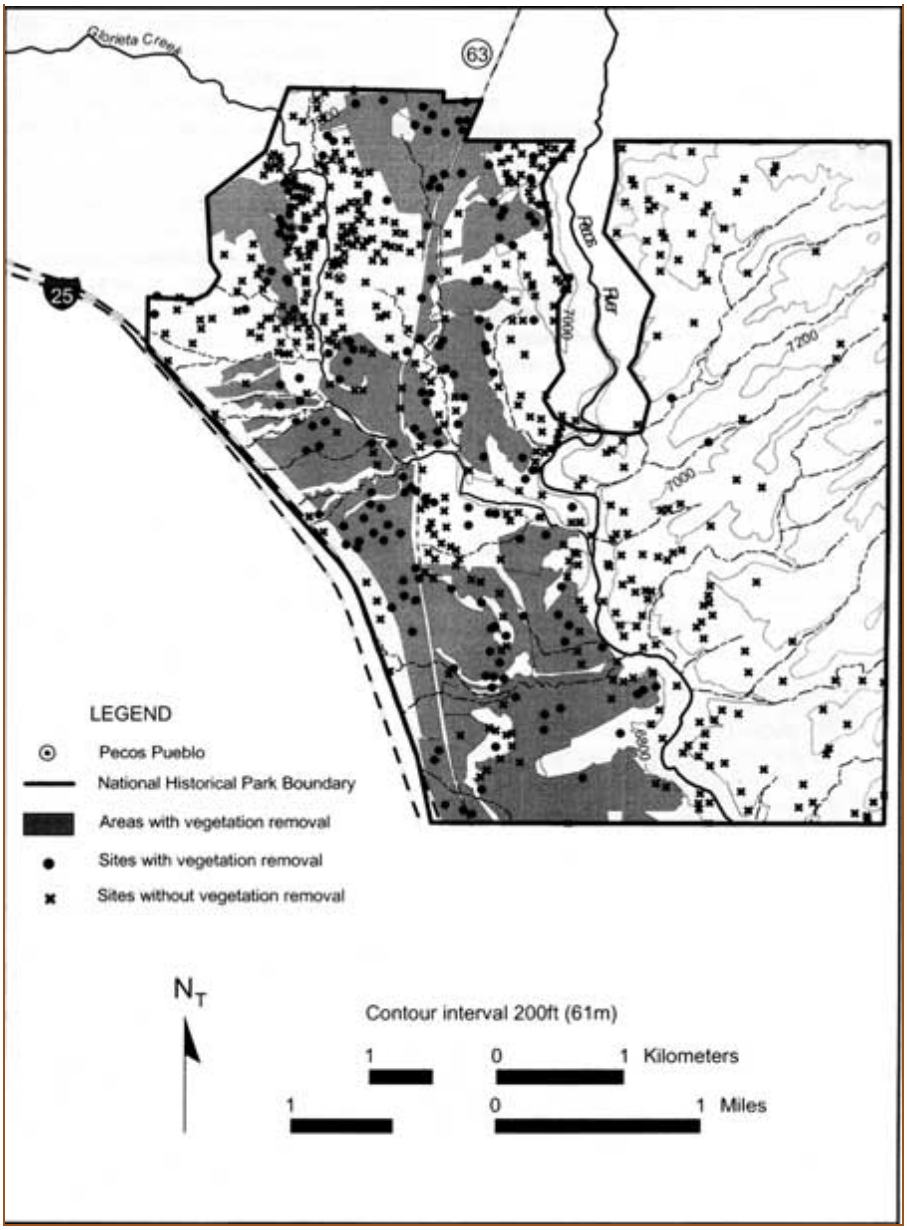


Figure 5.3. Map of the Pecos Unit showing areas of vegetation removal. *(click on image for an enlargement in a new window)*

It is estimated that 25 percent of the present Pecos Unit of the park was treated by vegetation removal. These areas still are readily visible as clearings, though after 30 years without continuing treatment some are almost entirely woodland once again. Vegetation removal was recorded as an impact on 176 sites, 28 percent of all sites recorded.

To address the second expectation discussed above, that artifact scatters on affected sites would be larger than those on unaffected sites Table 5.1 presents descriptive statistics for the area of artifact scatters on the two classes of sites. The survey recorded 837 artifact scatters. After removing outliers (scatters over 30,000 m^2, n=5) and those with missing values (n=3), 829 scatters were used in this analysis. The mean area for affected scatters is 2,669.03 m^2 while unaffected scatters have a mean area of 1,160.98 m^2. A t-test of the null hypothesis that the mean areas of these two groups of scatters are from the same population shows a significant difference between their means (t=5.1527; df=827; alpha=.05; p=.0000).[3] This indicates that scatters on sites affected by vegetation removal are indeed more extensive than scatters on sites that were not affected.

Table 5.1. Comparison of the size of artifact scatters on sites

affected by vegetation removal to those unaffected.

	n	Mean area	Minimum	Maximum	Standard Deviation
Affected	246	2,669	1	24,485	4,385
Unaffected	583	1,161	1	26,784	2,639
All	829	1,609	1	26,784	3,326

Note: All dimensions are in m^2.

Unfortunately specific impacts were not recorded at the feature level so the impact of vegetation removal to individual features cannot be separately quantified. It can be assumed, however, that if a site is affected by vegetation removal, all features on that site are affected.

Table 5.2 contains information to examine the third expectation outlined above, that ambiguous features would be more common on affected sites. There are 277 features recorded on sites with vegetation removal, 27 percent of the total 1,032 features recorded for all sites. Table 5.2 compares the count and proportions of different categories of features on affected and unaffected sites. A chi square analysis was performed to test the null hypothesis that there is no relationship between vegetation removal impacts and the types of features recorded on sites. This test resulted in a chi-square value of 76.772, (n= 1032, df=8) giving a *p* value of .001. With an alpha of .05 these results require rejection of the null hypothesis, demonstrating that there is a statistically significant relationship between vegetation removal and feature type.

Table 5.2. Comparison of feature categories between sites affected and unaffected by vegetation removal.

	Affected Sites		Unaffected Sites	
Structures	93	(34%)	190	(25%)
Architectural features	6	(2%)	32	(4%)
Fire-related features	29	(11%)	45	(6%)
Unknown rock features	93	(34%)	167	(22%)
Agricultural features	17	(6%)	42	(6%)
Bedrock features	20	(7%)	233	(31%)
Circulation features	9	(3%)	11	(2%)
Other features	7	(2%)	32	(4%)
Unknown features	3	(1%)	3	(>1%)
Total	277	(100%)	755	(100%)

To examine the fourth expectation, that there would be fewer structures on affected sites, a contingency table comparing presence of vegetation removal impacts and structures was created and is shown in Table 5.3. A chi square test of the null hypothesis that presence of vegetation removal and presence of structures are independent leads to rejection of the null hypothesis, indicating a statistically significant relationship between the presence on sites of vegetation removal impacts and structures (alpha=.05; chi-square=3.9287, df=1, p=.04). The high *p* value indicates this is a fairly weak relationship, but it is significant nonetheless. Sites affected by vegetation removal have slightly fewer structures than would be expected if these variables were independent.

Table 5.3. Contingency table of presence on sites of vegetation removal impacts and structures.

	Structures	No Structures	Row totals
Sites w/ impacts	64	112	176
Sites w/o impacts	128	325	453
Column totals	192	437	629

It appears, however, that vegetation removal does not reduce the recognition of structural sites. Consideration of Tables 5.2 and 5.3 shows that though structures are not as frequent as expected on sites impacted by vegetation removal, they make up a greater proportion of the features on sites with vegetation removal than they do on sites without. It might be, however, that clearing activities created concentrations of stone and artifacts that looked more like structures than any other feature type.

The fifth expectation was that there are more structures classified as "possible" or "unknown" on affected sites. Possible or unknown structures together (n=34) make up 37 percent of the structures on affected sites, while they constitute 33 percent (n=60) of structures on unaffected sites. Though not statistically significant, this indicates that clearing makes it slightly more difficult to specifically characterize structures. Relevant to this point, the severely disturbed structure shown in Figure 5.2 was recognized and recorded by the field crew as a small structure.

From this discussion it is apparent that the range rejuvenation activities of the 1950s and 1960s had definite impacts upon the surface cultural resources of Pecos National Historical Park. Though the bulldozers did not obliterate all sites in their paths, they certainly affected many of them. Scatter sizes on affected sites are larger than those on unaffected sites, indicating significant horizontal displacement of artifacts. More features on impacted sites were recorded as "unknown rock features." Structures were less common on impacted sites, and when they were recorded, they were more likely to have been categorized as "possible" or "unknown."

As stated in the introductory chapter, it is difficult to assess the implications these findings have for the project results. Certainly artifact densities on cleared sites will be lower than they would have been pretreatment, and the number of features in unknown categories are more numerous than they might be in surveys of areas with no clearing. The project design used these unknown and possible categories specifically to guarantee that the definite categories (such as "pueblo" and "small structure") are used to record only those features that can be clearly and unambiguously described. Beyond these precautions, little else is done to account for the affects of vegetation clearing in the analyses that follow.

Components and Features

The Pecos survey recorded 629 individual sites and 678 separate components. As described in Chapter 3 of this volume a component was defined as "an intra-site grouping of temporally and/or culturally related remains.... Multi-component sites were recorded when it was possible to attribute the site remains to two or more distinct occupations or cultural periods" (Chapter 3, pp. 49-50). The site component types used in the field were designed to be general yet descriptive and easily identify the dominant feature on a site. Twenty-nine different component types were listed in the site form manual (Appendix A). Eight of these were specifically for Euro-American remains (Table 5.4) while 21 (including "Other") were more general and used in most instances for Native American and prehistoric features, though some could be used for Euro-American remains as well (Table 5.5; see also Table 10.1). Two component types defined in the site manual (Kiva and Campsite) were not used in the field. The Euro-American component types account for 35 of the 678 components recorded (5 percent), while the remaining 643 components (95 percent) fall into the more general component types. The category "Other" was used for unusual or unanticipated component types. Table 5.6 lists the descriptions of components recorded as "Other."

Table 5.4. Euro-American specific component types recorded in the field.

Component Type	Count
Trash scatter	12
Euro-American structure	8
Homestead	5
Trash dump	3
Ranching feature	2
Trail (Santa Fe Trail ruts)	2
Road	2
Church	1
Total Components	35

Table 5.5. General component types recorded in the field.

Component Type	Count
Lithic and ceramic scatter	243
Lithic scatter	97
Small structure	97
Unknown rock feature	52
Possible structure	35
Rock Art/Inscriptions	21
Other	16
Unknown structure	12
Agricultural feature	11
Rock shelter	9
Shrine	8
Bedrock feature	7
Hearth	7
Pueblo	6
Ceramic scatter	6
Architectural feature	5
Communal pueblo	4
Storage	3
Fire/Roasting feature	2
Quarry — building stone	1
Tipi ring	1
Total Components	643

Table 5.6. Description and counts of components recorded as

"other."

Component Type	Count
Survey marker	4
Pithouse	3
Bridge	1
Dump/Shrine	1
Excavation fill	1
Glass scraper	1
Lime kilns	1
Military button	1
Mine	1
Mound	1
Stone circle	1
Total Other	16

Components are made up of nonportable features and scatters. The survey recorded 1,032 nonportable features and 836 artifact scatters. At the beginning of the project, feature types were organized according to functional groupings. Table 5.7 shows the type and number of nonportable features recorded in the field, organized by these groupings. Definitions of specific feature types can be found in the glossary for the site form manual (Appendix A). While some feature types appear on Table 5.7 they do not appear in the lists of component types (Tables 5.4 and 5.5) because component types were intended to capture only the dominant feature, not every feature, within the component. The three most common types of features are rock concentrations (n=192), grinding areas (n=110), and small structures (n= 109). An example of each is shown in Figures 5.4, 5.5, and 5.6, respectively.

Table 5.7. All nonportable features.

Feature Type	Count
Structures	
Communal pueblo	6
Pueblo	8
Small structure	110
Tipi ring	2
Rock shelter	7
Pit structure	2
Kiva	3
Shrine	8
Euro-American structure	29
Outbuilding, nfsa	6
Unknown depression	2
Unknown structure	18
Possible structure	76
Other structures	6

Architectural features	
Wall	13
Stone circle	8
Storage	4
Other architectural features	13
Fire-related features	
Hearth	30
Ash stain	21
FCR[b] concentration	16
FCR[b] w/adobe	5
Other Fire-related features	2
Unknown/Other rock features	
Rock alignment	59
Rock concentration	192
Vertical/Upright	2
Cairn	1
Building quarry	2
Other rock features	4
Agricultural/Water/Ranching features	
Terrace	11
Check dam	10
Grid garden	5
Acequia/Ditch	3
Reservoir/Catchment	4
Corral	5
Pen	1
Fence	1
Other agricultural features	19
Bedrock features	
Natural shelter	6
Grinding area	113
Sharpening area	8
Petroglyph/Pictograph	109
Inscriptions	2
Other bedrock features	15
Trails/Roads/Circulation features	
Trail	4
Road	5
Two-track/Wagon track	7
Other circulation features	4
Other features	39
Unknown features	6
Total	1,023

[a]nfs = not further specified.
[b]FCR = fire-cracked rock.



Figure 5.4. Example of a rock concentration, PECO 192 (LA 118795) feature 41-01, view north.



Figure 5.5. Example of a grinding area, PECO 477 (LA 119034), feature 61-03, view east.



Figure 5.6. Example of a small structure, PECO 245 (LA 118827), feature 03-01, view southeast.

Nonportable features, including structures and nonstructural features, were made using a wide variety of fabrics and construction techniques. Crews recorded several construction techniques and fabric materials for each structure or feature but always listed the predominant technique or material first. Tables 5.8 and 5.9 show the predominant stone fabric types used in structures and construction techniques, while Tables 5.10 and 5.11 show the predominant stone construction techniques and fabrics used with stone in structures and features, respectively. Tables 5.12 and 5.13 show the predominant nonstone fabric types at structures and features, and Tables 5.14 and 5.15 show the predominant construction techniques used with nonstone materials.

Table 5.8. Primary stone fabric types for structures.

	Bedrock	Boulders	Cobbles	Shaped Stone	Unshaped Sandstone	Unshaped Limestone	Unshaped Mixed Stone	Row Total
Communal pueblo	—	—	—	4	1	—	—	5
Pueblo	—	—	—	2	5	—	1	8
Small structure	1	1	24	8	43	15	18	110
Tipi ring	—	—	1	—	—	—	1	2
Rock shelter	3	—	—	1	1	2	—	7
Kiva	—	—	—	3	—	—	—	3
Shrine	—	—	—	—	3	4	—	7
Euro. structure	1	—	1	3	7	1	—	13
Outbuilding	—	—	—	—	—	—	2	2
Unknown structure	—	—	2	1	7	2	6	18
Possible structure	—	1	17	1	32	9	10	70
Other structure	—	—	—	1	—	—	—	1
Column total	5	2	45	24	99	33	38	246

Table 5.9. Primary stone fabric types for features.

	Bedrock, Limestone	Bedrock, Sandstone	Boulders	Cobbles	FCR[a]	Shaped Stone	Unshaped Limtsone	Unshaped Mixed Stone	Unshaped Sandstone	Row Total
Architectural features										
Wall	—	—	—	1	—	2	2	—	8	13
Stone circle	—	—	—	1	—	—	—	2	5	8
Storage	—	—	—	—	—	—	—	1	3	4
Other architectural	—	—	—	3	—	—	1	—	3	7
Fire features										
Hearth	—	—	—	6	2	2	3	—	17	30
FCR[a] concentration	—	—	—	2	10	—	1	1	2	16
FCR[a]/burned adobe	—	—	—	—	1	—	—	1	1	3
Other fire feature	—	—	—	—	—	—	—	—	—	—
Rock features										
Rock alignment	—	—	—	13	—	4	13	8	21	59
Rock concentration	—	—	4	53	—	4	23	35	73	192
Vertical slabs	—	—	—	—	—	2	—	—	—	2
Cairn	—	—	—	1	—	—	—	—	—	1
Building stone quarry	2	—	—	—	—	—	—	—	—	2
Other rock feature	—	—	—	1	—	1	1	—	1	4
Agricultural features										
Terrace	—	—	—	4	—	3	2	1	1	11
Check dam	—	—	—	1	—	—	3	3	3	10
Grid garden	—	—	—	3	—	1	—	—	1	5
Reservoir	—	—	—	—	—	—	—	1	—	1
Pen	—	1	—	—	—	—	—	—	—	1
Other agricultural	—	—	—	10	—	—	1	2	3	16
Bedrock features										
Natural shelter	4	1	1	—	—	—	—	—	—	6
Grinding area	—	71	40	—	—	—	—	1	1	113
Sharpening area	—	2	6	—	—	—	—	—	—	8
Petroglyph/pictograph	26	43	30	—	—	—	—	1	8	108
Inscription	1	1	—	—	—	—	—	—	—	2
Other bedrock feature	3	12	—	—	—	—	—	—	—	15
Circulation features										
Trail	—	—	—	—	—	1	—	—	—	1
Other feature	—	4	—	2	—	1	4	—	—	11
Unknown feature	—	—	—	1	—	—	—	—	1	2
Column totals	36	136	81	102	13	21	54	57	152	651

a

FCR = fire-cracked rock.

Table 5.10. Primary stone construction techniques for structures.

	Coursed Masonry	Indetermidiate Masonry	Piled Masonry	Natural Shelter	Single Course	Vertical Slabs	Row Total
Communal pueblo	5	—	—	—	—	—	5
Pueblo	4	3	—	—	—	—	7
Small structure	27	54	22	—	2	5	110
Tipi ring	—	—	—	—	2	—	2
Rock shelter	3	—	1	2	1	—	7
Kiva	3	—	—	—	—	—	3
Shrine	—	1	4	—	—	2	7
Euro. structure	19	—	—	—	—	—	19
Outbuilding	—	2	—	—	—	—	2
Unknown structure	2	10	5	—	1	—	18
Possible structure	3	40	19	2	1	—	65
Other structure	1	1	—	—	—	—	2
Column total	67	111	51	4	7	7	247

Table 5.11. Primary stone construction techniques for features.

Coursed Masonry	Indet. Masonry	Piled Masonry	Natural Shelter	Single Course	Vertical Slabs	Ground	Pecked	Incised	Row Total
Architectural features									
Wall	5	3	5	—	—	—	—	—	13
Stone circle	—	1	3	—	4	—	—	—	8
Storage	—	1	2	—	—	1	—	—	4
Other architectural	2	1	3	—	—	4	—	—	10
Fire features									
Hearth	1	3	7	—	12	2	—	—	25
FCR concentration	—	11	3	—	—	—	—	—	14
Rock features									
Rock alignment	2	20	18	—	16	1	—	—	57
Rock concentration	3	81	72	—	18	—	—	—	174
Vertical slabs	—	—	—	—	—	2	—	—	2
Cairn	—	—	1	—	—	—	—	—	1
Other rock feature	—	—	1	—	2	—	—	—	3
Agricultural features									
Terrace	—	4	1	—	6	—	—	—	11
Check dam	—	2	6	—	2	—	—	—	10
Grid garden	—	1	—	—	4	—	—	—	5

Reservoir	—	—	1	—	—	—	—	—	—	1
Pen	—	—	—	1	—	—	—	—	—	1
Other agricultural	2	11	2	—	1	—	—	—	—	16
Bedrock features										
Natural shelter	—	—	—	6	—	—	—	—	—	6
Grinding area	—	—	—	—	—	—	103	5	—	108
Sharpening area	—	—	—	—	—	—	8	—	—	8
Petroglyph/pictograph	—	—	—	—	—	—	21	81	3	105
Inscription	—	—	—	—	—	—	—	1	1	2
Other bedrock feature	—	—	—	—	—	—	11	4	—	15
Circulation features										
Trail	1	—	—	—	—	—	—	—	—	1
Other circ. feature	—	—	—	—	—	1	—	—	—	1
Other feature	—	—	9	—	—	—	—	—	1	10
Unknown feature	—	—	2	—	—	—	—	—	—	2
Column totals	16	139	136	7	65	11	143	91	5	613

Table 5.12. Primary nonstone fabric types for structures.

	Concrete	Earth/Soil	Mortar/Adobe	Wood	Other/Unknown/Missing	Row Total
Communal pueblo	—	—	1	—	—	1
Pit structure	—	2	—	—	—	2
Shrine	—	—	—	—	1	1
Euro. structure	12	—	1	3	—	16
Outbuilding	4	—	—	—	—	4
Unknown depression	—	1	—	—	1	2
Possible structure	—	2	3	—	1	6
Other structure	1	—	1	2	1	5
Column total	17	5	6	5	4	37

Table 5.13. Primary nonstone fabric types for features.

	Concrete	Earth/Soil	Metal	Mortar/Adobe	Wood	Missing/Other	Row Total
Architectural features							
Other architectural	1	—	—	2	3	—	6
Fire features							
Ash stain	—	1	—	—	—	20	21
FCR[a]/burned adobe	—	—	—	2	—	—	2
Other fire feature	—	—	—	2	—	—	2
Agricultural features							
Acequia/ditch	—	3	—	—	—	—	3
Reservoir	—	3	—	—	—	—	3

Corral	—	—	—	—	5	—	5
Fence	—	—	—	—	1	—	1
Other Agricultural	—	1	—	—	1	1	3
Bedrock features							
Petroglyph/pictograph	—	—	—	—	—	1	1
Circulation features							
Trail	—	3	—	—	—	—	3
Road	—	4	—	—	—	1	5
Two-track	—	7	—	—	—	—	7
Other circulation feature	2	—	1	—	1	—	4
Other feature	7	5	6	—	9	1	28
Unknown feature	—	1	—	—	—	3	4
Column totals	10	28	7	6	20	27	98

[a]FCR = fire-cracked rock.

Table 5.14. Primary nonstone construction techniques for structures.

	Adobe	Excavated	Frame	Jacal	Log	Probably Adobe	Upright Posts	Other	Row Total
Communal pueblo	1	—	—	—	—	—	—	—	1
Pueblo	1	—	—	—	—	—	—	—	1
Pit structure	—	2	—	—	—	—	—	—	2
Shrine	—	—	—	—	—	—	—	1	1
Euro. structure	1	—	2	—	1	1	—	5	10
Outbuilding	—	—	—	—	—	—	1	3	4
Unk. depression	—	1	—	—	—	—	—	1	2
Possible structure	—	1	—	2	—	1	1	6	11
Other structure	1	—	—	—	1	—	—	1	3
Column total	4	4	2	2	2	2	2	17	35

Table 5.15. Primary nonstone construction techniques for features.

	Adobe	Excavated	Frame	Jacal	Log	Probably Adobe	Upright Posts	Other	Raw Total	
Architectural features										
Other architectural	2	—	—	—	—	—	—	—	1	3
Fire features										
Hearth	—	—	—	—	—	—	1	—	4	5
Ash/charcoal stain	—	—	—	—	—	—	—	—	21	21
FCR[a] concentration	—	—	—	—	—	—	—	—	1	1
[a]	3	—	—	4	—	—	—	—	—	7

FCR /burned adobe										
Other fire	2	—	—	—	—	—	—	—	—	2
Rock features										
Rock alignment	—	—	—	—	—	—	—	—	2	2
Rock concentration	—	—	—	—	—	—	—	—	18	18
Stone quarry	—	2	—	—	—	—	—	—	—	2
Agricultural features										
Acequia	—	3	—	—	—	—	—	—	—	3
Reservoir	—	3	—	—	—	—	—	—	—	3
Corral	—	—	—	—	—	—	—	5	—	5
Fence	—	—	—	—	—	—	—	1	—	1
Other agricultural	—	1	1	—	—	—	—	—	1	3
Bedrock features										
Grinding area	—	—	—	—	—	—	—	—	5	5
Petroglyph/ pictograph	—	—	—	—	—	4	—	—	—	4
Circulation features										
Road	—	—	—	—	—	—	—	—	5	5
Two-track	—	—	—	—	—	—	—	—	7	7
Other circulation	—	—	1	—	—	—	—	—	2	3
Other feature	—	6	—	—	1	—	—	2	20	29
Unknown feature	—	1	—	—	—	—	—	—	3	4
Column totals	7	16	2	4	1	4	1	8	90	133

[a]FCR = fire-cracked rock.

Table 5.16 shows the type and number of artifact scatters recorded in the field. Descriptions of the different scatter types can be found in the site form manual (Appendix A).

Table 5.16. Artifact scatters recorded in the field.

Scatter Type	Count
Mixed lithic and ceramic scatter	224
Ceramic dominant lithic and ceramic scatter[a]	35
Lithic dominant lithic and ceramic scatter [b]	255
Ceramic scatter	10
Lithic scatter	164
Pot drop	37
Lithic quarry	2
Euro-American trash scatter	47
Euro-American trash dump	45
Isolated occurrences[c]	7
Other artifact scatters (middens, etc.)	10
Total artifact scatters	836

[a] 80% or greater of scatter is ceramics.
[b] 80% or greater of scatter is lithics.
[c] i.e., button on lithic scatter, etc.

Classification of the Survey Sites

The component and feature types discussed above provided a means for crews to efficiently and accurately describe and categorize the phenomena they encountered in the field. They are less useful for analysis however, because they supply few indications of the kinds of activities we think were performed on the sites or how the sites functioned within the settlement system. In order to provide analysts with site groupings that more closely represented function two steps were taken. The prehistoric/Native American Pecos survey sites were first classified according to the presence or absence of architecture or other nonportable features and by the type and variety of features present on the site. (The historic/Euro-American sites are discussed separately in Chapter 10). The groupings thus produced were then placed into one of three mutually exclusive site types, discussed below.

Categories for the Pecos Survey Sites

Nonportable features were chosen as the foundation for this classification because they are basic and often highly visible elements of the surface archeological record. Their relatively permanent nature makes them less subject to influence by postdepositional collecting than artifacts. This is a great advantage in an area like the Upper Pecos Valley, where humans have used and reused the landscape intensively for at least 700 years. Because of their portability, artifacts are more often subject to collection than architectural elements. As an example, metates are not common in surface assemblages on any kind of site (see Chapter 9). Though metates are generally less portable than their smaller partners, manos, they apparently are attractive for uses other than grinding. The broad hearth before the fireplace in the great room of the Forked Lightning Ranch house, built in 1926, is made entirely of slab metates. There is no record of the origins of these items, but it can be assumed they came from sites within the park. Other kinds of artifacts may have been functionally transformed in similar ways, without such prominent evidence of their displacement.

Architecture and other nonportable features also can be assumed to reflect human activity on the landscape at a general level and so are an appropriate basis for the present classification. The basic research questions presented in the introduction to this volume are concerned with broad changes and adaptations at Pecos. These are best addressed with a fairly general site classification, rather than attempting to approximate specific uses of particular areas through a more fine-grained classification. Grouping sites by their nonportable features alone also allows the analyses of artifacts later in this report without the danger of circularity that would occur if artifact variables were also used to create the site categories.

There are certainly drawbacks to using features to classify surface remains. What is now present on the surface probably represents only those constructions built of permanent materials, primarily stone. Features created of easily eroded or biodegradable materials, such as brush or jacal, will often be overlooked or difficult to distinguish because they leave few lasting remains. It is also necessary to clarify what kinds of phenomena are meant here by the use of the term "feature." For the purposes of this chapter, this term includes human modifications of the landscape, such as terraces, petroglyphs, and grinding slicks as well as architectural structures that would have contained roofed space. Features differ from artifacts in that they are nonportable. Their permanence gave them the potential to influence patterns of land use and land tenure as they became elements of the Pecos landscape. The presence of a certain kind of permanent feature, a grinding slick for instance, could increase the likelihood that grinding activities would continue to occur in that location. The presence of a relatively labor-intensive feature, such as a one to two room structure, also indicates an investment of time and labor. The structure had the potential not only to shelter but to indicate ownership as well (Head and Snead 1992; Kohler 1989).

Figure 5.7 shows the decision tree for categorizing the survey sites. Sites were first divided based on the presence or absence of nonportable features. Sites with no features were subdivided by the number of scatter types present on the site. Sites with features were split between those with structures and those with only nonstructural features. Structural sites were divided by the size of the largest structure as measured by the estimated number of rooms: 1-5

rooms for small structures, 6-99 rooms for pueblos, and 100 rooms or more for communal pueblos. Examination of the distribution of estimated room numbers suggests that the break between pueblos and small structures is a reasonable division (Figure 5.8). The category "Other structure" was used to capture structures that did not fit in these groups. It includes features such as shrines, tipi rings, and unknown structures.

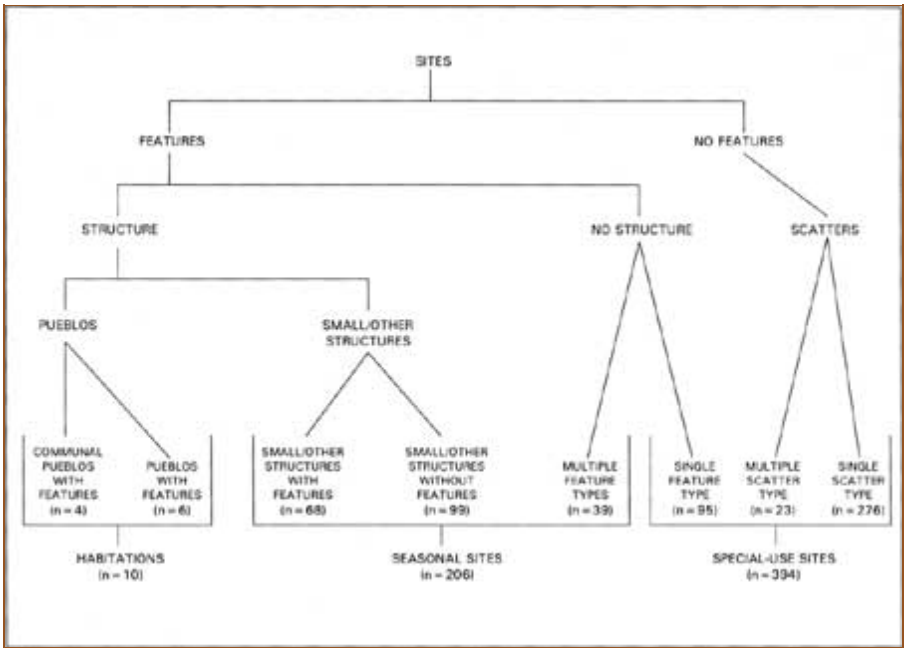


Figure 5.8. Decision tree for categorizing sites. *(click on image for an enlargement in a new window)*

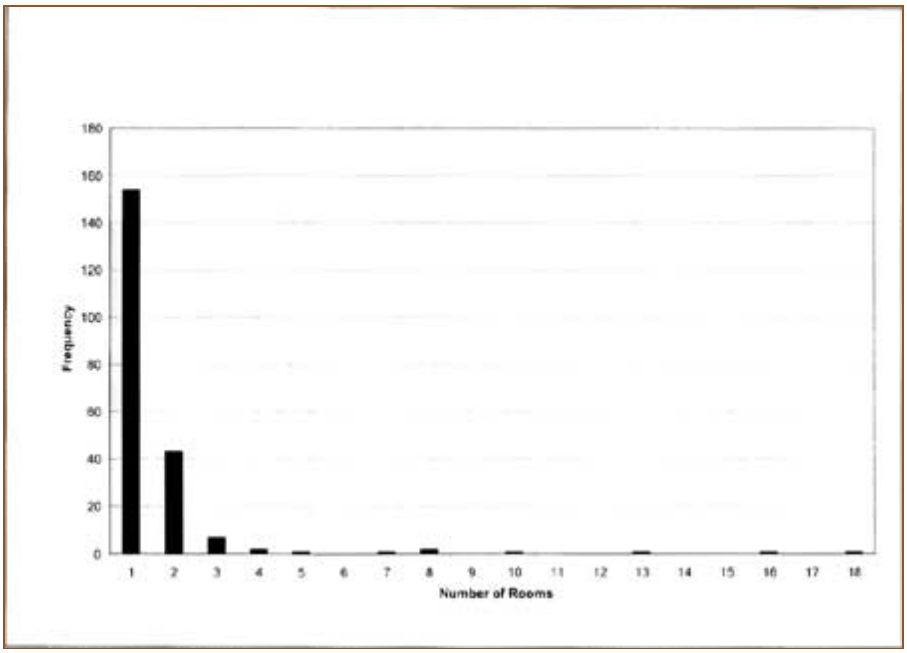


Figure 5.8. Frequency distribution of room counts for structures with fewer than 20 rooms. *(click on image for an enlargement in a new window)*

The decision to divide sites by the presence/absence of structures was based on the assumption that structures serve as permanent or semipermanent shelter and so attract repeated use and overnight stays with concomitant domestic activities. The number of rooms was deemed relevant because it is assumed to reflect the number of people using a

site. Structural sites were further subdivided by those that were accompanied by other features and those that were not. Significantly, there are no communal pueblos or pueblos not accompanied by other features.

Nonstructural feature sites were divided by whether they contained multiple types of features or a single type of feature. This distinction was made on the assumption that the number of different feature types, rather than the number of features alone, will most accurately reflect the variety of activities that took place at a site. A site with 20 terraces was most likely the location of a single kind of agricultural activity, albeit an intensive practice of that activity. A site with three terraces, a check dam, a grinding slick, and a fire-cracked rock concentration was very likely the location of a greater variety of agricultural and food processing activities. The ten subtypes derived by this method are shown in the first column of Table 5.17.

Table 5.17. Architectural categories and site types by component.

Architectural Category	No. Components	Site Type
Communal pueblo with features	4	Habitation (n=10)
Pueblo with features	6	
Small structure with features	42	Seasonal (n=206)
Small structure without features	53	
Other structure with features	26	
Other structure without features	46	
No structure, multiple feature types	39	
No structure, single feature type	95	Special-use (n=394)
No features, single scatter type	276	
No features, multiple scatter types	23	
Total	610	

Functional Types for the Pecos Survey Sites

While descriptive of the kind of features at sites, these categories do not go much further than the component types used in the field to provide information about the kinds of behaviors or activities that took place at the sites. To answer the questions put forth in the research design, namely what were the affects of aggregation on life in the Upper Pecos Valley, we needed to have some idea of where very general activities occurred. We wanted to know where most people lived, so reasonably accurate estimates of population could be obtained. We wanted to know where agricultural and horticultural activities took place so it could be determined how Pecos Pueblo was funded and maintained. And we also wanted to know where less intensive uses of the landscape, such as gathering of raw materials and wild resources, were performed to get a better idea of their role in the support of the pueblo.

Based on these needs a tripartite division of the survey sites was created. This division is based on a model of the general nature of Ancestral Puebloan land use (Kane 1983; Sebastian 1983). In this model, most Puebloan groups had primary habitations which were the places where most domestic activities took place and which gave shelter throughout the year to families, households, and communities (Kane 1983:23; Sebastian 1983:407). Supportive activities were performed at nonhabitation sites that were used regularly and often intensively during certain seasons (Kane 1983:21; Sebastian 1983:411). In addition, specific resource procurement sites exploited particular resources for very short periods of time (Kane 1983:22; Sebastian 1983:412).

Three site categories were defined: habitation sites, designating primary domiciles; seasonal sites, designating sites used intensively on a seasonal basis; and special-use sites, designating sites used infrequently throughout the year.

The ten architectural site groups discussed earlier were classified into these categories (see Figure 5.7 and Table 5.17).

In addition to feature characteristics, there are certain expectations for the kinds of activities at each of these site types that have concomitant expectations for the kinds of artifacts and the locations for each type of site. These expectations are laid out briefly here and are explored further in later chapters of this report.

Habitations

Communal pueblos and pueblos were placed in the habitation category, since the great number of rooms they contain is assumed to be for the purpose of housing large populations. Habitations are expected to be the location of most domestic activities for the majority of the population—sleeping, eating, food processing, storage, tool maintenance, and tool manufacture. As the domestic foci of communities, habitations are expected to have dense and diverse artifact scatters, the result of discard by large numbers of people throughout the year, over a number of years. Habitations are also expected to have kivas, plazas, or other socially integrative features. Most trade activities are expected to have taken place at habitations, so sites in this type should have the majority of trade goods found in each period.

Seasonal Sites

Small structures and other structures (with and without features) as well as nonstructural sites with multiple feature types were placed in the seasonal category. The structures likely provided roofed and contained space for protection from the elements during short overnight stays for both people and goods, while the multiple types of features suggests a variety of activities took place there. Seasonal sites are expected to be the location of most agricultural activities. We predict that they are located near resources or arable land. They are expected to have served some short-term domestic functions and so may have evidence of small-scale food processing, storage, and tool maintenance. However, the size and complexity of the scatters should be smaller than those at habitations, since seasonal sites are expected to have been used by smaller groups for shorter periods of time. Some seasonal sites might show evidence of activities not related to subsistence, primarily through the specific kinds of structure(s) or feature(s) at the site.

Special-Use Sites

Sites with only a single feature type and those comprised of scatters without structures or features were placed in the special-use category under the assumption that the lack of permanent structures implies that these sites were used infrequently or on a very limited basis. If they were revisited, subsequent visits were made because of the location of the site, not necessarily because of the features there. Special-use sites should be located near wild resources. They should not show signs of storage, because resources harvested from these sites would be moved to other locations for long-term keeping. Artifact scatters at special-use sites should be less dense and complex than those at either habitations or seasonal sites and may show evidence of tool maintenance and/or very small scale food processing. As with seasonal sites, there is the possibility that some special-use sites also were not subsistence oriented at all but were the focus of ritual activities. Because of the inclusion of scatter-only sites in the special-use sites category, there is also the great possibility that many of these sites are not Puebloan but are either earlier Archaic or contemporary Plains nomad sites.

General Artifactual Parameters of the Site Types

As mentioned above, it is undesirable to use artifact parameters to create the site types since that would create circularity in later discussions of ceramics and lithics at the site types. Artifacts are important indicators of site function, however, and should not be neglected in any classification of archeological sites. In order to determine very general artifactual parameters for the site types, statistical tests were run on the number of artifact types and the density of artifacts at sites in each category. A series of three tests was performed on the mean number of artifact types on sites, and another on the mean density of artifacts. The null hypothesis for both series of tests is that the three site types are samples from the same population of sites and so will show no significant difference in the number of artifact types or the density of artifacts. A finding of a significant difference would require rejection of the

null hypothesis, indicating that the site categories were distinctly different.

Because this method required three comparisons (habitation to seasonal, habitation to special-use, seasonal to special-use), a Bonferroni adjustment (Sokal and Rohlf 1995:240) was made by dividing the test alpha (.05) by the number of comparisons (3). This gave an alpha of .017. The Bonferroni adjustment is made to control for the greater likelihood of rejecting the null hypothesis even when it is true (a Type I error) that occurs with multiple comparisons. A further adjustment had to be made to the data. The frequency distributions of the number of artifact types and artifact densities were not normal, both being highly right skewed. A log transformation was performed on both distributions, which brought them closer to normality, allowing the use of parametric statistical tests.

Table 5.18 shows the results of the t-test comparisons of the logged artifact type data. The null hypothesis could be rejected in all three cases, indicating significant differences between the number of artifact types at the three site types. In general, the artifact assemblages at habitation sites have more artifact types, making them more complex than assemblages at the other site categories. As can be seen in Table 5.18, the log of the number of artifact types is larger at habitations than at either seasonal or special-use sites. The logs translate into actual numbers of a mean of 66 artifact types at habitations, a mean of 13 artifact types at seasonal sites, and a mean of eight artifact types at special-use sites.

Table 5.18. Results of t-tests between number of artifact types at site types.

Site Type	Habitation	Seasonal
Habitation n= 10 mean=3.8541 st. dev.=0.7734		
Seasonal n=206 mean=2.2801 st.dev.=0.9990	p=.0000 df=212 alpha=.017	
Special-Use n=394 mean=2.0273 st.dev.=0.6622	p=.0000 df=402 alpha=.017	p=.0012 df=298 alpha=.017

Artifact densities (used as a proxy for total counts, which were not available for the many sites that were sampled) are not as clear cut, but still show some significant differences. In t-tests of logged artifact densities (still using the Bonferroni adjustment), habitations were significantly different from both seasonal sites and special-use sites (Table 5.19). This indicates that there are real differences in the density and complexity of assemblages between habitations and other site types, reflecting the larger size of habitations and the wide variety of tasks performed there. Seasonal and special-use sites are not significantly different from one another in terms of artifact density, however. This indicates that seasonal sites, while roughly of the same density as special-use sites, have more different types of artifacts, suggesting more complex assemblages.

Table 5.19. Results of t-tests between logs of artifact density at site types.

Site Type	Habitation	Seasonal
Habitation n=10		

mean= -0.1319 st.dev. = 1.6765		
Seasonal		
n=206 mean=-2.3105 st.dev.=1.7644	p=.0002 df=212 alpha=.017	
Special-Use		
n=394 mean=-2.0935 st.dev.=1.2600	p=.0049 df=402 alpha=.017	p=.1191 df=313 alpha=.017

Nonstructural Feature Groups and Site Types

Another means to explore the nature of these site types is to examine the occurrence of different nonstructural features at each site type. It will be remembered that the type of feature (other than presence/absence and size of structures) was not used to create the site types, though the number of different feature types was important. In the survey recording scheme, nonstructural features were grouped into five general categories based on assumed use and/or material/fabric: architectural features; fire-related features; unknown/other rock features; agricultural features; and bedrock features. Structures are not included in this discussion, since they were used to create the site types. Circulation features (trails and roads) are omitted since none were recorded that were prehistoric. Unknown and other features (n=4) are also omitted from this discussion (Table 5.20 shows specific feature types in each group; see Appendix A for descriptions of these types).

Table 5.20. Nonstructural feature types at different site types.

Feature Type	Habitations	Seasonal	Special-Use	Row Totals
Architectural Features				
Wall	2	4	1	7
Stone circle (unknown)	—	5	1	6
Storage/cist	—	—	4	4
Other architectural feature	—	2	—	2
Total architectural	2	11	6	19
Fire-related features				
Firepit/hearth	3	13	6	22
Ash/charcoal stain	2	7	9	18
FCR[a] concentration	1	13	2	16
FCR[a] w/burned adobe	3	2	—	5
Total fire	9	35	17	61
Unknown/other rock features				
Rock alignment	10	21	17	48
Rock concentration/scatter	19	86	48	153
Vertical/upright slabs	1	1	—	2
Building material quarry	—	—	1	1
Other rock feature	1	1	—	2
Total unknown rock	31	109	66	206

Agricultural features				
Terrace	3	7	1	11
Check dam	—	6	1	7
Grid garden	—	4	1	5
Reservoir	—	1	1	2
Other agricultural feature	7	4	2	13
Total agricultural	10	22	6	38
Bedrock features				
Natural shelter	—	4	2	6
Grinding area	10	69	34	113
Sharpening area	1	7	—	8
Petroglyph/pictograph	5	86	14	105
Other bedrock feature	3	10	2	15
Total bedrock	19	176	52	247
Column totals	71	353	147	571

[a]FCR=fire-cracked rock.

The null hypothesis that the type of site and the kinds of nonstructural features found on sites are independent was tested using a chi-square test, with an alpha of .05. Table 5.21 shows the contingency table of site type and feature group. The results of this test (sample size=571 features, df=8, chi square=25.448, p=.001) lead to rejection of the null hypothesis and recognition of a definite association between site type and feature group (Table 5.21). Examination of Table 5.21, which shows the observed frequency, expected frequency, and difference of observed from expected for each cell, reveals that seasonal sites have a higher than expected number of bedrock features, while special-use sites have a higher than expected frequency of rock features. The association of feature groups with site types provides independent information which, when combined with the artifactual parameters of the site types, suggests that there are real differences between these three site types.

Table 5.21. Cross-tabulation of site type and feature group.

	Architectural Features	Fire Features	Rock Features	Agricultural Features	Bedrock Features	Row Totals
	2	9	31	10	19	71
Habitation		2.36	7.58	25.62	4.72	30.71
		-0.36	+1.42	+5.38	+5.28	-11.71
	11	35	109	22	176	353
Seasonal		11.75	37.71	127.35	23.49	152.7
		+0.75	-2.71	-18.35	-1.49	+23.3
	6	17	66	6	52	147
Special-Use		4.89	15.7	53.03	9.78	63.59
		+1.11	+1.3	+12.97	-3.78	-11.59
Column totals	19	61	206	38	247	571

Note: Each cell contains: observed frequency, expected frequency, and difference of observed from expected frequency. Sample size=571, df=8, chi-square=25.448, p=.001.

Change in Site Types through Time

Table 5.22 shows the number and proportion of components in each functional site type for each period (because each component could potentially occur in multiple periods, summing the numbers and proportions within columns is not of interest). The overall structure of the site types changes little over time. Special-use sites generally make up a little less than two-thirds of the sites in each period, seasonal sites make up a little more than one-third, and habitations make up a small fraction of the sites in each period. This suggests generally stable land use and settlement patterns during the ceramic periods. The biggest change can be seen in the great decrease in the number of habitations from Period 3 (A.D. 1325-1450) to 4 (A.D. 1450-1575), indicating the aggregation of population at Pecos Pueblo.

Table 5.22. Site types through time.

Ceramic Period	Habitations		Seasonal		Special-Use		Row Counts
	(No.)	(%)	(No.)	(%)	(No.)	(%)	
Period 0 (pre A.D. 1075)	—	—	1	100	—	—	1
Period 1 (A.D. 1075-1200)	—	—	1	50	1	50	2
Period 2 (A.D. 1200-1325)	6	6	39	38	56	56	101
Period 3 (A.D. 1325-1450)	10	3	104	34	188	63	302
Period 4 (A.D. 1450-1575)	3	1	90	38	142	61	235
Period 5 (A.D. 1575-1700)	4	1	67	38	107	61	178
Period 6 (post A.D. 1700)	1	2	20	36	34	62	55
Undated	0	0	32	23	107	77	139

Note: Because each component could potentially occur in multiple periods, summing the numbers and proportions within columns is not of interest.

Site Types across Space and through Time

Figures 5.9-5.13 show the spatial distribution of the three different site types throughout the Pecos Unit of the park for Periods 2 through 6 (A.D. 1200-1700; there were so few sites in Periods 0 and 1 that they are not included here). Visual inspection of these maps reveals several shifts through time. During Period 2 (A.D. 1200-1325), before the building of the Pecos Pueblo Quadrangle, most sites cluster around Forked Lightning Pueblo (PECO 226, LA 672), PECO 23 (LA 14124), PECO 30 (LA 14113), PECO 215 (LA 118811) and Glorieta Creek (Figure 5.9). The area of Pecos Pueblo is completely empty at this time.



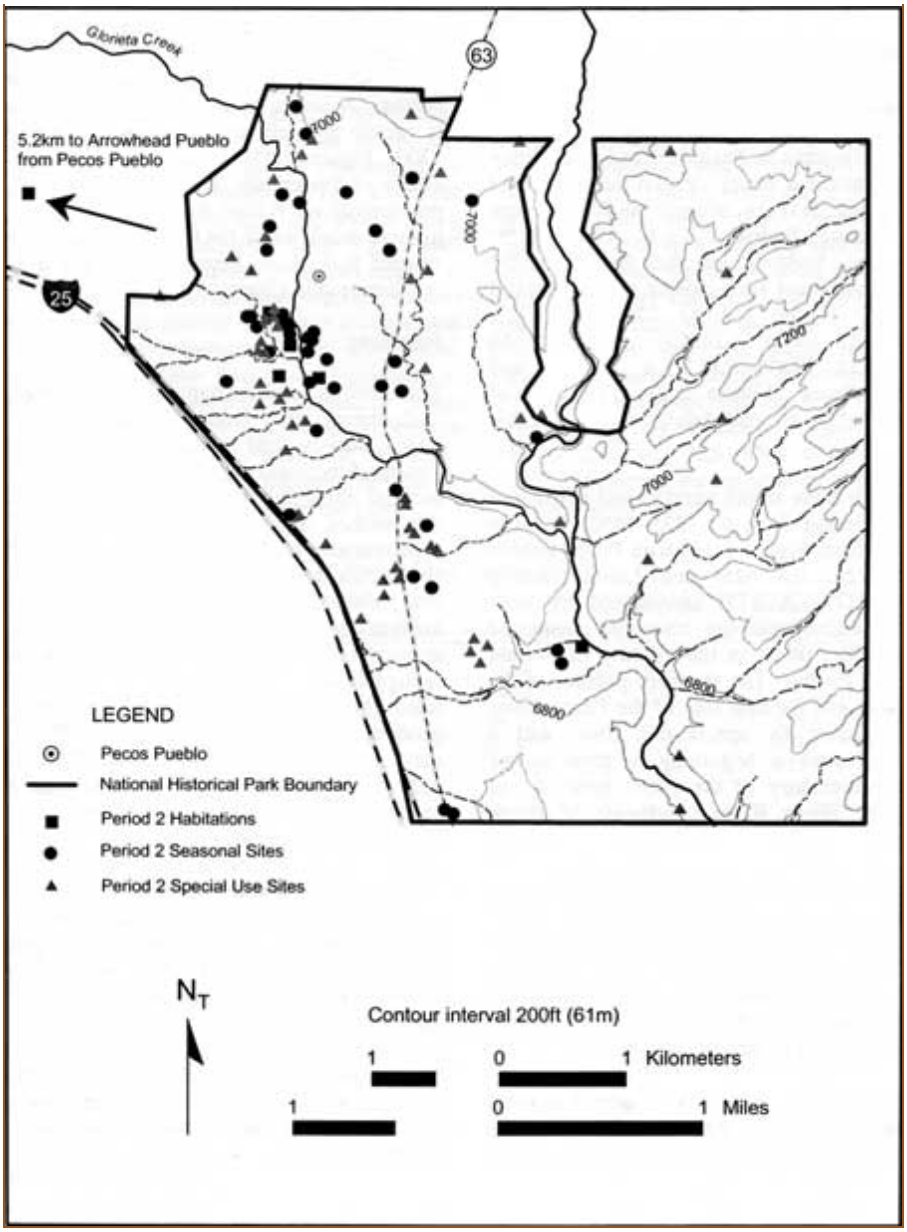


Figure 5.9. Sites dated to Ceramic Period 2 (A.D. 1200-1325), showing site types.
(click on image for an enlargement in a new window)

The increase in the number and density of sites in Period 3 (A.D. 1325-1450) is quite apparent from Figure 5.10, with Pecos Pueblo (PECO 228, LA 625) and Loma Lothrop (PECO 227, LA 277) surrounded by both seasonal and special-use sites. A cluster of sites is still evident in the vicinity of Forked Lightning Pueblo. The southern portion of the study area and the east side of the Pecos River are dominated by special-use sites, and a cluster of sites is beginning to form at the northern boundary of the park, west of and above the Pecos River, northeast of Pecos Pueblo.

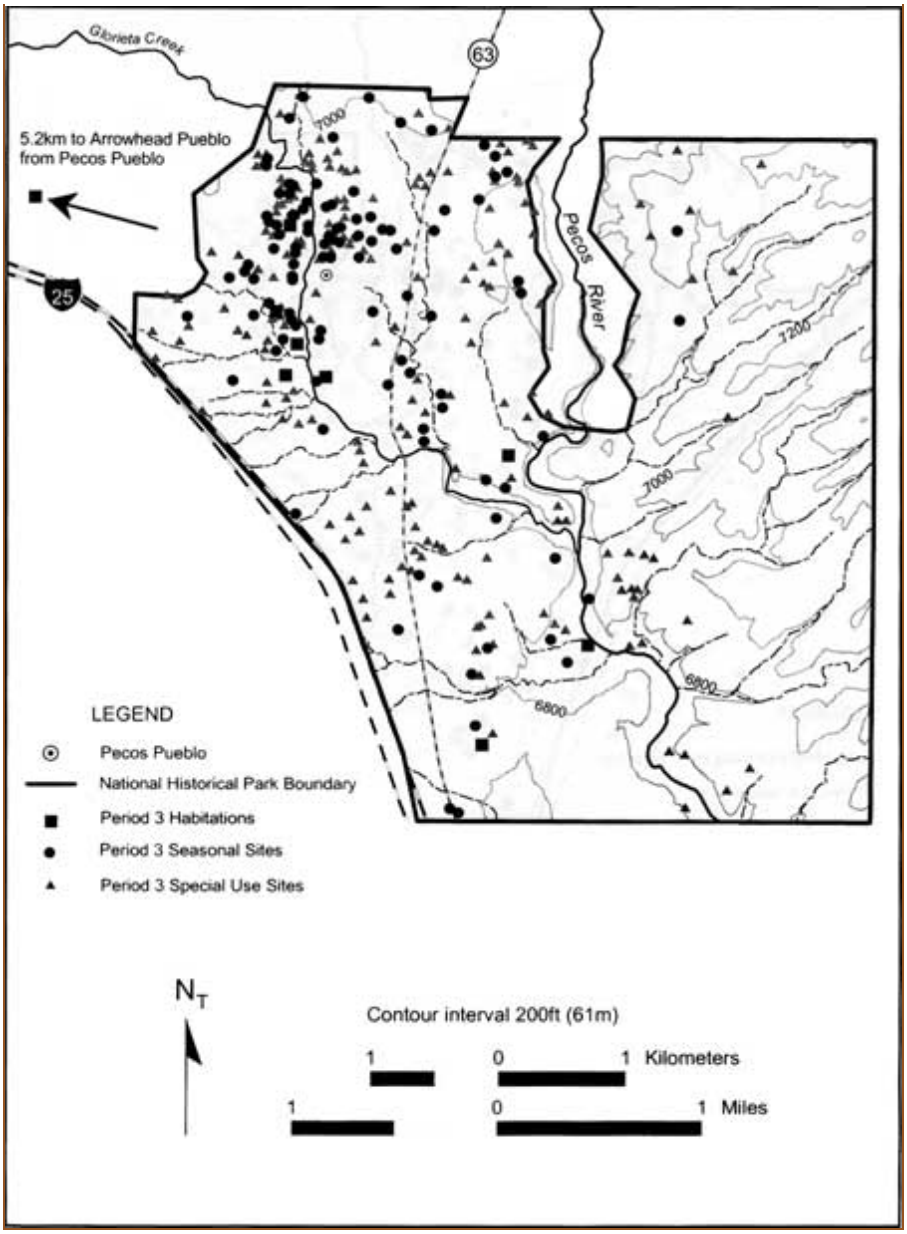


Figure 5.10. Sites dated to Ceramic Period 3 (A.D. 1325-1450), showing site types.
(click on image for an enlargement in a new window)

Period 4 (A.D. 1450-1575; Figure 5.11) appears to see increased clustering of activity to the north of Pecos Pueblo and intensification of the cluster to the northeast, above the river, and a slight increase of seasonal sites in the southern portion of the study area, along the Pecos River and to the east of the river.

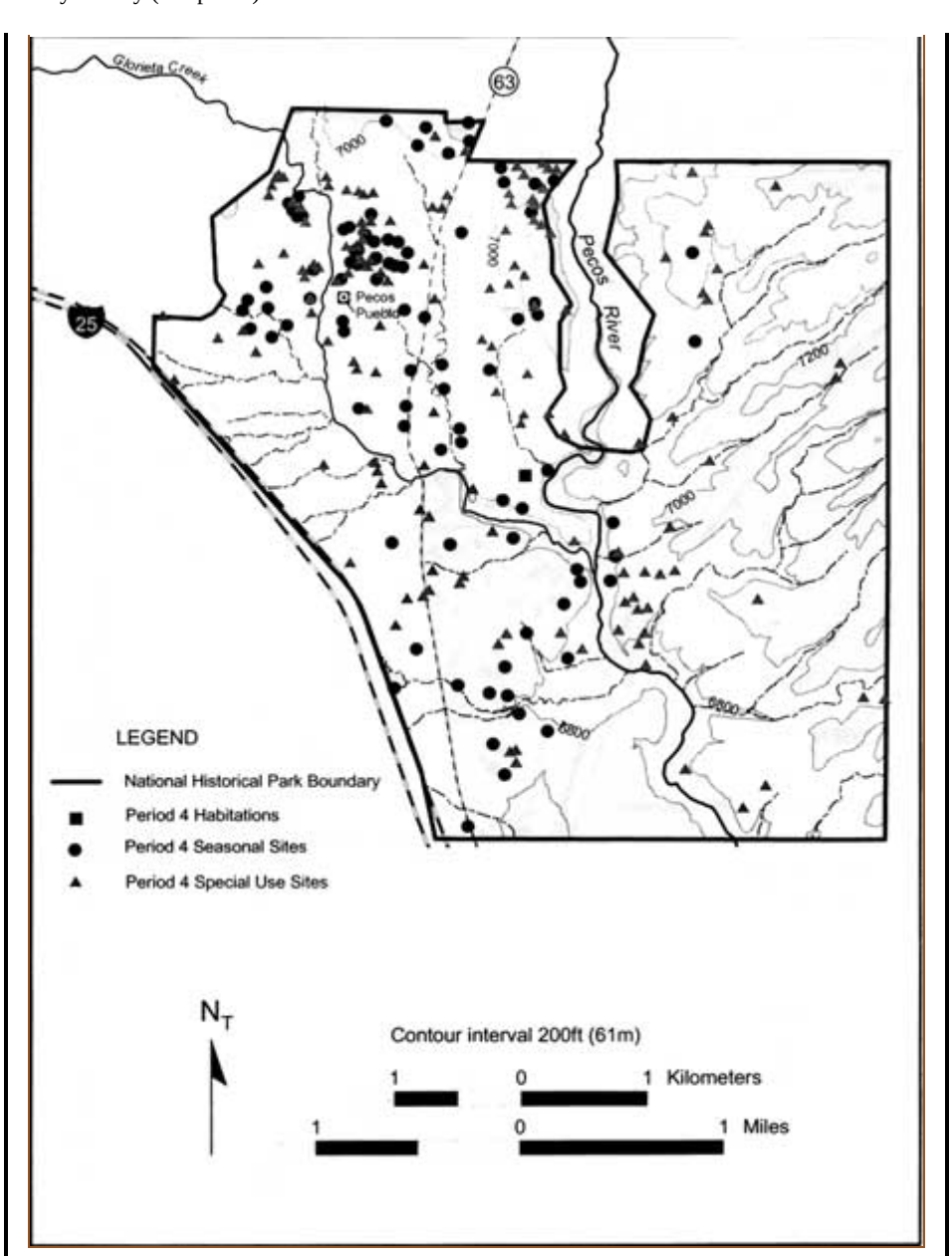


Figure 5.11. Sites dated to Ceramic Period 4 (A.D. 1450-1575), showing site types.
(click on image for an enlargement in a new window)

Period 5 (A.D. 1575-1700; Figure 5.12) sees the apparent breakup of the cluster of sites around Pecos Pueblo and more seasonal activity along the lowlands of the Pecos River, with more special-use sites in the higher elevation areas on the east side of the river. The cluster of sites above the river to the northeast of Pecos Pueblo persists. A severe decline in the number of sites is clearly apparent during Period 6 (post A.D. 1700; Figure 5.13). Chapter 6 looks at the effects of topography, other sites, and local soil productivity on Native American site placement in more detail, using the functional site types developed here. Euro-American sites and artifacts are discussed in Chapter 10.

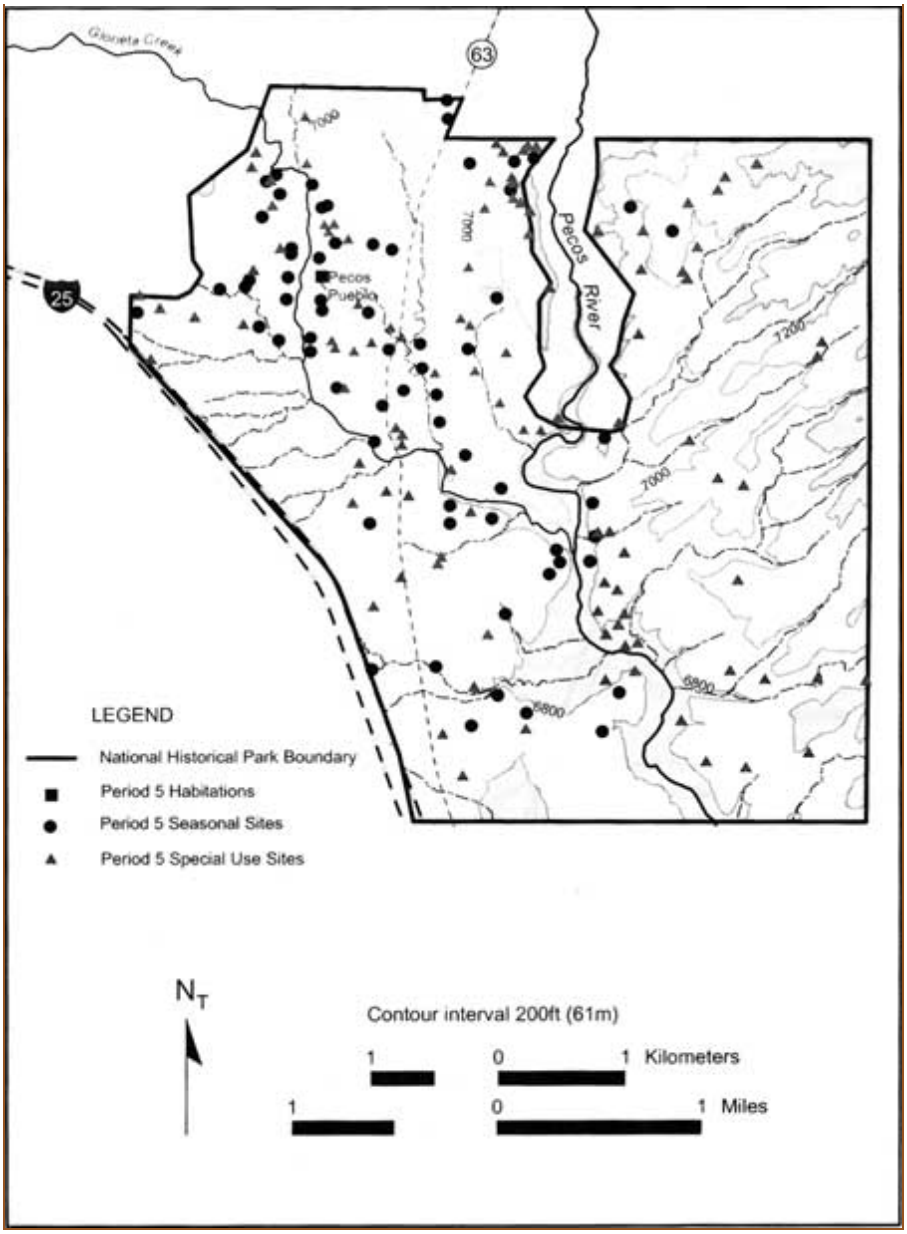


Figure 5.12. Sites dated to Ceramic Period 5 (A.D. 1575-1700), showing site types.
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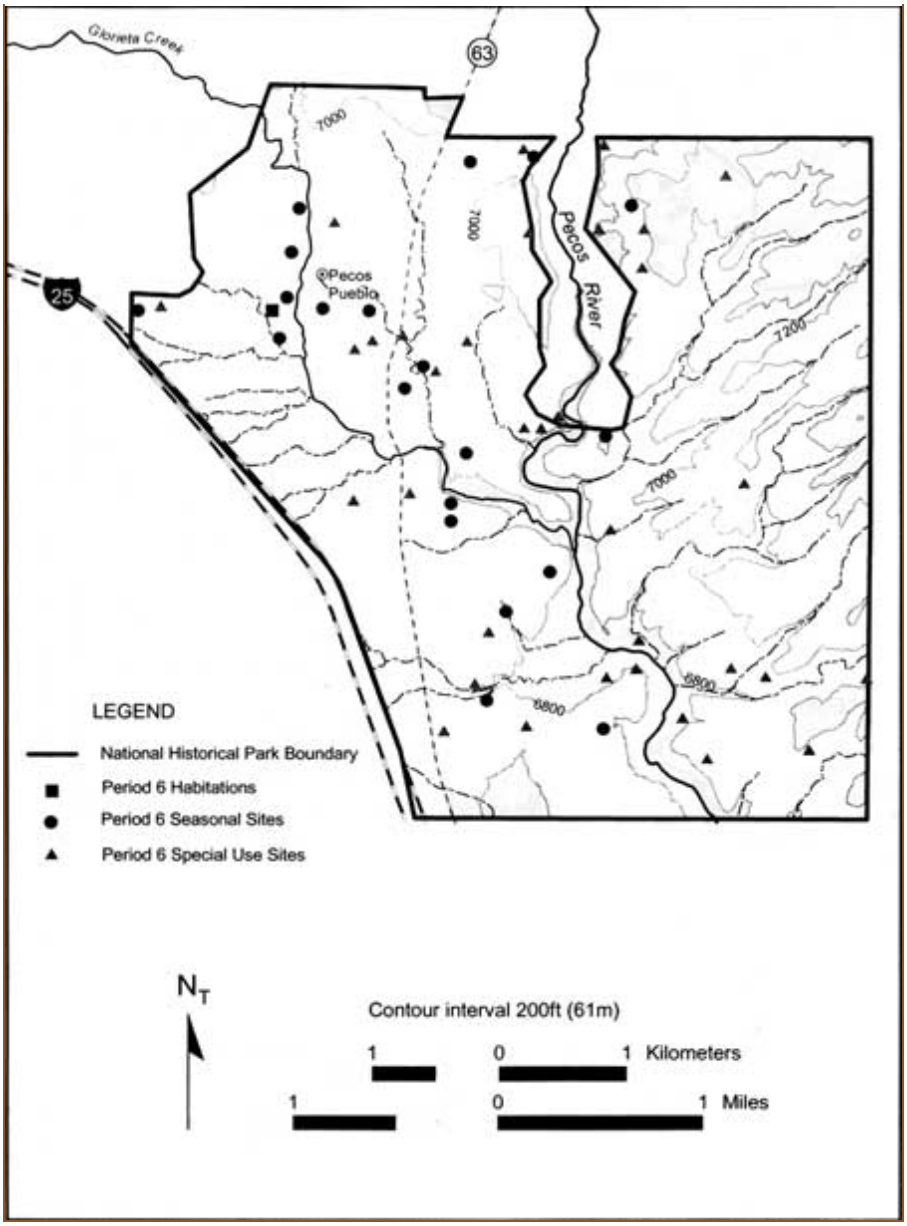


Figure 5.13. Sites dated to Ceramic Period 6 (post A.D. 1700), showing site types.
(click on image for an enlargement in a new window)

Summary

This portion of this chapter has described the components and features recorded by the Pecos survey and placed them into three general functional types based on their architectural characteristics. A major limitation of this method is that it does not use artifacts to approximate the activities that occurred at sites. This is also its greatest advantage, however, since it allows use of site types in the artifact chapters without fear of circular arguments. It also makes use of salient and easily recognizable information (nonportable features) in a way that can be readily reproduced. Placing components into three site categories reduces the variability of the component and feature types derived from field recording into groups that have associated activities and expectations for other data suites such as settlement, ceramics, and lithics. Comparison of two gross artifact assemblage parameters—artifact density and the number of artifact types—and general feature groups between site types demonstrates that these types are separable from one another using independent information. The following section of this chapter provides descriptions of individual habitation sites and more detailed information on the nature of features and artifact scatters on seasonal and special-use sites.

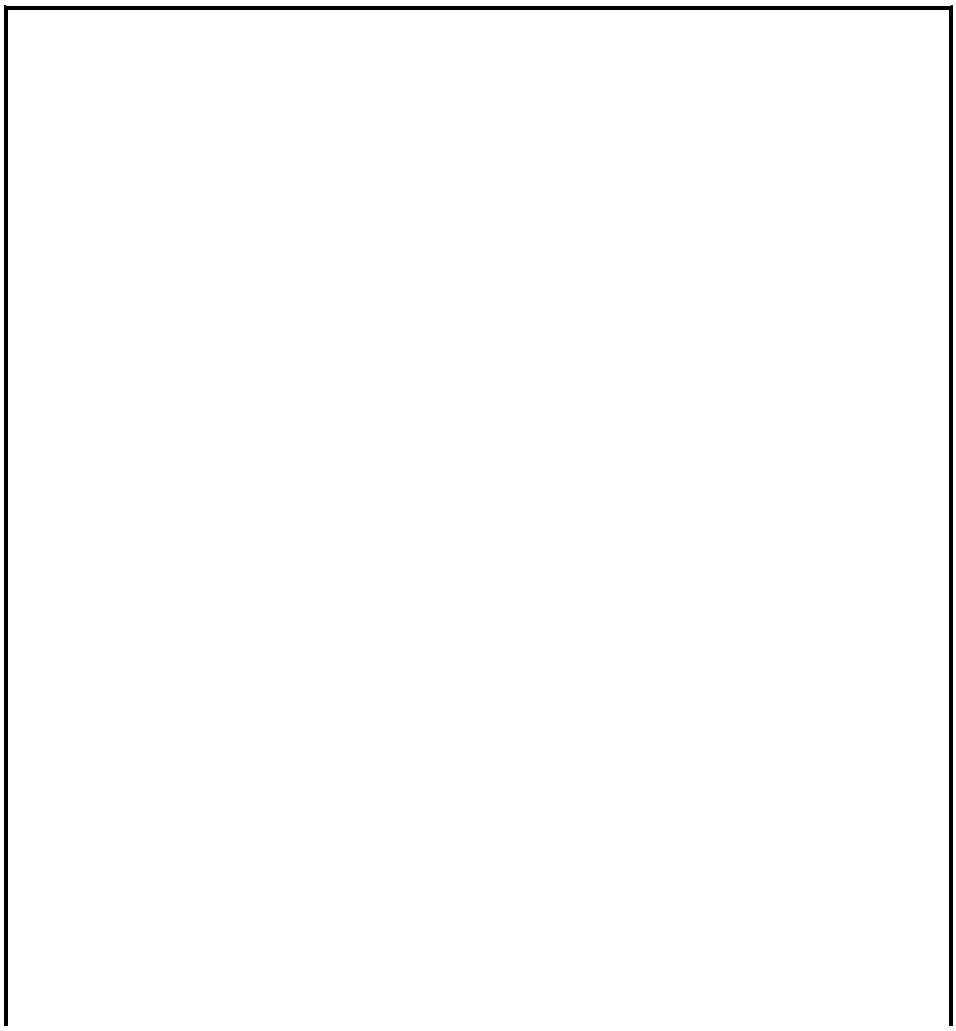
Description of the Survey Sites

The next section of this chapter provides descriptive information about the Native American sites recorded by the Pecos survey (Euro-American sites and artifacts are discussed in Chapter 10). As mentioned earlier, the large number of sites recorded does not allow for individual description of all sites. The discussion is organized by site type. Individual site descriptions are provided for habitation sites (communal pueblos and pueblos) since those are few in number and will be used for estimating population later in this volume. Seasonal and special-use sites are described through tables primarily, with commentary on certain aspects of these sites in the text. Table 5.20 summarizes the different feature types found at sites in each category with features.

Habitations

Communal Pueblos (100 rooms or more)

The survey recorded six communal pueblos at four sites. PECO 228 (LA 625), Pecos Pueblo (Figure 5.14), consists of three presently visible communal pueblos—the Quadrangle (also referred to as North Pueblo), South Pueblo, and the West Mound.[4] There is also a structure known as 700 House, so named in Kidder's notes because it occurred along the 700-foot line of his excavation grid (J. C. White, personal communication 2001), immediately south of the Quadrangle. The Quadrangle is estimated to have had 893 rooms (see Table 7.1) (Room estimates for the Quadrangle are discussed in detail in Chapter 7). From survey data, South Pueblo was estimated to contain 150 rooms; the West Mound was estimated to have 100 rooms; and 700 House was estimated to have 18 rooms. During excavation Kidder discovered structures underlying the Quadrangle and its trash deposits on the mesilla (1958:55-62). These have been referred to as Black-on-white House. He attributed these structures to Black-on-white and Glaze I and II times and noted that they were constructed without any plan, but just by the addition of rooms as needed. There was no evidence of these structures when Kidder began his excavations, nor can they be seen on the surface today.



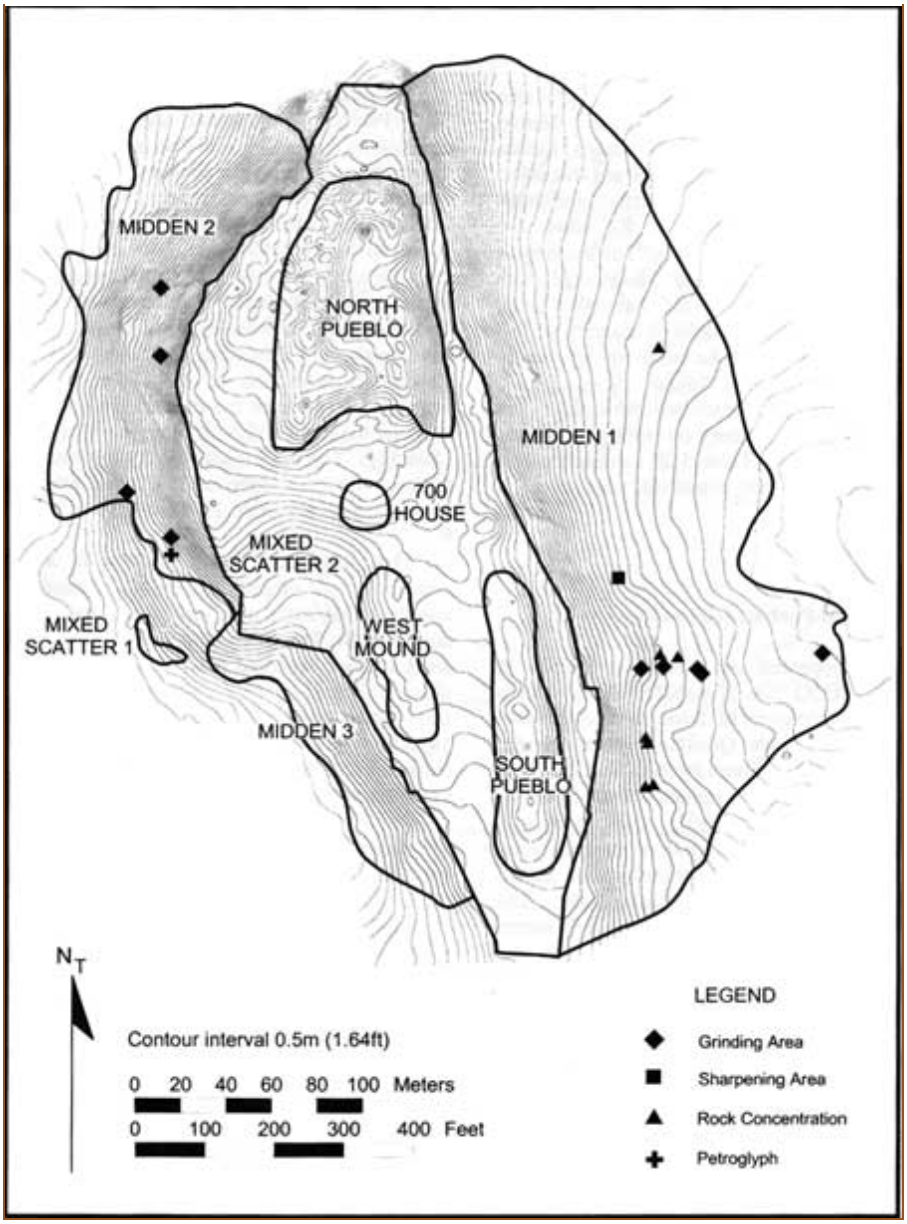


Figure 5.14. Pecos Pueblo north of South Pueblo (PECO 228 [LA 625]). Contour map by Shawn Penman, August 1996. *(click on image for an enlargement in a new window)*

The Pecos Pueblo structures (Quadrangle, South Pueblo, West Mound, and 700 house) are enclosed by a low rock wall that outlines the top of the mesilla, separating the pueblo complex from the outside world (Kidder 1958:113-118). Kidder estimated this wall was nowhere more than 3.5 feet (1 m) in height (1958:113), and given its great length it would have been ineffective as a physical barrier against attackers. It more likely served to clearly define Pecos Pueblo for both its residents and visitors. Castañeda, who documented Coronado's expedition of the 1540s, notes that visitors to Pecos from the Plains were not allowed to spend the night within the pueblo wall (Winship 1896:524). The date of construction of this wall is unclear, though Kidder notes it must have been after Glaze I times (A.D. 1315 to 1425).

The structures within this wall are all constructed of shaped and unshaped sandstone, and the Quadrangle may incorporate some adobe construction. The room blocks of the Quadrangle form a single enclosed plaza, and a second open plaza is formed by extensions of room blocks on the south end of the Quadrangle (Kidder 1958:Figures 20 and 21). A third plaza might be considered to be formed in the open area between the West Mound and South Pueblo.

Kidder (1958:64) shows 27 kivas within the enclosing wall both inside and outside the plaza of the Quadrangle and

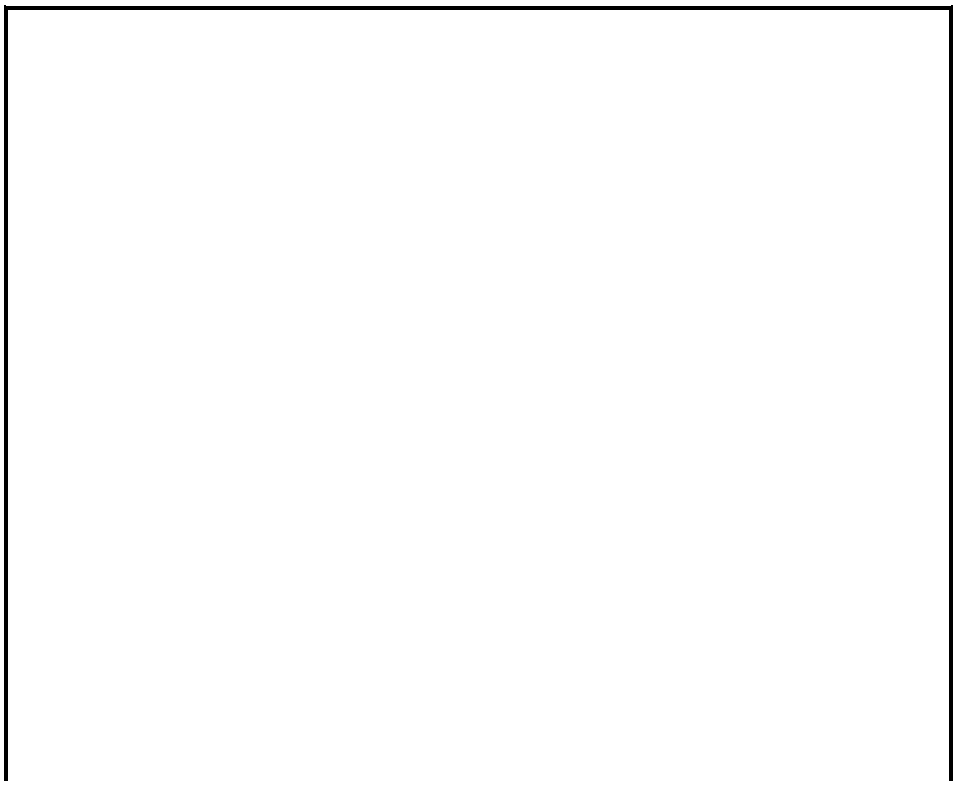
within or attached to the Quadrangle room blocks. Three of these kivas predate the construction of the Quadrangle (Kidder 1958:144). Other than these, Kidder did not associate any kivas with the other structures.[5]. Five of Kidder's 27 kivas were noted as visible by the 1990s survey field crew.

The Pecos Pueblo complex, as recorded by this survey, is surrounded by three separate middens, one on the east slope of the mesilla, below the east room block of the Quadrangle and South Pueblo; a second on the west slope of the mesilla, below what Kidder refers to as the "West Terrace," west of the west room block of the Quadrangle; a third midden was defined on the fairly shallow slope west of the West Mound. In addition two mixed artifact scatters were recorded with this complex. One was south and west of the Quadrangle, between it and the West Mound. This scatter occurs below an area of high sheet wash that has been denuded of vegetation. It is a mixed scatter of lithics and ceramics. The second scatter was defined within the area of the enclosing wall.

It was realized at the outset that this survey could contribute little further knowledge of the main structures of Pecos Pueblo because of the extensive excavation and recording done by previous researchers (see Chapter 2). One contribution this survey could make, however, was the discovery and description of minor non-structural features in the immediate environs of the pueblo structures. The area within the scatters was searched for features. Twenty-one features were discovered and recorded in this manner, including the enclosing wall. Eight of these features appear to relate to excavations, State Monument, or National Park Service activities (one possible structure, six rock concentrations, and one coursed stone wall). The rest of these features are bedrock grinding surfaces, including cupules and flatter grinding areas, one petroglyph (with a cupule) and a bed rock mortar. These features occur in bedrock outcrops on and below the mesilla rim and on the boulders and slabs that have eroded from the mesilla and ring its edge.

The Pecos Pueblo complex was occupied during ceramic Periods 3 through 5 defined for this project (A.D. 1325-1700). Tree-ring dates suggest construction episodes in the 1430s (see Chapter 4 and Appendix E) and historical documents indicate the final residents of the pueblo left in 1838 (Bandelier 1881; Hewett 1904; Kidder 1958).

PECO 710 (LA 251), known as Arrowhead Pueblo (Figures 5.15 and 5.16) consists of one communal pueblo and one pueblo. This site is located on a ridge near Glorieta Pass in the Pigeon's Ranch Unit of the park. The communal pueblo has an estimated 105 rooms and was partially excavated in the 1930s and 1940s by Texas Technical College under the direction of William Holden (Holden 1955; Pearce 1937) (see Chapter 2, this volume). Arrowhead Pueblo is constructed of coursed masonry using shaped and unshaped sandstone with some adobe.



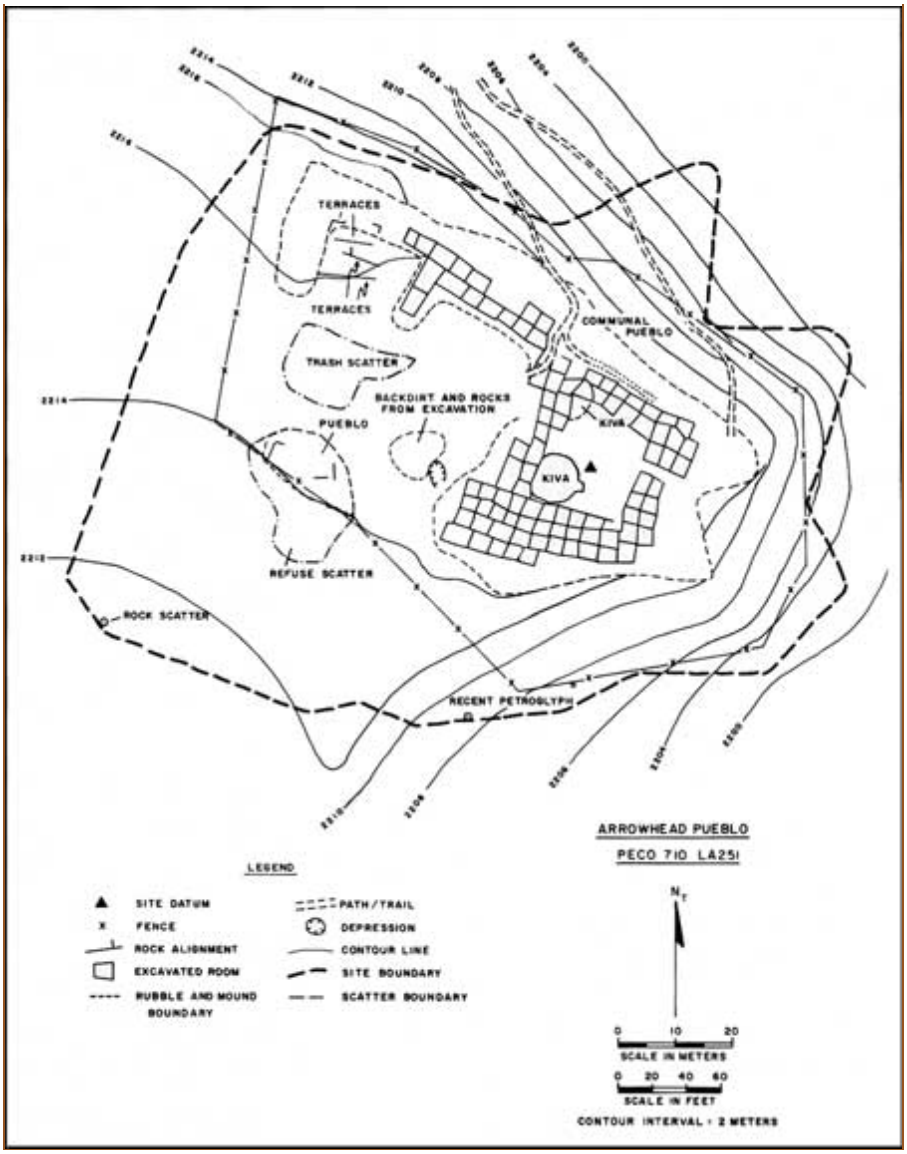


Figure 5.15. Map of Arrowhead Pueblo (PECO 710 [LA 251]). *(click on image for an enlargement in a new window)*

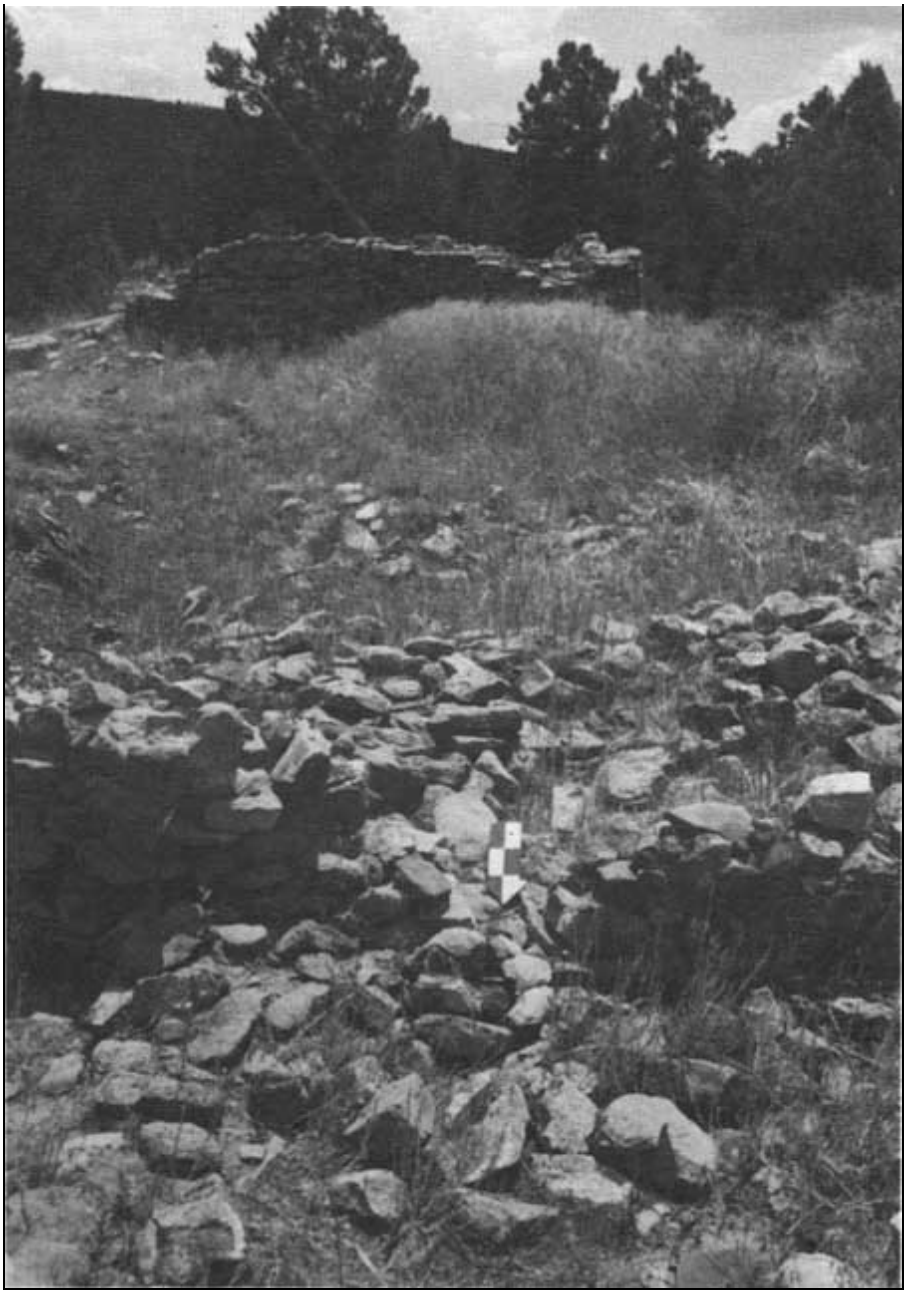


Figure 5.16. Arrowhead Pueblo (PECO 710 [LA 251]). View south across plaza, room 69 in foreground, reconstructed kiva in background.

Though it is irregular in shape, the four room blocks of the pueblo form a rough square around a plaza with a single opening to the east. An additional room block is attached to the northwest corner of the main structure. Two kivas are evident in the plaza, one built against the west wall of the plaza (Figure 5.16) and one in the northwest corner of the plaza. This latter was subsequently broken into rooms (Holden 1955:107).

The pueblo adjacent to the communal pueblo is evident from a mound with several rock alignments. It is estimated to have contained only eight rooms, based on the size of the mound. Field crews noted that this mound might have been an earlier structure that was partially dismantled for the construction of the larger pueblo. It was apparently built of shaped and unshaped sandstone, probably coursed masonry.

A series of three terraces that may actually constitute a grid garden was recorded near the pueblo, as were two ground cupules. Other features on the site such as hearths, trails, a scratched petroglyph, and a benchmark, are associated with excavation and historic use of the communal pueblo as a tourist attraction. Field crews recorded a mixed ceramic and lithic artifact scatter on the mesa top surrounding Arrowhead Pueblo and another on the slope

below the structure.

According to the chronology defined for this project, Arrowhead Pueblo was occupied during Periods 2 and 3 (A.D. 1200-1450). These dates reflect the early end date for Santa Fe Black-on white used in the chronology construction, however, as well as the removal of glaze ware ceramics from the surface by visitors to the site (Chapter 4). Excavation data and tree-ring dates define a later occupation, running from A.D. 1370 to 1450 (Holden 1955; see also Appendix E, this volume).

The two other sites with communal pueblos are Forked Lightning Pueblo and Loma Lothrop. Both were partially excavated early in the century by Kidder or by individuals associated with his project (see Chapter 2). Both lie in the main Pecos Unit of the park, on the west side of Glorieta Creek—Forked Lightning to the south and west of Pecos Pueblo, Loma Lothrop to the north and west (see Figure 1.2).

Forked Lightning Pueblo (PECO 226, LA 672) (Figure 5.17) lies in a low area at the juncture of Glorieta Creek (also called Arroyo del Pueblo) and a tributary drainage (called by Kidder "North Arroyo," 1958:Figure 2). Glorieta Creek has eroded an unknown number of rooms from the eastern portion of the structure. Forked Lightning Pueblo was constructed of coursed adobe, with some walls and floors of stone. Little is visible of the structure at the present time (Figure 5.18). Survey crews estimated 150 rooms, though Kidder comments that he never successfully delimited the full extent of the structure (1958:8-9). He shows 140 rooms in the East Pueblo (1958:6, Figure 2).

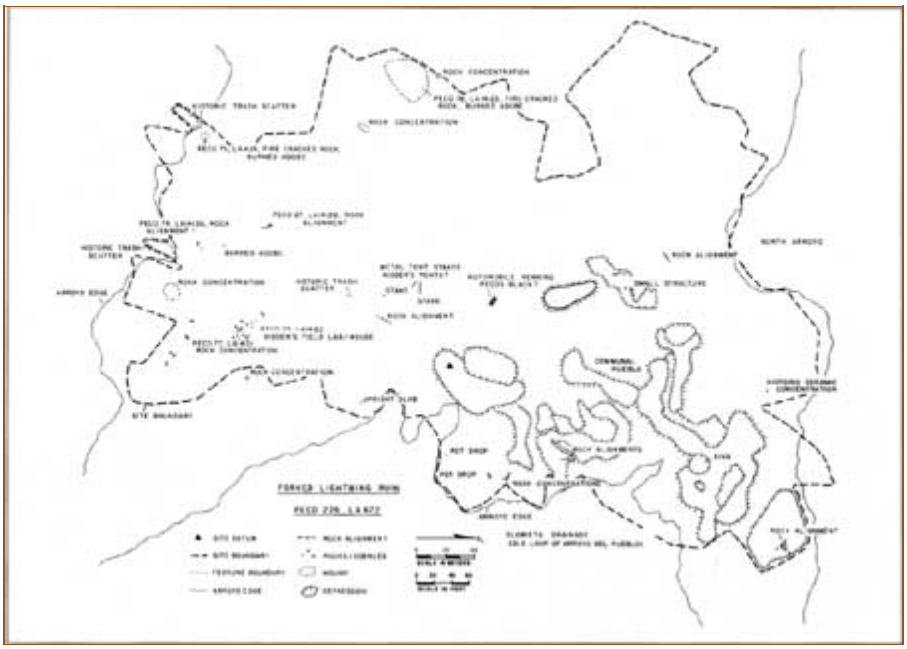


Figure 5.17. Map of Forked Lightning Pueblo (PECO 226 [LA 672]). *(click on image for an enlargement in a new window)*



Figure 5.18. Forked Lightning Pueblo (PECO 226 [LA 672]). View north of 1996 site stake.

The shape of Forked Lightning is irregular, reflecting, as Kidder noted, the growth of the pueblo through the agglomeration of rooms and room blocks. The room blocks excavated by Kidder appear to have formed a plaza with at least one opening to the west, though he mentions that the overall form may have included several plazas (Kidder 1958:9). Kidder identified seven kivas, two of which were subsurface, five of which were above ground (1958:29). None of these are presently visible on the surface, though the crew recorded a depression that might be a kiva. As recorded on survey, Forked Lightning Pueblo was accompanied by a variety of nonportable features including: a two-room small structure; three concentrations of burned adobe that may be from excavation or the burning of a portion of the pueblo noted by Kidder (1958:43); seven rock alignments, some of which may be walls within the pueblo; six rock concentrations; and an upright slab. The survey crew also recorded a second component on the site consisting of features associated with Kidder's field camp and laboratory, including the frame of one of his field vehicles. This is most likely "Pecos Black" the less well-known of Kidder's infamous field vehicles. "Old Blue" apparently made it back to the East Coast (Elliott 1995:42-43; Judd 1968:94) (Ann Rasor, personal communication 2001).

The occupation of Forked Lightning Pueblo falls into ceramic Periods 2 and 3 (A.D. 1200-1450) though tree-ring and ceramic evidence suggest a slightly earlier start date of A.D. 1175 (see Chapter 4 and Appendix E). Forked Lightning was probably empty by the time of the construction of the Pecos Pueblo Quadrangle.

Loma Lothrop (PECO 227, LA 277) (Figure 5.19) sits on a knoll above and immediately west of Glorieta Creek. It appears to have been constructed of hand-molded adobe, possibly with unshaped sandstone and cobble footings (Metzger 1990b:5-3). Today the pueblo is evidenced by numerous rock alignments and clear room outlines (Figure 5.20). It is in the shape of an E with room blocks forming two small plazas. Crews estimated 150 rooms in the pueblo. No kivas were visibly associated with the structure, nor found during the excavations of the 1920s (Kidder 1958:47). The pueblo was associated with one possible structure, a concentration of fire-cracked rock, a terrace with upright slabs, a rock alignment, and seven probable agricultural features made of linear cobble scatters parallel to the slope below the pueblo. A single scatter of lithics and ceramics was recorded on the site. Loma Lothrop was occupied during ceramic Period 3 (A.D. 1325-1450).

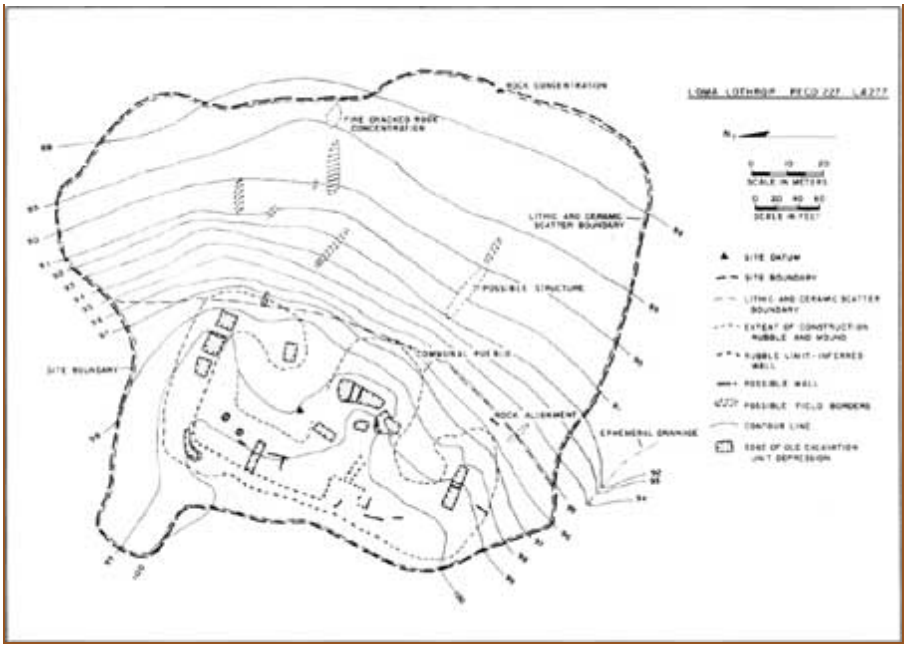


Figure 5.19. Map of Loma Lothrop (PECO 227 [LA 277]). *(click on image for an enlargement in a new window)*

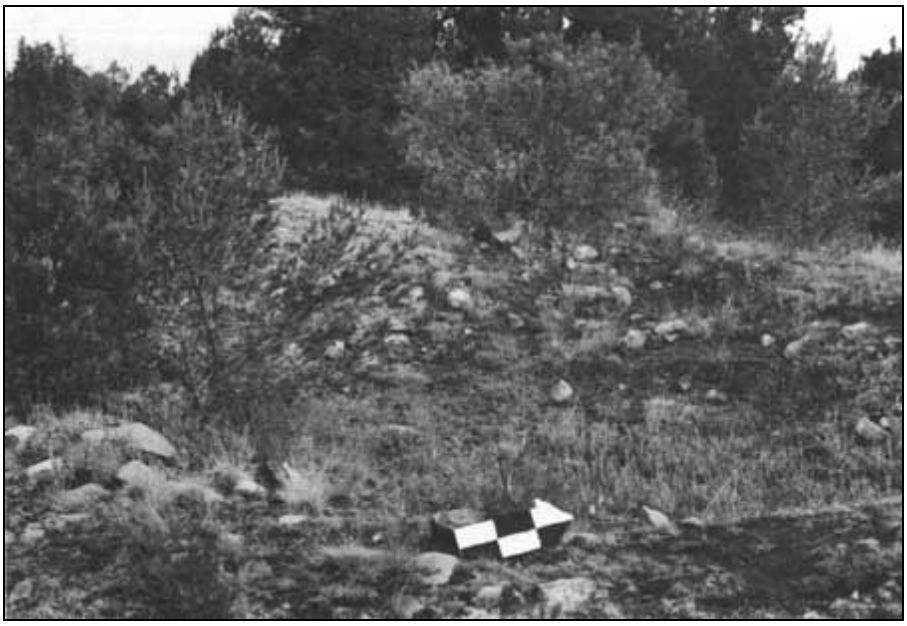


Figure 5.20. NE corner of Loma Lothrop (PECO 227 [LA 277]) excavated in the 1920s, view NW.

Pueblos (6-99 rooms)

Eight pueblos were recorded by the survey at eight different sites. One pueblo has been described in conjunction with the Pecos Pueblo complex (700 House) and one in conjunction with Arrowhead Pueblo. The remaining six were found at three named pueblos (Long House, Dick's Ruin, and Shin'po) and three unnamed sites (PECO 23, 30, and 215).

Although two excavated rooms are obvious at Shin'po (PECO 307, LA 267) (Figures 5.21 and 5.22), there is no record of it ever having received scholarly archeological attention. The site sits on a knoll about 50 m above a north-

south drainage area west of the Pecos River. Although it is not dissected, this low area generally flows toward the south and joins the arroyo that runs past Rowe Pueblo, approximately 3.2 km (2 mi) to the south. From this knoll, the structure of Shin'po has a clear view of a knoll above the river to the west and the two access points to the river on either side of it. It also has views south to Rowe Pueblo and the bottom end of the Upper Pecos Valley, northwest to Pecos Pueblo, and beyond to the pass at Glorieta.

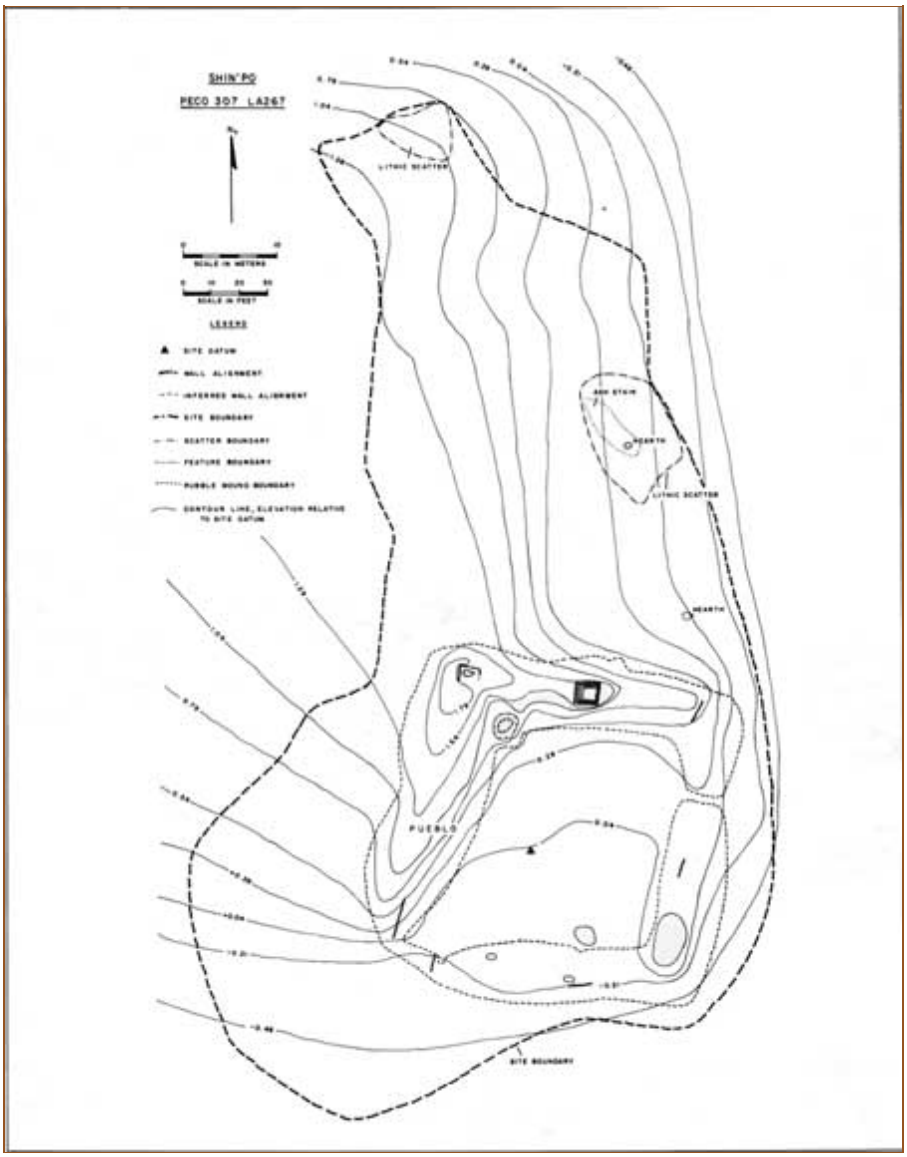


Figure 5.21. Map of Shin'po (PECO 307 [LA 267].) *(click on image for an enlargement in a new window)*



Figure 5.22. Partially excavated room at Shin'po (PECO 307 [LA 267]) in northern room block, view SSW.

Shin'po contains approximately 65 rooms (Figure 5.23), but very few artifacts were found in association with the structure—no more than 30 sherds were recovered across the site. The slopes below the structure were also examined, and though a few artifact scatters were found at the base of the slope, nothing suggests the kind of midden that might be expected from a site of this size had it been occupied for any long period of time. A small dense lithic scatter located immediately north of the pueblo was accompanied by ashy soil and some burned sandstone and may relate to later, nonoccupational use of the area (Head 1998) (1995 field notes on file at Pecos National Historical Park). A second lithic scatter north of the structure is composed almost entirely of small obsidian flakes. The structure appears to have been built of masonry. No kiva was visible. Jemez oral history (Levine et al. 1995) suggests that Shin'po was used mostly as a large field house or temporary farming location but not as a full time habitation.



Figure 5.23. Across the plaza of Shin'po (PECO 307 [LA 267]). Note site stake beneath plane table.

Long House (PECO 402, LA 118967) (Figure 5.24) is a single room block of an estimated 40 rooms, apparently two rooms wide, in an open flat area west of a deep bend in the Pecos River (Figure 5.25). Long House also had very few artifacts, though this might be partially explained by its close proximity to the Forked Lightning Ranch House about 0.4 km (0.25 mi) to the southwest. The structure was primarily of masonry construction, using both sandstone and unshaped limestone. Limestone is the predominant bedrock in areas near the Pecos River. This pueblo is accompanied by a small structure and was apparently occupied during Periods 3 and 4 (A.D. 1325-1575).

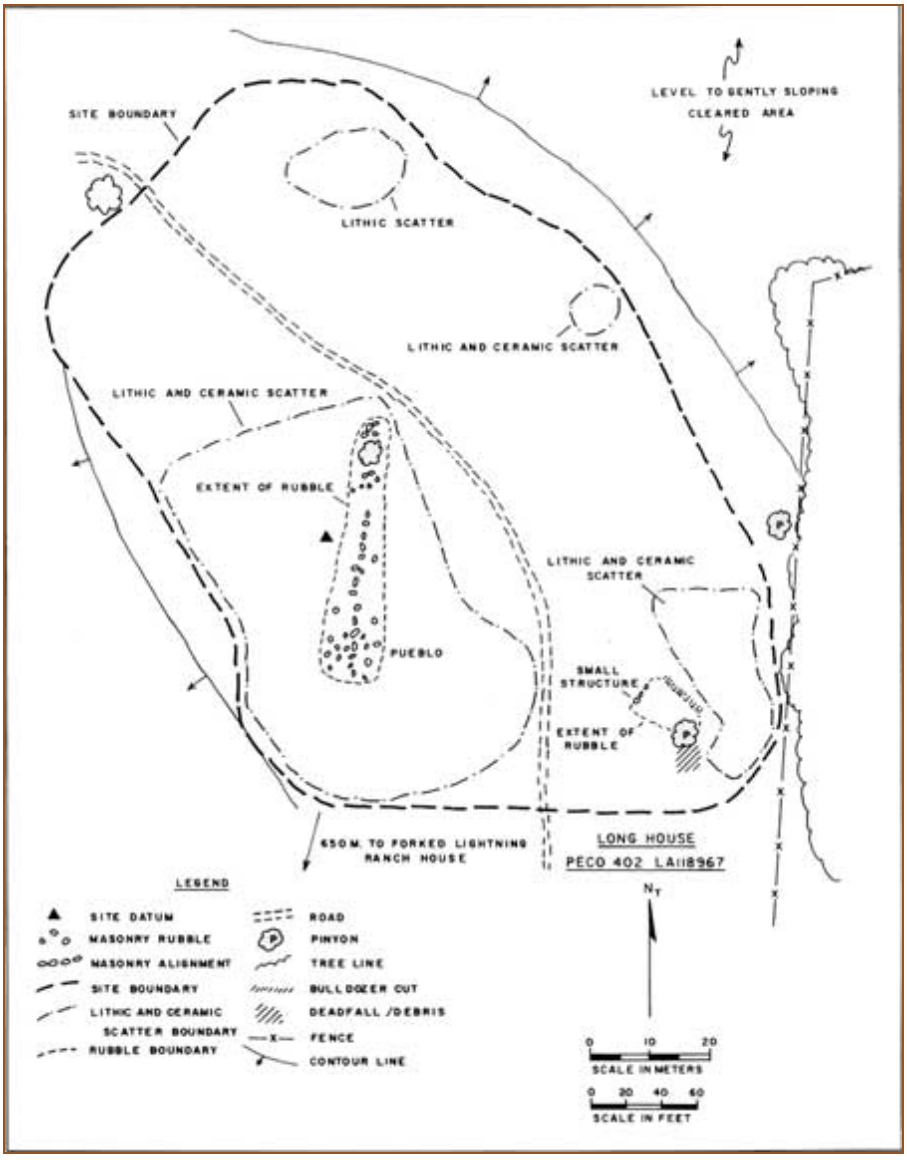


Figure 5.24. Map of Long House (PECO 402 [LA 118967]). *(click on image for an enlargement in a new window)*

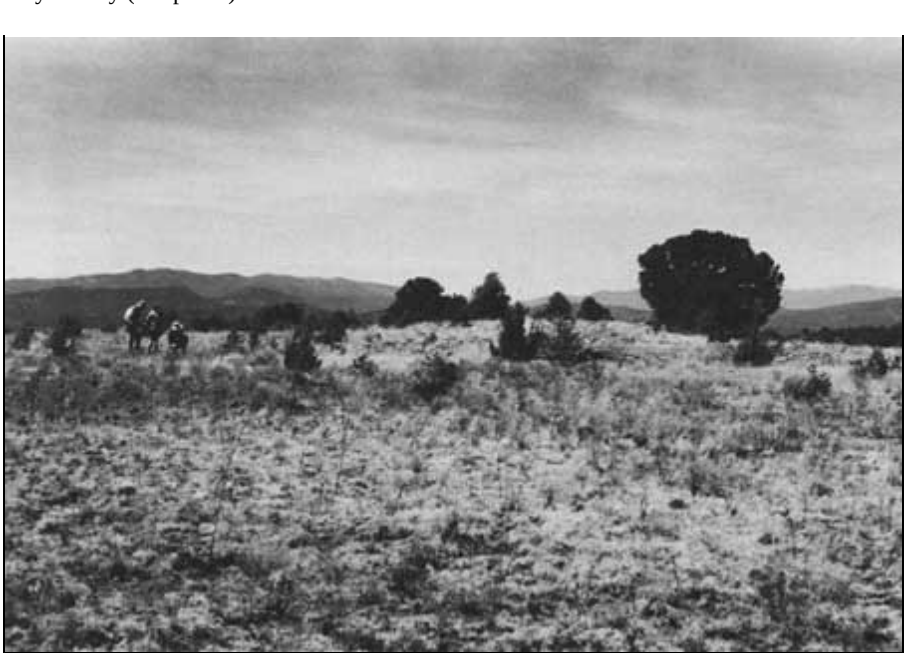


Figure 5.25. Long House (PECO 402 [LA 118967]). Note mound in center of photograph, view North.

Dick's Ruin (PECO 434, LA 276) (Figures 5.26 and 5.27) sits in a low area immediately above the Pecos River. It is roughly a C-shaped pueblo with an additional room block attached to the western side (closed side of the C). A low wall between the two ends of the C blocked off the opening of the plaza. The approximately 50 rooms of this structure were constructed of unshaped limestone and sandstone. The structure may have been two stories in some places. As in other pueblos, stones from Dick's may have been used in the creation of later structures, since there is a Hispanic site very close by. No kiva was noted from surface examination, but one corner kiva was found during excavations of the site during the 1920s (Kidder 1958:47). A possible tipi ring with a separate scatter was located just south of the pueblo (Figure 5.28). Dick's was occupied during ceramic Periods 2 and 3 (A. D. 1200-1450), though the dominance of black-on-white ware and the very small number of early glaze ware sherds suggests an end date closer to 1425.

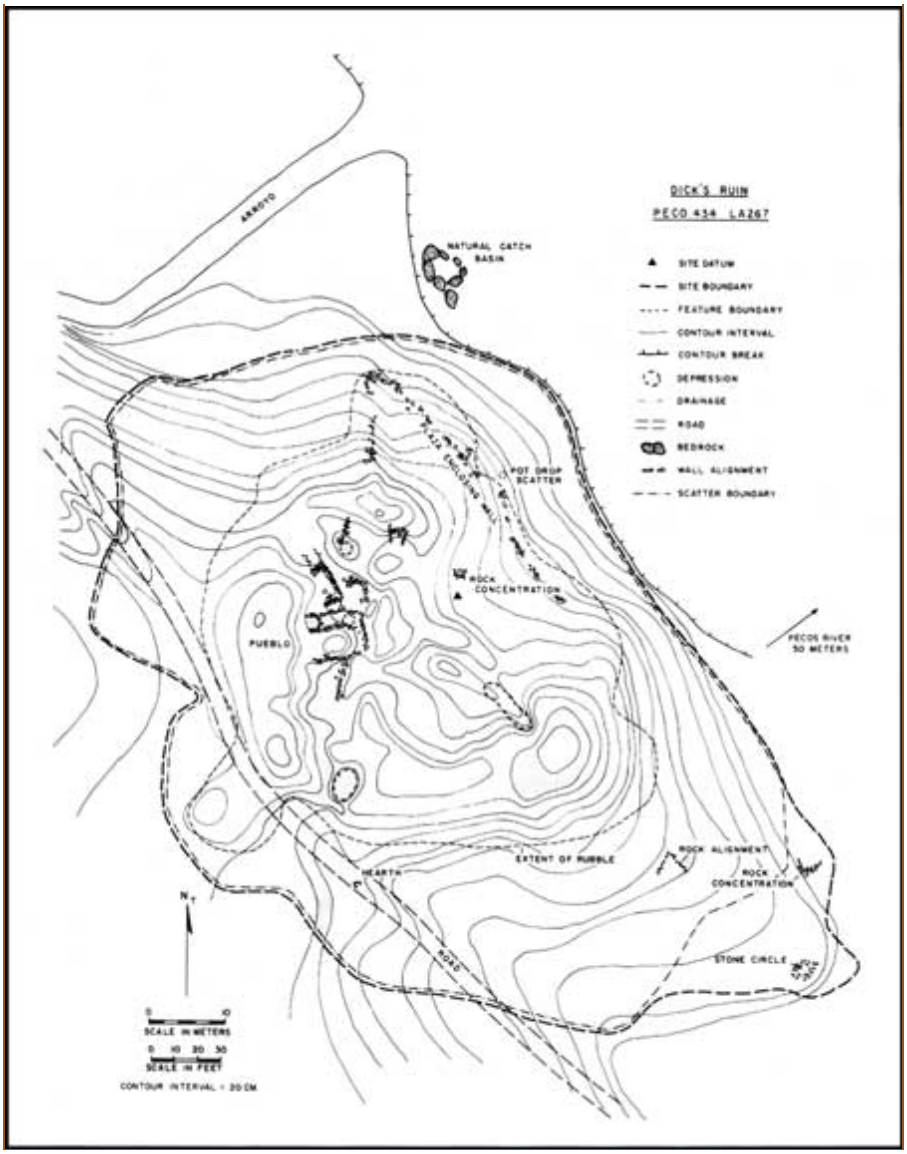


Figure 5.26. Map of Dick's Ruin (PECO 434 [LA 276]). *(click on image for an enlargement in a new window)*



Figure 5.27. Dick's Ruin (PECO 434 [LA 276D]). View NNW of plaza and areas excavated in the 1920s.



Figure 5.28. Stone circle or possible tipi ring near Dick's Ruin, view NNE. Note that pinflags mark the rocks in the feature.

The three unnamed pueblos are all in close proximity to Pecos Pueblo and Forked Lightning Pueblo. They are quite enigmatic but were recorded as pueblos in 1976 or 1992 by Nordby, and after field examination, the 1990s crews confirmed these attributions.

PECO 23 (LA 14124) (Figure 5.29) is the most enigmatic of the three unnamed sites, consisting of concentrations of burned adobe and a small rubble mound with a vegetation anomaly/depression that may be a kiva. It is in association with four petroglyph panels and numerous oval grinding areas on a bedrock outcrop immediately above a currently active spring. The possible kiva is in close association to the grinding areas and petroglyphs. The pueblo structure was estimated to have contained 10 rooms based on the extent of the adobe and rubble scatter.

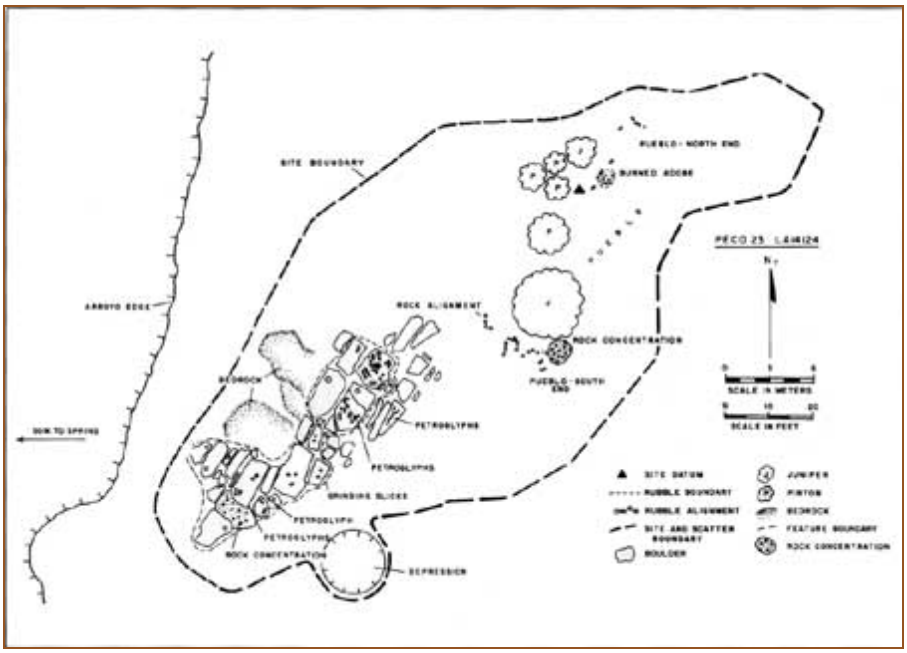


Figure 5.29. Map of PECO 23 ([LA 14124]). *(click on image for an enlargement in a new window)*

PECO 30 (LA 14113) (Figures 5.30 and 5.31) consists of mounds and rock scatters with some rock alignments. It is immediately south of Square Ruin (PECO 35, LA 14114), a Spanish-era enclosure (Nordby and Creutz 1993b) (James Ivey, personal communication 1997). The field crew noted that stone from the structure at PECO 30 was probably used in the later construction of Square Ruin. This probable stone robbing made it difficult to interpret the exact shape and size of the structure. Crews estimated 45 rooms based on the extent of the mound and rubble. The structure was predominantly masonry, with some adobe.

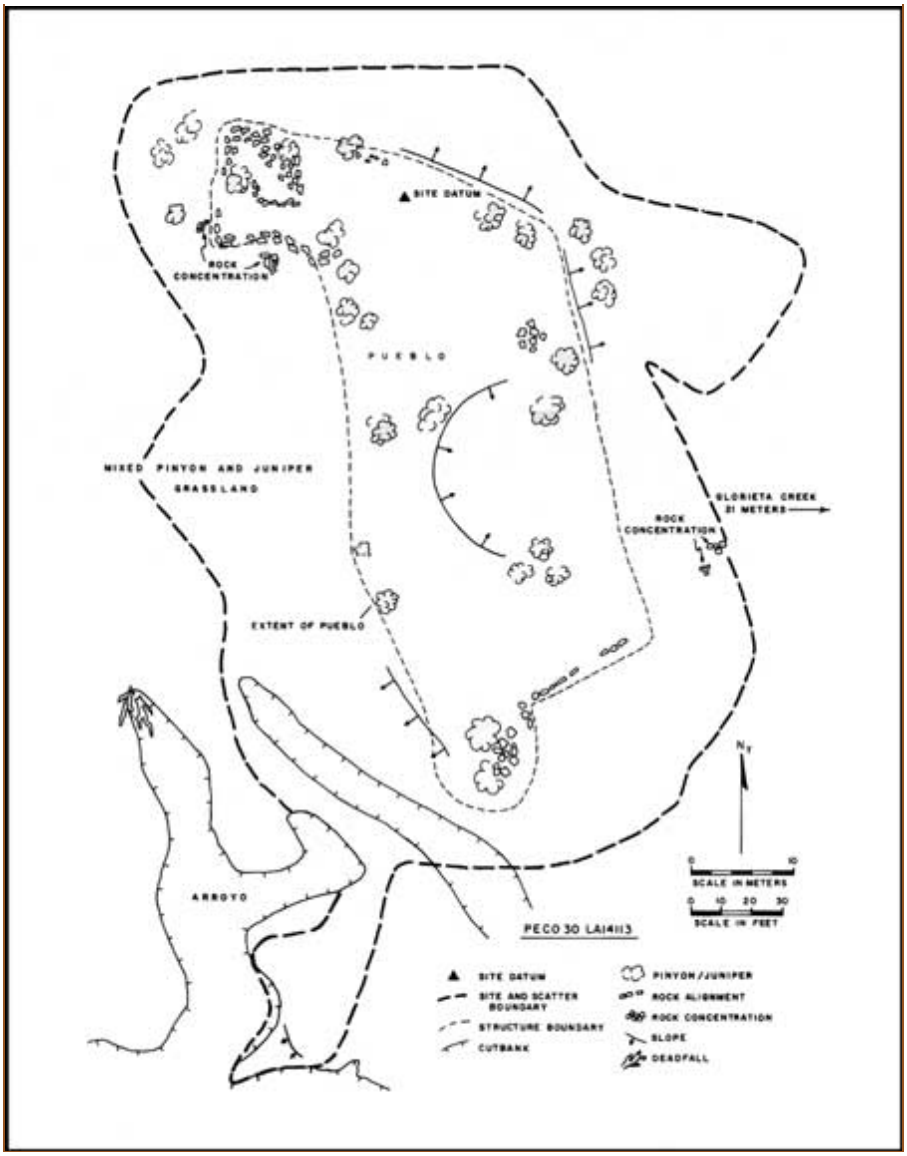


Figure 5.30. Map of PECO 30 (LA 14113). *(click on image for an enlargement in a new window)*



Figure 5.31. View SE of PECO 30 (LA 14113). Note mound just inside treeline.

At PECO 215 (LA 118811) (Figure 5.32) the pueblo structure is most easily recognized by a masonry corner exposed in a recent bulldozer cut (Figure 5.33). This corner is visible about 0.3 m (1 foot) below present ground surface and is at the west end of the site. On the surface to the east of this exposed corner are found rock alignments that are in line with the southern wall of this corner and suggest the extent of the pueblo, estimated to have contained 16 rooms. This pueblo structure is accompanied by an unknown structure that shows a slight depression (possibly a kiva), a tight concentration of rock, and a small structure evidenced by two alignments of upright cobbles that form a corner. An ash stain containing burned adobe and slag is also in immediate proximity to the pueblo.

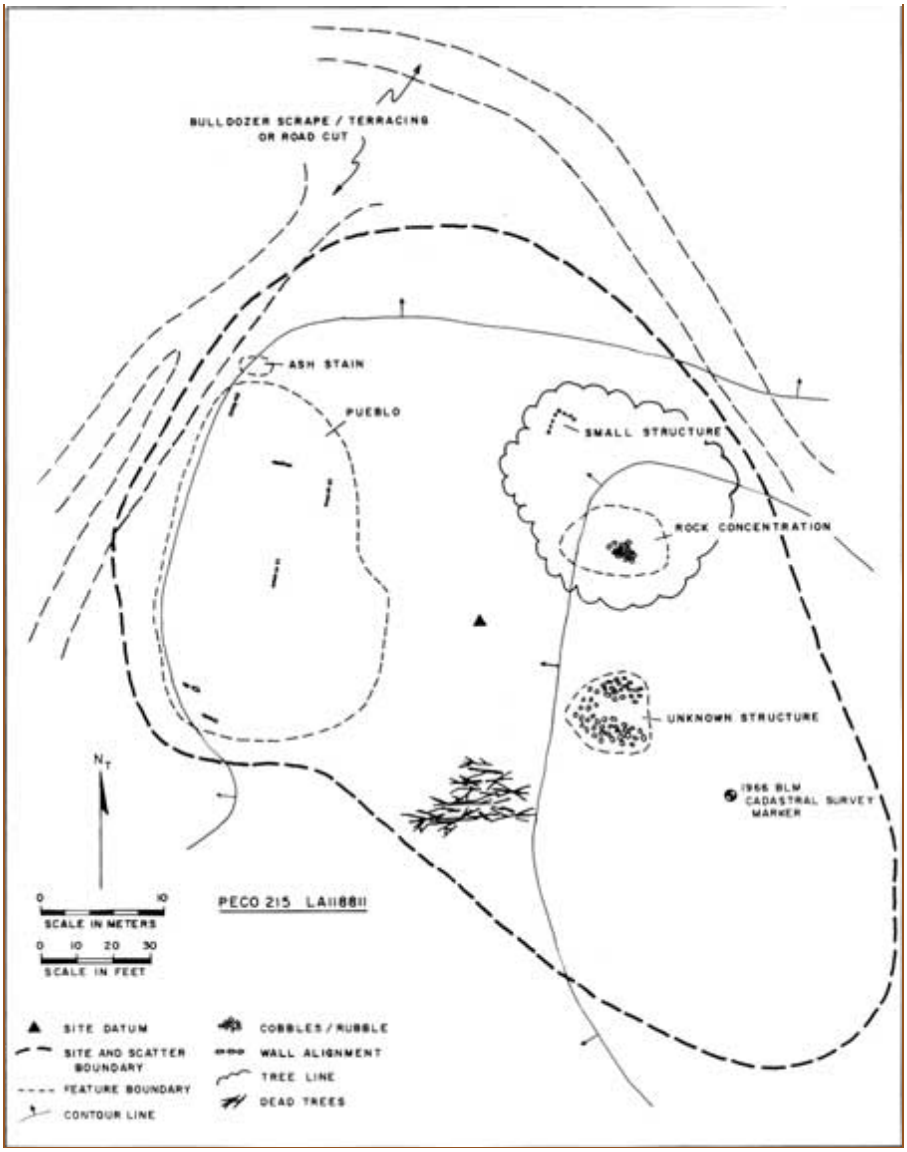


Figure 5.32. Map of PECO 215 (LA 118811). *(click on image for an enlargement in a new window)*



Figure 5.33. Wall at PECO 215 (LA 118811), exposed in recent road/bulldozer cut, view NNE.

These three pueblos, though all difficult to detect from the surface, suggest an occupation of the Upper Pecos Valley that may have predated Forked Lightning Pueblo. In a consideration of occupation probabilities based on ceramic types, these pueblos appear to date slightly earlier than Forked Lightning (see Chapter 4). Adobe construction and the borrowing of rocks from these sites to build later structures would explain their ambiguous appearance.

Seasonal Sites

Seasonal sites are defined as those with structures of six or fewer rooms, with or without features, and sites with no structures but with multiple nonstructural feature types present. There are 206 prehistoric sites in this site type. The kinds of nonstructural features found at seasonal sites are presented in Table 5.20. The types of structural features on seasonal sites are presented in Table 5.23. In Table 5.23, the category "Unknown structure" represents features that crews could determine were certainly structures but could not determine their exact nature due to disturbance from bulldozing, trees and over growth, or vandalism.

Table 5.23. Structure types on seasonal sites.

Structure Type	Count
Small structure (1-8 rooms)	105
Tipi ring	1
Rock shelter	5
Pit structure	2
Shrine	8
Unknown depression	1
Unknown structure	15
Possible structure	64
Other structure	1
Total	202

The most common types of features at seasonal sites are rock concentrations and petroglyphs/pictographs. In Table 5.21, a cross-tabulation of site type and feature group, the greatest difference between expected and observed frequencies is in the association of seasonal sites with bedrock features. Table 5.20, showing feature types at site types, indicates a high frequency of petroglyphs/pictographs and grinding areas on seasonal sites. Eighty-two percent of all petroglyphs/pictographs and 61 percent of all grinding areas are found on seasonal sites.

Table 5.24 shows the kinds of artifact scatters associated with seasonal sites. Fifteen seasonal sites had no artifact scatters at all. Lithic dominant lithic and ceramic scatters (where lithics account for more than 80 percent of the artifacts) were the most frequent, followed closely by mixed lithic and ceramic scatters (where neither artifact type makes up more than 80 percent of the assemblage). Lithic only scatters were also fairly common.

Table 5.24. Artifact scatter types at seasonal sites.

Scatter Type	Count	Percent
Mixed ceramic and lithic	90	33.8
Ceramic dominant[a]	13	4.9
Lithic dominant[b]	106	39.8
Ceramic only	3	1.1
Lithic only	38	14.3
Pot drop	14	5.3
Lithic quarry	2	0.8
Total	266	100.0

[a]>80% ceramics.
[b]>80% lithics.

Special-use Sites

Special-use sites are defined as those with only a single feature type or with no features whatsoever. There are 394 sites in this category. Two-hundred ninety-nine, or 76 percent, are artifact scatters with no features. The types of features on special-use sites are shown in Table 5.20. Rock concentration/scatters are the single most frequent kind of feature at special-use sites, followed by grinding areas, rock alignments, and petroglyphs/pictographs. The kinds of artifact scatters on special-use sites, both with and without features, are shown in Table 5.25. Lithic dominant artifact scatters are the most common type of scatter on special-use sites, followed by mixed ceramic and lithic, then lithic only scatters. A chi-square test of the null hypothesis that the variables in Table 5.25 are independent did not lead to rejection of the null hypothesis, indicating no significant relationship between the presence/absence of nonportable features and the kind of scatters on special-use sites.

The greatest apparent difference between scatters on special-use and seasonal sites is that lithic only scatters are much more common on special-use sites than on seasonal sites—28 percent and 14 percent respectively. Otherwise, the proportions of the different scatters at the two site types are roughly equivalent (see Tables 5.24 and 5.25). This may reflect the presence of preceramic scatters among the special-use sites.

Table 5.25. Artifact scatter types at special-use sites.

Scatter Type	Without Features	With Features	Row Totals	(%)
Mixed ceramic and lithic	89	31	120	(27.8)

Ceramic dominant[a]	18	2	20	(4.6)
Lithic dominant[b]	105	39	144	(33.3)
Ceramic	7	0	7	(1.6)
Lithic	100	20	120	(27.8)
Pot drop	15	4	19	(4.4)
Other	—	2	2	(0.5)
Column totals	334	98	432	(100.0)

[a]>80% ceramics.
[b]>80% lithics.

Subsistence and Social Change through Architecture

The purpose of the third section of this chapter is to examine the changes that took place pre-historically in the Upper Pecos Valley as seen through architectural data. Two categories of architecture will be considered specifically because of their inherent interest and their suitability for addressing concerns set out in the introduction of this volume, namely, how Pecos Pueblo differed from its predecessors and how it supported itself. Agricultural features are of interest because they can inform upon the methods and strategies used by the residents of the Upper Pecos Valley to grow crops and how aggregation and trade affected these strategies. Kivas are of interest because they can give us clues to how the Pecos people were organized and how that social organization was changed or maintained throughout the life of the pueblo.

Agriculture

Expectations

A population the size of Pecos must have relied on its own food production. Spielmann's simulation study for the protohistoric period indicates that in most years Pecos should have been able to supply corn for itself and at least three months' worth for trade (Spielmann 1991b). Bone chemistry analysis suggests that until the late 1600s, corn made up at least 75 percent of the diet at Pecos (Spielmann et al. 1990). Agriculture is thus assumed to have been a crucial activity to the residents of the Upper Pecos Valley.

Before the founding of Pecos Pueblo, agriculture is expected to have been performed primarily at the household level and to have required only minimal improvements for the retention of soil and water. Most agricultural activities should have taken place near habitations (this specific expectation is addressed in the Settlement chapter—Chapter 6) and should have required little in the way of shelter or field houses.

With the foundation of Pecos Pueblo and the increase in population and population density, we expect that there should be an increase in the intensification of agriculture. Though the household remains the basic unit of the pueblo economy (Ford 1972; Snow 1981), agricultural intensification may have involved the addition of community-level activities (Adler 1994; Snead 1995). Intensification should appear as increased investment in agriculture, evidenced by an increase in the number of agricultural features and the creation of more complex or labor-intensive features. The number of agricultural features is expected to increase throughout the occupation of Pecos Pueblo to supply the population there, as well as to fund Pecos' trade relationships.

These expectations are tested by examining the number and type of agricultural features recorded by the Pecos survey. The number and types of agricultural features should increase from ceramic Period 2 to Period 3 (A.D. 1200-1450) (formation) and remain high through ceramic Period 6 (post A. D. 1700) (maintenance). There should be more agricultural features in general in these periods than in earlier ones, and there should be more features that would require more than a single household to create and maintain, such as reservoirs or irrigation systems. There should also be more small structures, reflecting an increase in agricultural investment, as well as exploitation of areas farther from the habitation, necessitating greater shelter at field locations.

Expectation Testing

The survey recorded a total of 38 agricultural features. Table 5.26 shows the different kinds of agricultural features recorded and the types of sites on which they occur. Check dams were defined by the survey as "linear arrangements of stone (one to a few courses high) built across drainages for the purpose of slowing runoff and perhaps capturing water and soil" (Pecos Survey Site Manual Glossary, Appendix A). Grid gardens were defined as "rectilinear arrangement of rocks, often contiguous, forming a grid-like pattern; built to help retain soil and water in garden plot areas; typically single course alignments." Terraces were defined as "rock alignments or walls (one to a few stones high) built perpendicular to the slope direction ("on contour"), to control surface runoff and down-slope movement of soils." Reservoir/catchments were defined as "natural and/or modified (excavation, damming) catchments or basins used as water collection areas."

The last two feature descriptions in Table 5.26 require some explanation. The seven field borders are the linear alignments on the slopes below the pueblo of Loma Lothrop (PECO 227) (Figure 5.19). The field crew did not feel they fit the description for either terraces or grid gardens but that their arrangement suggested more the definition of a field area. The two rock piles both occur on the same site (PECO 334) along with a small structure, an unknown structure, and two check dams. The crew noted that both rock piles appeared to be for use as water or soil control and hence could be considered agricultural.

Over 73 percent of these agricultural features occur on seasonal or special-use sites, and well over half (58 percent) occur on seasonal sites. This lends verity to the expectation that agricultural activities would take place predominantly at seasonal sites. These 38 agricultural features occur on a total of 24 sites. Twenty agricultural features (over 52 percent) occur on a site with another agricultural feature.

Table 5.26. Agricultural features by site type.

Feature Type	Habitation	Seasonal	Special-Use	Count (%)
Check dam	—	6	1	7 (18)
Grid garden	—	5	1	6 (16)
Terrace	3	8	3	14 (34)
Reservoir/catchment	—	1	1	2 (5)
Rock pile	—	2	—	2 (5)
Field borders	7	—	—	7 (18)
Total	10	22	6	38 (100)
(%)	(26%)	(58%)	(16%)	

Table 5.27 shows the type and number of agricultural features in each period. There are three features on sites that could not be dated with ceramics. Two are grid gardens; one is a terrace. Many agricultural features appear on sites dated to multiple periods. It is assumed for this discussion that an agricultural feature was initially created in the first period in which it appears. This is considered the time of initial investment. The feature is then assumed to have been used with little cost in the subsequent periods to which it was assigned. The number of new features in each period is shown in the right hand column of Table 5.27 as an indication of investment in agriculture in each period.

Table 5.27. Agricultural features, by ceramic period.

Ceramic Period	Feature Type	Count	New
Period 2 (A.D. 1200-1325)	Check dam	4	4

	Grid garden	1	1
	Terrace	6	6
	Rock pile	2	2
	Total	13	13 (100%)
Period 3 (A.D. 1325-1450)	Check dam	5	3
	Grid garden	3	2
	Terrace	10	6
	Reservoir/catchment[a]	1	1
	Field borders[a]	7	7
	Total	26	19 (73%)
Period 4 (A.D. 1450-1575)	Check dam	6	1
	Grid garden	3	1
	Terrace	5	—
	Reservoir/catchment	2	1
	Rock pile	2	—
	Total	18	3 (17%)
Period 5 (A.D. 1575-1700)	Check dam	5	—
	Terrace	4	—
	Reservoir/catchment	1	—
	Rock pile	2	—
	Total	12	—
Period 6 (post A.D. 1700)	Terrace	1	—
	Total	1	—
Undated Sites	Grid garden	2	
	Terrace	1	
	Total	3	

[a]Indicates first appearance of this feature type.

Agricultural features first appear in Period 2 (A.D. 1200-1325), with 13 new features and four feature types. The number of features doubles in Period 3 (A.D. 1325-1450), and the number of types increases with the addition of a reservoir northeast of Pecos Pueblo and a complex of field borders on the slopes below Loma Lothrop. Grid gardens are also added. Period 3 appears to be the time of greatest agricultural investment, with 19 new agricultural features (73 percent of the total for the period) created. This finding supports the expectation that aggregation will be accompanied by more agricultural features, more types of agricultural features, and the creation of larger, more complex features.

The number of agricultural features declines in Period 4 (A.D. 1450-1575), however. Only three (17 percent) new agricultural features are created in this time period, and only 18 appear to have been used at all. This represents a decline of 69 percent from the number of agricultural features used in ceramic Period 3 (A.D. 1325-1450). The number of agricultural features declines by 33 percent in Period 5 (A.D. 1575-1700), and there are no new features created. This decline continues through Period 6 (post A.D. 1700), with only one agricultural feature dated to this period, and no new features created.

Discussion

It would appear from these results that the initial formation and occupation of Pecos Pueblo and the peak of population estimated from survey sites during ceramic Period 3 (A.D. 1325-1450) (see Chapter 7, Figure 7.1) was indeed accompanied by an increase in agricultural intensity. The peak of aggregation that occurred in ceramic Period 4 (A.D. 1450-1575) (see Chapter 7, Table 7.3), however, and the maintenance of Pecos Pueblo as a large aggregate up to ceramic Period 6 (post A.D. 1700) was apparently supported by reuse of preexisting agricultural features or with little agricultural activity at all. This is contrary to expectations and suggests that perhaps Pecos did, indeed, rely on interregional trade for its livelihood.

The first thing that strikes one on perusal of Tables 5.26 and 5.27, however, is that there are so few agricultural features. The thirty-eight features recorded here mean there is on average one agricultural feature for every 158 acres (64 hectares) of land surveyed at Pecos. In contrast, the Bandelier survey recorded a total of 1,156 agricultural features of types very similar to those recorded by the Pecos survey (VanZandt 1999:332-333). This gives an average of one agricultural feature for every 12 acres (5 hectares) of land surveyed on the Pajarito Plateau. If we increase the number of agricultural features at Pecos by assuming that every rock concentration and rock alignment recorded was agricultural in function, that increases the number of agricultural features to 289. That gives one agricultural feature for every 20 acres (8 hectares), still far below that for the Pajarito Plateau.

There are several explanations for this relative dearth of agricultural features at Pecos. One is previous land use within the park. The lands of the Upper Pecos Valley have been intensively used certainly since Spanish colonization (Adams and Chavez 1956; Hall 1984; Kessell 1979) and very likely before that. The lands within Bandelier National Monument historically have been heavily grazed but rarely cultivated. Much of Bandelier has been protected since the 1930s, and major portions have been designated wilderness since the 1970s, while the land at Pecos has been a productive ranch since the 1930s, and many of the archeological sites themselves have been tourist attractions. At Pecos, bulldozing performed during the 1950s and 1960s across roughly 25 percent of the lands that are now within the park may have obliterated many small features.

The number of recognizable agricultural features still seems miniscule, despite these depredations. One other explanation is that the location of much of the intensification of agricultural efforts and investments made by the Pecosenos occurred in areas outside the boundaries of Pecos National Historical Park. In a description of New Mexico missions in 1776, Fray Dominguez gives an account of the pueblo of Pecos and states that "The Indians have arable lands in all the four principal directions, but only those which lie to the north, partly east, enjoy irrigation. The rest are dependent on rain" (Adams and Chavez 1956:213). "To the north, partly east" points directly to the broad floodplain of the Pecos river in the area now occupied by the village of Pecos, outside the boundaries of Pecos National Historical Park. Through the park, the river runs in a steep canyon, with little or no floodplain on either side.

In her consideration of the subsistence system of Pecos Pueblo, Spielmann (1991b:102-104) notes that Manzano fine sandy loam soils, soils suitable for irrigation, occur only in the floodplain to the northeast of the pueblo. Evidence for capital investment in agriculture by the people of Pecos Pueblo might be found in the acequias that still water these lands (Hall 1984). Vibo and Ribera fine sandy loams, which Spielmann (1991b:102-104) notes are currently used for dry farming, can be found in the immediate vicinity of Pecos Pueblo, about 1 km (0.62 mi) due north, and on the west side of Glorieta Creek. The drop in agricultural features within the park beginning with Period 4 (A.D. 1450-1575) may indicate a shift in emphasis of agricultural activities away from dry farming by individual families in these areas to greater communal exploitation of the irrigable land to the northeast by the river.

Social Integration

Expectations

The formation of large villages through the aggregation of human population has been called "socially difficult and economically inefficient" (Cordell 1996:230). Close proximity of many people increased the potential for interpersonal conflict and stress. The consolidation of people from several communities into a single pueblo would have created challenges for decision making and for social integration—integration that was essential to the well being of the community and the individuals within it.

In a community where group consensus formed the basis for most decision making and where coercive measures were not used to ensure cooperation, one means of relieving the scalar-stress associated with aggregation would be to increase the size of the basal social unit, thus decreasing the number of social units involved in decision making (Adler 1989; Johnson 1982). Communitywide ritual provided a valuable means of maintaining and reinforcing social order above the level of the household, relieving scalar-stress and preventing village fragmentation (Adler 1989; Hegmon 1989). Many (though certainly not all) such rituals were held in kivas.

As community size increased through aggregation, the size of groups using kivas should also increase. As the size of groups using kivas increased, so the size of the kivas themselves should have increased. Logically, an increase in the size of base social groups is expected to shrink the number of groups in the community. If population growth or aggregation is great enough, however, or if there are cultural constraints on the minimum number of social units required for maintaining a viable community, there is the possibility that the number of basal social units will remain the same or even increase. If it can be assumed that there is a positive relationship between the number of social units and the numbers of kivas, changes in the size and numbers of kivas can reflect changes in the size and numbers of the social groups using them. With the consolidation of population into Pecos Pueblo, therefore, it is expected that there were larger kivas and most likely more kivas, as evidence of an increase in the number and size of base social groups.

Expectation Testing

Unfortunately, but not surprisingly, very few kivas were identified on survey. For this reason, most of the information on kiva numbers and sizes presented here was reconstructed from Kidder (1958) and reports of other excavations in the Upper Pecos Valley (Cordell 1998; Hayes 1974; Holden 1955). There are several pueblo sites with no excavation information and/or no surface indication of a kiva (Shin'po — PECO 307; Hobson-Dressler — LA 32388; Loma Lothrop — PECO 227; Long House — PECO 402; PECO 30). It is assumed that if the inhabitants of these pueblos used kivas, they went to those at other sites.

Table 5.28 lists all the possible kivas reported for the Upper Pecos Valley, along with the sizes and ceramic periods for use of the kivas, where these could be determined.[6] Table 5.29 shows the total number of kivas estimated and the number of rooms estimated to be occupied (from the demography chapter, Table 7.2) for each site in each period. Table 5.30 shows kiva size, both average and total, for the measurable kivas from each period. Each kiva was counted in every period to which it, or the site it is on, was dated, so many appear in multiple periods.

The total number of estimated kivas in the Upper Pecos Valley increases from 16 in ceramic Period 2 (A.D. 1200-1325) to 17 in ceramic Period 3 (A.D. 1325-1450), then drops to 15 in ceramic Period 4 (A.D. 1450-1575), to nine in Period 5 (A.D. 1575-1700), and remains at nine in Period 6 (post A.D. 1700). This reflects the patterns of population growth, outlined in Chapter 7 (Demography) where population peaks in Period 3. The large drop to Periods 5 and 6 are very likely the result of population decrease at the pueblo during Spanish colonization (Kessell 1979; Levine 1999). The greatest number of kivas at a single site increases from seven at Forked Lightning Pueblo in Periods 2 and 3, to 15 at Pecos Pueblo in Period 4.

The number of rooms per kiva shows no real trend through time (Table 5.29; Figure 5.34) but counters the expectation that there would be more rooms (as a proxy for people) for each kiva in Period 4 (A.D. 1450-1575), the peak of aggregation. This index almost doubles from Period 2 (A.D. 1200-1325) to Period 3 (A.D. 1325-1450), then drops in Period 4, increases again in Period 5 (A.D. 1575-1700) and drops precipitously in Period 6 (post A.D. 1700). The great drop in this ratio during Period 4 shows that the increase in number of kivas did not keep up with the increase in the number of occupied rooms. The rise in the ratio of rooms to kivas in Period 5 may reflect the effects of Christianity on the people of Pecos. Those who accepted Christianity may have continued to reside in the pueblo but no longer used kivas.



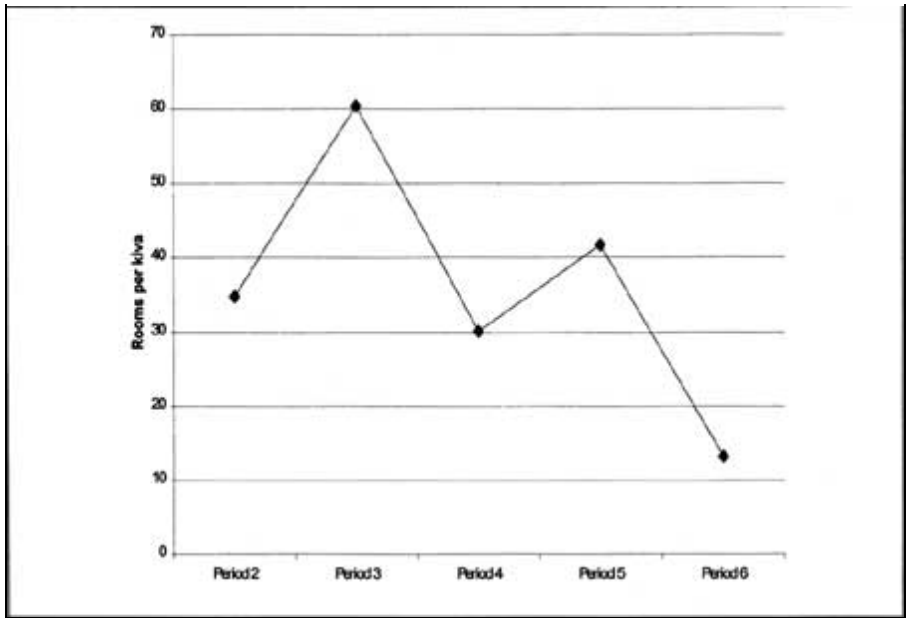


Figure 5.34. Ratio of rooms to kivas, through time.

Kiva size changes little from Period 2 (A.D. 1200-1325) to Period 3 (A.D. 1325-1450) but increases between ceramic Periods 3 and 4 (A.D. 1325-1575), jumping from an average of 23.26 m^2 to peak at 43.74 m^2 (Table 5.30; Figure 5.35). Average kiva size declines to 34.07 m^2 in Period 5 (A.D. 1575-1700), then drops to 30.35 m^2 in Period 6 (post A.D. 1700), but never drops back down to the average sizes for Periods 2 and 3. This conflicts with the information on room to kiva ratios, which suggests that the number of people per kivas drops during Period 4 (A.D. 1450-1575) but confirms the expectation that kiva size, and hence basal social group size, increased with aggregation.

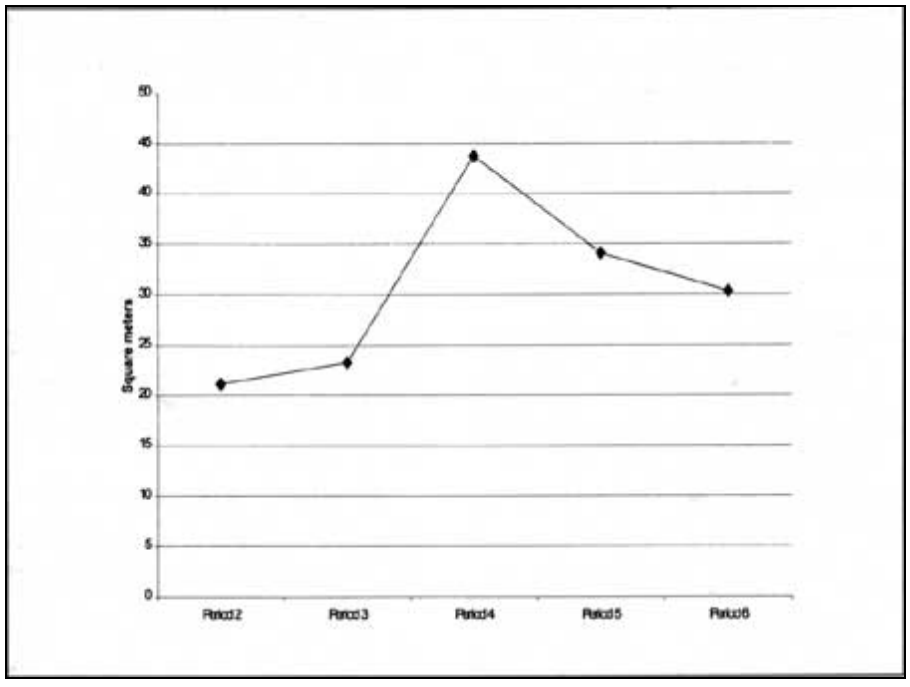


Figure 5.35. Kiva size through time.

Examination of Table 5.30 and Figure 5.35 shows that Period 4 (A.D. 1450-1575) sees the introduction of one very large kiva. Kiva 12, estimated to have been built during ceramic Period 4 (Kidder 1958:199-204), covers over 134

m^2—almost two and a half times the size of the next largest kiva at Pecos Pueblo during the same time period. This may shed light on the low number of rooms per kiva for Period 4. Though the number of social groups seems to have dropped slightly (from 17 kivas in Period 3 [A.D. 1325-1450] to 15 in Period 4), a higher level integrative structure was introduced in Period 4, the time that aggregation peaked (Adler 1989). This suggests the existence of rituals that brought together the entire community through a single integrative facility and may have incorporated those not served by smaller kivas. Kidder positively identified Kiva 12 as a kiva, but he concluded that it was never completed or used, primarily because it was never roofed (Kidder 1958:218). Unroofed kivas or open ceremonial areas that greatly resemble kivas, are not uncommon from archeological contexts in western New Mexico, eastern Arizona, and the Mesa Verde region, however (Herr 1994:46; LeBlanc 1989:348; McGimsey 1980:171-176; Orcutt et al. 1990:200; Roberts 1939:128). Period 5 (A.D. 1575-1700) also has one kiva that is much larger than the others used in that period, though the difference is nowhere near as great as that seen for Period 4.

Table 5.28. Kivas, measurable kiva sizes, and periods.

Site No.	Site Name	Feature No.	Dimensions (as reported)	Area (m^2)	Ceramic Periods	Reference
P23		11-01	4 m Diameter	12.57	2, 3, 6	Site form
P215		12-01	7 m Diameter	38.48	2, 3	Site form
P226	Forked	RK-A	17' Diameter	21.09	2, 3	Kidder 1958:29
	Lightning	RK-D	11'8" Diameter	9.94	2, 3	Kidder 1958:33
		SK-1	13' x 14'	16.91	2, 3	Kidder 1958:32
		SK-2	11'4" x 11'	11.58	2, 3	Kidder 1958:34
		CK-3	15'9" x 15'3"	22.31	2, 3	Kidder 1958:36
		CK-4	14'3" x 16'	21.18	2, 3	Kidder 1958:40
		CK-5	8' x 11'	8.18	2, 3	Kidder 1958:41
P434	Dick's Ruin	Kiva 1	15'6" x 15' 6"	22.32	2, 3	Kidder 1958:48
P710	Arrowhead	07-01	7 m x 6.15 m	43.05	2, 3	Site form
		07-02[a]	—	—	2, 3	Site form
LA 108	Rowe	Trench 2	—	—	2	Cordell 1998:40, 44
LA 108		Room 30	—	—	3	Cordell 1998:46
P228	Pecos	Kiva 6	20'9" Diameter	31.42	2	Kidder 1958:145
		Kiva 10	12' Diameter	10.51	2	Kidder 1958:167
		Kiva 5	19' Diameter	26.34	2, 3, 4, 5, 6	Kidder 1958:154
		Kiva 2	22' Diameter	35.32	3, 4	Kidder 1958:175
		Kiva 4	18'8" Diameter	25.43	3, 4, 5	Kidder 1958:178
		Kiva 7	21'8" Diameter	34.26	3, 4, 5, 6	Kidder 1958:186
		Kiva 3	—	—	4	Kidder 1958, Fig. 21
		Kiva 8	20' Diameter	29.19	4	Kidder 1958:174
		Kiva 9	—	—	4	Kidder 1958:176
		Kiva 11	20' Diameter	29.19	4	Kidder 1958:170
		Kiva 12	43' Diameter	134.91	4	Kidder 1958:218
		Kiva 15	—	—	4	Kidder 1958:176
		Kiva 17	—	—	4	Kidder 1958:175-176
		Kiva 21	—	—	4	Kidder 1958, Fig. 21
		Kiva 13	—	—	4, 5	Kidder 1958:183

Kiva 18	—	—	4, 5	Kidder 1958, Fig. 21
Kiva 1	22' Diameter	35.32	4, 5, 6	Kidder 1958:183
Kiva 16	25' x 24'	55.74	5	Kidder 1958:199
Kiva 14	21' Diameter	32.18	5, 6	Kidder 1958:206
Kiva 19	—	—	—	Kidder 1958:218
Kiva 20	—	—	—	Kidder 1958:218
Kiva 22	—	—	—	Kidder 1958:219
Kiva 23 — Convento	20' Diameter	29.19	5	Hayes 1974:33 Ivey 1998:140
Guard House Kiva—I	18' x 17'	28.43	6	Kidder 1958:221
Guard House Kiva—H	22' Diameter	35.32	6	Kidder 1958:223
Guard House Kiva—J	16' x 16'	23.78	6	Kidder 1958:223
Guard House Kiva—K	22' x 22'	44.97	6	Kidder 1958:225

[a]The measurements reported on the site form for kiva 07—02, PECO 710 do not represent the entire feature as it would have been during its period of use. Rather than estimate the measurements based on insufficient information, they are omitted.

Table 5.29. Numbers of rooms and kivas through time.

Ceramic Period	Site No.	Site Name	Occupied Rooms[a]	Number of Kivas	Rooms/Kiva	Total Period Rooms/Kiva
2 (A.D. 1200-1325)	PECO 23		3.6	1	3.6	
	PECO 30		45.2	—	—	
	PECO 215		11.36	1	11.36	
	PECO 226	Forked Lightning	180	7	25.71	
	PECO 228	Black-on-white House[b]	100[c]	3	33	
	PECO 434	Dick's	25	1	25	
	PECO 710	Arrowhead	31.5	2	15.75	
	LA 108	Rowe	90	1	90	
	LA 32388	Hobson-Dressler	70	—	—	
Total			557	16	(avg. = 29.20)	34.81
3 (A.D. 1325-1450)	PECO 23		2.9	1	2.9	
	PECO 30		16.9	—	—	
	PECO 215		3.7	1	3.7	
	PECO 226	Forked Lightning	45	7	6.43	
	PECO 227	Loma Lothrop	182.3	—	—	
	PECO 228	Pecos Pueblo	281.3	4	70.33	
	PECO 307	Shin'po	52	—	—	
	PECO 402	Long House	26	—	—	
	PECO 434	Dick's	25	1	25	
	PECO 710	Arrowhead	126	2	63	
	LA 108	Rowe	210	1	210	
	LA 32388	Hobson-Dressler	56	—	—	

Total			1027.1	17	(avg. = 54.48)	60.42
4 (A.D. 1450-1575)	PECO 228	Pecos Pueblo	442	15	29.47	
	PECO 402	Long House	10	—	—	
Total			452	15	(avg. = 29.47)	30.13
5 (A.D. 1575-1700)	PECO 228	Pecos Pueblo	375	9	41.67	
Total			375	9	(avg. = 41.67)	41.57
6 (post A.D. 1700)	PECO 23		1.2	1	1.2	
	PECO 228	Pecos Pueblo	117.7	8	14.63	
Total			118.9	9	(avg. = 7.92)	13.21

[a]From Table 7.2.

[b]Early Pecos Pueblo.

[c]Orcutt (Chapter 7) does not give estimates for occupation of the Pecos mesilla during period 2, so the number of rooms for the mesilla was estimated in the following manner: Kidder shows close to 150 rooms on both the West Terrace and the North Terrace (1958:Figure 20), and clearly states that three kivas date back to black-on-white times (58). Given that not all rooms would have been occupied at one time and that certainly not all were exposed through excavation, 100 rooms seemed a reasonable estimate for the number of occupied rooms in this area during Period 2.

Table 5.30. Kiva size, by period.

Period	No. Measurable Kivas	Mean Kiva Size (m^2)	Total Kiva Area (m^2)
2 (A.D. 1200-1325)	14	21.13	295.87
3 (A.D. 1325-1450)	15	23.26	348.96
4 (A.D. 1450-1575)	8	43.74	349.96
	(7)[a]	(30.72)[a]	(215.04)[a]
5 (A.D. 1575-1700)	7	34.07	238.5
	(6)[b]	(34.88)[b]	(209.3)[b]
6 (post A.D. 1700)	9	30.35	273.2
	(5)[c]	(28.13)[c]	(140.7)[c]

[a]The numbers in parentheses do not include Kiva 12 at Pecos Pueblo. Kidder states (1958:218) that this kiva may never have been completed or used. It is over twice the size of the next largest kiva at Pecos Pueblo.

[b]The numbers in parentheses do not include Kiva 23, the Convento Kiva. White (1996:357) and Ivey (1998:139-140) place the construction of this kiva in the 1620s, probably under the auspices of the Franciscans.

[c]The figures in parentheses do not include the Guardhouse Kivas (H, I, J, K) at Pecos Pueblo. Kidder (1958:219) states they were built late in the occupation of the pueblo, possibly after the Pueblo Revolt, and there is documentary evidence indicating they were built in 1750 by Governor Velez Cachupin as torreones to provide protection against the Comanche (Kessell 1979:382).

Discussion

It would appear from this information on kiva number, size, and ratio to habitation rooms that the formation of Pecos Pueblo was not accompanied by an increase in the number of base social units as the number of kivas in the Upper Pecos Valley increases by only one from Period 2 (A.D. 1200-1325) to Period 3 (A.D. 1325-1450), then drops by two in Period 4 (A.D. 1450-1575). This suggests a consolidation of social groups, rather than a proliferation. Average kiva size does increase, however, as might be expected if more people were coming together in fewer groups. The low ratio of habitation rooms to kivas in Period 4, however, conflicts with these findings. The formation of the Quadrangle at Pecos Pueblo (late in Period 3 or early in Period 4) was also accompanied by the introduction of a kiva much larger than all others at the pueblo. This kiva may have served as a higher level integrative facility pulling together the many separate social groups that used the smaller kivas.

The pueblo was also constructed to create an enclosed plaza. Plazas can provide space for communitywide ritual, beyond that provided by kivas, and it has been suggested that enclosed plazas replace great kivas throughout the Southwest (Adams 1991). Construction of room blocks around plazas can also increase the frequency of face-to-face encounters between individuals in the community which, while they do not occur within a ritual context, can serve to reinforce integration. The presence of an enclosed plaza is not a complete departure from previous villages in the valley, however. Both Shin'po (PECO 307) and Arrowhead (PECO 710) are built to fully enclose their plazas.

Summary and Conclusions

Through description of sites, components and features this chapter has presented a general introduction to the sites recorded by the Pecos CRIS. It also organized the sites through a simple typology based on architectural characteristics. Consideration of artifact assemblage parameters and feature characteristics in each site type confirmed that basic differences exist among the types. This typology does not rely on artifact variables to classify sites and so provides an independent base for further discussion of site function in later chapters. In addition, the chapter examined subsistence and social change within the Upper Pecos Valley using two kinds of prehistoric features, agricultural facilities and kivas.

From these analyses it appears that the land-use and settlement structure of the Upper Pecos Valley was fairly stable through time, with a preponderance of special-use and seasonal sites, and very few habitation sites in any period. The major change in settlement structure was the reduction of the number of habitation sites from 10 in Period 3 (A.D. 1325-1450) to two in Period 4 (A.D. 1450-1575), with the aggregation of population at Pecos Pueblo. Consideration of agricultural features suggests that Pecos Pueblo thrived without major corporate capitol investment in agriculture, at least not in the dry-farming that was probably performed within what are now the boundaries of Pecos National Historical Park. Historic documents and information on soils suitable for irrigation suggest that the "bread-basket" for Pecos Pueblo lay in the rich floodplain of the Pecos River, in the area that is now the Village of Pecos, outside the present study area. These irrigated fields may have seen the investment in agricultural facilities that was expected to accompany the formation of the pueblo and to fund its continuation.

The consideration of integrative ritual facilities, in particular kivas, suggests that the formation of Pecos Pueblo brought with it a consolidation of social groups, as seen in the low number of kivas and the low ratio of habitation rooms to kivas. Kiva size is much larger after the formation of Pecos Pueblo than at earlier sites, however, suggesting that with greater aggregation kivas were used by more people. Pecos Pueblo also had one kiva that was much larger than all the others at the pueblo, indicating the existence of a new overarching level of integration that brought together members of the smaller kiva groups.

The image of life and change in the Upper Pecos Valley derived from the information presented in this chapter is one of basic stability, with changes in settlement and integration at key points in time. The formation of Pecos Pueblo brought about change in the organizational structure of the people of the valley, but their modes of subsistence appear to have remained fairly constant through time. The following chapters in this report make use of the typology developed and presented in this chapter in tandem with the chronology presented in Chapter 4, to give more detailed consideration to many of the issues broached here.

Notes

1. Though reportedly not employed on the Forked Lightning Ranch, chaining is a commonly used method for clearing piñon and juniper. Chaining involves dragging a heavy anchor chain between two large bulldozers or caterpillar tractors, uprooting trees in the path of the chain (deBloois et al. 1975).

2. Figure 5.3 was created using GIS layers in ArcView 3.1 and a digital orthophotograph of the park. Cleared areas within the park boundary were visually identified on the computer and their outlines screen digitized after fieldwork was completed. They had not been field checked at the time of this writing. The GIS layers and database are on file at Pecos National Historical Park and the National Park Service in Santa Fe.

3. Because the raw scatter area data were highly skewed to the right, this test was performed after logging all area figures in order to achieve a normal distribution.

4. These names are derived from Kidder 1958 and unpublished field notes. This survey did not record the Spanish mission church and convento that sit at the south end of the mesilla. For detailed information on these structures, see the recently completed Historic Structures Report (Ivey 1996).

5. Kidder (1958:Figure 20) shows Kiva 13 as being immediately adjacent to 700 House but notes that it was probably of much later date (1958:58).

6. The size and dates of kivas at Pecos Pueblo were reconstructed from Kidder (1958). When exact dimensions were not mentioned in the text, measurements were taken from plan view maps of individual kivas. No dimensions are given for unexcavated kivas or those for which Kidder does not give specific dimensions or map individually. Since Kidder refers to the dates of kivas by reference to the Pecos ceramic Glaze ware sequence, some rules were developed for assigning individual kivas to the ceramic periods created for this report. If Kidder noted that a kiva was used in black-on-white times, it was assigned to ceramic Period 2 (A.D. 1200-1325). If he noted that a kiva was used in Glaze I or II times it was assigned to ceramic Period 3 (A.D. 1325-1450), in Glaze III, IV, or early Glaze V it was assigned to ceramic Period 4 (A.D. 1450-1575). Kivas noted to be used in Glaze V, VI, or to have "modern painted ware" were assigned to ceramic Period 5 (A.D. 1575-1700). Those that Kidder noted to have been built historically or after the Pueblo Revolt were assigned to ceramic Period 6 (post A.D. 1700). In addition, Kidder often was able to determine the time a kiva was dug but not when it was abandoned. Likewise, there were some kivas where he was able to determine a date of abandonment but did not excavate enough to determine when the structure was built. These kivas were assigned to the single period mentioned by Kidder. If Kidder noted that a kiva was used for a very long time, it was assigned to each period covered by that interval.

<<< Previous <<< Contents>>> Next >>>

PECOS

From Folsom to Fogelson:

The Cultural Resources Inventory Survey of Pecos National Historical Park

CHAPTER 6:
SETTLEMENT

Karl K. Benedict and Janet D. Orcutt

Site locations have the potential to provide insight into community development in the Pecos area. Decisions about where to build a structure or conduct activities reflect the exploitation of critical resources, including wild plants, fauna, agricultural land, and nonfood raw materials. They also reflect knowledge about past activities in the area, the current activities of other people in the area, and the nature of one's relationships with those people. This chapter explores these aspects of settlement through a variety of approaches. In the first part of the chapter, the Palmer Drought Severity Index (PDSI) is used to characterize potential agricultural productivity in each period, and this information is used to generate expectations for site locations. These expectations are evaluated using information recorded by survey crews on site elevation, landform, and modern vegetation. In the second section of the chapter, the effects on site placement of the changing social and economic relationships accompanying aggregation are explored through nearest-neighbor distances between site types. In the last part of the chapter, the relationships between site location and localized resources are examined in sharper detail using plant productivity potentials for soils derived from a recent soil survey in Pecos National Historical Park. Throughout the chapter our expectations for site locations relative to the physical and cultural landscape differ according to the general activities expected at each site type (see Chapter 5).

Characterizing Climate through the Palmer Drought Severity Index

The pueblo period occupants of the Pecos area grew corn and other domestic crops and also depended heavily on hunting large game and gathering wild plants for their subsistence (Cordell 1998; Kidder 1958). The population's ability to meet subsistence needs, therefore, depended first on the nature of climatic variability.

Certain aspects of prehistoric climate are important in understanding how the agricultural subsistence system at Pecos functioned and the problems that farmers faced. Climatic changes affecting agricultural productivity should influence locational decisions, especially with regard to field houses (seasonal sites) and habitations where agriculture may take place. The PDSI is one way to estimate climatic stress on crops (Rose et al. 1982), because it is a rough measure of the moisture available to plants during the growing season. The PDSI, which is "an index of meteorological drought, as opposed to a specific biological or hydrological measure" (Rose et al. 1982:109), is calculated using estimates of potential evapotranspiration and is based on tree-ring indices.

The mean and variance of the PDSI have been used to examine potential agricultural productivity in other areas of the Southwest and are especially useful for characterizing local conditions when time periods are relatively short (Kohler and Van West 1992; Orcutt 1999b). The mean, in particular, is not helpful in characterizing lengthy time spans however, because it over-simplifies a great deal of variability. Because the time periods developed for the Pecos survey are long (see Chapter 4), we created a dryness index for the PDSI for Periods 2-5 (A.D. 1200-1700) that transforms the PDSI values into an ordinal scale. The annual PDSI values and classes were transformed according to the following: 0 is normal/wet, 1 is dry, and 2 is very dry (Table 6.1). Five-year moving averages were calculated for each year. We chose to calculate five-year

moving averages for each year because if people rely on two to three years of storage to help them through dry periods, as is known for Pueblo groups in the southwest, five drier years most likely would stress the storage system and invoke adaptive responses.

Table 6.1. Palmer Drought Severity Index values and dryness index.

PDSI Value	PDSI Class	Dryness Index
> 3.99	Extremely wet	0
3.00 to 3.99	Very wet	0
2.00 to 2.99	Moderately wet	0
1.00 to 1.99	Slightly wet	0
0.50 to 0.99	Incipient wet spell	0
0.49 to -0.49	Near normal	0
-0.50 to -0.99	Incipient drought	1
-1.00 to -1.99	Mild drought	1
-2.00 to -2.99	Moderate drought	2
-3.00 to -3.99	Severe drought	2
< -3.99	Extreme drought	2

The median dryness index is 0.4 for each period, and Period 2 (A.D. 1200-1325) has the widest range of values. Periods 3 (A.D. 1325-1450) and 4 (A.D. 1450-1575) are similar except for one outlier (drier) year (A.D. 1425) in Period 3. Variability is lower in Periods 3 and 4 than Period 2. Period 5 (A.D. 1575-1700) is more normal/wet than the others, but several dry years are outliers—1587, 1601, 1602, 1667, 1669, and 1671—and extreme outliers—1583, 1668, and 1670. The general trend in the index over time is toward more normal/wet conditions.

Dry periods are considered to be any number of consecutive years corresponding to the median dryness of 0.4 or greater. The following are the extended dry intervals in Period 2 (A.D. 1200-1325) (Figure 6.1): 1215-1231, 1234-1240, 1248-1267, 1274-1298, 1304-1310, and 1316-1319 (mild). The dry periods average more than 13 years in duration, and approximately one quarter of the indices are 0.8 or larger, which is towards the dry end of the scale. The actual yearly PDSI values, not the dryness index, indicate high variability associated with wide swings above and below normal between 1270 and 1298. Slightly less variability characterizes the 1240-1265 interval.



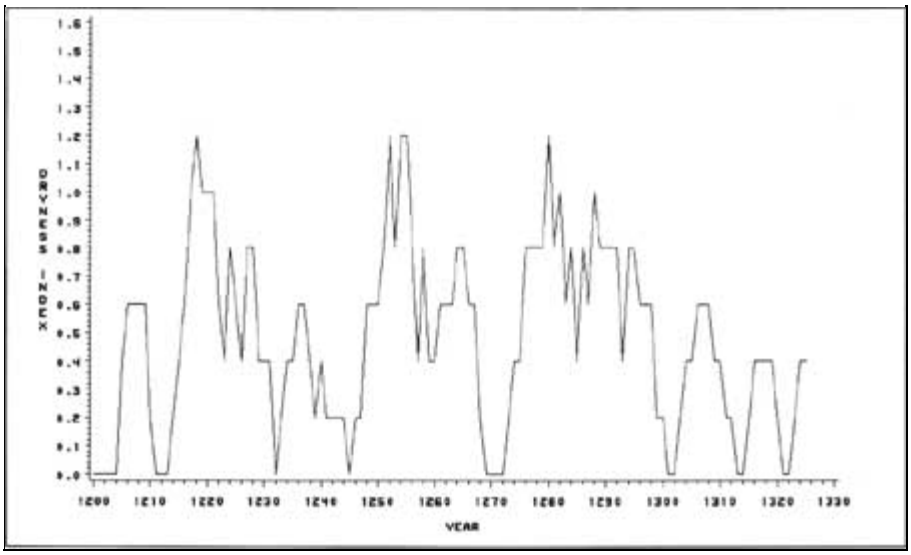


Figure 6.1. Palmer Drought Severity Index dryness index for Period 2 (A.D. 1200-1325).

There are more dry periods in Period 3 (A.D. 1325-1450) (Figure 6.2), seven rather than six, but the average of nearly 11 years is slightly shorter than the average in Period 2 (A.D. 1200-1325). The dry periods are 1324-1331, 1336-1356, 1360-1370, 1377-1386, 1390-1394 (mild), 1397-1403, and 1415-1428. Fifteen percent of the annual indices are 0.8 or greater, 10 percent fewer than Period 2. The yearly PDSI values indicate much less variability than Period 2.

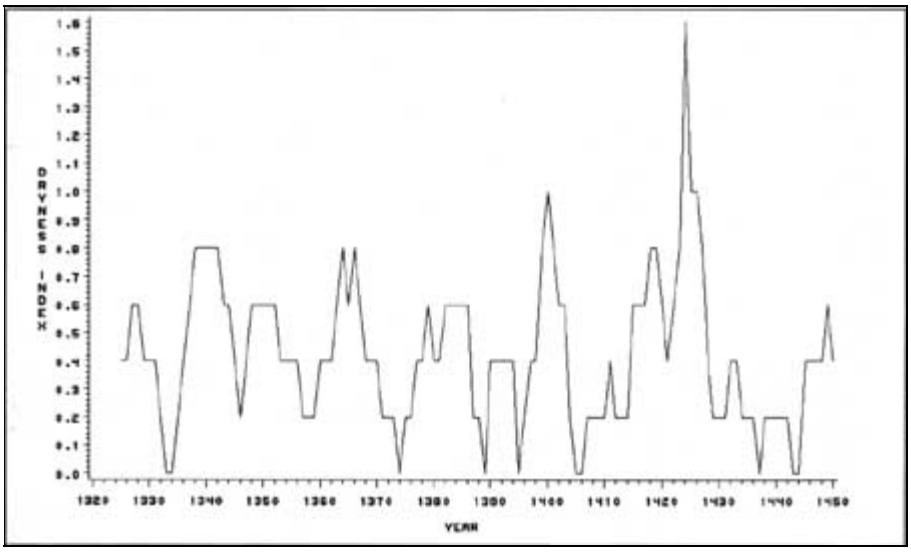


Figure 6.2. Palmer Drought Severity Index dryness index for Period 3 (A.D. 1325-1450).

The eight dry periods in Period 4 (A.D. 1450-1575) (Figure 6.3) average approximately 10 years and occur during the years 1445-1465, 1471-1484, 1495-1501, 1506-1510 (mild), 1516-1520, 1523-1528, 1542-1553, and 1558-1566. Twelve percent of the indices are greater than or equal to 0.8. The yearly PDSI values indicate fewer very wet years and more very dry ones than in Period 3 (A.D. 1325-1450).

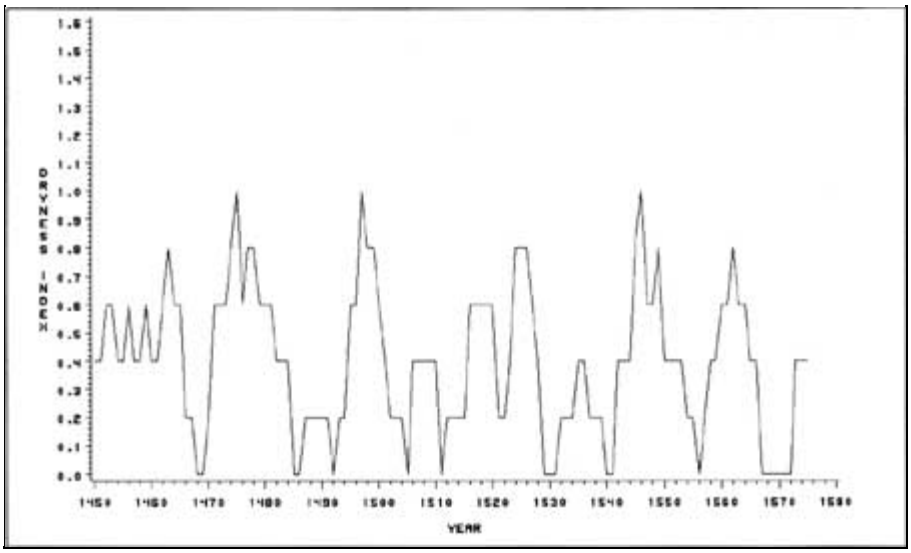


Figure 6.3. Palmer Drought Severity dryness indexx for Period 4 (A.D. 1450-1575).

There are ten dry periods in Period 5 (A.D. 1575-1700) (Figure 6.4), but they are shorter than those in previous periods, averaging approximately seven years. The extended dry periods are 1573-1577 (mild), 1579-1591, 1600-1605, 1608-1610 (mild), 1625-1629, 1644-1652, 1658-1673, 1678-1680 (mild), 1685-1689, and 1696-1699. Only seven percent of the indices are greater than or equal to 0.8. There are no wide extremes in the yearly PDSI values until late in the period, approximately 1680-1700. Drier spikes in PDSI values are not as severe as previous periods, and there are many very wet years. Overall, from Period 2 (A.D. 1200-1325) to Period 5 there is a trend towards shorter but more frequent dry periods.

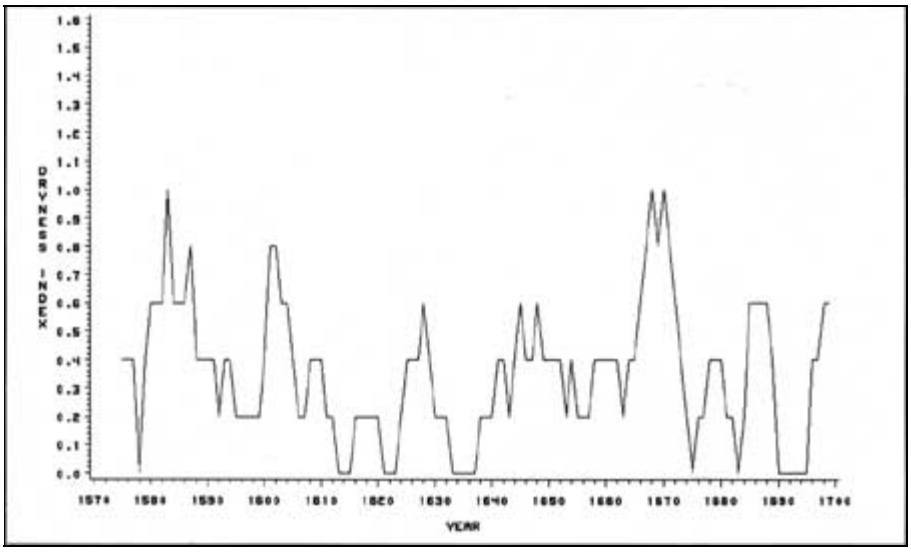


Figure 6.4. Palmer Drought Severity Index dryness index for Period 5 (A.D. 1575-1700).

Expectations for Site Locations

This characterization of the rainfall regime elicits a series of expectations for site locations through time. In subsequent sections of this chapter expectations for the diversity of site locations will be tested using site environment information recorded by the field crews, and a nearest-neighbor analysis is used to examine the social influences on site locations and the distances between sites. In addition, decisions concerning site placement will be further explored through the relationship between the potential productivity of local soils

and the location of different site types.

Extended and frequent dry periods should affect agricultural yields, which, in turn, affect people's choices for site locations. This is true especially for habitation and seasonal sites where we expect agriculture to occur. Depending on the levels of stress experienced during dry periods, people may locate sites to avoid conflict with their neighbors over scarce arable land. Period 2 (A.D. 1200-1325) appears to be the most variable, and it is drier than the others. To cope with the variability, we expect sites in diverse settings, which would provide a range of subsistence options that could be used depending on the conditions in a particular year. Because there are few habitation sites in Period 2, there should be a number of locational choices available. Competition, which is indicated by regular spacing between sites, is not expected in Period 2.

The unpredictability and dryness in Period 2 (A.D. 1200-1325) disappear in Period 3 (A.D. 1325-1450), which may be the best prehistoric climate period. Because climate appears to improve in Period 3, agricultural production should be more predictable and reliable. We expect diverse site locations in Period 3 because the number of sites increases. If the increase in sites also indicates that more people are using the landscape, we expect competition over land to arise, and so more regular spacing between sites.

The dryness index suggests that Period 4 (A.D. 1450-1575) is similar to Period 3 (A.D. 1325-1450). The annual PDSI values, however, show more very dry years and fewer very wet years than Period 3. We know there are fewer sites in Period 4 and that Pecos Pueblo is the dominant habitation. Site locations may reflect several things, including the presence of the large aggregate at Pecos Pueblo, climate and agricultural productivity, and interactions with neighbors. By Period 4, land and resources had been exploited for over 200 years, and it may be necessary for people to go farther to find suitable arable land and wild resources. Concentrating people in one location also forces them to farm and forage farther from the main pueblo. We expect smaller sites to be located away from Pecos Pueblo.

Period 5 (A.D. 1575-1700) appears to be the least dry period. The annual PDSI values indicate that the widest annual extremes primarily occur between A.D. 1680 and 1700, the period of the Pueblo Revolt and Reconquest. Drier spikes in the annual values are less severe than in previous periods, and there are numerous very wet years throughout Period 5. It is likely that Pueblo land use during Period 5 is affected by factors other than climate, however, so our expectations may not be valid for the seventeenth century. Pecos Pueblo remains the dominant habitation, but the Spanish mission is built nearby, using pueblo labor and supplies, and requiring pueblo labor for its maintenance. In addition, the Pueblo Revolt and the Reconquest also occur during this period. We expect people to continue farming and foraging at a distance from Pecos Pueblo, and nearest-neighbor distances should indicate that residents in other habitation sites avoid locating close to Pecos Pueblo. Seasonal sites should be situated in good agricultural areas, and we expect special-use sites to be in a diversity of locations to exploit wild plants, fauna, and nonfood raw materials.

Site Types by Environment

To test these expectations for site location based on the characterization of climate, we examine the distributions of site types relative to several environmental variables for Periods 2-5 (A.D. 1200-1700). Use of the area was light and sporadic in Periods 0 (pre A.D. 1075; number of sites=3) and 1 (A.D. 1075-1200; number of sites=2), and there are so few sites that we can not identify trends or patterns in locations. We also do not discuss Period 6 (post A.D. 1700) because the period is so long and encompasses many cultural changes.

The analyses rely on the following variables recorded by the survey crews: elevation, landform, and vegetation. The numerous vegetation types used by the survey, however, are grouped into Sivinski's (1995) four vegetation communities—grassland, riparian, piñon-juniper woodland, and mixed conifer forest—and combinations of those communities. The placement of the different site types in each period is first discussed, then changes in each site type over time are presented.

Period 2 (A.D. 1200-1325)

Five of the habitations occur between 6,770 and 6,910 ft (2,063 and 2,106 m) in elevation. The sixth one is at 7,280 ft (2,219 m) (Figure 6.5). Half of the habitations are on a flat-gentle slope/plain, and one each is on a ridge top, a low rise, or a terrace (Figure 6.6). Habitations are associated with piñon-juniper woodland and grassland vegetation (Figure 6.7).

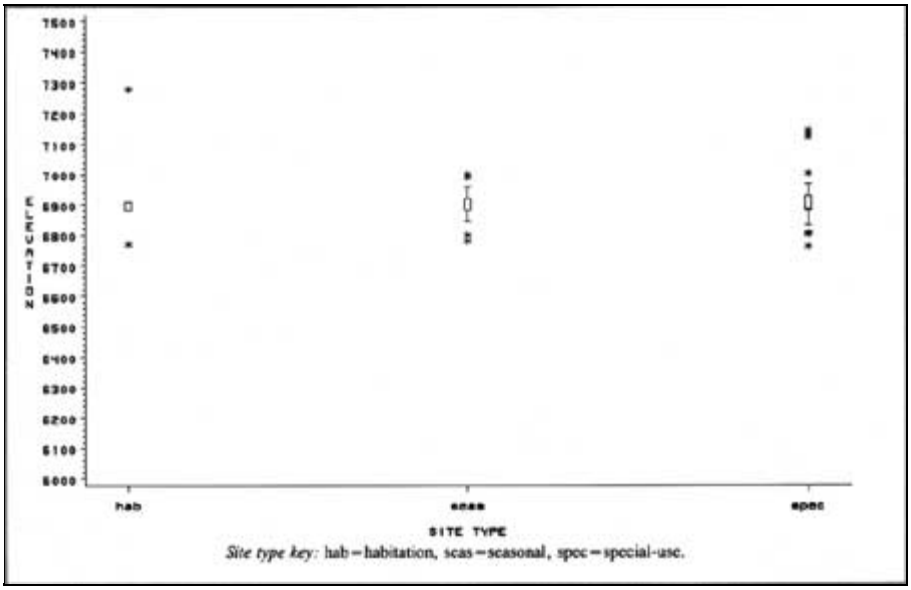


Figure 6.5. Box plot of elevation (in feet) by site type for Period 2 (A.D. 1200-1325).

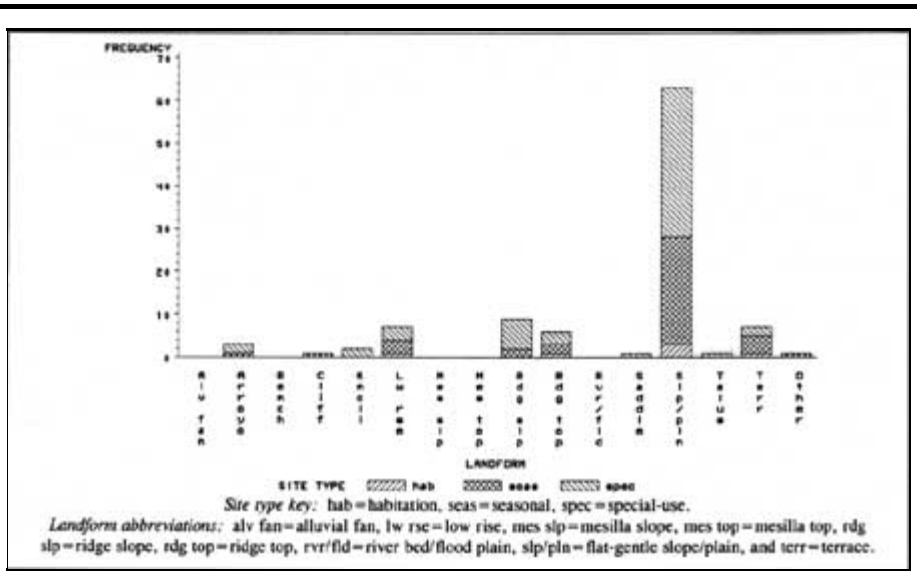


Figure 6.6. Frequencies of each site type by landform types in Period 2 (A.D. 1200-1325).

Although seasonal sites (n=39) are more numerous than habitations (n=6), they occur in a smaller elevation range, extending from 6,780 to 7,000 ft (2,067 to 2,225 m) (Figure 6.5). Approximately 67 percent of the sites are between 6,860 and 6,920 ft (2,091 and 2,109 m). Most seasonal sites are on a flat-gentle slope/plain, but seven other landforms also are used (Figure 6.6). Seasonal sites are associated with more vegetation communities than habitations; however, nearly 70 percent are found in piñon-juniper woodland (Figure 6.7).

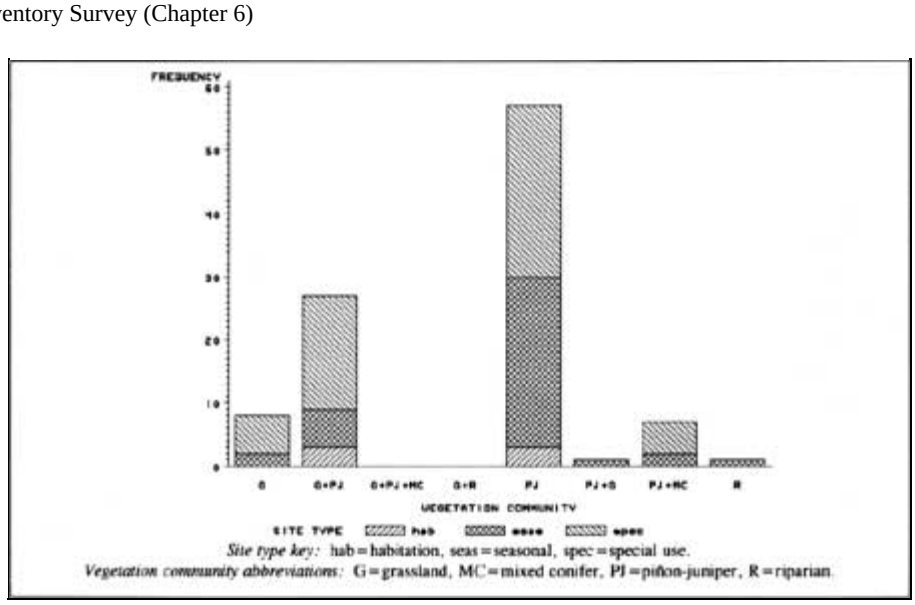


Figure 6.7. Frequencies of each site type by vegetation community for Period 2 (A.D. 1200-1325).

Special-use sites (n=56) cover a slightly greater elevation range than seasonal sites, extending from 6,760 to 7,140 ft (2,060 to 2,176 m). There are three clusters or concentrations of sites. The largest group, 41 percent of the sites, is between 6,850 and 6,880 ft (2,088 and 2,097 m); the second group comprises 20 percent of the sites and is between 6,900 and 6,920 ft (2,103 and 2,109 m), while the third group, 14 percent of the sites, is between 6,960 and 7,000 ft (2,121 and 2,134 m) (Figure 6.5). Several landforms are represented in special-use site locations. The most common is a flat-gentle slope/plain, and eight others also are occupied (Figure 6.6). Special-use sites occur in several vegetation communities, although 70 percent of the sites are in piñon-juniper woodland or a combination of grassland and piñon-juniper woodland (Figure 6.7).

Period 3 (A.D. 1325-1450)

Habitations (n=10) occur between 6,770 and 7,280 ft (2,063 and 2,219 m) in elevation; however, 70 percent are in a band between 6,880 and 6,920 ft (2,097 and 2,109 m) (Figure 6.8). Habitations are found on seven different landforms, although 40 percent of them are on a flat-gentle slope/plain (Figure 6.9). Ninety percent of habitations are in piñon-juniper woodland and grassland/piñon-juniper woodland (Figure 6.10).

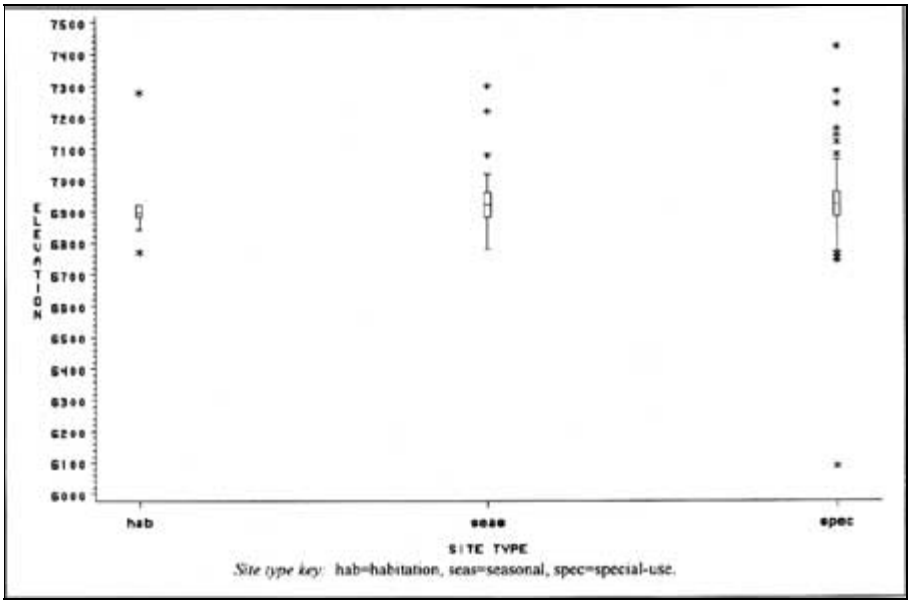


Figure 6.8. Box plot of elevation (in feet) by site type for Period 3 (A.D. 1325-1450).

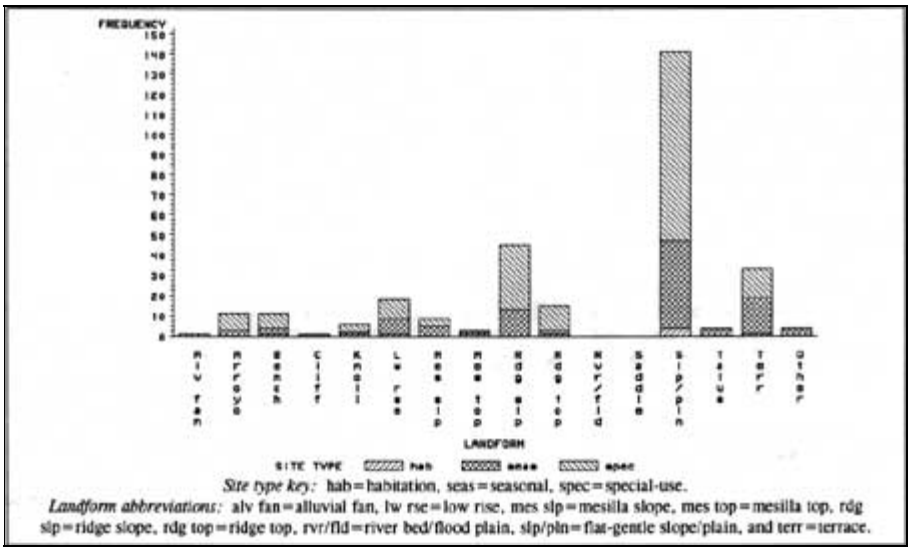


Figure 6.9. Frequencies of each site type by landform types in Period 3 (A.D. 1325-1450).

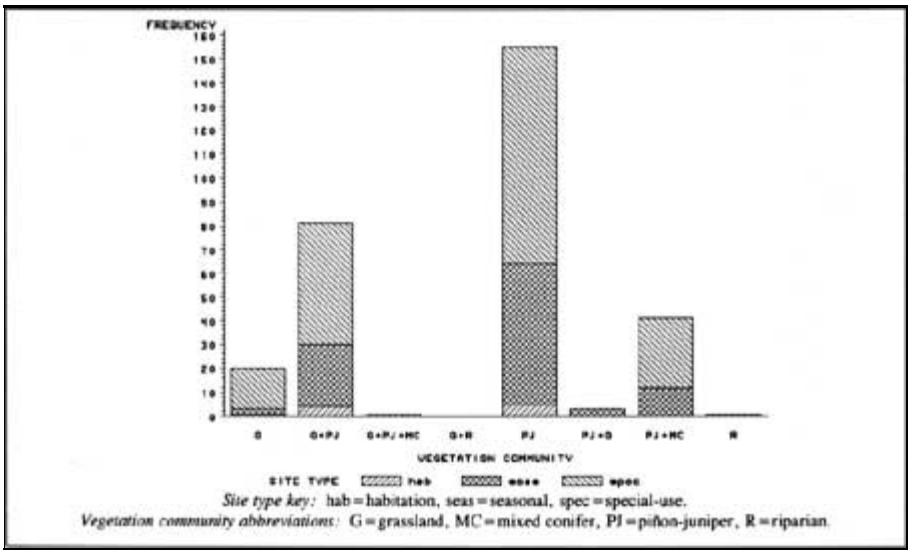


Figure 6.10. Frequencies of each site type by vegetation community for Period 3 (A.D. 1325-1450).

Seasonal sites (n=104) cover a slightly larger elevation range than habitations, from 6,780 to 7,300 ft (2,067 to 2,225 m), and are most common between 6,880 and 6,960 ft (2,097 and 2,121 m) (Figure 6.8). Seasonal sites occupy a variety of landforms, although a flat-gentle slope/plain is predominant (Figure 6.9). Seasonal sites are in a greater diversity of vegetation communities than Period 2 (A.D. 1200-1325), which goes along with almost triple the number of sites. Piñon-juniper woodland and grassland/piñon-juniper woodland remain the most common communities, but there is an increase in locations associated with piñon juniper woodland/mixed conifer forest (Figure 6.10).

Special-use sites (n=188) cover a wider elevation range, from 6,740 to 7,420 ft (2,054 to 2,262 m), than in Period 2 (A.D. 1200-1325) (Figure 6.8). Most special-use sites are found between 6,880 and 6,980 ft (2,097

and 2,128 m). A diversity of landforms is represented in special-use site locations, although a flat-gentle slope/plain is the most common (Figure 6.9). Eighty-four percent of the sites are in piñon juniper woodland, grassland/piñon-juniper woodland, and grassland, and a higher percentage of sites is in piñon-juniper woodland/mixed conifer forest than Period 2 (A.D. 1200-1325) (Figure 6.10).

Period 4 (A.D. 1450-1575)

Each of the three habitation sites is at a different elevation, ranging from 6,840 to 6,920 ft (2,085 to 2,109 m) (Figure 6.11). There are more habitations than listed in Chapters 5 and 7 for this period because one Euro-American site is included in our analysis. Two of the sites are on a flat-gentle slope/plain and Pecos Pueblo is on the mesilla top (Figure 6.12). Habitations are either in grassland or grassland/piñon-juniper woodland vegetation (Figure 6.13).

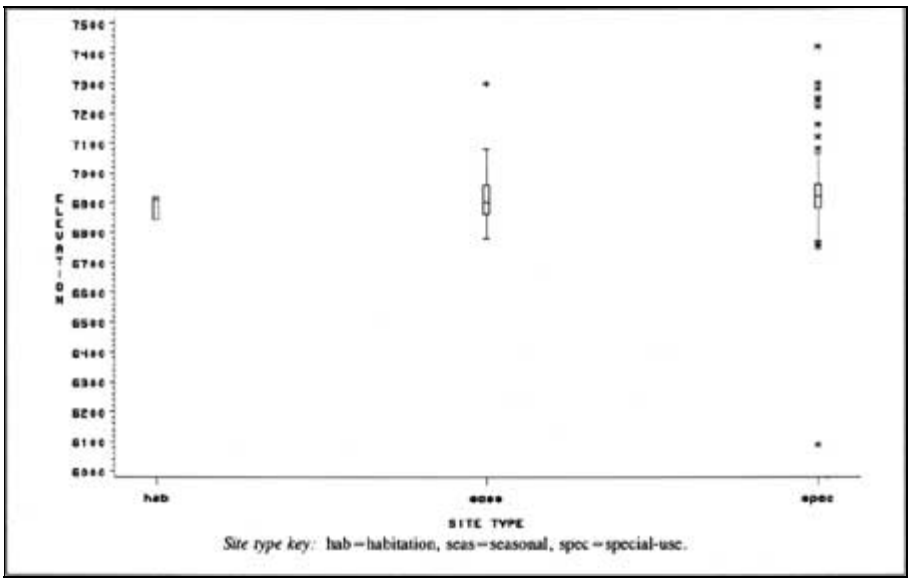


Figure 6.11. Box plot of elevation (in feet) by site type for Period 4 (A.D. 1450-1575).

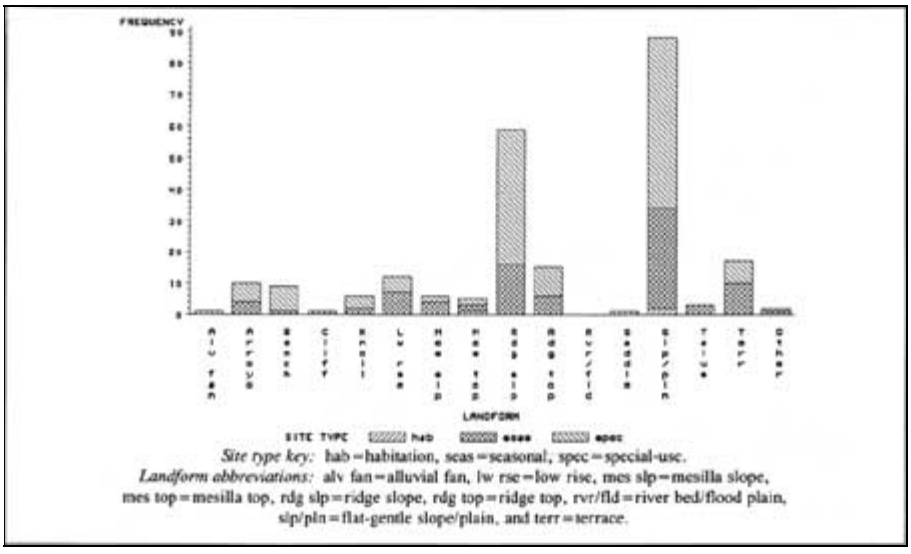


Figure 6.12. Frequencies of each site type by landform types in Period 4 (A.D. 1450-1575).

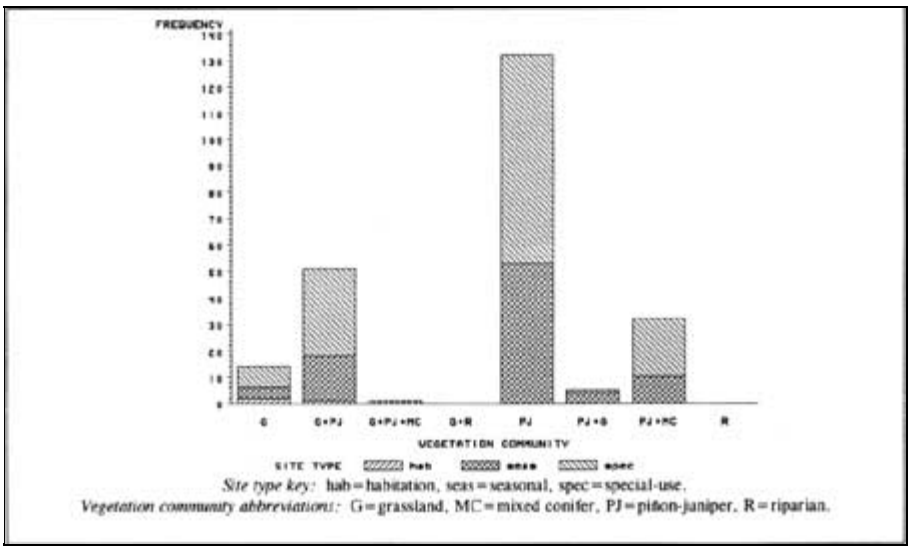


Figure 6.13. Frequencies of each site type by vegetation community for Period 4 (A.D. 1450-1575).

The elevation range of seasonal sites (n=89) is 6,780-7,300 ft (2,067-2,225 m), the same as Period 3 (A.D. 1325-1450); however, the distribution within that range changes as the percentage of sites above 7,000 ft (2,134 m) decreases (Figure 6.11). Seasonal sites are associated with 13 different landforms, although a flat-gentle slope/plain is the most common (Figure 6.12). Seasonal sites occur in a variety of vegetation communities, although three-quarters of them are in piñon-juniper woodland and grassland/piñon-juniper woodland (Figure 6.13).

Special-use sites (n=143) cover roughly the same elevation range as in Period 3 (A.D. 1325-1450), 6,750-7,420 ft (2,057-2,262 m) (Figure 6.11). There are thirteen different landforms represented in the locations of special-use sites; however, only two—flat-gentle slope/plain and ridge slope—are common (Figure 6.12). The percentage of special-use sites in piñon-juniper woodland and grassland/piñon-juniper woodland decreases slightly from the previous period. The percentage of sites in grassland increases slightly over Period 3, while it remains the same in piñon-juniper woodland/mixed conifer forest (Figure 6.13).

Period 5 (A.D. 1575-1700)

Habitations (n=4) in Period 5 (A.D. 1575-1700) occur between 6,760 and 6,920 ft (2,060 and 2,109 m) (Figure 6.14). Again, there are more habitations than listed in Chapters 5 and 7 for this period because two Euro-American sites are included in our analysis. There is a shift down in the lowest elevation, 6,760 ft (2,060 m), compared to the low of 6,840 ft (2,085 m) in Period 4 (A.D. 1450-1575). There is some variability in the landforms occupied—two sites are on a flat-gentle slope/plain, one is on the mesilla top, and one is on a terrace (Figure 6.15). The four habitations are in grassland and piñon-juniper woodland vegetation (Figure 6.16).

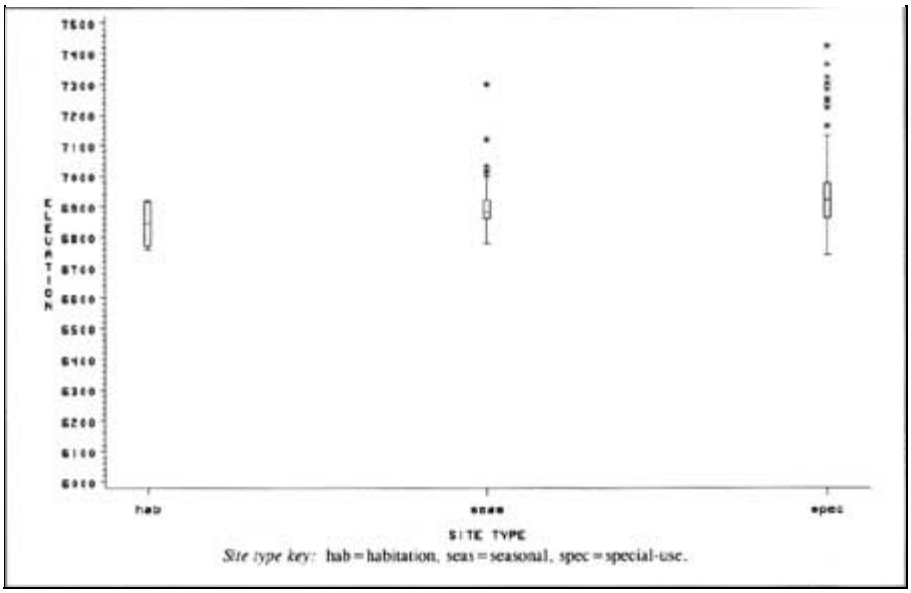


Figure 6.14. Box plot of elevation (in feet) by site type for Period 5 (A.D. 1575-1700).

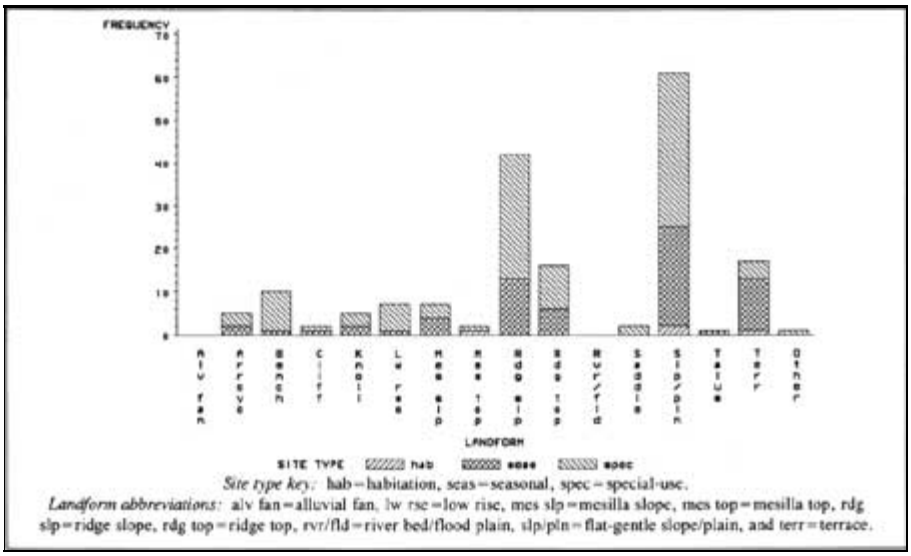


Figure 6.15. Frequencies of each site type by landform types in Period 5 (A.D. 1575-1700).

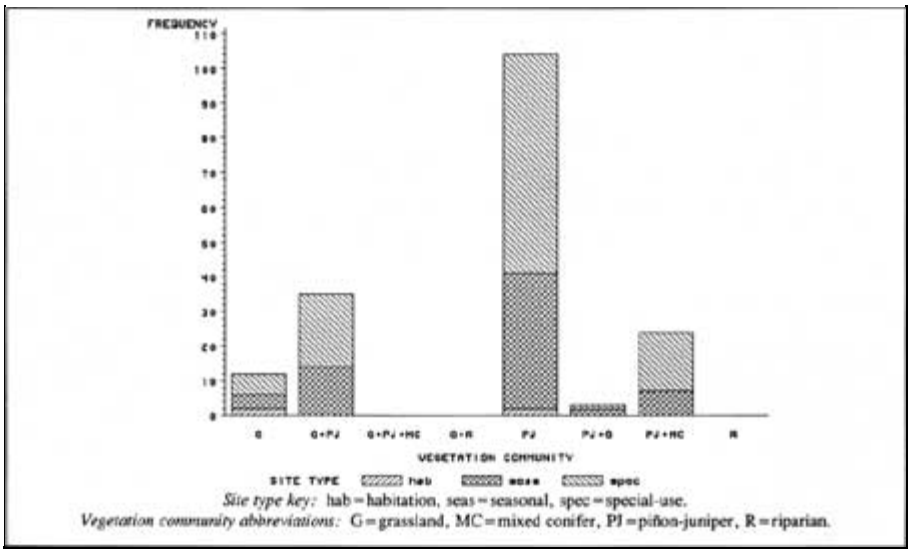


Figure 6.16. Frequencies of each site type by vegetation community for Period 5 (A.D. 1575-1700).

Seasonal sites (n=66) are in a wide range of elevations, from 6,780 to 7,300 ft (2,067-2,225 m), although the majority is below 6,900 ft (2,103 m) (Figure 6.14). Seasonal sites occupy 11 different landforms, with a flat-gentle slope/plain the most common (Figure 6.15). More than 80 percent of seasonal sites are in piñon-juniper woodland and grassland/piñon-juniper woodland (Figure 6.16).

Special-use sites (n=108) range from 6,740 to 7,420 ft (2,054 to 2,262 m) in elevation, although more than 50 percent are below 6,900 ft (2,103 m) (Figure 6.14). Thirteen different landforms provide locations for special-use sites. The most common are a flat-gentle slope/plain and ridge slope (Figure 6.15). The percentage of special-use sites in the different vegetation communities is only slightly different than Period 4 (A.D. 1450-1575)—over three-quarters of the sites are in piñon-juniper woodland and grassland/piñon-juniper woodland (Figure 6.16).

Habitation Site Locations through Time

The elevation distribution of habitation sites changes slightly through time. There is one habitation site at 7,280 ft (2,219 m) in Periods 2 (A.D. 1200-1325) and 3 (A.D. 1325-1450) (Arrowhead, PECO 710, LA 251), but most are below 7,000 ft (2,134 m). Period 3 has the most habitation sites (n=10), and except for two outliers at 6,770 and 7,280 ft (2,063 and 2,219 m), the others are found within an 80-ft range. Spielmann (1991b) and Snow (1991) discuss the implications of short growing seasons and the difficulties of producing a successful harvest of mature, modern corn in the higher elevations of Pecos and New Mexico in general. Most Pecos habitations are above 6,600 ft (2,012 m), the level Snow (1991) identifies as too high, suggesting that agriculture was difficult at Pecos. As Snow (1991) notes, green corn can be harvested during a short growing season, but this would not provide any seed corn.

A flat-gentle slope/plain is the most common landform in each period. Because of the small number of habitations in each period, it is probably not very meaningful to draw conclusions from the distributions. There do not seem to be other locational trends except the persistent occupation of the mesilla beginning in Period 3 (A.D. 1325-1450). The greatest variety of landforms associated with habitations is in Period 3, the period with the most habitations.

Modern vegetation communities at Pecos are a product of heavy, relatively recent manipulation of the environment (Sivinski 1995; see Chapter 5). Therefore, their usefulness for interpreting prehistoric or early historic site locations is questionable. Piñon-juniper woodland and grassland/piñon-juniper woodland are the predominant vegetation communities associated with habitation sites in Periods 2 (A.D. 1200-1325) and 3

(A.D. 1325-1450). Period 4 (A.D. 1450-1575) habitations are in grassland and grassland/piñon-juniper woodland, and Period 5 (A.D. 1575-1700) sites are evenly split between grassland and piñon-juniper woodland vegetation communities. Even though we can identify trends and change through time, we are not sure how modern vegetation relates to prehistoric vegetation so it is difficult to relate settlement decisions to the distribution of modern vegetation communities.

Seasonal Site Locations through Time

Seasonal sites in Period 2 (A.D. 1200-1325) cover the smallest elevation range; this range expands during Period 3 (A.D. 1325-1450), along with an increase in the number of sites. When the number of sites decreases in Periods 4 (A.D. 1450-1575) and 5 (A.D. 1575-1700), the elevation range does not shrink. Like habitation sites, seasonal sites, most of which we assume are agricultural field houses, are found at elevations presumably too high for successful agriculture. Elevation range is not the most diverse in Period 2 (A.D. 1200-1325), the driest period, nor is it the least diverse in the wetter periods, contrary to what we expected based on the PDSI.

There is some variability in the types of landforms used through time, although a flat-gentle slope/plain is the most common in each period. Ridge slope and terrace are also fairly common beginning in Period 3 (A.D. 1325-1450). If the seasonal sites in Periods 2-5 (A.D. 1200-1700) are field houses, it is obvious that a great deal of effort was invested in distributing them over a diversity of landscapes. As the number of seasonal sites increases in Period 3, so do the number of landforms used. This variety is maintained in Periods 4 (A.D. 1450-1575) and 5 (A.D. 1575-1700) despite decreasing numbers of sites. Apparently, locational diversity was a goal in all periods, which does not conform to our expectations based on the PDSI dryness index. We expected diversity to decrease after Period 3 because there are fewer sites and potential agricultural productivity increases.

Piñon-juniper woodland and grassland/piñon-juniper woodland are the two most common vegetation communities at seasonal sites in all periods. Seasonal sites in Period 3 (A.D. 1325-1450) occur in the greatest variety of vegetation communities (n=6), followed by Periods 2 (A.D. 1200-1325) and 4 (A.D. 1450-1575), with five communities represented in each. These distributions may have little meaning for interpreting site distributions because prehistoric vegetation probably consisted of more grassland and less piñon-juniper woodland (Sivinski 1995).

Special-use Site Locations through Time

The elevation range represented in special-use site locations is smaller in Period 2 (A.D. 1200-1325) than Periods 3-5 (A.D. 1325-1700). Once the range expands in Period 3 (A.D. 1325-1450), it does not contract, except for the disappearance of one very low elevation site in Period 5 (A.D. 1575-1700), even when site numbers decrease. The range suggests that the population always exploited a variety of resources, which is contrary to an expected decline in diversity based on the PDSI.

Although the most common landforms associated with special-use sites through time are a flat-gentle slope/plain and ridge slope, there is great diversity of landforms in Periods 3-5 (A.D. 1325-1700). Ridge slopes represent a much higher percentage of the locations in Periods 4 (A.D. 1450-1575) and 5 (A.D. 1575-1700) than in previous periods. The continued use of a diverse number of landforms in periods with fewer sites points to the amount of effort invested in maintaining variety, even when the PDSI indicates more favorable conditions for agriculture.

Piñon-juniper woodland and grassland are the most common vegetation communities at special-use sites in Periods 2-5 (A.D. 1200-1700). Although special-use sites outnumber seasonal sites in all periods, they are associated with fewer vegetation communities (n=4 for each period) than seasonal sites in Periods 2-4 (A.D. 1200-1575).

Overall it appears that habitation sites stay in much the same elevations and landforms through time. Period 3 (A.D. 1325-1450) sees a great expansion in the diversity of elevation and landforms for both seasonal and

special-use sites. Contrary to expectations derived from the characterization of climate change, this diversity is maintained in subsequent periods.

Social Influences on Site Location

In an effort to examine potential social and economic influences on activity locations, this portion of the chapter characterizes the spatial association of sites within each time period. The method used will compare the distribution of the observed distances between sites to those expected for a simulated random distribution of sites. The nearest-neighbor distance (NND) between sites of specific types is measured, and statistical comparisons use the median NND (mNND) for each assemblage of sites.

While the other sections of this chapter seek to better understand the effects of the natural environment on decisions about site and activity location, this analysis seeks to determine whether the placement of contemporaneous sites is to some degree influenced by the locations of other sites. Although this discussion is primarily descriptive (in terms of the characterization of the relationship between sites), there are several hypotheses related to the spatial distribution of sites relative to each other that will be examined. First, in reference to special-use and seasonal sites, the following hypotheses are evaluated:

- Hypotheses 1-3: Nearest-neighbor distances for special-use and seasonal sites, both within each site type (Hypothesis 1: between special-use sites, Hypothesis 2: between seasonal sites) and between the two site types (Hypothesis 3: between special-use and seasonal sites) should reflect more clustering as population density increases. This is expected as a result of the increasing intensification of landscape use through the pursuit of agricultural (seasonal sites) and wild resource procurement (special-use sites) activities in previously unutilized intermediate locations.

- Hypotheses 4-5: It is expected that the large population concentration at Pecos Pueblo will have a negative impact on local resources, depleting them over time. Nearest neighbor values between special-use and habitation sites (Hypothesis 4) and between seasonal sites and habitation sites (Hypothesis 5) are expected to reflect greater dispersion as resource extraction activities must take place farther away from the large pueblo.

In reference to habitation sites, the following hypothesis is evaluated:

- Hypothesis 6: As population density increases, a pattern of increased dispersion among habitations is expected because it becomes necessary to clearly define territories to minimize competition and conflict for resources.

It is important to note that this analysis addresses only one set of factors—those that relate to the relative positioning of sites to each other—out of many that might influence site location.

Traditional Spatial Analysis Methods

There are several methods to evaluate spatial patterning of sites or, more generally, the analysis of point patterns in data (Bailey and Gatrell 1995:75-139; Ripley 1981:102-190, 1991:22-48). In most cases, archeological site distributions are compared to those expected if site patterning were random. This type of analysis is often presented in reference to a continuum between clustered points and evenly dispersed points, with the corresponding patterns then interpreted in behavioral terms. While there are a variety of approaches to examine site-to-site patterning, the two most frequently employed in archeology are quadrat analysis and nearest-neighbor analysis (Hodder and Orton 1976).

Quadrat Analysis

Quadrat analysis subdivides an area into units of equal size. Within each, the frequency of events of interest (e.g., archeological sites) is counted. Examination of the distribution of observed frequencies within quadrats allows us to determine whether that distribution differs from a random one. Specifically, the ratio of the

variance to the mean frequency is used to determine whether the observed patterning is more closely associated with clustering (high ratio values) or dispersion (low ratio values). A ratio of 1 is interpreted as random spacing, a ratio greater than 1 suggests clustering, and a ratio less than 1 indicates dispersion. This numeric interpretation is based upon the expected behavior of a Poisson process in which rare events are randomly distributed through space (or time).

Problems with quadrat analysis commonly arise in archeological research. In particular, small mean frequencies within each cell may yield erratic results. This situation is analogous to a chi-square analysis in which the expected values for a large number of cells are less than 5. Related to this issue is the influence that quadrat size and shape have on the results. One obvious impact is that with small quadrats, there will be fewer sites, which may yield mean frequencies that are too small to be dependable. Other important effects of quadrat size result from the relationship between the size of quadrats used and the spatial patterning of the phenomena under analysis. For example, if site clusters are larger than the size of the quadrats, this tends to lessen the "signal" for clustering because the clusters will overlap several quadrats, decreasing the variance and mean frequencies (though not in proportion to each other). On the other hand, if the quadrats are as large as the spacing between clusters of sites, the distribution will appear more random than with smaller quadrats. Quadrat shape has also been noted to influence the values obtained in the analysis, again highlighting the impact of analytic decisions on the interpretation of the results (Bailey and Gatrell 1995:84, 96-98). Nearest-neighbor analyses have been proposed to circumvent some of these problems.

Nearest-Neighbor Analysis

Nearest-neighbor analyses have the potential to mitigate some of the problems noted for quadrat-based analyses, particularly the effects of quadrat size and shape. Nearest-neighbor analysis measures the distance between one location and the nearest location of interest (Bailey and Gatrell 1995:89-90). For example, a nearest-neighbor analysis of the relationships between habitation sites measures the distance from one habitation to the next nearest habitation site. This process is repeated for each habitation site in the area of consideration, with the resulting distances providing an estimate of the average (or median) nearest-neighbor distance for all sites of that type. This value can then be compared to the expected nearest-neighbor distance to determine whether the observed value is significantly different. In general, the expected nearest-neighbor distance is determined from the ratio of the size of the area to the number of sites in the area. If the observed nearest-neighbor distance is greater than the expected value, the conclusion is that the sites are more uniformly distributed than expected from a random distribution. On the other hand, if the observed distance is less than the expected value, clustering is inferred.

Traditional nearest-neighbor analyses also have problems, particularly edge effects and decreased utility when site frequencies are small. Edge effects refer to bias introduced into the calculated nearest-neighbor distances through the influence of sites located near the boundary of the analysis area. These effects result from the fact that, in many cases, the analysis boundaries artificially demarcate space, potentially eliminating sites that may be the nearest neighbors but are outside the area of consideration. This phenomenon has the potential to artificially increase the estimated nearest-neighbor distance. Often, establishing a buffer zone within the outer edge of an analysis area within which nearest-neighbor distances will not be calculated mitigates edge effects. An alternative approach is to "wrap-around" from one side of the analysis area to the opposite side, essentially creating a three-dimensional surface over which distances are calculated. One significant drawback to this approach is that it requires rectangular analysis areas to facilitate the "wrap" (Bailey and Gatrell 1995; Ripley 1981). Finally, in order to use tests of significance in evaluating deviations from randomness, the number of locations used in the analysis should be greater than 50 (Hodder and Orton 1976). This requirement often limits the use of nearest-neighbor analyses in some archeological contexts.

Conclusions Regarding Traditional Spatial Analysis Methods

The preceding discussion outlined the general characteristics of two methods commonly used to examine the spatial relationships among sites. One characteristic that both quadrat and nearest-neighbor analysis share is the fact that both are based upon an assumed underlying distribution, the Poisson for quadrat analysis and the

normal distribution for nearest-neighbor analysis. The assumed distributional characteristics of Poisson or normal distributions contribute to some of the problems noted above, particularly in cases where sample sizes are small, or values are biased because of problems such as edge effects. A simulation-based approach was utilized in this analysis to avoid or mitigate some of the problems noted above for nearest-neighbor analyses.

Simulation-based Nearest-Neighbor Analysis

We have made an effort to overcome some of the problems associated with traditional nearest neighbor analyses by comparing observed nearest-neighbor distances to expected distances derived from simulations. Significance tests were performed by comparing the observed NND to the NND values for the simulated assemblages of sites. The major advantages of this simulation approach are the distributional independence of the significance tests and the mitigation of edge effects by generating expected values that also reflect edge effects, therefore controlling for potential bias in the observed data sets when compared to theoretical data.

Simulation Analysis Methods

The general procedure employed in the simulations was one in which randomly distributed points were generated within a rectangular region whose dimensions were defined using the northern-, southern-, eastern-, and westernmost site locations in the survey area (regardless of period) as the source for the coordinates for the northern, southern, eastern, and western boundaries for the simulation rectangle (Figure 6.17). This results in a simulation region somewhat larger than the survey area. The number of random points generated in each simulation corresponds to the number of sites for the period under consideration (Table 6.2). Random points were generated 500 times for each comparison.

Table 6.2. Number of sites simulated for each period.

	Site Type		
Period	Special-Use	Habitation	Seasonal
0 (pre A.D. 1075)	—	—	3
l (A.D. 1075-1200)	l	—	l
2 (A.D. 1200-1325)	56	6	39
3 (A.D. 1325-1450)	188	10	104
4 (A.D. 1450-1575)	143	3	89
5 (A.D. 1575-1700)	107	4	66
6 (post A.D. 1700)	35	3	20



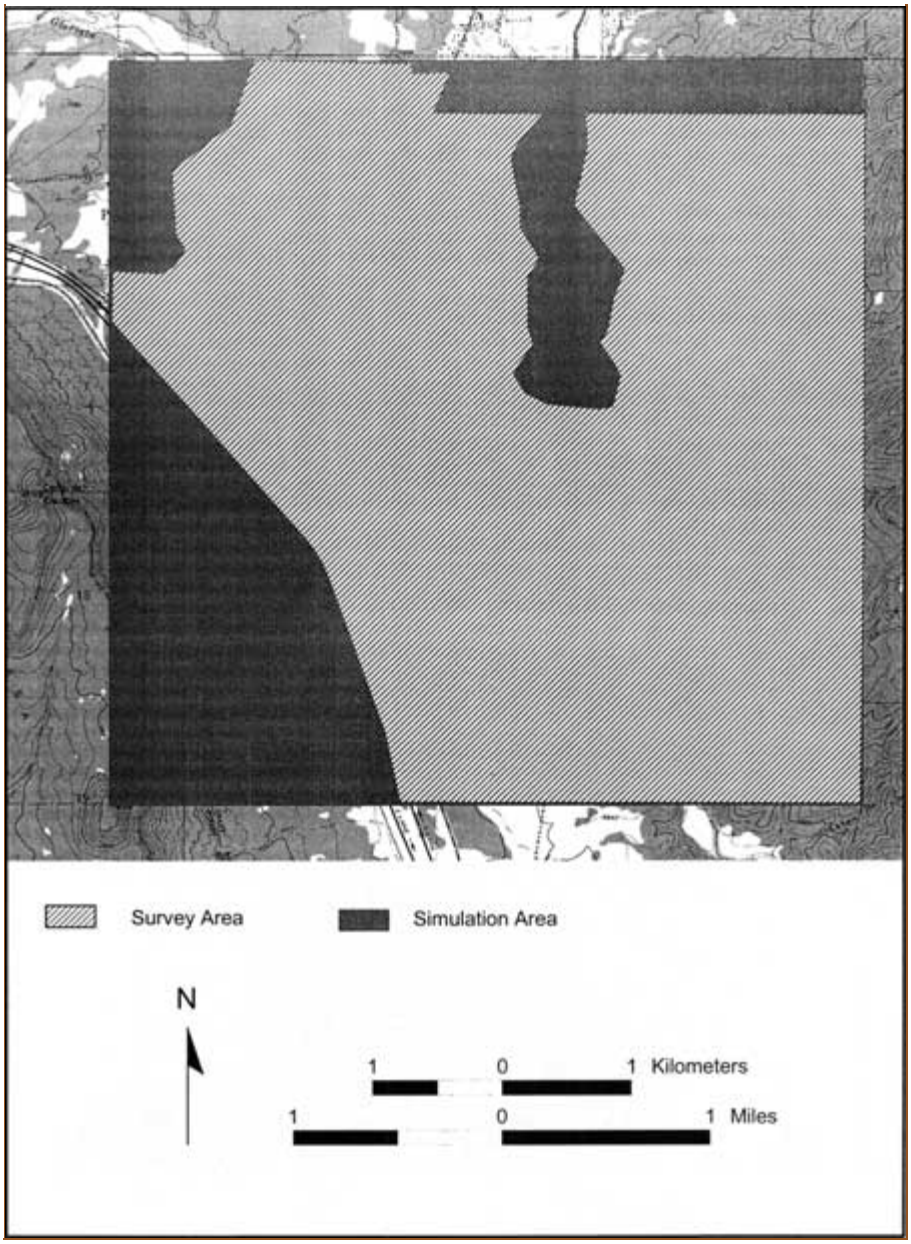


Figure 6.17. Simulation region in comparison to survey area. *(click on image for an enlargement in a new window)*

For example, in the analysis of the distances between special-use sites and habitation sites in Period 2 (A.D. 1200-1325), six habitation sites and 56 special-use sites were identified. In the simulation of relationships between these sites, 56 random special-use site locations and six random habitation site locations were generated. Nearest-neighbor distances were then determined for each of five hundred sets of random points generated for each simulation, yielding frequency distributions of mean and median NND values (Figures 6.18 and 6.19). The frequency distributions of these means and medians were then used to calculate significance values to assess the direction and magnitude of the deviation of the observed NNDs from the expected simulated random distribution. The simulated random distribution is thus used in lieu of the Poisson or normal distributions underlying traditional spatial analyses.

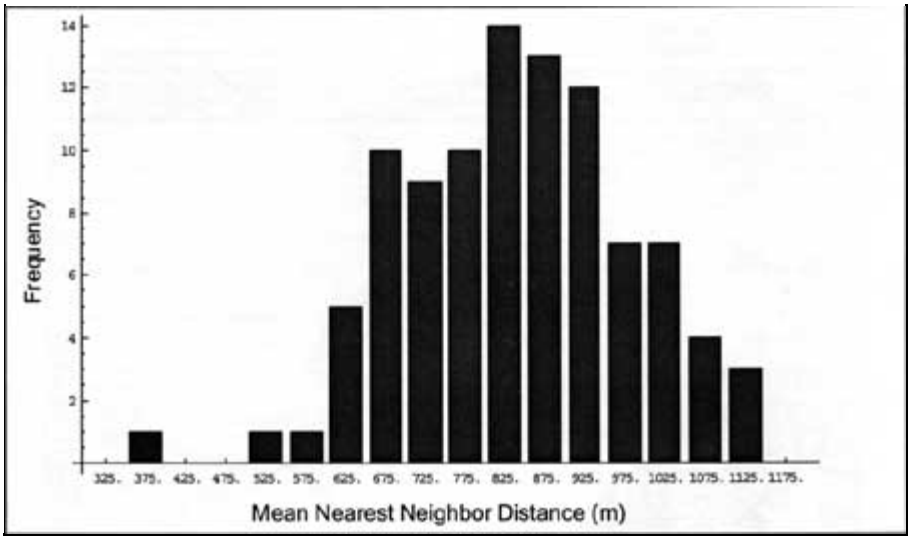


Figure 6.18. Frequency distribution of mean NND between habitations in Period 3 (A.D. 1325-1450).

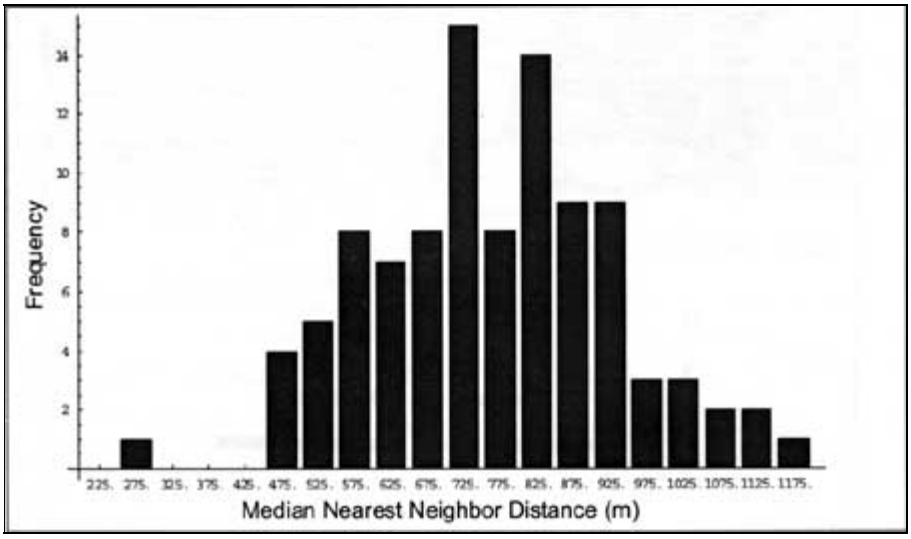


Figure 6.19. Frequency distribution of medium NND between habitations in Period 3 (A.D. 1325-1450).

The magnitude and direction of deviations from randomness are determined by calculating the proportion of the simulated means or medians that are less than the observed value. If a large or small proportion—97.5 percent or 2.5 percent for a significance level (a) of .05—of the simulated mean or median distances is less than the observed mean or median distance, one can conclude that the observed values deviate significantly from random. If a large proportion of the simulated distances are less than that observed, dispersion is indicated. Conversely, if a small proportion of the simulated distances are less than the observed, clustering is indicated. In those instances where a nonsignificant proportion of the simulated mean or median distances differ from the observed proportion, the null hypothesis (Ho) of random patterning (or independence) cannot be rejected.

The following nearest-neighbor simulations were run in each period:

- special-use to special-use (spec-spec in tables and figures),
- special-use to habitation (spec-hab),
- special-use to seasonal (spec-seas),

habitation to habitation (hab-hab),
- habitation to seasonal (hab-seas), and
- seasonal to seasonal (seas-seas).

In some cases there were no sites of a given type in a particular period, so that out of a total of 42 possible simulations, 34 actually yielded results.

The absolute number of sites observed in a particular period plays a significant role in determining the nearest-neighbor distances that are obtained both through simulation and observation. In cases where the number of sites is large, we would expect nearest-neighbor distances to be lower purely as a function of packing more sites into a nonexpanding spatial area. Since the simulations take into account the number of sites of each type in the comparison, the resulting significance tests reflect deviations from a random distribution that uses the same number of sites, thus taking into account fluctuations in distance that are a function of increasing or decreasing site frequencies.

Results of Simulated Nearest Neighbor Analysis

The results presented below are organized by comparison with consideration of both significance of values obtained within each period, and diachronic variation in the observed NNDs. The results are summarized in Table 6.3 and Figure 6.20 and discussed in the following sections. While mean NNDs are presented for each analysis, the following discussion utilizes the median (referred to hereafter as mNND) because some markedly asymmetric distributions exist in which the mean is not a reasonable measure of central tendency in the observed data. This disparity is illustrated by the dramatic change in *p* values for some of the simulations presented in Table 6.3—differences ranging from one extreme to another (i.e., clustering to dispersion as in Period 2 (A.D. 1200-1325) for Habitation-Seasonal (Table 6.31)—depending on whether the *p* value is calculated from the distribution of mean or median simulated values and compared to the corresponding observed values.

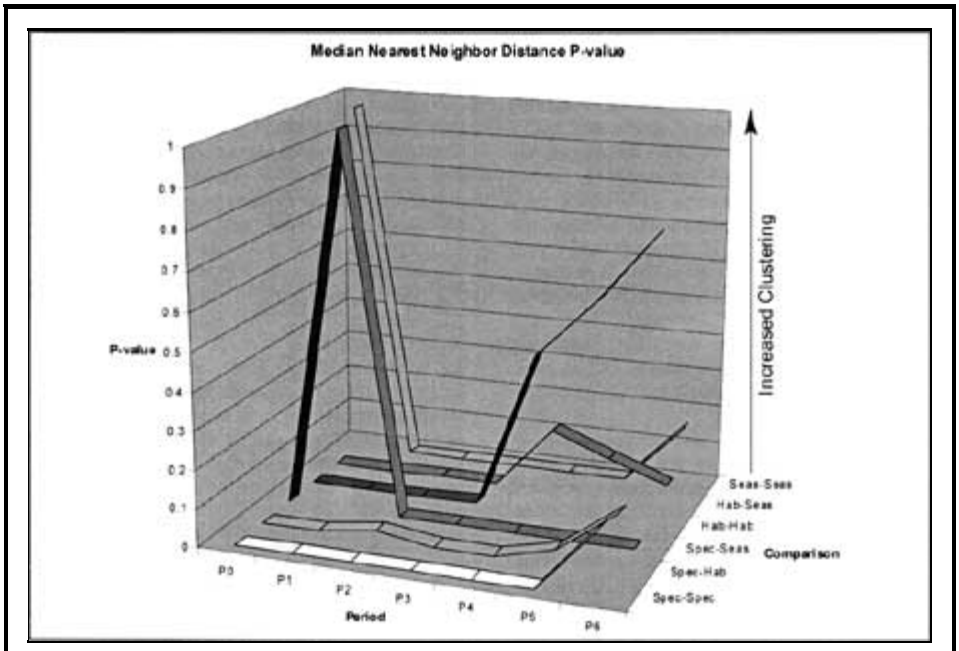


Figure 6.20. Median NND *p* value by period and site type comparison.

Table 6.3. Nearest-Neighbor simulation results.

Comparison[a]	Period	Mean NND (m)	*p* value Mean NND[b]	Median NND (m)	*p* value Median NND[b]

Spec-Spec	0	—	—	—	—
	1	—	—	—	—
	2	247.22	.0000	144.03	.0000
	3	137.16	.0000	100.49	.0000
	4	163.44	.0000	104.64	.0000
	5	216.00	.0000	195.26	.0000
	6	455.70	.4460	379.36	.1760
Spec-Hab	0	—	—	—	—
	1	—	—	—	—
	2	1086.69	.0000	1075.83	.0220
	3	809.44	.0000	696.84	.0000
	4	1212.19	.0000	1096.99	.0000
	5	1248.05	.0720	1143.02	.0360
	6	1371.00	.1180	1291.16	.1520
Spec-Seas	0	—	—	—	—
	1	5358.25	1.0000	5358.25	1.0000
	2	424.82	.5660	263.58	.0020
	3	254.11	.1960	197.27	.0000
	4	313.11	.5900	216.83	.0000
	5	376.47	.8220	237.35	.0000
	6	568.15	.1580	413.49	.0020
Hab-Hab	0	—	—	—	—
	1	—	—	—	—
	2	1501.06	.8120	308.85	.0000
	3	1084.47	.6000	484.88	.0040
	4	840.13	.9760	387.74	.4200
	5	829.25	.5140	829.27	.5720
	6	1916.83	.9880	1270.81	.7580
Hab-Seas	0	—	—	—	—
	1	—	—	—	—
	2	909.94	.9840	151.06	.0020
	3	564.04	1.0000	153.12	.0020
	4	151.43	.1100	147.64	.1700
	5	205.80	.1180	181.01	.1100
	6	235.00	.0260	214.66	.0560
Seas-Seas	0	126.09	.9880	112.97	.9680
	1	—	—	—	—
	2	212.25	.0000	160.80	.0000
	3	158.17	.0000	108.07	.0000
	4	191.11	.0000	159.35	.0000
	5	234.26	.0020	198.90	.0000
	6	490.95	.4400	389.97	.1600

[a]Spec = Special Use, Hab = Habitation, Seas = Seasonal

[b]Proportion of simulated values that are less than that observed. *P* values <0.025 or >0.975 would be considered significant at the *a*=0.05 level and are shaded.

Comparison of Special-Use to Special—Use Sites

Special-use sites are significantly clustered (mNND *p* value < 0.025) for all periods except Period 6 (post A.D. 1700). This is not surprising since these sites probably represent resource gathering and processing locations that would be in close proximity to the materials being gathered or processed. Because resources across the landscape tend to be spatially correlated (i.e., there may be several productive areas near each other, or large productive areas may exist that are utilized repeatedly or contemporaneously), clustering of sites related to these resources is expected. The fact that there is no significant deviation from randomness in Period 6 may be related to the substantial decrease in the number of special-use sites, yielding an overall low density of sites on the landscape. The decrease in site density may be associated with a more spatially extensive wild resource utilization strategy that was not closely tied to the clustering of productive areas. It may also represent disuse of much of the study area due to the threats from Comanche raiding that were prevalent at Pecos during the eighteenth century.

The plots of mNND against the number of sites for each period (Figure 6.21), the mNND by period (Figure 6.22), and the mNND *p* values by period (Figure 6.20) illustrate the temporal trends in these relationships. Specifically, they demonstrate the strong negative correlation between the mNND and the number of sites (Figure 6.21). As the number of sites increases, the mNND decreases, and the mNND p values remain consistently significant in their indication of clustering. This trend supports Hypothesis 1 (outlined at the beginning of this section), insofar as this hypothesis predicts a decrease in mNND values among special-use sites as population density increases. When plotted by period (Figure 6.22), the low point in the curve of mNND values occurs in Period 3 (A.D. 1325-1450), the peak in local population. This relationship reinforces the interpretation that the intensity of patch utilization is driving the significant clustering, with the special-use site densities in Period 6 (post A.D. 1700) perhaps crossing a threshold where individual resource patches are occupied by one or fewer special-use sites.

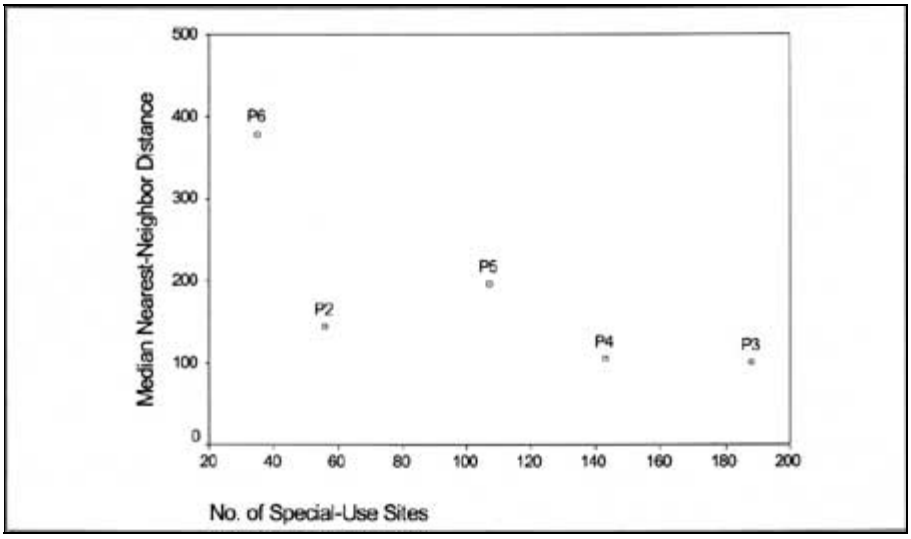


Figure 6.21. Plot of observed median NND for special-use sites vs. the number of special-use sites in each period.

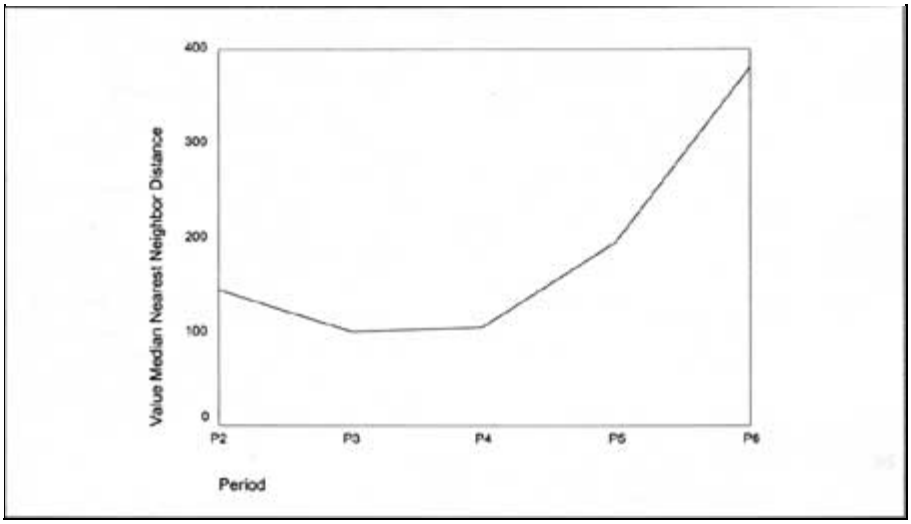


Figure 6.22. Median observed N?ND between special-use sites by period.

Comparison of Special-Use to Habitation Sites

Habitation and special-use sites are significantly clustered in Periods 2 (A.D. 1200-1325), 3 (A.D. 1325-1450), and 4 (A.D. 1450-1575), while there is no significant clustering or dispersion in Periods 5 (A.D. 1575-1700) and 6 (post A.D. 1700). This result is consistent with a conclusion that special-use sites, while being associated with patches of resources (see above and localized plant productivity analysis in later section), are also selected based upon proximity to habitation sites. This supports Hypothesis 4 for greater dispersion of habitation and special-use sites with increasing population density. It also is consistent with the common sense conclusion that populations will first tend to utilize resources close to their place of residence before taking advantage of more distant resources.

Another interesting trend in the relationship between special-use and habitation sites is the nonlinear relationship between the number of special-use sites and the mNND between special-use and habitation sites (Figure 6.23). The plateau in the middle of the distribution, particularly for Periods 4 (A.D. 1450-1575) and 5 (A.D. 1575-1700), suggests that distances between special-use and habitation sites are not decreasing with increasing frequency of special-use sites, as would be expected due to the simple process of packing additional sites into a limited area. This may be related to an increasing need to utilize resources more distant from large aggregated habitation sites like Pecos Pueblo. This result again is consistent with the expectation outlined in Hypothesis 4 at the beginning of this section of the chapter—that as population grows at specific locations, local resources may be inadequate to meet the requirements of the aggregated population. The fact that Periods 5 and 6 (post A.D. 1700) also showed no significant clustering between special-use and habitation sites (Table 6.3; Figure 6.20) further reinforces this argument. Specifically, while habitation and special-use sites are clustered in Periods 2-4 (A.D. 1200-1575) suggesting a consistent utilization of local resources, it is possible that localized resource inadequacy or depletion led aggregated populations in Periods 5 and 6 to exploit resources more distant from their settlements. An alternative explanation for this pattern is that the patchiness of resources prevents the establishment of sites at intermediate locations, leading to a bottom limit below which mNND values cannot exist. While these suggestions can not be evaluated with the available survey data, they present interesting questions for further study.

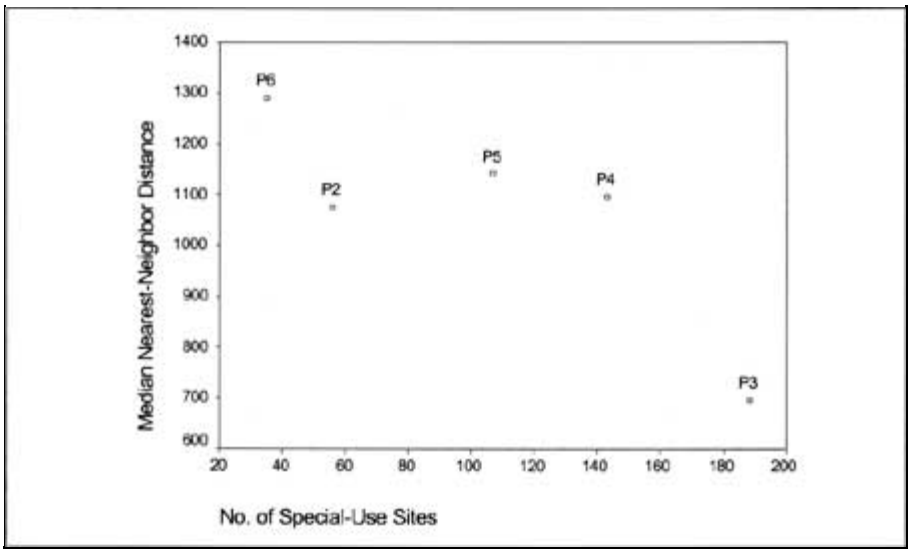


Figure 6.23. Plot of observed median NND between special-use and habitation sites vs. the number of special-use sites for each period.

Overall, the trends observed in the relationship between special-use and habitation sites are consistent with a generalized pattern of localized resource use, with increasingly distant resources exploited as local resources become depleted. This conclusion is supported through both the nonlinear trend in the relationship between the number of special-use sites and the observed mNND, and the transition from a clustered to a random pattern of association between these site types through time.

Comparison of Special-Use to Seasonal Sites

Excluding Period 1 from discussion (pre A.D. 1075) because of an insufficient sample (n=1 for each site type), special-use and seasonal sites are significantly clustered in Periods 2, 3, 4, 5, and 6 (A.D. 1200-1700+) (Table 6.3; Figure 6.20). Environmental factors probably play an important role in this relationship. Specifically, the environmental conditions conducive to agricultural production are also conducive to wild plant production, leading to co-occurrence of special-use and seasonal sites.

There seems to be a relative insensitivity of the mNND to the number of special-use sites in a given period (Figure 6.24). It is possible that land use within the 200-400 m (656-1,312 ft) distances indicated by the mNNDs in Periods 2-5 (A. D. 1200-1700) (Figure 6.25) occurs at a relatively constant rate and that additional resource acquisition (through the complementary activities of agriculture and wild resource acquisition) is achieved through spatial expansion as opposed to localized intensification. If this were not the case, one would expect to find a negative correlation between the number of sites and the mNND, because localized intensification would have the effect of reducing the mNND for periods with greater intensification.

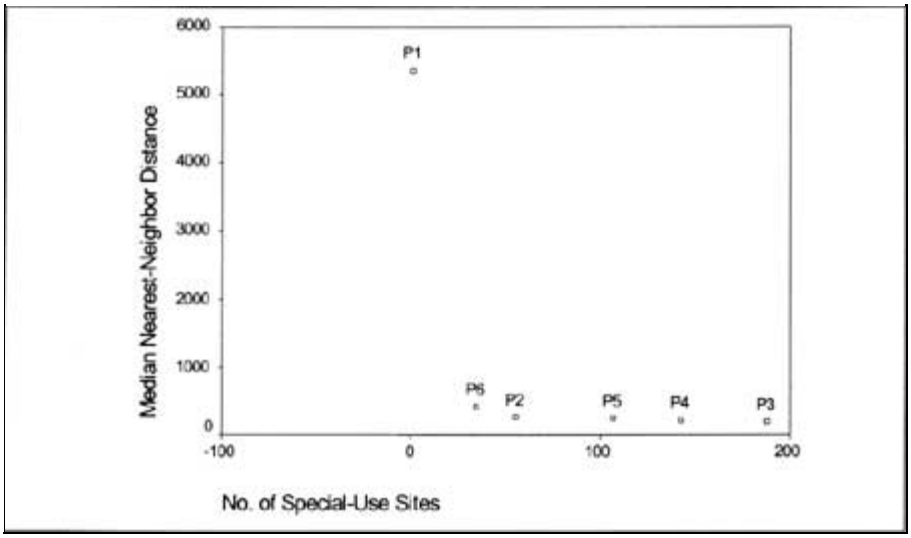


Figure 6.24. Plot of observed median NND between special-use and season sites vs. the number of special-use sites in each period.

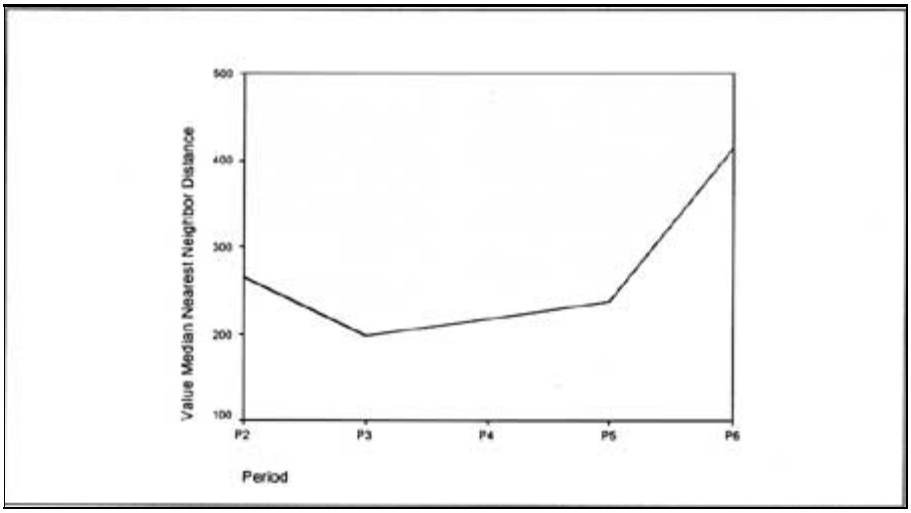


Figure 6.25. Median observed NND between special-use and seasonal sites by period.

This conclusion fails to support Hypothesis 3 (outlined above) that NND values between special-use and seasonal sites should decrease as population density increases. This conclusion is also inconsistent with the results of the comparison among special-use sites (Hypothesis 1), in which the mNND decreased as the number of special-use sites increased. This inconsistency may be the result of a differential labor investment in components at special-use as opposed to seasonal sites. Because of the investment of labor in building architectural features and preparing fields at seasonal sites, they may be more likely to be reoccupied than special-use sites, therefore reducing the number of sequentially occupied seasonal sites when compared to special-use sites. This pattern of differential reoccupation may lead to the different conclusions outlined above. When considered by themselves, special-use sites have a lower probability of reoccupation, therefore increasing the likelihood for nearby, sequentially occupied sites, leading to an interpretation of intensification where sequential occupation may be a valid alternative explanation.

Overall, the relationship between special use and seasonal sites suggests clustering and a constant NND for each period except Period 1 (pre A.D. 1075). In contrast with Hypothesis 3 (outlined above), these results are consistent with an interpretation of relatively constant intensity of land use, independent of population. One by-product of this inference is that as additional resources were required for a growing population, those

resources may have been obtained through a more spatially extensive—as opposed to intensive—acquisition region, or through an increase in trade, although these suggested explanations cannot be evaluated with the current survey data.

Comparison of Habitation to Habitation Sites

Habitation sites were clustered in Periods 2 (A.D. 1200-1325) and 3 (A.D. 1325-1450). During Periods 4-6 (A.D. 1450-1700+) there are no significant deviations from randomness (Table 6.3; Figure 6.20). Specifically, the mNNDs for Periods 2 and 3 are significantly smaller than those obtained through simulation. In contrast, the mNNDs for Periods 4-6 (A.D. 1450-1700+) are within the range of variation obtained in the simulation. These differences define two distinct patterns, one temporal and the other spatial.

The fact that there is significant clustering—and relatively small mNNDs (Figure 6.26)—in only the earlier periods suggests that prior to the development of Pecos Pueblo there was little competition for resources among communities. If localized resources were inadequate to support the habitation sites extant during Periods 2 (A.D. 1200-1325) and 3 (A.D. 1325-1450), the sites would not be clustered. This interpretation is reinforced by the subsequent dispersal of habitation sites into a nonclustered—but not evenly dispersed—distribution. The concentration of population at Pecos Pueblo may have had a substantial impact on local resources, necessitating the location of other habitation sites farther away from Pecos.

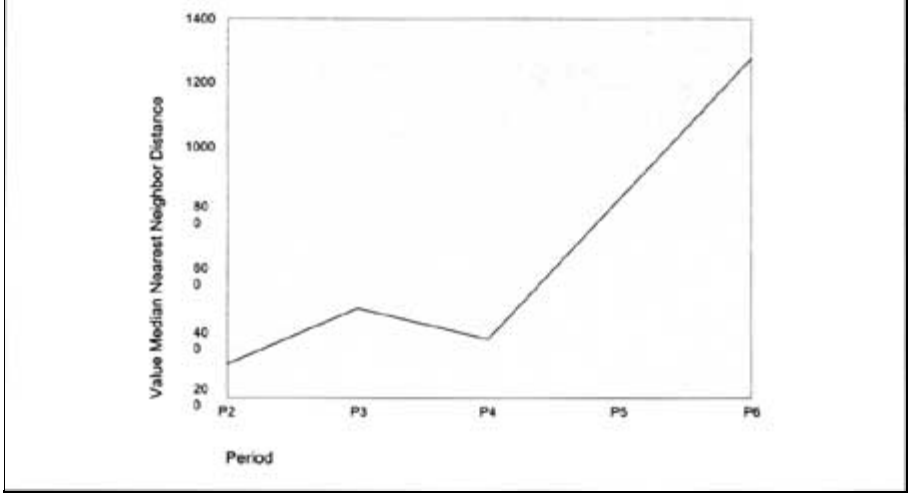


Figure 6.26. Median observed NND between habitation sites by period.

There was a qualitative change in the spatial relationships between habitation sites following the appearance of Pecos Pueblo, with these changes providing strong support for Hypothesis 6 (outlined above). Specifically, there was a relatively constant mNND for habitation sites in Periods 2-4 (A.D. 1200-1575) (Figure 6.26), but mNND values increase substantially in Periods 5 (A.D. 1575-1700) and 6 (post A.D. 1700) while the number of habitation sites is small—four in Period 5, three in Period 6 (Figure 6.27) (these site counts do not agree with Table 7.1 because the nearest-neighbor dataset includes Euro-American sites).

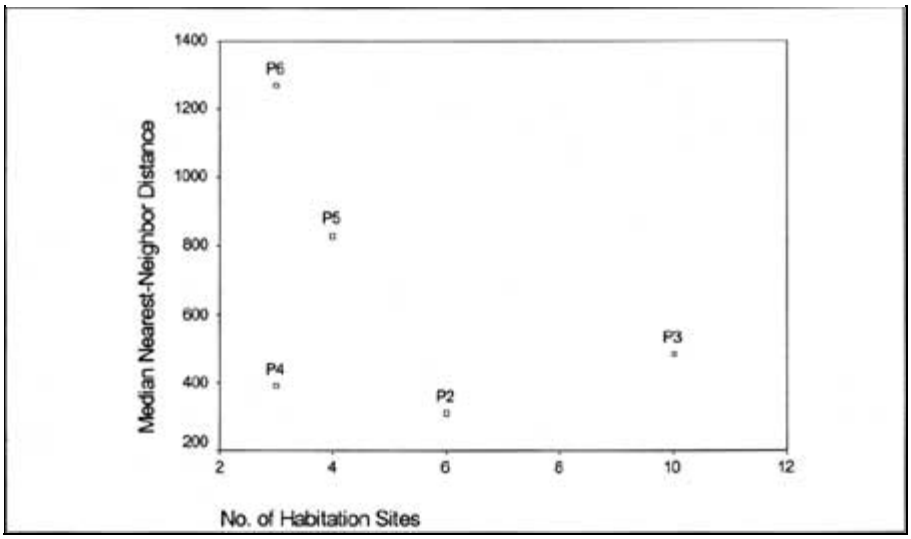


Figure 6.27. Plot of observed median NND between habitations vs. the number of habitations in each period.

The expectation that increasing population density would lead to increasing dispersion of habitations (Hypothesis 6), is supported by the results of the NND analysis. There is indeed evidence that habitations become more dispersed as population increases through Period 3 (A.D. 1325-1450), and this trend toward dispersion continues after Period 3 (Figure 6.20), accompanying continuing aggregation and despite the decline of population in the Pecos area (see Figure 7.1).

These changes in the spatial organization of habitation sites suggest that there were fundamental shifts in how individual communities related to each other and to the land from which they derived their living. With increased local impacts resulting from population aggregation, it became necessary to live farther and farther from other habitations in order for local populations to support themselves and avoid conflicts over resources.

Comparison of Habitation to Seasonal Sites

Like the trends observed among habitation sites, habitation and seasonal sites are clustered in Periods 2 (A.D. 1200-1325) and 3 (A.D. 1325-1450), and there are no significant deviations from randomness in Periods 4, 5, and 6 (A.D. 1450-1700+). Although the mNNDs are substantially lower than those between habitation sites (compare Figure 6.26 to Figure 6.28), the temporal and spatial patterning are remarkably similar.

As was found among habitation sites, there is a trend away from clustering after Period 3 (A. D. 1325-1450) (Figure 6.28). This finding supports Hypothesis 5, outlined above, expecting greater dispersion between habitation and seasonal sites with increasing aggregation. As habitation locations become more stable with substantial investments in architectural features, new agricultural sites are established farther and farther from the habitations.

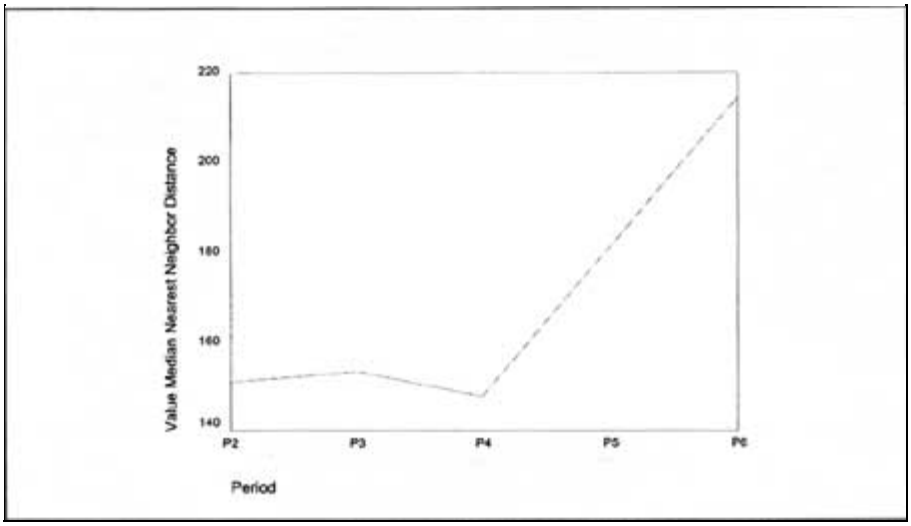


Figure 6.28. Median observed NND between habitations and seasonal sites by period.

The spatial patterning between habitations and seasonal sites is also strikingly similar to that observed between habitation sites. Specifically, the mNNDs between habitation and seasonal sites appear independent of the number of habitations (albeit low) throughout all periods (Figure 6.29). This may also be related to the increased dispersal of agricultural fields through time, independent of the number of habitation sites.

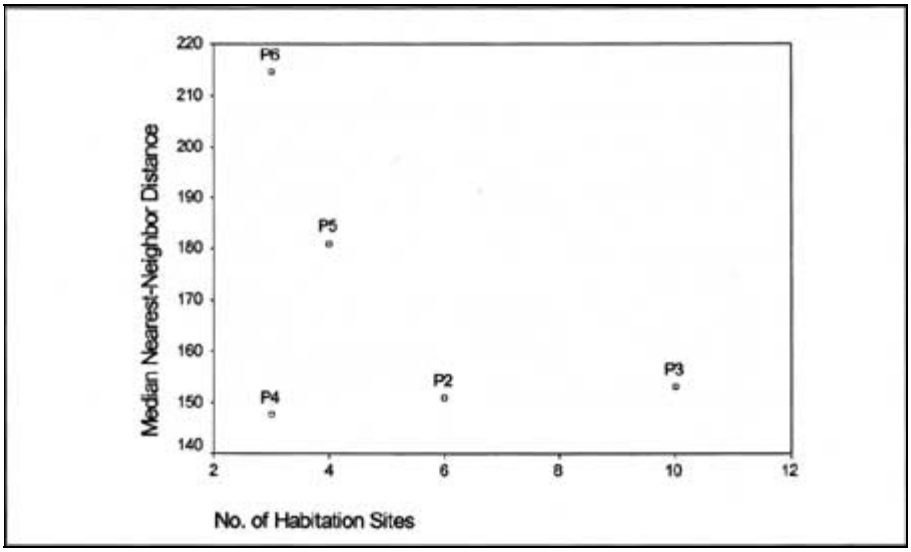


Figure 6.29. Plot of observed median NND between habitations and seasonal sites vs. the number of habitations in each period.

Comparison of Seasonal to Seasonal Sites

Like the relationships among special-use sites, the relationships among seasonal sites is characterized by significant clustering for Periods 2, 3, 4, and 5 (A.D. 1200-1700), with decreasing mNND values associated with greater numbers of seasonal sites (Figure 6.30), and increasing mNND values starting in Period 3 (A.D. 1325-1450) (Figure 6.31). These results support Hypothesis 2 (outlined above), and the expectation that NND values among seasonal sites will decrease with increasing population density. These trends are consistent with the pattern of environmental productivity (as discussed in the analysis of the relationship between special-use and seasonal sites) influencing the concentration of agricultural fields within more productive subregions, leading to clustering of seasonal sites.

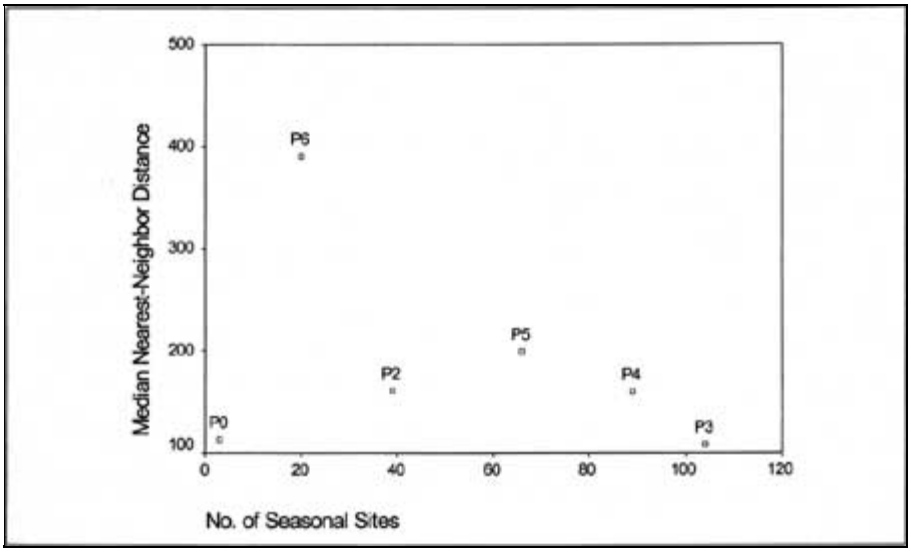


Figure 6.30. Plot of observed median NND between seasonal sites vs. the number of seasonal sites in each period.

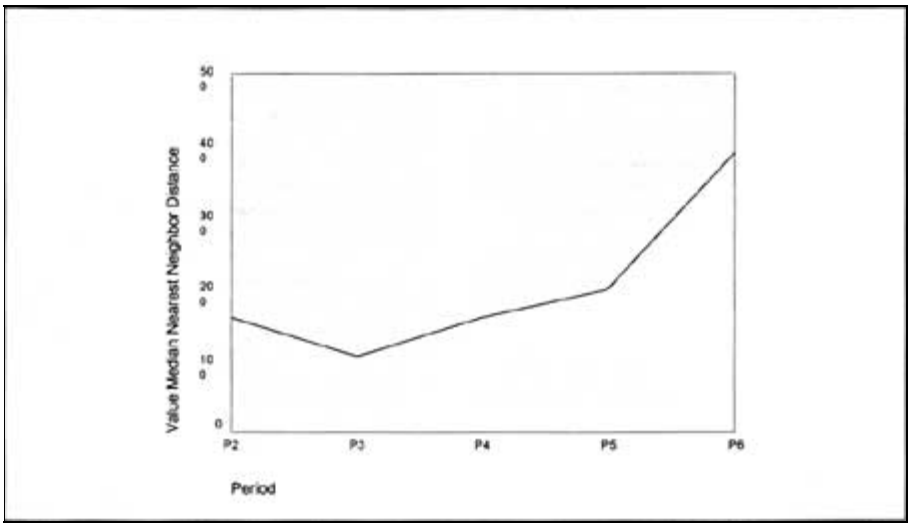


Figure 6.31. Median observed NND between seasonal sites by period.

Only about one-third of the relationships examined in the nearest-neighbor analysis are something other than clustered. With seasonal and special-use sites, the high degree of clustering both within and between these site types supports the conclusion that these locations were largely determined by resource availability, with those resources closest to the habitation site being used first. Nonhabitation sites were moved farther away from habitations through time, suggesting that localized resource depletion may have played a role in the relationship between habitation and resource procurement locations.

Special-use and seasonal sites are clustered in every period, and are the only comparison to show that consistency through time. It is likely that the same factors favoring agriculture also favor wild plant production so that resource locations encouraged multiple strategies in the same area.

In reference to the hypotheses outlined at the beginning of this section, the following comments can be made:

- Hypothesis 1, that increasing population densities would be associated with decreasing NND values among special-use sites, received strong support in this analysis.

- Hypothesis 2, that increasing population densities would be associated with decreasing NND values between seasonal sites, also received strong support in this analysis.

- Hypothesis 3, that increasing population densities would be associated with decreasing NND values between special-use and seasonal sites, received no significant support.

- Hypothesis 4, that local resource depletion around Pecos Pueblo would increase NND values between special-use and habitation sites, received strong support in this analysis. The analysis also revealed that the NND values remained high even when the number of special-use sites increased.

- *Hypothesis 5*, that local resource depletion would increase NND values between seasonal and habitation sites, received strong support in this analysis.

- Hypothesis 6, that increasing population density would create increase NND values among habitation sites received strong support in this analysis.

Habitation sites are clustered in Periods 2 (A.D. 1200-1325) and 3 (A.D. 1325-1450), suggesting that resource competition between communities may not play a strong role in determining the spatial relationship between communities during these periods. Habitations in Periods 4-6 (A.D. 1450-1700+) are increasingly dispersed, with their relative distribution not significantly different from that expected for a random distribution of sites. Although this is not a case of even spacing between sites, a situation indicative of conflict, the move from clustered to random distributions and the greater distances between sites probably points to resource competition between habitation sites during the later periods of occupation. This result is consistent with the expectations associated with Hypothesis 6, that with the aggregation of population at Pecos Pueblo mNND values would increase as a result of necessary dispersion of habitation sites to locales outside the resource procurement zone surrounding Pecos. Specifically, the trend in habitation site dispersion (relative to other habitation sites) supports Hypothesis 6 through Period 4 (A.D. 1450-1575), but the continuing dispersion of sites through Periods 5 and 6 (A.D. 1575-1700+) is contrary to this expectation.

Overall, this analysis has provided a summary of the spatial relationships between the three major site types identified within the Pecos CRIS study area. While consideration of the relationships between sites only addresses one set of variables that influence the location of human activities on the landscape, when integrated with the results of other analyses in this chapter, it provides an important insight into how the cultural landscape at Pecos was formed.

Site Location and Localized Soil and Resource Productivity

As part of the analysis of environmental conditions influencing the selection of particular locations for different activities, this last section of the chapter summarizes the results of an analysis of the local plant productivity immediately proximate to site locations. As mentioned in the first part of the chapter, recent vegetation is not always representative of past conditions, especially in an area that has been so long affected by human use as the Upper Pecos Valley. Characterization of potential plant productivity of soils should more directly reflect the prehistoric setting, since the nature of soils is relatively immutable. Unlike the data taken from the site forms, this approach also uses information on areas that are not archeological sites, providing more detailed characterization of site placement.

This analysis considered each of the three functional site types separately, regardless of time period. The decision to combine sites from different periods was made for three reasons. First, it is assumed that the activities associated with each site type are relatively constant through time (i.e., agricultural activities at seasonal sites, wild resource collection and processing at special-use sites). Second, we assume that the general conditions represented by the plant productivity estimates from the Pecos Soil Survey (Soil and Water West 1996) are relatively constant through time. Third, subdividing the sites into discrete periods would reduce the number of sites in each analysis, yielding smaller sample sizes for each site type.

Overall, this analysis seeks to determine if there are significant relationships between the localized productive potential of soils for economic plant species and the locations of habitation, special-use, and seasonal sites. In contrast to traditional catchment analyses in which polygonal regions of more than 3 km (1.9 mi) in diameter are employed to examine the influence of regional resource availability on site location (e.g., Van West 1994, Varien 1999), this analysis employs relatively very small 100-m radius "catchments" to differentiate between the areas upon which sites are found and those where they are not found. This small "buffer" (used here as a more appropriate term than "catchment") size is better suited to the relatively small survey area for this project. As can be seen in Figure 6.32, larger catchment radii of sizes traditionally employed in catchment analysis would effectively eliminate the "nonsite" catchment component for the Pecos survey area. In the absence of comparable site and nonsite catchment areas, a standard catchment analysis is impossible. Furthermore, the use of small site buffer areas allows for more precise characterization of specific site location criteria than would large catchment areas.

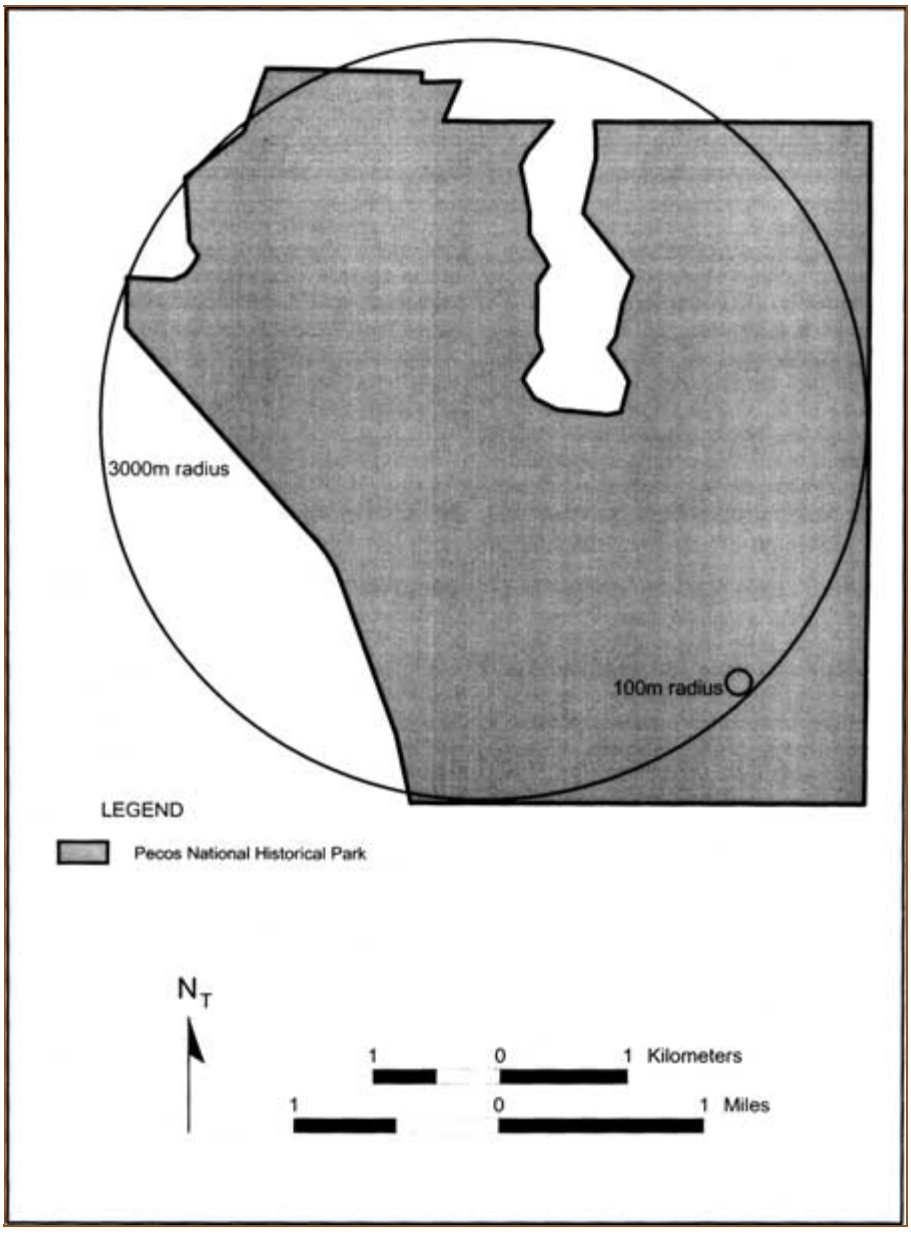


Figure 6.32. Comparison of 3-km radius catchment and 100-m radius buffer area.
(click on image for an enlargement in a new window)

Potential Plant Productivity of Soils

The recent soil survey of Pecos National Historical Park (Soil and Water West 1996) provides qualitative estimates of the potential productivity for different plant classes of the soil units mapped in the project area. The specific plant productivity potentials used in this analysis fall into two groups: those associated with food production or gathering and those that, while having potential food value, may also provide fuel wood. Within the food-related group, the following three classes of resources are considered: grain and seeds, grasses, and herbaceous plants. Within fuel woods, coniferous species and shrubs are considered.

Productivity values assigned by the soil survey range from 0 (Very Poor) through 2 (Fair) to a maximum value of 4 (Very Good). These are best conceptualized as relative qualitative measures of productivity, where higher is more productive, rather than absolute, quantitative figures. Figure 6.33 illustrates the mapped grain and seed productivity potentials provided by the soil survey as an example. Similar mapped distributions exist for the other vegetation classes used in the analysis. In Figure 6.33 the western boundary of the soil survey does not coincide with the current park boundary because at the time of the soil survey the park boundary did not extend to the interstate.

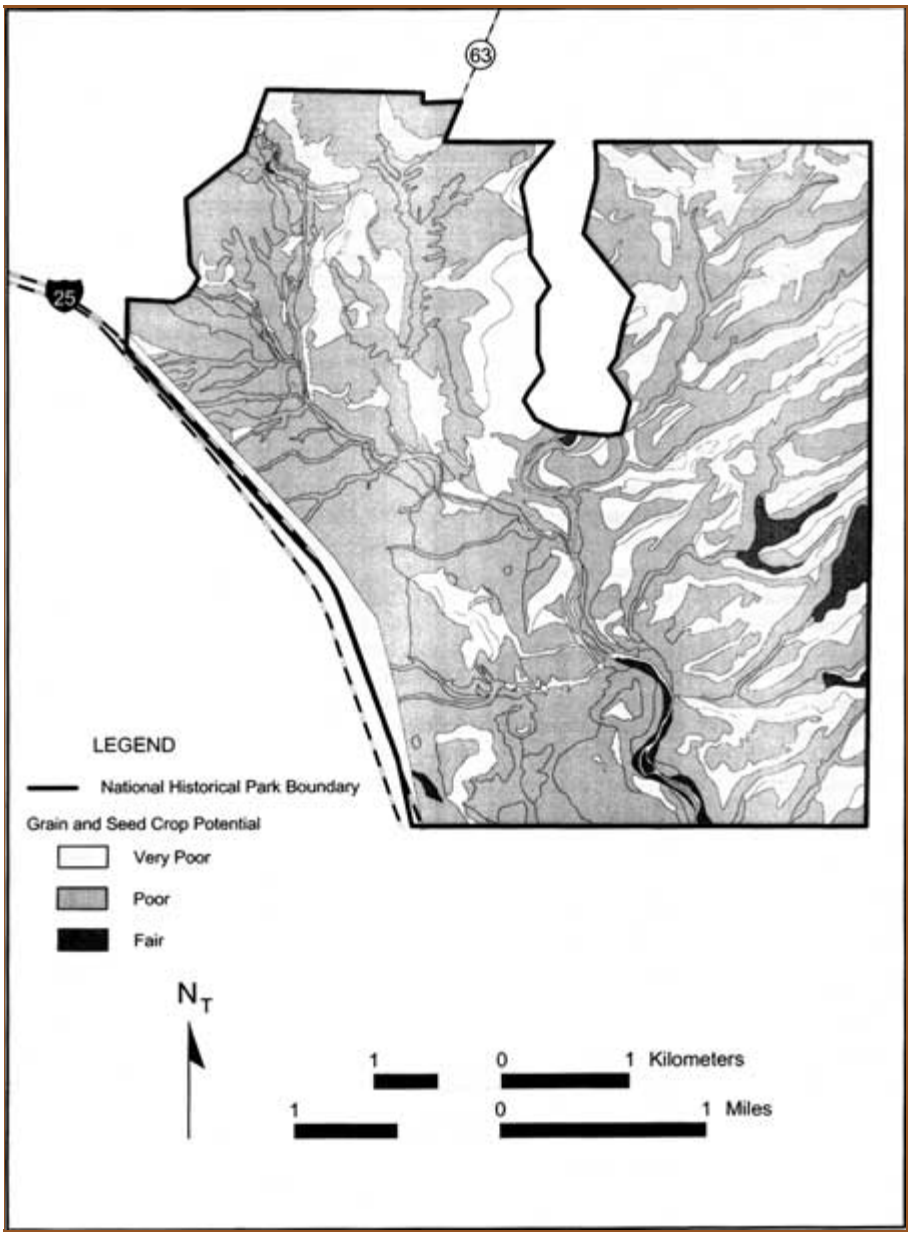


Figure 6.33. Grain and seed productivity for Pecos National Historical Park based on soil survey data. *(click on image for an enlargement in a new window)*

The particular economic plant species (Soil and Water West 1996:Table 4, 72-73), their potential uses (Dunmire and Tierney 1997:270-283), and likely classification within the categories defined by Soil and Water West (1996) are shown in Table 6.4. The economic categories in Table 6.4 are derived from Dunmire and Tierney (1997:270-283). The species listed in Table 6.4 do not include all those listed in the soil survey report but only those species that could be classified as grain and seeds, grasses, herbaceous, coniferous, or shrubs.

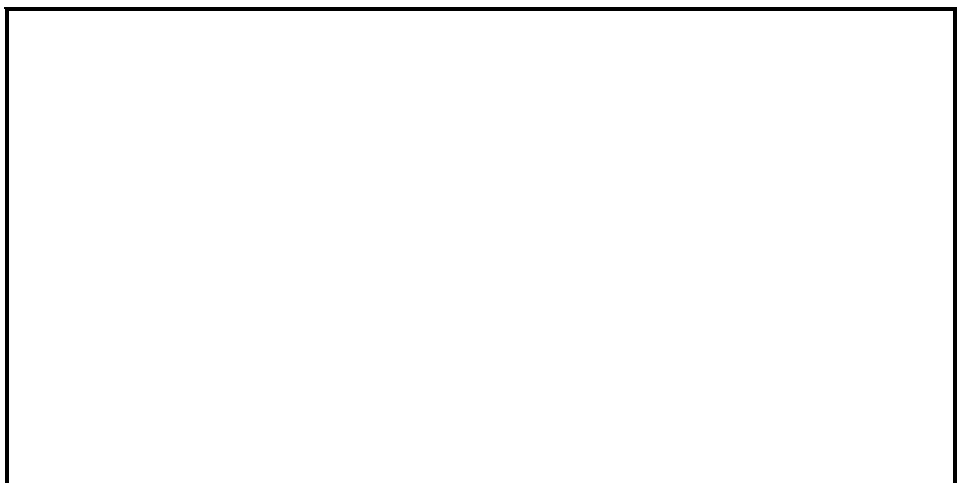
Table 6.4. Economic plant species and their potential uses.

		Plant Class					Economic Use		
Scientific Name	Common Name	Grain and Seeds	Grasses	Herbaceous	Coniferous	Shrubs	Food	Fuel/Construction	Medicine
Aster hesperius	Marsh aster			X					X
Atriplex canescens	Fourwing saltbush			X		X	X	X	X
Brickellia sp.	Bricklebush			X		X			X
Carex sp.	Sedge		X						X
Cercocarpus montanus	Mountain mahogany					X			X
Chrysothamnus nauseosus	Rabbitbrush					X	X	X	X
Erigeron speciosus	Snowy fleabane			X					X
Gutierrezia sarothrae	Broom snakeweed			X					X
Helianthus annuus	Annual sunflower	X		X			X	X	X
Hymenoxys argentea	Silvery bitterweed			X					X
Hymenoxys richardsonii	Pingue			X					X
Juncus sp.	Rush		X	X			X		X
Juniperus monosperma	One-seed juniper					X	X	X	
Juniperus scopulorum	Rocky Mountain Juniper					X	X	X	
Linum lewisii	Western blue flax			X					X
Oryzopsis hymenoides	Indian ricegrass		X				X		
Pinus edulis	Pinyon pine				X		X	X	X
Pinus ponderosa	Ponderosa pine				X			X	X
Potentilla anserina	Silver cinquefoil			X					X

Pseudotsuga menziesii	Douglas-fir			X			X	X
Quercus gambelii	Gambel oak				X	X		
Quercus undulata	Wavy-leaf oak				X	X	X	
Ranunculus acris	Tall buttercup		X					X
Ratibida columnifera	Prairie coneflower		X			X		
Rhus trilobata	Skunkbush sumac				X	X		X
Ribes cereum	Wax currant				X	X		X
Salix exigua	Coyote willow				X		X	X
Smilacina stellata	False solomon's seal		X					X
Sporobolus airoides	Alkali sacaton	X				X		X
Sporobolus cryptandrus	Sand dropseed	X				X		X
Typha latifolia	Cattail		X			X		X
Veronica americana	American speedwell		X					X

Data Analysis

To determine if there are significant associations between the site types and localized plant productivity, a categorical data analysis was performed in which the areas of different plant productivity classes within 100-m of all sites of a particular type were compared to the areas of those productivity classes farther than 100-m from the sites. This was accomplished by generating 100-m buffers around all the sites of each type (illustrated in Figure 6.34 for special-use sites). This buffering process separates the survey area into two classes—those areas within 100-m of sites and those areas more than 100-m from sites (illustrated in Figure 6.35 for special-use sites).



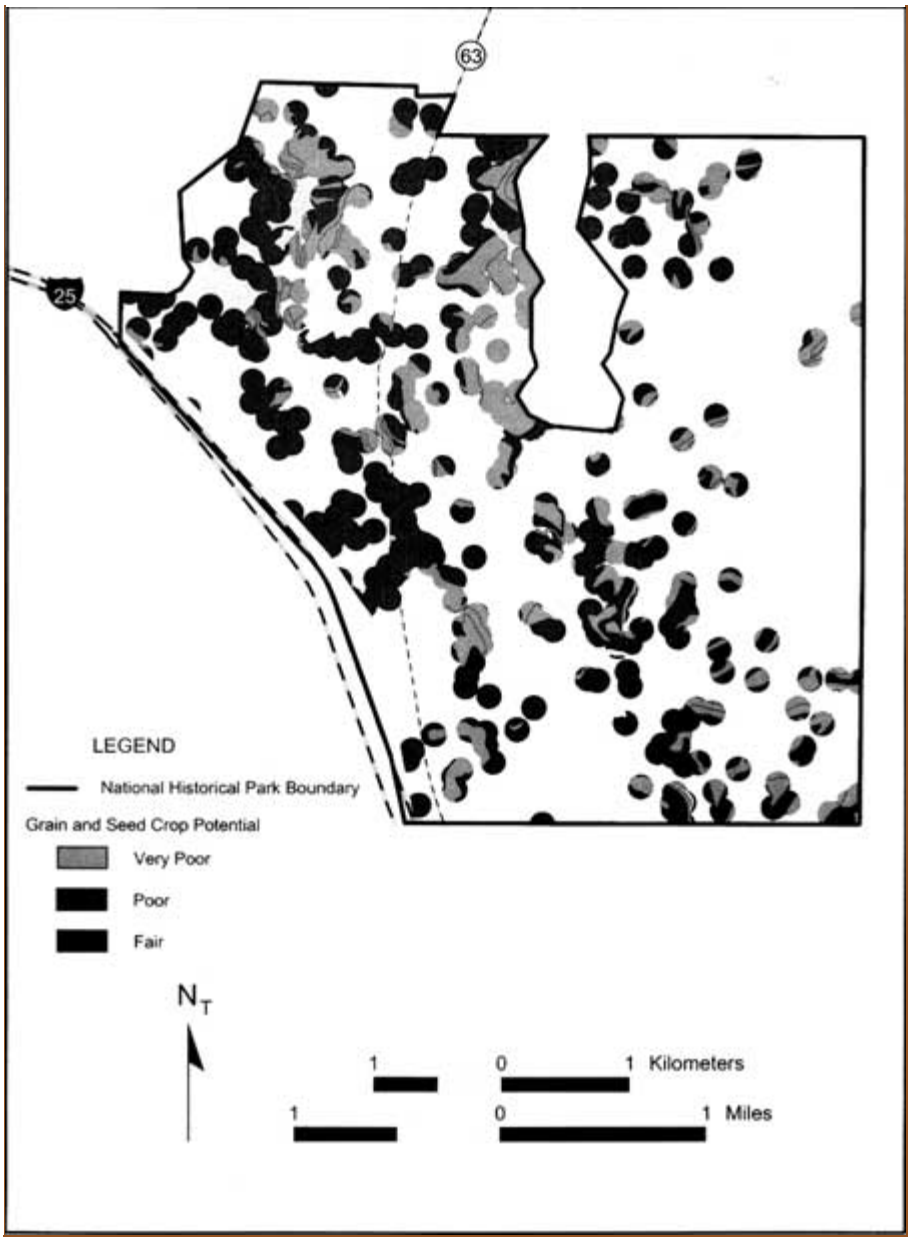


Figure 6.34. Grain and seed potential for areas within 100-m of special-use sites.
(click on image for an enlargement in a new window)

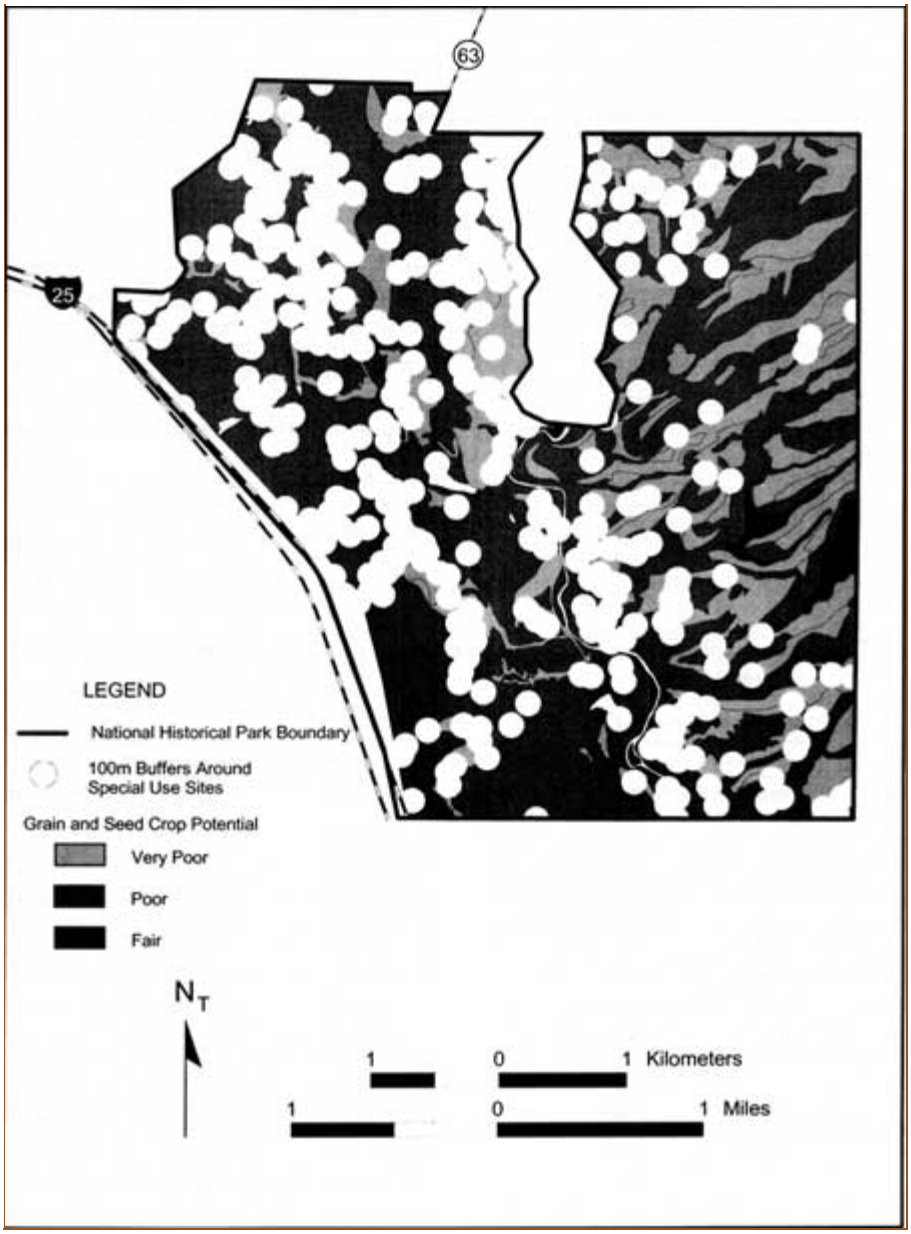


Figure 6.35. Grain and seed potential for areas more than 100 m from special-use sites. *(click on image for an enlargement in a new window)*

Statistical Considerations

The analysis presented here utilizes categorical data analysis techniques to determine the degree and character of influence that localized plant productivity had on the selection of prehistoric activity locations. Categorical data analysis is appropriate because of the nature of the data being analyzed. These data represent the areal extent (originally in m^2 and converted to 400 m^2 blocks [see below]) of different classes of plant productivity within and outside the 100-m buffer defined around each of the different site types. These data are presented most effectively as frequencies within a hierarchical cross-tabulation in which each variable is a column, and each unique combination of values is represented by a row. Each row also presents summary information for each combination of values—the combined areal extent of soil polygons with a unique combination of productivity values, for example. Cross tabulations of this type are illustrated in Tables 6.5, 6.6, and 6.7, in which the productive potential for the food classes are subdivided into those areas within and outside the 100-m buffer defined for habitation sites, special-use sites, and seasonal sites, respectively. These tables differ from standard two-way cross tabulations in that they represent the intersection of more than two variables, necessitating the use of a nested structure for representing the frequencies for each unique combination of

variable values (excluding combinations that do not occur in the dataset). Each soil polygon in the study area has a value for each of the three plant productivity classes in addition to an areal extent (in m^2). The combined areal extent for each combination of values is presented in the fourth and fifth columns of each table. In the analysis that follows, these calculated areas are used as the foundation of the statistical analysis.

Table 6.5. Area of plant productivity classes within and outside the 100-m buffer defined for habitation sites.

Plant Productivity Potential			Area (m^2)		
Grain	Herbaceous	Grasses	Within 100-m Buffer	Outside 100-m Buffer	Total
Very Poor	Poor	Very Poor	75,949	7,079,172	7,155,121
		Poor	9,113	483,408	492,521
	Fair	Very Poor	9,670	191,859	201,529
		Fair	9,763	236,512	246,275
	Good	Very Poor		767,111	767,111
Poor	Poor	Poor	7,726	282,056	289,782
		Fair	13,013	334,628	347,641
	Fair	Poor		5,109,412	5,109,412
		Fair	99,193	5,824,582	5,923,775
	Good	Fair	28,761	2,633,369	2,662,130
Fair	Good	Fair		328,807	328,807
		Good		145,176	145,176
Total			253,188	23,416,192	23,669,280

Table 6.6. Area of plant productivity classes within and outside the 100-m buffers defined for special-use sites.

Plant Productivity Potential			Area (m^2)		
Grain	Herbaceous	Grasses	Within 100-m Buffer	Outside 100-m Buffer	Total
Very Poor	Poor	Very Poor	2,366,418	4,788,703	7,155,121
		Poor	171,270	321,251	492,521
	Fair	Very Poor	54,225	147,304	201,529
		Fair	93,197	153,077	246,274
	Good	Very Poor	121,229	645,882	767,111
Poor	Poor	Poor	81,401	208,380	289,781
		Fair	60,758	286,883	347,641
	Fair	Poor	1,483,000	3,626,411	5,109,411
		Fair	2,266,409	3,657,366	5,923,775
	Good	Fair	1,001,271	1,660,859	2,662,130
Fair	Good	Fair	23,896	304,910	328,806

Good	31,115	114,061	145,176
Total	7,754,289	15,915,187	23,669,276

Table 6.7. Area of plant productivity seasonal sites.

Plant Productivity Potential			Area (m^2)		
Grain	Herbaceous	Grasses	Within 100-m Buffer	Outside 100-m Buffer	Total
Very Poor	Poor	Very Poor	1,233,512	5,921,610	7,155,122
		Poor	185,787	306,734	492,521
	Fair	Very Poor	107,747	93,781	201,528
		Fair	120,491	125,784	246,275
	Good	Very Poor	6,634	760,477	767,111
Poor	Poor	Poor	88,042	201,740	289,782
		Fair	72,207	275,434	347,641
	Fair	Poor	443,222	4,666,190	5,109,412
		Fair	1,837,461	4,086,314	5,923,775
	Good	Fair	381,267	2,280,863	2,662,130
Fair	Good	Fair		328,807	328,807
		Good	17,016	128,160	145,176
Total			4,493,386	19,175,894	23,669,280

Two classes of statistical analysis are commonly used to analyze multiway tables—multiple analyses/comparisons and inultivariate methods. Multiple analyses/comparisons entail the analysis of multiple pairings of variables to identify significant associations between pairs of variables in the analysis. There is some question, however, about the utility of the results of the multiple paired analyses for two reasons. First, there is the possibility that some of the identified associations are the result of associations between variables not specifically modeled in the analyses. Without simultaneous consideration of the possible interactions of all of the variables in the analysis, there is always the possibility that identified interactions are the result of unexamined relationships between variables.

The second reason for questioning multiple comparisons is that when the number of analyses increases, the likelihood increases of identifying a significant association when none exists. This is a simple result of the definition of a significance level for a given analysis. For example, if twenty comparisons are performed at a .05 significance level, it is likely that at least one of those comparisons will be significant when it is not, purely as a result of sampling error. While there are methods to control for this effect, it is best to minimize the number of comparisons (Manly 1994:43-44).

Multivariate statistical methods simultaneously consider more than two variables, allowing a single model to quantify the influence of individual variables while also quantifying the interaction among all of the variables. Because of this characteristic, inultivariate statistical methods allow the development of more realistic models. For example, it is more realistic to develop a single model in which localized productivity of multiple resources is considered, as opposed to multiple models in which single resources are considered. Finally, inultivariate methods allow the explicit development of alternative models of the relationships between variables in the context of the known associations among other variables. For these reasons, a

inultivariate categorical log-linear analysis is used here (Sokal and Rohlf 1995:743-760).

Log-linear analysis is commonly used with multivariate categorical data. Its primary advantage is that it yields a model for the expected frequencies within a multiway contingency table that can separate the effects of the column and row variables (i.e., the variation in frequencies that is solely dependent upon the values of each individual variable) from the effects of their interaction (i.e., the dependence of expected frequencies on some degree of interaction between the variables). Such partitioning allows for testing the null hypothesis that the variables in the analysis are independent of each other. Furthermore, a custom model for some set of "base" effects can be developed, against which the observed frequencies can be compared (Reynolds 1977:57-79). The comparison of expected frequencies to observed is the basis for the chi-square test. The main difference is that in log-linear analysis the expected frequencies can be calculated using any number of different models, depending on the theoretical underpinnings of the particular analysis, as opposed to the single model used in chi-square analysis. Furthermore, log-linear analyses allow for the development of models in which the simultaneous interaction of multiple variables can be considered and quantified (Fienberg 1977:47-76).

Since this analysis is concerned with the relationship between activity location and localized productivity, it is necessary to focus on the specific interactions between site location and localized plant productivity while controlling for the interactions between the different plant productivity values, independent of activity location. Here, this goal is accomplished by including plant productivity interaction (e.g., the interaction between grain/seed potential and grass potential, or the interaction between coniferous and shrub potential) in the "base" (null hypothesis) model in which site location is assumed to be independent of localized plant productivity.

The Models Considered in the Current Analysis

The null-hypothesis (Ho) for each of these analyses is that there are no significant associations between soil plant productivity and site location. More specifically, Ho is that the variation in the observed frequencies (e.g., the observed areas summarized in columns four and five in Tables 6.5-6.7) can be explained by random variation within each variable and the interaction between the vegetation variables.[1] If this cannot account for a significant proportion of the variation in the observed frequencies in the contingency table, Ho may be rejected. If Ho is rejected, further analysis of the data can lead to the development of alternative models that include the interaction between the plant productivity variables and site location.

The likelihood-ratio chi-square statistic (G^2) is used to measure the "goodness of fit" between the expected frequencies generated by the null-hypothesis model and the observed frequencies (SPSS Inc. 1999:177).[2] To reject Ho, the *p* value of G^2 should be less than the significance level defined for this analysis: =.05. If Ho is rejected, one can conclude that there are additional factors contributing to variability in the frequencies.

To identify meaningful associations between localized plant productivity and site location, an analysis of the adjusted residuals ("residuals") for the Ho model (against the observed frequencies) was performed for each of the six analyses reported below (residuals are the difference between expected and observed frequencies). In each case the residuals were examined for directional trends indicating significant associations between plant productivity and site location. Residuals that exceed a 95 percent confidence interval around the mean (i.e., ± 1.96 standard deviation units) are significant, while their directions indicate the direction of the deviation (i.e., negative values = lower than expected frequencies, positive values = greater than expected frequencies). The deviations from expected frequencies provide the foundation for the interpretations that follow.[3]

The Analysis Procedure

The first step in the analysis was to generate 100-m buffers around each site within each site type using the buffer.ave script in ArcView 3.0a and a site location GIS coverage generated from the UTM coordinates for

the sites. The buffers were then used to extract soil data from a GIS coverage of the soil polygons for the majority of the archeological survey area (e.g., Figure 6.33). This extraction yielded two complementary GIS coverages, one containing soil data for the polygons (or portions of polygons) within the 100-m buffer zone, and one with soil data for the polygons outside the 100-m buffer zones (e.g., Figures 6.36-6.38).

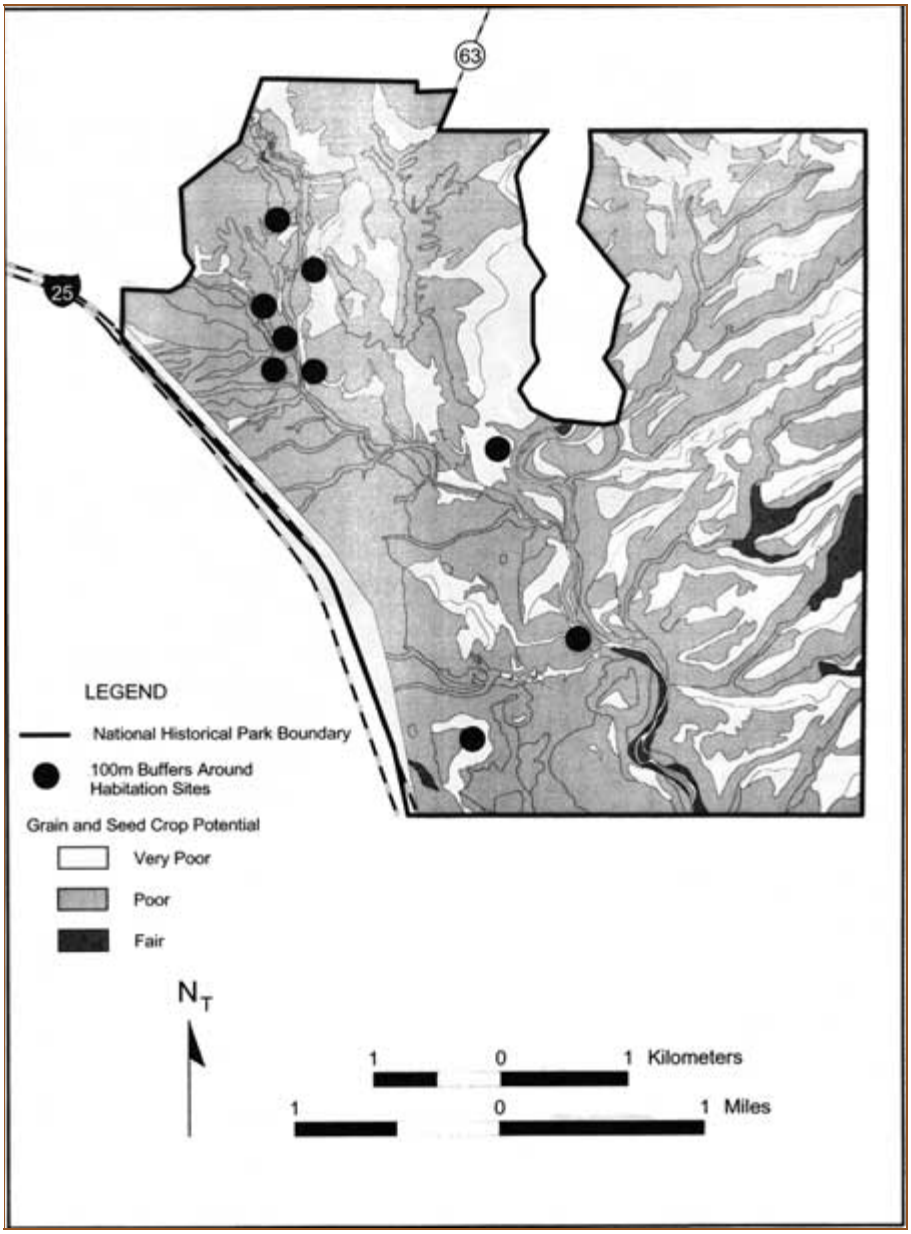


Figure 6.36. 100-m buffers around habitation sites, with grain and seed potential productivity. *(click on image for an enlargement in a new window)*

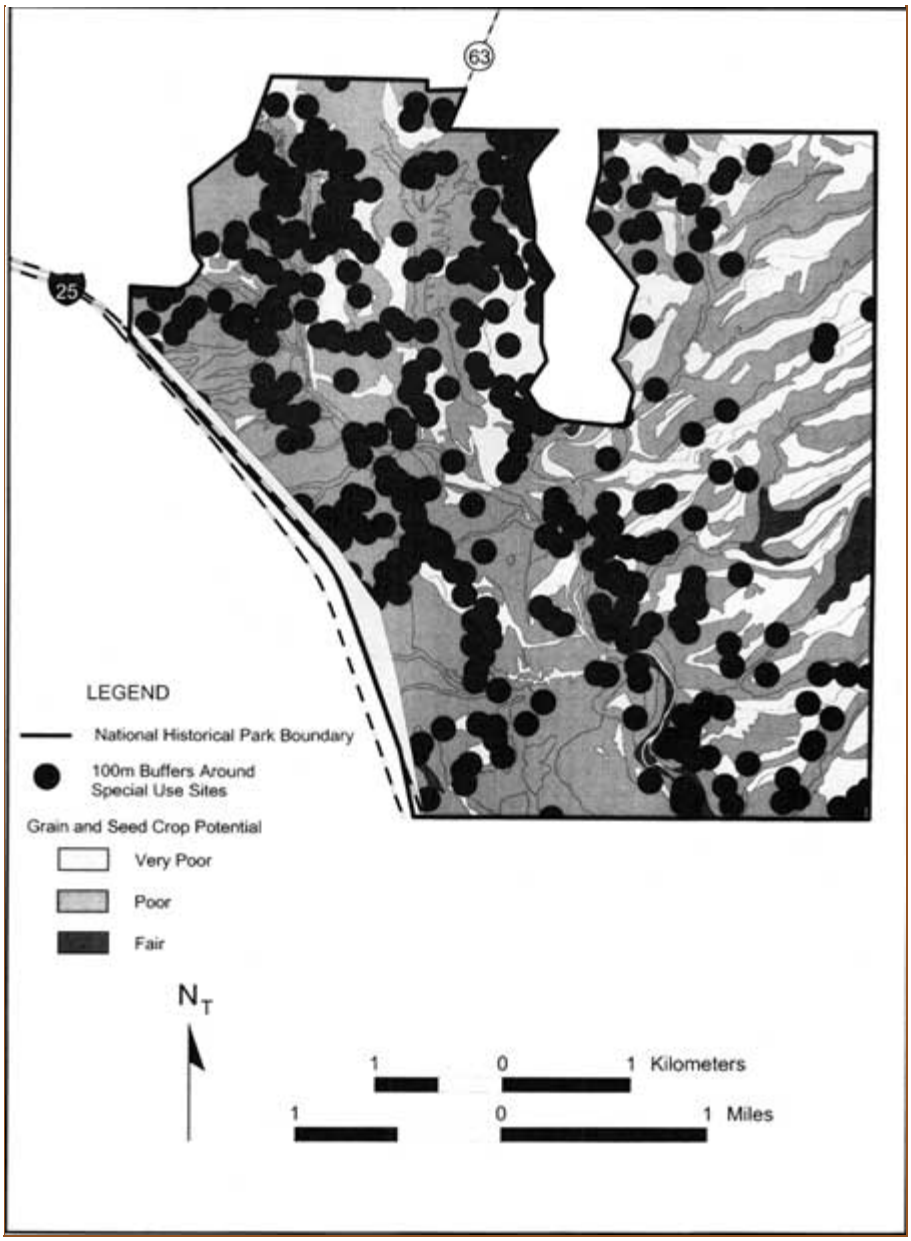


Figure 6.37. 100-m buffers around special-use sites, with grain and seed potential productivity. *(click on image for an enlargement in a new window)*

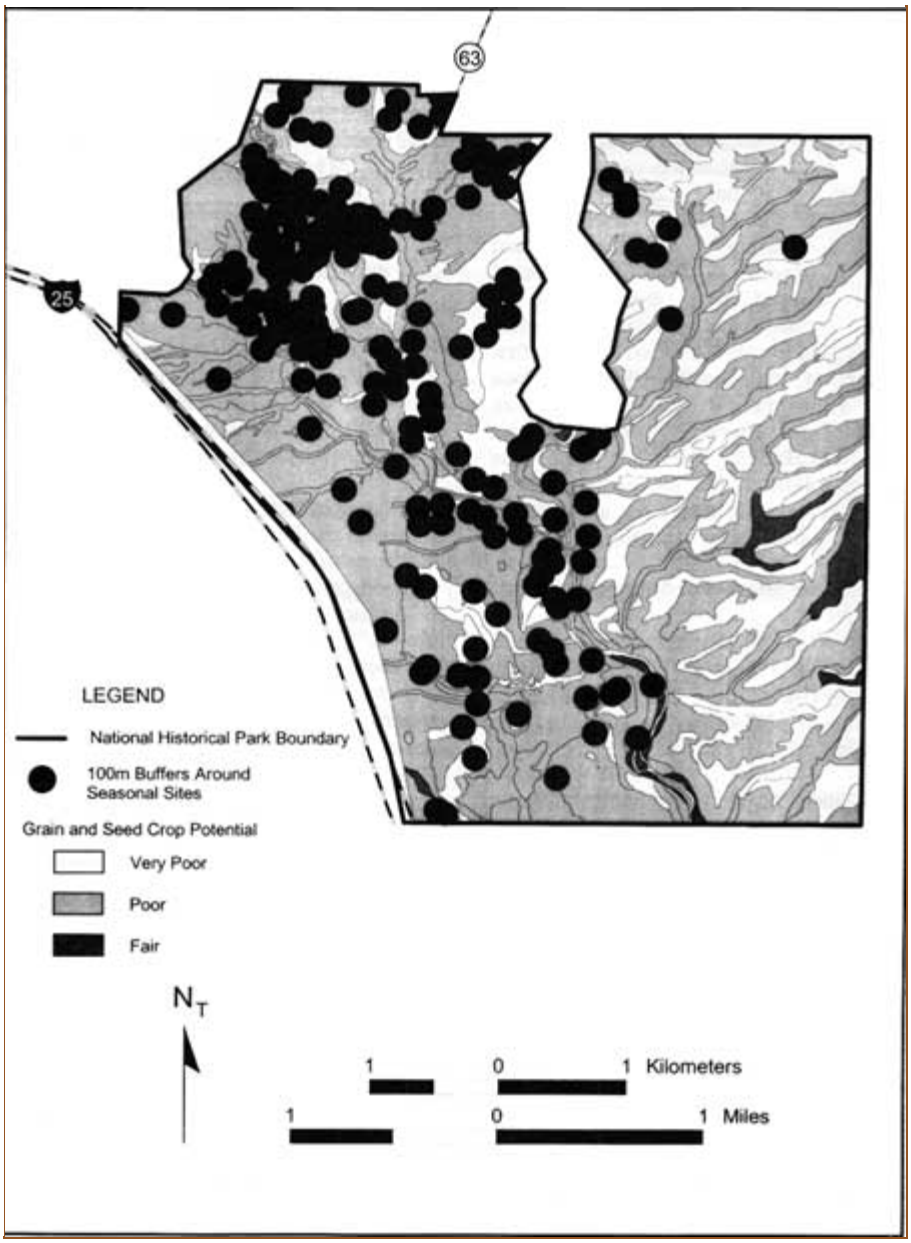


Figure 6.38. 100-m buffers around seasonal sites, with grain and seed potential productivity. *(click on image for an enlargement in a new window)*

To provide a spatial scale in line with the sampling strategy used in the survey, the raw areas (in m^2) of each polygon in the analysis were converted into an equivalent number of 400 m^2 sampling blocks. These blocks correspond with the 10 to 30-m interval used in the archeological survey (averaged to 20-m intervals) and have the effect of subdividing the survey area into 20-x-20-m blocks superimposed on each of the soil polygons. This procedure allows for an explicit definition of the spatial domain for the analysis, mitigating the effects of sample size on the length of the confidence intervals for the parameter estimates in the various models employed.

To determine the best model for explaining the variation in cell frequencies (weighted by the number of 400 m^2 blocks calculated for each polygon), Model Selection Log-linear Analyses (using the SPSS hilog procedure) were performed using backward selection. These analyses identified the minimum number of variables (and their interactions) necessary to sufficiently explain the cross-tabulation frequency variation. After verifying that each "best" model required at least one interaction variable above and beyond those represented by Ho (as defined above) and noting which interaction variables were included in the "best"

model, the SPSS genlog procedure was run using the Ho model (based on a multinomial log-linear model). The genlog procedure yielded expected frequencies and residuals (among other variables) for each cell in the cross tabulation.

Residuals represent the difference between the observed and expected frequencies for each cell in the cross tabulation and are adjusted to be standardized to a mean of 0 and standard deviation of 1. With a significance level of =.05, residuals greater than 1.96 or less than -1.96 are significant, warranting further examination.

Analysis Results

The results reported herein consist of six separate analyses, two for each of the three site types (habitation, special use, and seasonal)—one for food resources and one for fuel resources. Each discussion outlines the significant interactions between plant productivity and site locations. The residuals are analyzed, focusing on the direction and magnitude of deviations from the expected frequencies derived from the Ho of no significant association between plant productivity and site location. The first presentation of the results (that for food resources at habitation sites) includes an assessment of the interactions resulting from the Model Selection Log-linear analysis. These steps were followed for all analyses. The results are presented in tables but are outlined in the text only once as an example.

Habitation Sites — Food Resources

The results of the Model Selection Log-linear analysis *(hilog)* suggest that significant interactions exist (above and beyond those between the plant productivity variables) between the following groups of variables:

- Areas Within/Outside 100-m buffer * Grasses * Herbaceous
- Areas Within/Outside 100-m buffer * Grain and Seed
- Areas Within/Outside 100-m buffer * Grasses
- Areas Within/Outside 100-m buffer * Herbaceous

The results suggest that there are significant differences between the frequencies predicted by the model associated with Ho (Ho:G^2 = 0) and those observed. Since the *hilog* procedure indicates that there are significant interactions beyond those specified in Ho, the *genlog* procedure was run for the Ho model to calculate a *p* value for Ho and to generate expected frequencies and residuals for Ho. The *p* value for Ho was <.0001 (G^2 = 503.7077, df = 35, *p* value = $2*10^{-64}$), confirming the results of the *hilog* procedure, and indicating that Ho can be rejected. These results are summarized in Table 6.8.

The residuals (Table 6.9) for the Ho model show the following patterns:

- The observed frequencies within the buffer are higher than expected (given the Ho model) for the relatively low and middle values for grain and seed productivity, grass productivity, and herbaceous productivity.
- Correspondingly, the observed frequencies within the buffer are lower than expected for the relatively high values for grain and seed productivity, grass productivity, and herbaceous productivity.

These patterns suggest that habitation sites tend to be in locations with relatively low potential food productivity within their immediate area.

Table 6.8. Analysis results summary, habitation sites and food resources.

G^2	*df*	*p* value	result

503.7077	35	$2*10^{-64}$	reject Ho ($G^2=0$)

Significant Site Location and Plant Productivity Interactions:

- Areas Within/Outside 100-m buffer * Grasses * Herbaceous
- Areas Within/Outside 100-m buffer * Grain and Seed
- Areas Within/Outside 100-m buffer * Grasses
- Areas Within/Outside 100-m buffer * Herbaceous

Table 6.9. Observed frequencies, expected frequencies, and adjusted residuals for the localized food resource analysis for habitation sites.

Within/Outside Buffer	Grain	Grasses	Herbaceous	Observed Frequency	Ho Expected Frequency	Ho Adjusted Residual[a]
Within 100-m Buffer	Very Poor	Very Poor	Poor	189.87	191.34	-0.13
			Fair	24.17	5.39	8.17
		Poor	Poor	22.78	13.17	2.69
		Fair	Fair	24.41	6.59	7.02
	Poor	Poor	Poor	19.31	7.75	4.20
		Fair	Poor	32.53	9.30	7.72
			Fair	247.98	158.42	8.26
			Good	71.90	71.19	0.09
Outside 100-m Buffer	Very Poor	Very Poor	Poor	17,697.93	17,696.43	0.13
			Fair	479.65	498.43	-8.17
			Good	1,917.78	1,897.26	4.63
		Poor	Poor	1,208.52	1,218.13	-2.69
		Fair	Fair	591.28	609.10	-7.02
	Poor	Poor	Poor	705.14	716.70	-4.20
			Fair	12,773.53	12,636.87	13.28
		Fair	Poor	836.57	859.81	-7.72
			Fair	14,561.45	14,651.00	-8.26
			Good	6,583.42	6,584.12	-0.09
	Fair	Fair	Good	822.02	813.22	3.00
		Good	Good	362.94	359.06	1.99

a Key to shading in Adjusted Residual Column

values = observed frequencies significantly lower than predicted by Ho.

values = observed frequencies significantly higher than predicted by Ho.

Habitation Sites—Fuel Resources

The null hypothesis (Ho) of no relationship between fuel resource productivity and habitation site locations was rejected (Table 6.10). An examination of the residuals (Table 6.11) for the Ho model shows the following patterns:

- The observed frequencies are higher than expected for relatively high levels of coniferous production, while the observed frequencies are lower than expected for moderate and low conifer production potential.
- The *hilog* procedure yielded a "best" model that excluded any interaction between shrubs and the within/outside buffer variable, indicating that no significant association exists between these two variables. Shrub species, therefore, do not contribute significantly to the association between habitation site locations and fuel wood availability.

Overall, these results suggest that there is a significant positive relationship between areas of high potential coniferous production and habitation sites, leading to the conclusion that the availability of fuel wood, or perhaps building materials, influenced habitation site locations.

Table 6.10. Analysis results summary, habitation sites and fuel resources.

G^2	*df*	*p* value	result
457.1269	8	$1*10^{-93}$	reject Ho ($G^2=0$)

Significant Site Location and Plant Productivity Interactions:

- Areas Within/Outside 100-m buffer * Coniferous

Seasonal Sites—Food Resources

The null hypothesis (Ho) of no relationship between food resource productivity and seasonal site locations was rejected (Table 6.12). An examination of the residuals (Table 6.13) for the Ho model shows the following patterns:

- Relative to grain and seed production potential, the areas within 100-m of seasonal sites show a mixed pattern of association (some specific cases of higher than expected frequencies, some specific cases of lower than expected frequencies) with relatively low and intermediate values, and consistently lower than expected frequencies with high values of grain and seed productivity.
- A similar pattern emerges when grass production is considered. There are mixed patterns of association for relatively low and intermediate values of grass production, while there are consistently lower than expected frequencies for higher values of grass production.
- Herbaceous production exhibits a different pattern than that observed for grains and seeds, or grasses. Specifically, the areas within 100-m of seasonal sites generally have higher than expected frequencies for relatively low and intermediate values of herbaceous productivity and lower than expected frequencies for the highest values of herbaceous productivity.

These results suggest that, in general, seasonal sites show the clearest association with locations that have relatively low to moderate potential for herbaceous species, while also showing weaker (in terms of clarity of patterning) associations with low to moderate values for grains and seeds and grasses.

Table 6.11. Observed frequencies, expected frequencies, and residuals for the localized fuel resource analysis for habitation sites.

Within/Outside Buffer	Coniferous	Shrubs	Observed Frequency	Ho Expected Frequency	Ho Adjusted Residual[a]
Within 100-m Buffer	Very Poor	Poor	111.75	103.64	0.93
	Good	Good	280.52	128.89	16.39
Outside 100-m Buffer	Very Poor	Poor	9,419.51	9,427.59	-0.93
	Fair	Fair	12,773.53	12,634.60	14.75
		Good	1,917.78	1,896.92	4.72
	Good	Good	11,573.03	11,724.62	-16.39

a Key to shading in Adjusted Residual Column
values = observed frequencies significantly lower than predicted by Ho.
values = observed frequencies significantly higher than predicted by Ho.

Table 6.12. Analysis results summary, seasonal sites and food resources.

G^2	*df*	*p* value	result
4314.9339	35	0.0000	reject Ho (G^2=0)

Significant Site Location and Plant Productivity Interactions:

- Areas Within/Outside 100-m buffer * Grasses * Herbaceous
- Areas Within/Outside 100-m buffer * Grain and Seed
- Areas Within/Outside 100-m buffer * Grasses
- Areas Within/Outside 100-m buffer * Herbaceous

Seasonal Sites—Fuel Resources

The null hypothesis (Ho) of no relationship between fuel resource productivity and seasonal site locations was rejected (Table 6.14). An examination of the residuals (Table 6.15) for the Ho model shows the following patterns:

- The observed frequencies are higher than expected for relatively high and low levels of coniferous production, while the observed frequencies are lower than expected for moderate conifer production. This pattern is similar to that observed for special-use sites (see below).
- There are higher than expected frequencies for relatively high and low productivity values for shrubs within the 100-m buffer areas, while there is a mixed pattern of association for the intermediate values.

Table 6.13. Observed frequencies, expected frequencies, and residuals for the localized food resource analysis for seasonal sites.

			Ho	Ho

Within/Outside Buffer	Grain	Grasses	Herbaceous	Observed Frequency	Expected Frequency	Adjusted Residual[a]
Outside 100-m Buffer	Very Poor	Very Poor	Poor	3,083.78	3,395.82	-7.12
			Fair	269.37	95.65	19.82
			Good	16.58	364.07	-20.57
		Poor	Poor	464.47	233.75	16.94
		Fair	Fair	301.23	116.88	19.04
	Poor	Poor	Poor	220.10	137.53	7.87
			Fair	1,108.06	2,424.93	-33.55
		Fair	Poor	180.52	164.99	1.35
			Fair	4,593.65	2,811.43	43.13
			Good	953.17	1,263.45	-10.29
	Fair	Good	Good	42.54	68.90	-3.54
Within 100-m Buffer	Very Poor	Very Poor	Poor	14,804.02	14,491.96	7.12
			Fair	234.45	408.18	-19.82
			Good	1,901.19	1,553.70	20.57
		Poor	Poor	766.84	997.55	-16.94
		Fair	Fair	314.46	498.80	-19.04
	Poor	Poor	Poor	504.35	586.92	-7.87
			Fair	11,665.47	10,348.59	33.55
		Fair	Poor	688.58	704.11	-1.35
			Fair	10,215.78	11,997.99	-43.13
			Good	5,702.16	5,391.87	10.29
		Fair	Fair	822.02	665.96	13.98
			Good	320.40	294.04	3.54

a Key to shading in Adjusted Residual Column
values = observed frequencies significantly lower than predicted by Ho.
values = observed frequencies significantly higher than predicted by Ho.

Table 6.14. Analysis results summary, seasonal sites and fuel resources.

G^2	*df*	*p* value	result
3640.0023	8	0.0000	reject Ho (G^2=0)

Significant Site Location and Plant Productivity Interactions:

- Areas Within/Outside 100-m buffer * Coniferous * Shrubs
- Areas Within/Outside 100-m buffer * Coniferous
- Areas Within/Outside 100-m buffer * Shrubs

The patterns indicated by the residuals suggest that there may be some overlap between the food resource and

fuel wood analyses, specifically in reference to the collection of fuel resources and the selection of locations that are low in conifer density. Low conifer density would facilitate clearing agricultural fields. The higher than expected frequencies for the extreme values for coniferous production within the 100-m buffers and lower than expected frequencies for intermediate values may represent two different patterns of association within this class of sites. First, one set of sites is associated with high productivity conifer areas, perhaps for collecting fuel or construction materials. Second, another set of sites is associated with low coniferous productivity, perhaps indicating a preference for areas requiring less labor to clear and prepare agricultural fields.

Special-Use Sites—Food Resources

The null hypothesis (Ho) of no relationship between food resource productivity and special-use site locations was rejected (Table 6.16). An examination of the residuals (Table 6.17) for the Ho model suggests the following patterns:

- The observed frequencies within the buffer are higher than expected (given the Ho model) for some of the relatively intermediate values of grain and seed productivity, otherwise, they are lower than expected for relatively low and high values for grain and seed productivity.
- The observed frequencies within the buffer are higher than expected for the relatively middle and high-middle values for productivity of grasses. There are corresponding lower than expected frequencies for the highest and lowest values for grasses productivity.
- There are higher than expected frequencies for relatively intermediate values of herbaceous productivity within the buffers, while there are lower than expected frequencies at the lower and upper extremes in potential productivity.

Overall, special-use sites are most frequently associated with intermediate values for all three categories of food resources than would be expected from a random distribution of sites relative to these resources.

Table 6.15. Observed frequencies, expected frequencies, and residuals for the localized fuel resource analysis for seasonal sites.

Within/Outside Buffer	Coniferous	Shrubs	Observed Frequency	Ho Expected Frequency	Ho Adjusted Residual[a]
Within 100-m Buffer	Very Poor	Poor	2,343.94	2,041.40	8.81
	Fair	Fair	1,108.06	2,735.83	-43.68
		Good	16.58	410.75	-22.55
	Good	Good	4,258.19	2,538.79	46.98
Outside 100-m Buffer	Very Poor	Poor	7,187.33	7,489.85	-8.81
	Fair	Fair	11,665.47	10,037.69	43.68
		Good	1,901.19	1,507.03	22.55
	Good	Good	7,595.35	9,314.75	-46.98

a Key to shading in Adjusted Residual Column

values = observed frequencies significantly lower than predicted by Ho.

values = observed frequencies significantly higher than predicted by Ho.

Table 6.16. Analysis results summary, special-use sites and food resources.

G^2	*df*	*p* value	result
1096.1850	35	$2*10^{-207}$	reject Ho ($G^2=0$)

Significant Site Location and Plant Productivity Interactions:

- Areas Within/Outside 100-m buffer * Grasses * Herbaceous
- Areas Within/Outside 100-m buffer * Grain and Seed
- Areas Within/Outside 100-m buffer * Grasses
- Areas Within/Outside 100-m buffer * Herbaceous

Table 6.17. Observed frequencies, expected frequencies, and residuals for the localized food resource analysis for special-use sites.

Within/Outside Buffer	Grain	Grasses	Herbaceous	Observed Frequency	Ho Expected Frequency	Ho Adjusted Residual[a]
Within 100-m Buffer	Very Poor	Very Poor	Poor	5,916.05	5,860.14	1.07
			Fair	135.56	165.05	-2.81
			Good	303.07	628.27	-16.08
		Poor	Poor	428.18	403.38	1.52
		Fair	Fair	232.99	201.70	2.70
	Poor	Poor	Poor	203.50	237.33	-2.69
			Fair	3,707.50	4,184.68	-10.16
		Fair	Poor	151.90	284.72	-9.67
			Fair	5,666.02	4,851.65	16.47
			Good	2,503.18	2,180.32	8.95
	Fair	Fair	Good	59.74	269.30	-15.68
		Good	Good	77.79	118.90	-4.61
Outside 100-m Buffer	Very Poor	Very Poor	Poor	11,971.76	12,027.65	-1.07
			Fair	368.26	338.77	2.81
			Good	1,614.70	1,289.50	16.09
		Poor	Poor	803.13	827.92	-1.52
		Fair	Fair	382.69	413.98	-2.70
	Poor	Poor	Poor	520.95	487.12	2.69
			Fair	9,066.03	8,588.84	10.16
		Fair	Poor	717.21	584.38	9.67
			Fair	9,143.42	9,957.77	-16.47
			Good	4,152.15	4,475.00	-8.95
	Fair	Good	Good	762.28	552.72	15.68
		Good	Good	285.15	244.04	4.61

a Key to shading in Adjusted Residual Column

values = observed frequencies significantly lower than predicted by Ho.
values = observed frequencies significantly higher than predicted by Ho.

Special-Use Sites—Fuel Resources

The null hypothesis (Ho) of no relationship between fuel resource productivity and special use site locations was rejected (Table 6.18). An examination of the residuals (Table 6.19) for the Ho model suggests the following patterns:

- The observed frequencies are higher than expected for relatively high and low levels of coniferous production, while the observed frequencies are lower than expected for moderate conifer production.
- Frequencies are higher than expected for relatively high and low productivity values for shrubs within the 100-m buffer areas, while there is a mixed pattern of association for the intermediate values.

The patterns indicated by the residuals suggest that for special-use sites there also may be some overlap between the food resource and fuel wood analyses, specifically in reference to the collection of coniferous food resources and food resources that may not coexist well with coniferous species. The higher than expected frequencies for the extreme values of coniferous production within the 100-m buffers and lower than expected frequencies for intermediate values may represent two different patterns of association within this class of sites. First, one set of sites is associated with relatively high productivity conifer areas, perhaps for collecting arboreal food resources or fuel wood. Second, another set of sites is associated with low conifer productivity, perhaps for collecting food resources that do not coexist with coniferous species. Without a more detailed analysis that works with mapped productivity potentials at the individual plant species level and more specific information on activities at sites than can be derived from the site typology, it is difficult to assess these potential explanations for the observed patterns.

Table 6.18. Analysis results summary, special-use sites and fuel resources.

G^2	*df*	*p* value	result
471.0905	8	$2*10^{1*10^{-96}}$	reject Ho ($G^2=0$)

Significant Site Location and Plant Productivity Interactions:

- Areas Within/Outside 100-m buffer * Coniferous
- Areas Within/Outside 100-m buffer * Shrubs

Table 6.19. Observed frequencies, expected frequencies, and residuals for the localized fuel resource analysis for special-use sites.

Within/Outside Buffer	Coniferous	Shrubs	Observed Frequency	Ho Expected Frequency	Ho Adjusted Residual[a]
Within 100-m Buffer	Very Poor	Poor	3,264.29	3,082.47	4.64
	Fair	Fair	3,707.50	4,131.04	-9.97
		Good	303.07	620.22	-15.91
	Good	Good	4,392.41	3,833.51	13.39

Outside 100-m Buffer	Very Poor	Poor	6,266.97	6,448.77	-4.64
	Fair	Fair	9,066.03	8,642.45	9.97
		Good	1,614.70	1,297.55	15.91
	Good	Good	7,461.13	8,020.00	-13.39

a Key to shading in Adjusted Residual Column

values = observed frequencies significantly lower than predicted by Ho.

values = observed frequencies significantly higher than predicted by Ho.

Conclusions

This analysis has examined the relationship between localized food and fuel wood resource productivity and site locations. The results indicate that there are significant relationships between localized plant productivity and site locations for all three site types. While the direction and magnitude of the relationships vary from analysis to analysis, in all but one case, all of the variables included in the analysis made a significant contribution to the variance in frequencies observed in cross tabulations generated for each analysis. The exception was the one between habitation locations and fuel wood resources, in which the productivity of only one of the two plant types was significant. Furthermore, each of the analyses indicated that there are significant associations between the different classes of plant productivity, independent of site location, which reaffirms the choice of a multivariate approach.

The patterns of association for habitation site locations can be summarized as follows:

- Habitation site locations are associated with areas of relatively low food resource potential.
- Habitation site locations are associated with relatively high coniferous resource potential, indicating a preference for areas with high fuel wood, or perhaps construction material, potentials.

The results of the analysis of seasonal site locations can be summarized as follows:

- Seasonal site locations are most clearly associated with low herbaceous potentials, while showing mixed results for grain and seeds and grasses.
- Seasonal sites are positively associated with high and low potentials for coniferous and shrub species and negatively associated with intermediate potentials for these species.

The results of the analysis of special-use site locations can be summarized as follows:

- Special-use sites are more frequently found in locations with intermediate plant productivity for all three classes of food resources, while the frequencies for high and low potentials are lower than expected.
- There are higher than expected associations with high and low values for both shrubs and conifers, and lower than expected frequencies for intermediate shrub and conifer productivity.

The overall results of this analysis suggest that the relationships between site locations and plant productivity are significant and complex. Habitation sites clearly are associated with areas of low food plant productivity and high wood productivity. This indicates that habitation sites are specifically situated to minimize impact on productive food patches, while also providing convenient access to fuel and construction materials.

The relationships between seasonal and special-use sites and localized plant productivity indicate that simple models which assume these activity locations map onto areas of high productivity may be inadequate. The association of seasonal sites with low herbaceous productivity and mixed association with the other food

resource categories suggest that factors other than localized food production play a role in the placement of these sites. Similarly, the association of special-use sites with intermediate productivity values for the three food resource classes also indicates that factors other than food resource productivity are making a significant contribution to the decision-making process associated with the placement of these sites.

In summary, this analysis has provided a more detailed assessment of the contribution of plant resources to variation in site location in the survey area than could be derived from current vegetation patterns. While not providing a complete explanation for the locations of sites on the landscape, these results, when combined with the results of complementary analyses, provide a greater understanding of the variables involved in prehistoric land-use decisions. The significant results obtained in this analysis suggest that small-scale spatial analyses have the potential to complement larger-scale analyses, including catchment analyses, when both can be utilized.

Summary and Conclusions

In this chapter we have tried to examine site locations and community development from several different perspectives. Site locations according to elevation and landform indicate a persistent diversity that is contrary to what we expected based on the number of sites in each period and the PDSI dryness index. It appears that diversity is always desirable, probably because there are elements of the social and physical environment that are always unpredictable, and diversity helps smooth the unpredictability. Habitations and seasonal sites often are above 6,600 ft (2,012 m) in elevation, which Snow (1991) considers the upper limit for producing a mature corn crop in New Mexico.

In addition to environmental variables, social conditions also affect site locations. The nearest neighbor analysis was designed to identify social, and to some extent, economic influences on site locations. Nearest-neighbor distances (NND) within and between site types in each period were examined. In two-thirds of the analyses, sites were clustered. Seasonal and special-use sites, both within and between types, were consistently clustered, probably reflecting occurrence of resources and similar environmental conditions conducive to domestic and wild resources. It was clear that resources closest to habitations were used first, and in response to local depletion, nonhabitation sites were moved farther from habitations through time.

When the productive potential of soils in specific site environments was examined it became clear that the different site types were found in areas with distinct characteristics. Habitation site locations are associated with areas of low food resource potential but high coniferous production. It appears that habitations were situated to minimize impact on potentially productive food resources, while being located to exploit wood resources for fuel or construction. Seasonal and special-use sites appear to fall into three classes. Some seasonal and special-use site locations appear to select for food resource potential, while others are significantly associated with high wood resource productivity. Other locations are significantly associated with low conifer and shrub productivity, probably representing areas that are easier to clear for agricultural fields. More specific information on activities at different kinds of sites might elicit clearer relationships with different soil productivity potentials.

Approaching settlement from three different perspectives has allowed us to see that topography (elevation and landform), the proximity of other sites and the character of specific locations are all important aspects of the settlement system in the Upper Pecos Valley. Future research into settlement at Pecos might fruitfully consider further the important role of water in site location, and noneconomic aspects of site placement, as well as the numerous isolated finds recorded by the survey that could not be considered here. Adding these details will more fully flesh out our understanding of the ways the Pecos people created a dynamic cultural landscape that allowed them to survive in an unpredictable world.

Notes

1. Models Used in the Analysis

In mathematical terms, the models used in this analysis can be summarized as follows: The base models represent the model used to calculate the expected frequencies for each cell in the contingency table based upon Ho, while the saturated model (Modelsat) represents a model in which all possible interaction terms are included (which also yields frequencies equal to those observed). If no significant difference is found between the frequencies calculated from the base model and those from the saturated model, Ho is not rejected, and no significant associations between the localized plant productivity values and site location are found. If, on the other hand, significant differences are found between the expected frequencies generated using the base model and those calculated from the saturated model, significant associations between localized productivity and site location may be supported.

$G^2 = 2\Sigma_i O_i \text{In}(O_i/E_i)$

G^2 = Likelihood - Ratio Chi - Square
0/ = Observed Frequency for Cell i
E, = Expected Frequency for Cell

For the Food-Related Variables
$Model_{base}$:In E_i = θ + &lamda;$_{1i}$ + &lamda;$_{2i}$ + &lamda;$_{3i}$ + &lamda;$_{4i}$ + &lamda;$_{23i}$ + &lamda;$_{24i}$ + &lamda;$_{234i}$
$Model_{sat}$:In E_1 = θ + &lamda;$_{1i}$ + &lamda;$_{2i}$ + &lamda;$_{3i}$ + &lamda;$_{4i}$ + &lamda;$_{23i}$ + &lamda;$_{24i}$ + &lamda;$_{34i}$ + &lamda;$_{234i}$ + &lamda;$_{12i}$ + &lamda;$_{13i}$ + &lamda;$_{14i}$ + &lamda;$_{123i}$ + &lamda;$_{124i}$ + &lamda;$_{134i}$ + &lamda;$_{1234i}$ = InO_i
&lamda;$_1$ = within /outside buffer, &lamba;$_2$ = grain&seed, &lamda;$_3$ = grasses, &lamba;$_4$ = herbaceous, &lamda;$_{12}$ = interaction between within /outside buffer and grain&seed, etc.

For the Fuel-Related Variables
$Model_{base}$:InE_i = θ C
$Model_{sat}$:In E_i = θ + &lamda;$_{1i}$ + &lamda;$_{2i}$ + &lamda;$_{3i}$ + &lamda;$_{23i}$ + &lamda;$_{12i}$ + &lamda;$_{13i}$ + &lamda;$_{123i}$ + =In O_i
&lamda;$_1$ = within /outside buffer, &lamba;$_2$ = coniferous, &lamda;$_3$ = shrubs, &lamda;$_{12}$ = interaction between within /outside buffer and coniferous, etc.

$Model_{base}$:In E_i = Model used in the calculation of the E_i values for H_o
$Model_{sat}$ = Saturated model that represents all possible interactions between variables
E_i = Expected Frequency for Cell i
O_i = Observed Frequency for Cell i
θ = constant Term
&lamda;$_{ni}$ = Parameter Representing a Single Variable (e.g. &lamda;$_1$) or the interaction between variables (e.g. &lamda;$_{12}$), for Cell i
&lamda;$_{addi}$ = Parameter Representing Term(s) Added to Model to be Tested for Significance for Cell i

2. Calculation of the Likelihood-Ratio Chi-square Statistic

$$G^2 = 2\sum_i O_i \ln\left(\frac{O_i}{E_i}\right)$$

G^2 = Likelihood - Ratio Chi - Square

O_i = Observed Frequency for Cell i

E_i = Expected Frequency for Cell i

3. This form of descriptive analysis of the residuals is only an approximation of a more detailed analysis that is beyond the scope of this report. This more detailed analysis would calculate log-odds ratios for the different levels between pairs of variables while controlling for interaction terms (Le 1998:95-101). These calculations would yield a more detailed picture of the association between variables of interest but require the calculation of numerous equations.

<<< Previous <<< Contents >>> Next >>>

PECOS

From Folsom to Fogelson:
The Cultural Resources Inventory Survey of Pecos National Historical Park

CHAPTER 7:
DEMOGRAPHY

Janet D. Orcutt

This chapter examines changes in estimated population size and aggregation in the Pecos area using the habitations (Chapter 5) and time periods (Chapter 4) identified earlier. Describing fluctuations in population size in the periods before the formation of Pecos Pueblo may provide some insight into the process by which ancestral Puebloans aggregated into one large pueblo after living a more dispersed, independent life in several different pueblos. This chapter also reviews Kidder's (1958) perspective on the development of Pecos Pueblo and Welker's (1997) reanalysis of Kidder's excavation notes and ceramics so that we have a better idea of how the pueblo evolved.

Many areas of the prehistoric Southwest experienced aggregation. A number of causes have been proposed for this phenomenon that Cordell (1996:230) describes as "socially difficult and economically inefficient." Kidder's (1924) theory is that Plains raiders created a need for defense at Pecos, hence aggregation in the Quadrangle protected by an encircling wall. Archeologists have used defense to explain aggregation and settlement changes across the Southwest. Recent research on warfare (Haas and Creamer 1996; Wilcox 1989; Wilcox and Haas 1994) indicates that concerns for defense help explain the occurrence of settlement patterns that are economically inefficient. Other suggested causes of aggregation revolve around minimizing conflict over resources (Hunter-Anderson 1979; Orcutt et al. 1990; Powers and Orcutt 1999) and encouraging cooperation or sharing to offset short-term food shortages caused by climatic perturbations (Kohler and Van West 1992). It is likely that all these causes played a role in aggregate formation in the Pecos area.

In addition to describing changes in the Pecos area, this analysis examines population fluctuations in other portions of the northern Rio Grande. Events at Pecos did not develop in a vacuum, and although it is not appropriate to reanalyze survey and excavation data from other regions, several previous studies that relate to this issue are summarized. The Upper Pecos Valley needs to be placed within an appropriate regional context so that we may better understand its place in northern Rio Grande prehistory and early history.

Reconstructing Population

The sites used in this analysis include the 10 habitation sites recorded by the Pecos survey and two pueblos on private land adjoining Pecos National Historical Park. Table 7.1 lists the 12 sites, the time periods to which they are assigned, and the estimated room counts. Rowe Ruin (Cordell 1998) and Hobson-Dressler Ruin (National Park Service 1992a), the two sites on private land, are placed in the Pecos time periods and room counts are derived from published data. Brief descriptions of Rowe and Hobson-Dressler are presented below. The habitation sites recorded by the survey are described in Chapter 5.

Table 7.1. Habitation sites used in population estimates.

Pecos Site No.	LA No.	Site Name	Period(s)	Number of Rooms
23	14124		2, 3, 6	10
30	14113		2,3	45
215	118811		2,3	16
226	672	Forked Lightning	2, 3	150
227	277	Loma Lothrop	3	150
228	625	Pecos Pueblo	3, 4, 5, 6	893[a]
307	267	Shin'po	3	65
402	118967	Long	3,4	40
434	276	Dick's Ruin	2, 3	50
710	251	Arrowhead Pueblo	2, 3	105
N/A	108	Rowe Ruin	2, 3	200
N/A	32388	Hobson-Dressler	2, 3	70

[a]Does not include the mission.

Rowe Ruin, approximately 1.5 km (0.9 mi) south of Pecos National Historical Park, has been the focus of professional archeological excavations at least twice in the past. Most recently, Cordell and her colleagues conducted test excavations at the site (Cordell 1998). The pueblo consists of three large quadrangular roomblocks, each arranged around its own plaza. Wall construction is limestone masonry, although earlier adobe rooms lie under one portion of the site (Cordell 1998:27). Most of the pueblo probably is two stories. Cordell does not estimate the number of rooms at the site but does provide the estimated "living area" in each roomblock (Cordell 1998:Table 1), although she does not describe how the area was calculated. The average size of the rooms excavated is ca. 7 m^2 in the middle roomblock and ca. 9 m^2 in the other two roomblocks. Using these average room sizes, Cordell's living space converts to 550 ground-floor rooms. Other estimates (National Park Service 1992a), however, are in the vicinity of 200 rooms. I chose to use the more conservative estimate of 200 ground-floor rooms.

Cordell (1998:46) believes Rowe was occupied for 100-150 years. She reconstructs the occupation sequence as follows: (1) the adobe structure is established in the 1240s or 1250s; (2) the masonry rooms are built approximately 100 years later; (3) building and remodeling continues until the 1360s and 1370s; and (4) an archeomagnetic date of 1395 from a hearth in the north quadrangle may shortly precede the abandonment of the pueblo. It appears that Rowe falls into Periods 2 (A.D. 1200-1325) and 3 (A.D. 1325-1450).

Hobson-Dressler Ruin is located about 2 km (1.2 mi) east of Arrowhead Ruin and 4.5 km (2.8 mi) northwest of Pecos Pueblo, and there is a visual link among the three (National Park Service 1992a:4). The ruin resembles a "D" with 3-4 rows of rooms radiating out from the center. Its configuration is somewhat reminiscent of Tyuonyi in Bandelier National Monument, only much smaller. There are approximately 70 masonry rooms, all apparently one story, and there is no surface evidence of plazas or kivas. The site may date to late Period 2 (A.D. 1200-1325) through the middle of Period 3 (A.D. 1325-1450) (National Park Service 1992a:8).

Using the 12 pueblos identified in the Pecos area, I constructed a population curve estimating

the number of people in each time period. The curve also allows us to compare the Pecos area with other contemporaneous regions in the northern Rio Grande. Welker (1997) uses Kidder's publications and notes to break down the occupation of Pecos Pueblo into four periods and estimates population for those periods. Her estimates are reviewed here because they are based on excavation data that should be more accurate than the surface survey data from Pecos Pueblo.

Population Estimation Methods

Counting rooms and measuring floor area are the two most common techniques for estimating population at pueblos. Because of the disturbed nature of some Pecos area sites and visibility problems on others, it is difficult to measure roomblock area. The Pecos survey estimated the number of rooms at each habitation based on visible architecture, which makes calculating population fairly straight forward. Because the survey also estimated the number of stories in each pueblo, I have added upper story rooms to the estimated room counts. Except for Pecos Pueblo, none of the survey sites appears to have more than two stories. For those sites with a second story, I have increased the ground-floor room count by 0.5.

The number of rooms in use at the same time affects population estimates. Many large Southwestern pueblos are occupied over a long period of time and attain part of their size through accretion, so not all rooms are contemporaneous. This is the case at several Pecos area sites, including Forked Lightning (Kidder 1958), Rowe (Cordell 1998), and Arrowhead (Holden 1955). Early portions of Pecos Pueblo grew through haphazard abandonments and additions, leading Kidder to describe the early pueblo as "formless" (1958:59). The Quadrangle at Pecos, however, is clearly planned (Kidder 1958:63), and most rooms are occupied from 1425 until sometime in the seventeenth century (Welker 1997:Figures 28-29).

Rowe Ruin also appears to be planned, largely because the roomblocks are oriented around plazas, but in reality the outward appearance "hides a great deal of architectural building, rebuilding, and remodeling, which suggests a more complicated and longer-term development of the final community plan" (Cordell 1998:46). The fact that plaza space is "set aside," however, makes it more difficult to add rooms to the roomblocks built around a plaza, which conveys a concept of community planning (Cordell 1998:88). To escape the constraints of orienting a building around a plaza, the residents add more plaza-roomblock units.

Arrowhead Ruin also may be a planned community, although not all of it is built and occupied at the same time. Holden (1955) suggests that people from Pecos Pueblo live at Arrowhead for 75-100 years, then abandon it and return to Pecos Pueblo.

It is ideal if we know how many rooms at a site are contemporaneous, and their dates of use, but that requires excavation and the ability to date each room's construction, remodeling (if any), and final abandonment. If we can estimate the number of rooms occupied in any one period, population estimates are more accurate than assuming that all rooms are occupied. The approach to making these estimates differs from area to area depending on the kind of data available. In Bandelier National Monument, for example, data from recent excavations allowed us to estimate site use lives and occupancy rates (Kohler and Powers 1993) that could be applied to the surveyed sites (Orcutt 1999b). Without the same kind of excavation data for Pecos sites, I use a different approach to estimate the number of rooms occupied at a site in each Pecos period.

There are several steps involved in calculating how many people lived in the Pecos area. When a site is occupied in more than one time period, it is necessary to estimate how many rooms are occupied in each period. In developing the Pecos chronology, Powell (Chapter 4)

generated probabilities for each site that portray the strength of a site's statistical association with each time period based on the ceramic assemblage. Because these probabilities reflect intensity of use, which is related to the number of people at a site, they are a good proxy for occupation rate. I estimate the number of occupied rooms by multiplying the total number of rooms at a site by the ceramic probability value for the site in each period of occupation. Because the information used to produce the probabilities relates directly to each individual site, the procedure is more satisfying than imposing assumptions on site use generated from archeological or ethnographic data from other regions.

The probabilities for Arrowhead (PECO 710), Forked Lightning (PECO 226), and Dick's Ruin (PECO 434) are modified based on Powell's evaluation of published or other data because the ceramic assemblages recorded by the survey are skewed by previous excavation and collection (Melissa Powell, personal communication 1998). Rowe Ruin and Hobson-Dressler are apportioned to periods based on information in Cordell (1998) and National Park Service (1992a), respectively. Table 7.2 lists the sites, probabilities, total number of rooms (taking multiple stories into account), and estimated number of occupied rooms (based on the probabilities) in each period.

Table 7.2. Pueblos used in population estimates.

Pecos No.	LA No.	Site Name	Period	Total Rooms	Probability	Occupied Rooms
23	14124		2	10.0	.36	3.6
30	14113		2	67.5	.67	45.2
215	118811		2	16.0	.71	11.4
226	672	Forked Lightning	2	225.0	.80	180.0
434	276	Dick's Ruin	2	50.0	.50	25.0
710	251	Arrowhead	2	157.5	.20	31.5
N/A	108	Rowe	2	300.0	.30	90.0
N/A	32388	Hobson-Dressler	2	70.0	.10	7.0
23	14124		3	10.0	.29	2.9
30	14113		3	67.5	.25	16.9
215	118811		3	16.0	.23	3.7
226	672	Forked Lightning	3	225.0	.20	45.0
227	277	Loma Lothrop	3	225.0	.81	182.3
228	625	Pecos Pueblo	3	1339.5	.21	281.3
307	267	Shin'po	3	65.0	.80	52.0
402	118967	Long House	3	40.0	.65	26.0
434	276	Dick's Ruin	3	50.0	.50	25.0
710	251	Arrowhead	3	157.5	.80	126.0
N/A	108	Rowe	3	300.0	.70	210.0
N/A	32388	Hobson-Dressler	3	70.0	.80	56.0
228	625	Pecos Pueblo	4	1339.5	.33	442.0
402	118967	Long House	4	40.0	.25	10.0
228	625	Pecos Pueblo	5	1339.5	.28	375.1
23	14124		6	10.0	.12	1.2
228	625	Pecos Pueblo	6	1339.5	.17	117.7

Estimating Population in the Pecos Area

Figure 7.1 illustrates the number of occupied rooms through time in Periods 2-6 (A.D. 1200-1700+) based on the survey data. Beginning at around 400 rooms in Period 2, the number jumps to approximately 1,000 rooms in Period 3 (A.D. 1325-1450). In Period 4 (A.D. 1450-1575), the number of occupied rooms declines to around 450 and continues to drop slightly through Period 6 (A.D. 1700±). In Periods 4-6 (A.D. 1450-1700+), Pecos Pueblo is the only major habitation.

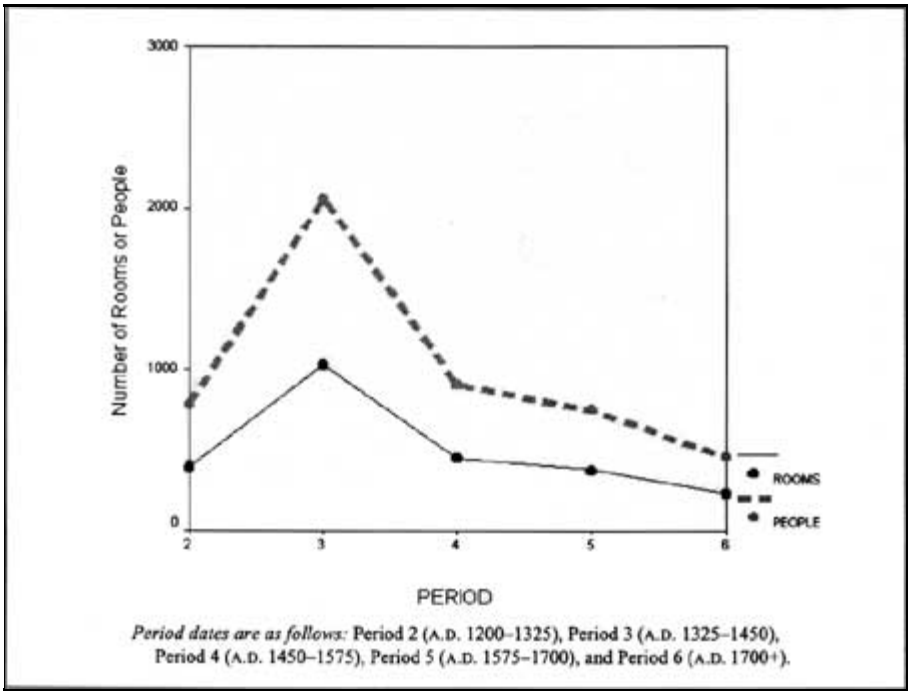


Figure 7.1. Estimated number of people and occupied rooms for Pecos area habitation sites.

Next, I convert occupied rooms to number of people. In the absence of excavation data to suggest how many rooms the average family used, I follow Kintigh (1985) and Orcutt (1999b) in counting two people per occupied room in all periods regardless of room function. I include Pecos Pueblo in my calculations using survey data; however, a more appropriate way to model the relationship between number of rooms and number of people at the pueblo is discussed below. Population peaks in Period 3 (A.D. 1325-1450), then declines after that (Figure 7.1). The growth rate from Period 2 (A.D. 1200-1325) to Period 3 is approximately 0.8 percent, higher than Hassan's "probable maximum growth rate for prehistoric groups" of 0.52 percent (1981:140). This suggests that people move into the Pecos area, possibly from the Plains or elsewhere in the northern Rio Grande.

Pecos Pueblo

The survey data are inadequate for an in-depth analysis of Pecos Pueblo because of the amount of excavation, surface collection, and deterioration over the years. Kidder's excavations and Welker's recent reworking of Kidder's data are far more informative (Kidder 1958; Welker 1997).

Welker (1997:108-115) uses Kidder's unpublished maps and notes to revise the occupation sequence at Pecos Pueblo. She uses stratigraphy and ceramics to define the following four

time periods (1997:108-111): A.D. 1200-315, A.D. 1315-1425, A.D. 1425-1515, and A.D. 1515-1700. Her periods reflect the data for one site, thus they are different enough from those developed in Chapter 4 for the Pecos survey sites that they cannot be integrated easily into the survey scheme.

To calculate population for the first two periods (A.D. 1200-1315 and A.D. 1315-1425), Welker divides the number of rooms by two (rooms per family), and multiplies that by five (family size) (Welker 1997:114). In the two later periods, A.D. 1425-1515 and A.D. 1515-1700, the pueblo is organized into "apartments" of six rooms each, with no connecting doors from one apartment to another, even when the apartments are back-to-back in a 12-room unit (Kidder 1958:63). To calculate population in these later periods, Welker divides the number of rooms by six (rooms per family) and multiplies that by five (family size). Kidder (1958:134) and Welker (1997:86-87) both estimate family size at five people based on ranges recorded for modern pueblos. The number of rooms in each of Welker's periods increases through time while the number of people fluctuates because of the change to "apartments" in the later periods. Number of rooms and population peak in her last period, A.D. 1515-1700 (Figure 7.2).

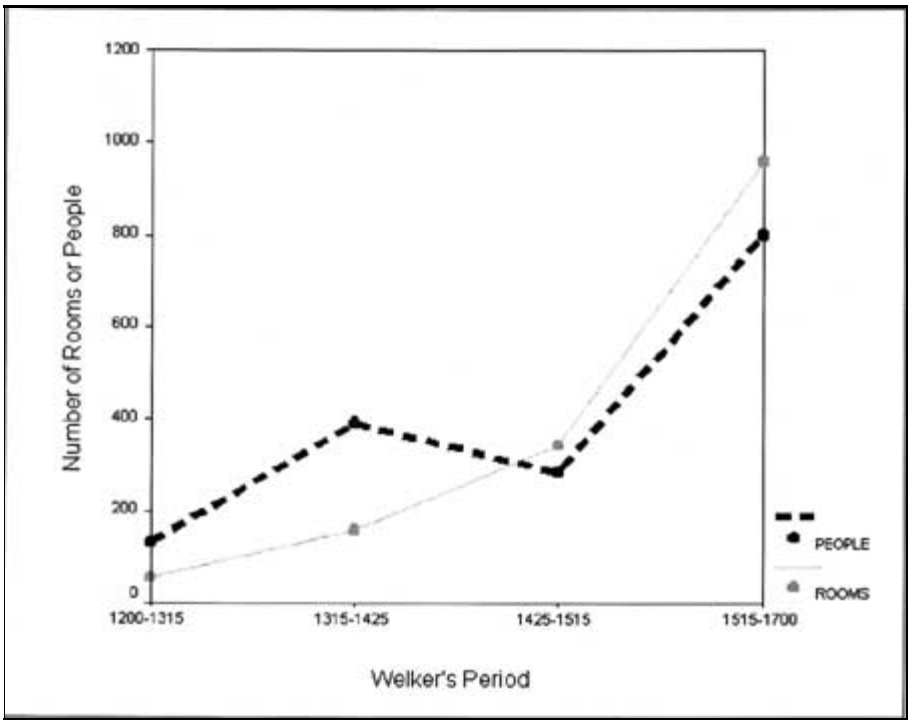


Figure 7.2. Welker's (1997) estimates of the number of occupied rooms and population in her four time periods at Pecos Pueblo.

Neither Welker's (1997) nor Kidder's (1958) population estimates approach the 2,000 reported for 1541 when Coronado's expedition visited the pueblo (Kessell 1987:12). Welker's peak population is 800 in the A.D. 1515-1700 period, and Kidder's (1958:133) is 970 people. Kidder questions his own methodology, especially his assumption of five people per family, but it would have taken 10 people per apartment to fit 2,000 into the rooms he thinks are occupied (Kidder 1958:135). If family size is seven people, which is at the upper end of the range of 1.6 to 7.6 people per household in historic and modern pueblos (Welker 1997:86-87), population still falls well short of 2,000 (Figure 7.3).

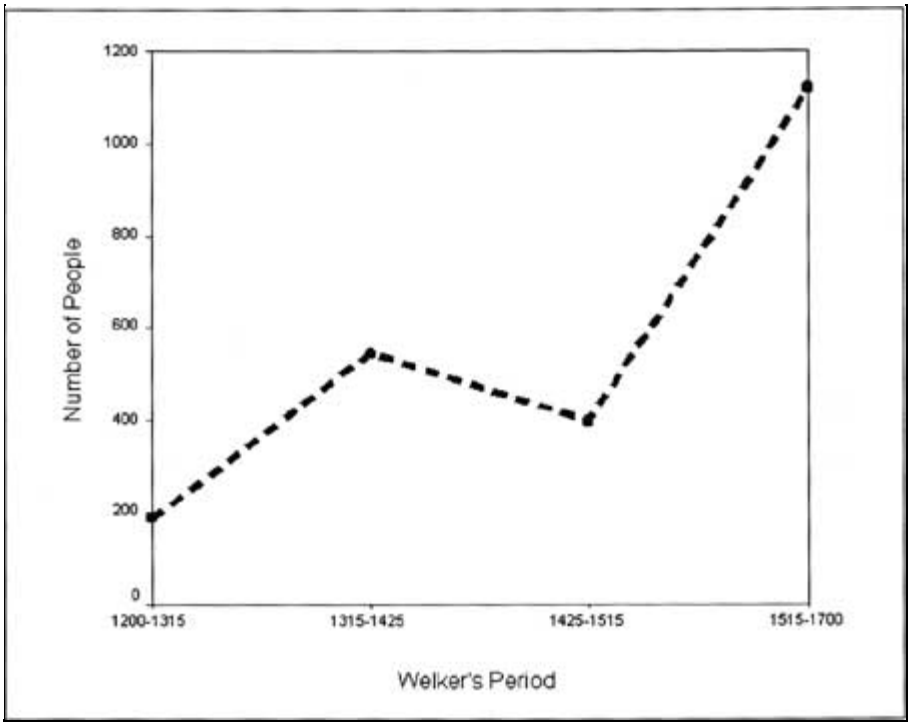


Figure 7.3. Estimated population at Pecos Pueblo using Welker's (1997) time periods and room counts and a family size of seven people.

There are several reasons to accept the archeological estimates of population rather than the Spanish ones. The Spanish tended to exaggerate or were not very good at judging village sizes; in addition, it is possible that many of the estimates were made long after the fact (Winifred Creamer, personal communication 2000). If there were 2,000 people at Pecos Pueblo upon Coronado's arrival, it may be that members of other pueblos had gathered there to help defend Pecos Pueblo. Apaches wintering outside the pueblo walls also may have been part of the group that the Spanish encountered.

The massiveness of the building at Pecos Pueblo may have deceived the Spanish into thinking there must be many more people there. Externally, Pecos Pueblo's layout is quite different from anything else in the northern Rio Grande. Kidder views the Quadrangle as "the product of a new architectural concept which involved designing the building in advance and constructing it as a unit" (1958:63). In addition to the apartments, the pueblo has a system of corridors or galleries running all around it that are accessed through hatchways and ladders (Kidder 1958:65).

This arrangement of rooms and corridors provides better defense than earlier pueblo layouts, and Pecos Pueblo also is unique in "the rigid adherence to a transverse linear arrangement of rooms" (Kidder 1958:63). Based on his review of northern Rio Grande pueblos of comparable size and age to Pecos, Kidder concludes that many displayed transverse arrangements of rooms joined together around plazas, but often the pueblos are large, rambling, and not designed for defense like Pecos (Kidder 1958:125-127). In addition, he feels that "no site of the age and type of those... [such as San Cristobal, Paa-ko, Puye, Tyuonyi, Tschirege, Otowi, Chipiinuinge, Po-shu-ouinge, Te'ewi, Howiri, Homayo, and Posege] can be supposed to have held so long and so strictly, as did Pecos, to sections uniform in room arrangement, or to ones which invariably possessed either three or six ground-floor rooms" (Kidder 1958:127).

Welker also remarks on Pecos Pueblo's uniqueness and feels it "may be less typical than we

think" (1997:118). Like Kidder, she doubts "we could say that the apartment layout of Pecos was standard for the northern Rio Grande."

Internally, the probable room functions of rooms within a six-room apartment, as interpreted by Kidder (1958:122-123) suggest that Kidder and Welker are justified in using a family size of five per apartment and that archeological estimates of population are reliable. Each six-room suite has three lower rooms, A, B, and C in Figure 7.4, that Kidder calls "cellar" rooms (1958:122). These rooms are "low-studded and usually much reduced in size by the piled 'buttressing' of all four walls, the two inner ones offering no immediate access to either light or air" (1958:122-123). The "A" rooms have access through the roof to Gallery II and initially may have been storage rooms, "but those we excavated practically always proved to have become dumps and to be choked, often almost to their low roofs, with household refuse: corn husks and cobs, squash rinds, other unidentifiable rotten organic materials, and always quantities of bones" (1958:123). Some "A" rooms are permanently sealed, possibly because of the odor (1958:123). According to Kidder, "the real purpose of the blank-walled exterior, A, rooms was of course defensive. Their roofs, all at the same level, made it possible... to go freely about the whole village. And it could be done under cover, for the second story street-like way was itself roofed" (1958:124).

The "B" and "C" rooms, on the same level as "A" rooms, "were much like A and seldom could be entered save from above. Many of them also held cellar refuse, but perhaps because living rooms were above, it consisted largely of corn husks and cobs, with few animal bones" (Kidder 1958:123). The rooms on the second and third story, which Kidder (1958:123) labels "D," "E," and "F," probably are living ("D" and "F") and living/maize storage ("E") (Figure 7.4). The "D" and "F" rooms have the best light and air circulation of any in the apartment. It appears that although one family may have six rooms, half of them at most are for living, and it is possible that the configuration of rooms is the result of the defensive architecture rather than a need to house a very large family.

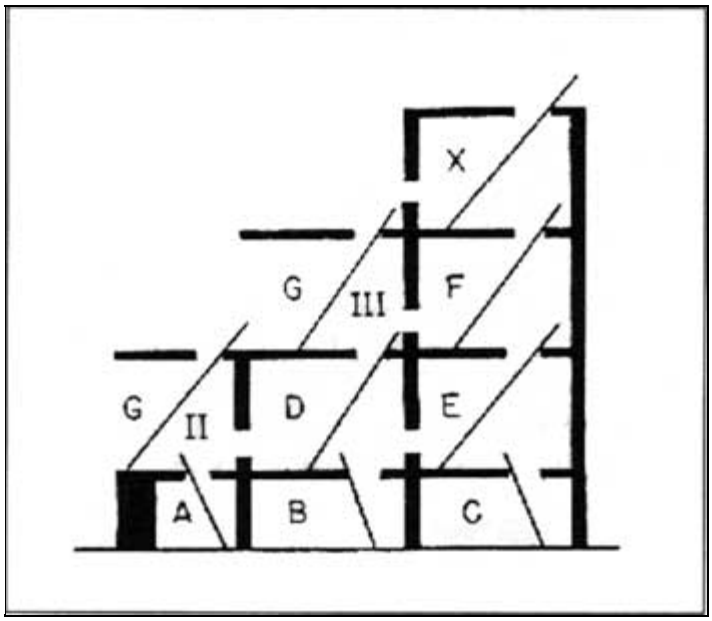


Figure 7.4. Kidder's (1958:Figure 33a) reconstruction of Pecos Pueblo apartments. ©Robert S. Peabody Museum of Archaeology, Phillips Academy, Andover, Massachusetts. All rights reserved.

Population Aggregation

Throughout the prehistoric Southwest, people eventually cluster in villages, and the Pecos area is no exception. The sequence of aggregate formation in the Pecos area coincides with population increase, at least for a while. Aggregation, expressed as the number of people at individual sites, increases from Period 2 (A.D. 1200-1325) to Period 3 (A.D. 1325-1450). The sites in Period 2 average 98 people, with a median of 57 people. There is quite a range in the number of people at individual sites, from seven to 360. The mean number of people increases to 171 in Period 3, and the median jumps to 97. There is an even bigger range in the number of people—from six to 563—at individual sites in Period 3. Despite the wide range, there is a definite trend toward larger aggregates. In Period 2, there are 100 or more people at two of eight sites (25 percent), while in Period 3, there are 100 or more people at five of 12 sites (42 percent), and there are more than 200 people at four of those sites.

Pecos Pueblo is the only large residence in Periods 4-6 (A.D. 1450-1700+), so means and medians are not valid. According to the survey data, almost 900 people occupied Pecos Pueblo during Period 4 (A.D. 1450-1575). The number of occupants drops to 750 in Period 5 (A.D. 1575-1700), and declines to 455 people in Period 6 (A.D. 1700+). Welker's (1997:114-115) in-depth analysis of Pecos Pueblo using Kidder's excavation data indicates that the aggregate peaked at 800 people in the A.D. 1515-1700 period (end of survey Period 4 and all of Period 5). If Welker's data are used with a family size of seven people, which may be too large as discussed earlier, the population is more than 1,100 people (Figure 7.3). Census data for 1750 and 1790 indicate 449 and 152 people, respectively (Levine 1999:43-50, Table 2), reflecting continuous decline from disease, raids, and emigration.

Northern Rio Grande Population

What are the population dynamics in the general northern Rio Grande area during the Puebloan occupation of the Pecos area? Although survey coverage in the region is spotty, researchers have reconstructed population for the Taos, Chama, Pajarito Plateau, Jemez, Gallina, Santa Fe, and Galisteo Basin districts (Crown et al. 1996; Orcutt 1999b; Orcutt et al. 1994). Of these, only the Pajarito Plateau (Hill and Trierweiler 1986; Powers and Orcutt 1999) has been systematically surveyed.

Orcutt et al. (1994) reconstructed Classic period (A.D. 1325-1600) through early Historic period (A.D. 1600-1700) population for large pueblos in several northern Rio Grande subareas. We used the northern Rio Grande time periods, and because each of the four periods is a different length, room counts were standardized to the length of the shortest period. We used this approach so that room counts were not highest in the Middle Classic phase (A.D. 1400-1550), for example, just because more rooms may have been built and abandoned during its longer time span. Room counts were not converted to people because we simply wanted to identify gross trends in population dynamics across the larger region.

Population in each area was graphed at the beginning and end of the Early Classic phase (A.D. 1325-1400), beginning and end of the Middle Classic phase (A.D. 1400-1550), the Late Classic phase (A.D. 1550-1600), and the Historic period (A.D. 1600-1700) (Figure 7.5). The Chama and Pajarito Plateau populations peak at the end of the Early Classic, then decline through time. The Santa Fe area's population is highest at the beginning of the Early Classic, and it generally decreases from there. Population declines in the Jemez and Galisteo areas from the end of the Early Classic through the beginning of the Middle Classic. Their populations increase at the end of the Middle Classic, peak in the Late Classic, then decline in the Historic period.



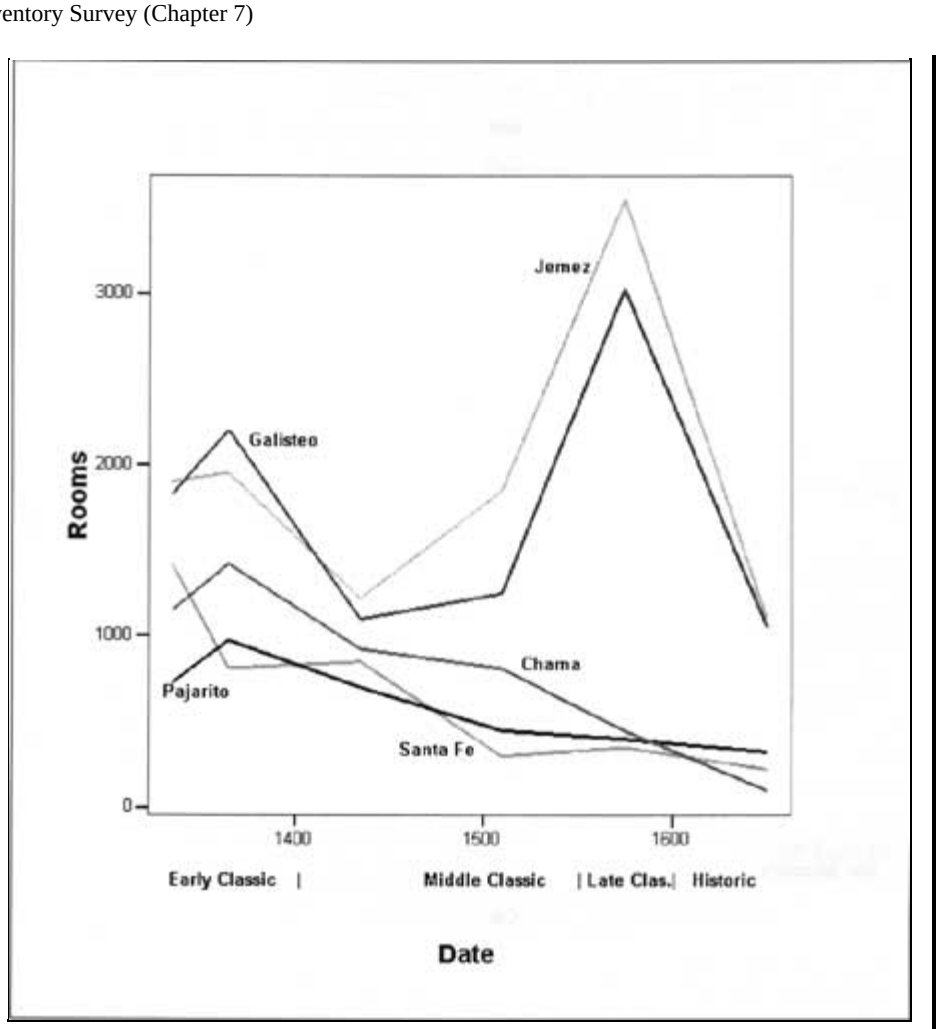


Figure 7.5. Number of rooms adjusted to time period lenght for several areas in the northern Rio Grande, Early Classic through Early Hispanic period (Orcutt, et al. 1994).

The Rio Grande periods and Pecos survey periods are slightly different, but there is enough similarity to compare population trajectories. The Early Classic (A.D. 1325-1400) is roughly contemporaneous with Period 3 (A. D. 1325-1450), the Middle Classic (A.D. 1400-1550) with Period 4 (A.D. 1450-1575), and the Late Classic (A.D. 1550-1600) plus early Historic (A.D. 1600-1700) with Period 5 (A.D. 1575-1700). In the Pecos survey area, population peaks in the Early Classic, as it does in the Pajarito, Santa Fe, and Chama areas. Peaks occur in the Jemez Mountains and Galisteo Basin during the Late Classic when aggregation at Pecos Pueblo is at its height.

Arroyo Hondo Pueblo, San Marcos, and San Lazaro are three large sites used in the regional population reconstructions that have been excavated or systematically surface collected in recent years, making it possible to compare their population curves to the estimates for Pecos Pueblo. Of these, only Arroyo Hondo, in the Santa Fe area, has been the scene of major professional excavations (Schwartz 1971, 1972; Schwartz and Lang 1973).

There are two temporal components at Arroyo Hondo. The earliest has 1,000 rooms in multiple roomblocks built around several different plazas. Most of the construction took place between 1315 and 1330. Creamer (1993) suggests that when construction peaks in 1330, at least 90 percent of the Component I rooms are in use. Allowing two rooms per household and three to six people per household, she estimates a peak population of 1,300 to 1,700 people (1993:153), much higher than previous estimates for the site (Wetterstrom 1986:51). Creamer (1993:153) acknowledges that any modification of her assumptions would

lower the estimates; for example, if households use three rooms rather than two, the range becomes 900 to 1,800 people. In any case, Arroyo Hondo represents a large aggregate that takes shape quickly and is fairly short lived. Most people leave the pueblo by 1340, and there is a hiatus in occupation until the 1370s. Most of the 200 Component II rooms are built between 1370 and 1390, and if 90 percent are occupied at the peak of construction, the population is between 250 and 550 people (Creamer 1993:153).

San Marcos and San Lazaro Pueblos, both in the western Galisteo Basin, are known primarily from intensive surface collection and test excavation (San Marcos) and in-field analysis of surface ceramics (San Lazaro). Welker (1997:39-45) provides details for the various excavation and survey projects at San Marcos, beginning with Nels C. Nelson's work in 1915. She identifies the following four time periods at San Marcos that are correlated with the presence of different glaze wares: A.D. 1340-1425, A.D. 1425-1515, A.D. 1515-1600, and A.D. 1600-1700.

Welker (1997:87-90) calculates population in each time period at San Marcos using Nelson's room counts for each building. She assigns roomblocks to periods based on ceramics. Because most roomblocks are at least three rooms wide and probably are two stories, she assumes that a family has six rooms, two of which are living rooms (Welker 1997:87). To arrive at numbers of people, she divides the number of rooms in a building by six (rooms per family) and multiplies that by five (family size). Welker also tries multiplying the number of ground-floor rooms by two (people per room), but she feels the estimates are too large (Welker 1997:88-89).

San Marcos's population is not small in any time period (Figure 7.6). In the A.D. 1340-1425 period, 738 people are in residence. By the A.D. 1425-1515 period, there are nearly 1,700 people at the pueblo, which is the peak of population at the site. There is a substantial decline to 729 people between 1515 and 1600, which is roughly equivalent to the original population. The population drops to 536 people in the A.D. 1600-1700 period.

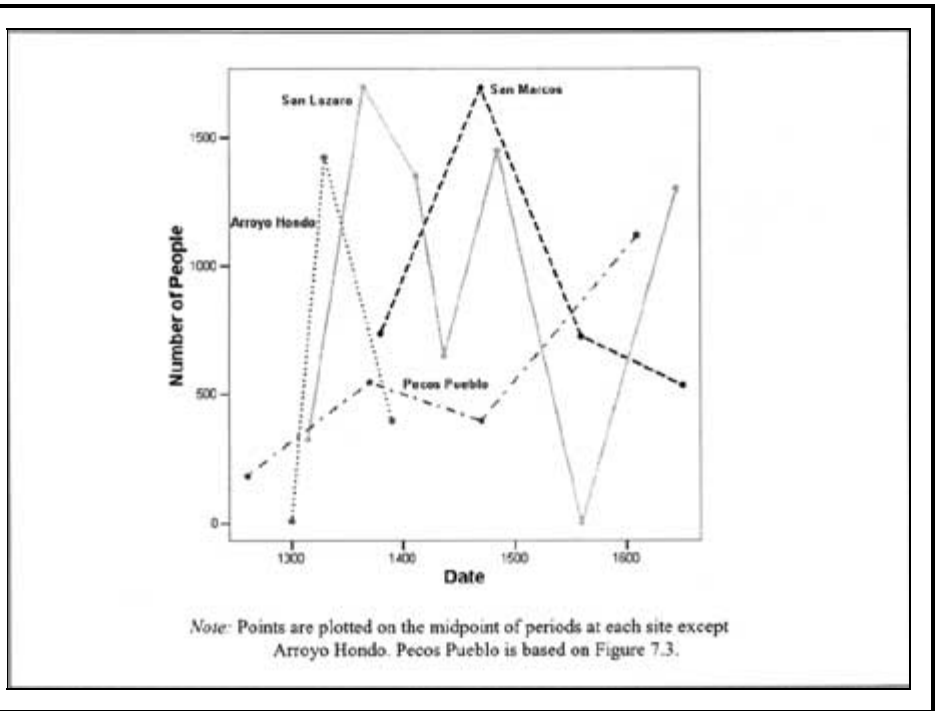


Figure 7.6. Estimated population at Pecos Pueblo, San Lazaro, San Marcos, and Arroyo Hondo. *Note: Points are plotted on the midpoint of periods at each site except Arroyo Hondo. Pecos Pueblo is based on Figure 7.3.*

San Lazaro pueblo, a few miles south of San Marcos, is equally large and impressive. There are two major occupations at San Lazaro, one prehistoric and one historic, on opposite sides of the Arroyo del Chorro. Very little work has been done at the site by professional archeologists. Nelson excavated 60 rooms in 26 roomblocks in 1912 (Nelson 1914), and the Museum of New Mexico and Southern Illinois University held a joint testing and surface collection project there in 1988-1989 (Smiley 1993).

In 1994, I examined the ceramics associated with the prehistoric and historic roomblocks and plazas at San Lazaro in order to reconstruct the occupation sequence of the roomblocks at the site (Ware et al. 1998:19). While tabulating ceramics, I also counted the number of rooms in each roomblock based on wall alignments or extent of rubble (Ware et al. 1998:20), estimating a range of 1,600 to 1,900 ground-floor rooms for the entire site. Informal excavations at San Lazaro reveal prehistoric household suites of three rooms, although it is possible they could range up to five rooms. For my population estimates, I assume three rooms and five people per household during the prehistoric and historic periods, and I also assume that portions of both pueblos have multiple stories (Ware et al. 1998:20, 21).

Based on the decorated ceramics at the site, there are several time periods at San Lazaro (Ware et al. 1998:19, 21-27). Roomblocks are dated to the different periods and population is estimated for each period (Figure 7.6). The first period, A.D. 1300-1330, is the one of least population, estimated in the range of 250 to 400 people. The earliest portion of the site is next to the arroyo, which washed away an unknown number of rooms over the years. The A.D. 1330-1400 period is a time of much construction and appears to be the height of population, estimated to range between 1,400 and 2,000 people. In the A.D. 1400-1425 period, population decreases slightly to between 1,100 and 1,600 people. In the following period, 1425 to 1450, there are 600-700 people at San Lazaro, a 35 to 40 percent decline. Another major building episode between 1450 and 1520 results in a resurgence of population to between 1,300 and 1,600 people, very close to the earlier peak in the A.D. 1330-1400 period. Within the first quarter of the sixteenth century, San Lazaro is abandoned, so that the A.D. 1520-1600 period represents a hiatus in occupation.

A large pueblo and mission were established in 1613 on the east side of the Arroyo del Chorro, apparently under the direction of the Spanish (John Ware, personal communication 1996). The historic pueblo at San Lazaro, built around a central plaza, is large and compact. The height of the rubble suggests the original roomblocks were two to three stories. Assuming three rooms per family, five people per family, and two to three stories, I estimate that 1,300 to 2,000 people occupied the pueblo during the A.D. 1600-1690 period. If the pueblo is one to two stories and rooms were larger than the prehistoric ones, as suggested by nonprofessional excavations at the site, a more likely range is 700 to 1,200 residents (Ware et al. 1998:25-26). The pueblo was abandoned after the Pueblo Revolt of 1680 but before the reconquest of Santa Fe in 1692 (Kessell 1987).

Figure 7.6 shows the population curves for Arroyo Hondo, San Lazaro, San Marcos, and Pecos pueblos. The curve for Pecos Pueblo is based on Welker's periods and room counts but uses a family size of seven people (Figure 7.3). Population is plotted at the midpoint of each period identified at a site, except Arroyo Hondo, for which Creamer's (1993:152-153) dates for the peaks of the two components are used. The occupation of Arroyo Hondo is declining when Pecos Pueblo and San Lazaro are growing and San Marcos is established. Whether there is any relationship between the decline at Arroyo Hondo and increases elsewhere is unknown.

It appears that San Lazaro is occupied earlier than San Marcos; however, this may reflect the different beginning dates that Welker and I use for glaze wares. She cites 1340 as the earliest date for glaze manufacture in the northern Rio Grande (Welker 1997:85). I prefer the more

traditional beginning date of 1315, at least at San Lazaro, because the early glaze-on-red wares are being made just after 1300 in the south and are imported into the Galisteo Basin. The first areas occupied at San Lazaro are dominated by these glaze-on-reds. Locally made glaze-on-yellow ceramics do not appear at San Lazaro until slightly later.

There are a couple of peaks and valleys in the prehistoric occupation of San Lazaro. During the first stage of growth, San Lazaro and Pecos Pueblo grow and peak in the mid- to late-fourteenth century. Both enter a period of decline that is slower and gentler at Pecos Pueblo. San Marcos is established and grows while the others decline. San Marcos continues to grow to its peak population in the late 1400s. San Lazaro experiences another growth spurt during the 1400s and reaches a second population peak just slightly lower than the earlier one. Pecos Pueblo grows steadily as the other two decline in the 1500s.

Prehistoric San Lazaro is abandoned ca. A.D. 1515-1520, probably because of a raid, which is suggested by intact assemblages of household and ceremonial goods recovered from the latest roomblocks (Ware et al. 1998). San Lazaro may be the pueblo described by Castaneda (Winship 1896:523-524) that was in ruins, with stone balls scattered around "which seemed to have been thrown by engines or catapults" (Winship 1896:524), and had been destroyed 16 years before by the Teyas. According to Nelson (1914), San Lazaro is the only pueblo in the Galisteo Basin with an abundance of round sand stone concretions ("stone balls") in the surrounding hills.

In contrast to San Lazaro, the occupations at San Marcos and Pecos continue into the Historic Period, when missions are built at both sites. The location at San Lazaro is reoccupied in the early 1600s when a group of Pueblo Indians, under Spanish direction, built a pueblo and mission across the wash from the old prehistoric pueblo (Ware et al. 1998). The population at Pecos Pueblo continues to grow in the Historic Period, although historic documents indicate that major population decline begins before the middle of the seventeenth century (Kessell 1987:170). The last occupants leave Pecos Pueblo in 1838 and move to Jemez Pueblo. San Lazaro and San Marcos are abandoned much earlier, sometime between the Pueblo Revolt in 1680 and the Reconquest in 1692.

The persistence of Pecos Pueblo through time and the lack of wide swings in population like those at San Lazaro and San Marcos may have several explanations. One may be the advantage of using excavation data to identify and quantify earlier occupations. The use of surface data at San Marcos and San Lazaro potentially accentuates the dips in population because the ceramic assemblages associated with those periods are underrepresented. It is difficult to state that Pecos Pueblo is more stable without better subsurface information from the other pueblos. If Pecos Pueblo's population is more stable, it may be because of the consistent need to regulate trade between the Plains and Rio Grande Valley.

Conclusions

According to reconstructions using the Pecos survey data, plus information from Rowe and Hobson-Dressler, the number of people living in the Pecos area peaks in Period 3 (A.D. 1325-1450). The high rate of population growth from Period 2 (A.D. 1200-1325) to Period 3 suggests that a portion of the increase is through immigration. At the same time, in the northern Rio Grande region as a whole, population grows, levels off, then declines (Crown et al. 1996; Orcutt et al. 1994:Figure 9). When the northern Rio Grande is subdivided into smaller regions, we see that many of them experience growth, then decline between 1300 and 1450 (Figure 7.5).

Population in the Pecos area declines in Periods 4 (A.D. 1450-1575) and 5 (A.D. 1575-1700), and most people are living at Pecos Pueblo. At approximately the same time, some areas in

the northern Rio Grande experience population decline, while others grow and then decline. According to Welker's estimates, the number of people residing at Pecos Pueblo between 1515 and 1700 reaches a peak, and population appears to increase in the Galisteo Basin and Jemez Mountains while it declines in other areas (Figure 7.5).

Climate and Pecos Area Population

Returning specifically to the Pecos area, it might be possible to understand population fluctuations, especially changes in population aggregation, in terms of climatic events affecting agricultural productivity (Kohler and Van West 1992; Orcutt 1999b). Benedict and Orcutt (Chapter 6) devised a dryness index for the Palmer Drought Severity Index (PDSI) to characterize Periods 2-5 (A.D. 1200-1700). The index uses a scale from 0 to 2 to transform the annual PDSI values to normal/wet (0), dry (1), and very dry (2). The index emphasizes drier conditions over moister ones because we are interested in the potential affect of droughts on agricultural productivity. We calculated five-year moving averages of the index and examined the fluctuations in each period (see Chapter 6 for details).

Kohler and Van West (1992) argue that periods of high agricultural productivity and high temporal variability in production promote aggregation, which facilitates sharing to even out irregularities in productivity. Even when overall productivity is high, temporal and spatial irregularities do occur that can leave some families with a shortfall. In the long run, everyone benefits from sharing as long as there is sufficient food to go around. The dryness index and annual variability in the actual PDSI values provide a relative view of productivity in Periods 2-5 (A.D. 1200-1700).

Period 2 (A.D. 1200-1325) (Figure 6.1) is the driest, and variability is high between approximately A.D. 1240 and 1300. On a relative scale, productivity in Period 2 probably is lower and variability is higher than the other periods; on that basis, I expect lower aggregation than during Periods 3-5 (A.D. 1325-1700).

Compared to Period 2 (A.D. 1200-1325), Period 3 (A.D. 1325-1450) (Figure 6.2) is not as dry, and variability is lower. Period 4 (A.D. 1450-1575) (Figure 6.3) is similar to Period 3, but there are more very dry years and fewer very wet ones. Both periods probably are characterized by higher potential productivity than Period 2. Although variability is lower than Period 2, aggregation should be a viable strategy to survive years of low agricultural production. I expect greater aggregation in Periods 3 and 4 than Period 2.

Period 5 (A.D. 1575-1700) (Figure 6.4) is the least dry and, therefore, probably has the highest agricultural potential. Variability is low until approximately 1680. Between 1680 and 1700, a critical period encompassing the Pueblo Revolt (1680) and Reconquest (1692), variability is high. On the basis of relative potential productivity, aggregation should remain high in Period 5.

Returning to the population estimates for all known and dated habitation sites in the Upper Pecos Valley, the peak of population size in Period 3 (A.D. 1325-1450) occurs during one of the better climatic periods. Population size declines in Periods 4 (A.D. 1450-1575) and 5 (A.D. 1575-1700), despite relatively good climatic interludes.

Population aggregation conforms well to the expectations based on the PDSI. I expect aggregation to be lowest in Period 2 (A.D. 1200-1325), and to increase in Periods 3-5 (A.D. 1325-1700). To test the proposition, I identify the size of the largest aggregate (i.e., the most people at any one site) in each time period (Table 7.3). The aggregate of 360 people in Period 2 is the smallest during the periods examined, as expected. Aggregates increase in size in Periods 3 and 4 (A.D. 1450-1575), reaching a peak in the latter. By Period 4, Pecos Pueblo is the only large aggregate, as measured with survey data. According to the survey data, Pecos

Pueblo also is the only large aggregate in Period 5 (A.D. 1575-1700). The Period 5 aggregate is slightly smaller than Period 4, but it is much larger than those in Periods 2 or 3.

Table 7.3. Size of the largest aggregate in each period.

Period	People
2 (A.D. 1200-1325)	360
3 (A.D. 1325-1450)	563
4 (A.D. 1450-1575)	884
5 (A.D. 1575-1700)	750
6 (post A.D. 1700)	455

Based on Welker's (1997) reconstruction, it appears that an aggregate forms on the Pecos mesilla during Period 3 (A.D. 1325-1450), which is climatically more favorable for agriculture than Period 2 (A.D. 1200-1325). The Quadrangle at Pecos Pueblo takes shape during Welker's Period 3, which overlaps with the late portion of survey Period 3 through mid-Period 4 (A.D. 1450-1575). The height of population and aggregation at Pecos Pueblo is in Welker's Period 4, overlapping survey Periods 4 and 5 (A.D. 1575-1700). Except for the last 20 years of Welker's Period 4, this is one of the least dry periods in the Pecos area.

Overall, the survey data for all Pecos area habitations and Welker's reconstructions of Pecos Pueblo population indicate that aggregation is greatest during periods of higher agricultural potential. The PDSI is only one small aspect of climate and does not consider any social or other climatic factors that might affect aggregation. It is likely that aggregation in the Pecos area before Pecos Pueblo is established reflects sharing (Kohler and Van West 1992). In the specific case of Pecos Pueblo, nonclimatic factors facilitating its persistence through time include its strategic location at the gateway between the Great Plains and the Rio Grande Valley, and because of that location, the ability to regulate trade between Plains Indians and the northern Rio Grande pueblos. Because Pecos Pueblo clearly is designed for defense, warfare must be a factor in aggregation. The threat is not coming from within the Upper Pecos Valley because all residents are in Pecos Pueblo, so it is originating outside the valley, probably from other northern Rio Grande populations and from the Plains.

<<< **Previous** <<< **Contents**>>> **Next** >>>

PECOS

From Folsom to Fogelson:

The Cultural Resources Inventory Survey of Pecos National Historical Park

CHAPTER 8:
CERAMICS

Melissa S. Powell

Ceramic data from sites in Pecos National Historical Park are used to address several topics outlined in the project research design, including issues of community dynamics and culture contact (Head 1997a). This chapter focuses on three major research domains: (1) analysis of the cultural, temporal, and spatial variability in the Pecos survey ceramic assemblages; (2) the functional content of ceramic assemblages and the implications for social processes such as aggregation and the intensification of agriculture; and (3) the organization of utility and white ware ceramic production in relation to the topic of trade.

The chapter begins with a review of previous ceramic research at Pecos and briefly describes the nature of the ceramic data collected by the survey. A summary of the main ceramic types found within the park is then presented, along with a discussion of the likely cultural affiliation of the various types. To provide a culture historical context for the current research, the temporal and spatial distributions of the ceramic types are discussed. The distribution of possible trade ware is examined, and comparisons are made to ceramics found elsewhere in the northern Rio Grande region, including Rowe Pueblo, Arroyo Hondo Pueblo, and sites in the Galisteo Basin.

Ceramic Research in the Northern Rio Grande Region

Ceramic analysis occupies a central place in the history of research at Pecos, with A. V. Kidder and A. O. Shepard, pioneers in Southwestern archeology, conducting the most significant work of their careers at Pecos Pueblo. While many early Southwesternists (Judd 1922; Kidder 1915, 1916a, 1916b, 1924, 1927, 1932; Mera 1933, 1935; Morris 1939; Roberts 1935) were primarily interested in artifact description, chronology, and defining regional patterns, Shepard (1936, 1939, 1942, 1965, 1985) was the first investigator to reach beyond concerns of cultural historical reconstruction to posit questions about ceramic production and exchange. Shepard's work with ceramic petrography in pursuit of these broader objectives still sets the standard for ceramic research today. Her findings that pottery was often traded over great distances and her recognition that some communities specialized in making certain kinds of pottery, changed archeological thinking, which until then had regarded ceramic production as a purely household-based activity with each household producing ceramics to meet its own needs.

Beginning with Kidder (1916a, 1924, 1932, 1958) and Shepard (1936, 1942, 1965), research in the Upper Pecos Valley has highlighted the role of Pecos Pueblo as a center of commerce and trade in late prehistoric times, an emphasis which has continued in recent years (Habicht-Mauche 1988; Spielmann 1982, 1983, 1991b; Welker 1997). Despite this emphasis, evidence for the nature of ceramic production and trade at pueblos antecedent to Pecos Pueblo and at small sites of all time periods is virtually nonexistent. Likewise, most ceramic studies in the northern Rio Grande region have ,argely centered on the specialized production and exchange of glaze ware ceramics (Bower et al. 1986; Herhahn 1995; Motsinger 1997; Reed 1990; Staley 1990; Vint

1992; Warren 1969, 1970, 1979). Production and exchange of the earlier utility and black-on-white ware is largely unknown. The second half of the chapter addresses this problem by investigating the organization of ceramic production at the early pueblos preceding Pecos Pueblo.

Methods of Ceramic Analysis

Analysis of the Pecos ceramics was performed in the field. Sampling and recording methodologies for the project are presented in Chapter 3. Within each scatter, sherds were grouped together and classified by ware and by ceramic type and form when possible. Since construction of a site chronology (Chapter 4) was a primary goal of the survey, ceramic types were identified as the most effective means of assigning relative dates to most sites, rather than recording other attribute data such as temper, paste characteristics, or design elements. The survey recorded the vessel form for each sherd within the following categories: jar, bowl, shouldered bowl, special closed shape, canteen, soup plate, ladle, handle, pipe, miniature, other, and unknown. Sherds were also weighed in the field by groups of vessel type and form. In addition, counts of rim sherds were recorded, along with metric data on those rim arcs large enough to be measured. The curvature of rim sherds was used to estimate vessel diameter and percentage of the rim present. Rim sherds that could be refitted were measured together on the rim arc template (see Appendix D).

Finally, an experimental variable, the minimum or actual number of vessels present for each ceramic group, was assessed. This variable required analysts to visually compare the paste, surface treatment, curvature, rim forms, and decorative elements of the sherds within each type/form group and to assess the probable number of whole vessels represented by the sherds. Analysts further specified whether this figure approximated a minimum or actual number of vessels. When assemblages were small and only a few sherds of each type were present, the actual number of vessels could usually be determined with reasonable confidence. For large assemblages where this was impossible, the ceramicists made a conservative estimate of the minimum number of vessels present in each type and form class.

The resulting vessel estimates do not seem well supported, except perhaps at the smallest sites where the actual number of vessels represented on the surface could be estimated accurately. The condition of the ground cover on sites also factors into the ability to estimate numbers of surface vessels, as do other formation processes which affect the relationship between surface and subsurface materials. In the end, the estimates were considered too subjective to be of great value. The resulting data on minimum and actual numbers of vessels are reviewed briefly in the section on trends in ceramic wares.

The Ceramic Assemblage

The ceramic database for the Pecos survey is composed of information recorded for a total of 30,709 sherds from 496 site components. Despite the limitations of the field estimates of the number of vessels in each ceramic grouping, these sherds appear to represent a minimum assemblage of 7,480 total vessels, although this figure is probably conservative.

Ceramic Types

The primary unit of analysis for the survey is the ceramic type. Rather than repeat previously published descriptions of individual ceramic types, the reader is referred to Table 8.1 for the references used by the project for ceramic type descriptions, organized by ceramic ware. The Pecos Archeological Survey Ceramic Typology Field Manual (available through National Park Service, Santa Fe) contains the project coding guide and lists complete descriptions of ceramic types with details about paste, temper, surface treatment, slip, paint, and decorative attributes. Table 8.2 is a comprehensive list of the total sherd count for all ceramic types by vessel form.

Chronological dates for the ceramic types—often based on tree-ring dates, but also derived from relative stratigraphic information, and in some cases, on researchers' best estimates—are provided in Table 4.1.

Table 8.1. References for ceramic type descriptions by ware.

Ware	Reference
Rio Grande Gray Ware	Habicht-Mauche 1988; Kidder and Shepard 1936; McKenna and Miles 1991; Mera 1935
Pajarito White Ware	Breternitz 1966; Habicht-Mauche 1993; Hawley 1950; Honea 1968; Kidder and Amsden 1931; Kidder and Shepard 1936; McKenna and Miles 1991; Mera 1935; Stubbs and Stallings 1953; Traylor and Scaife 1982
Rio Grande Glaze Ware	Barnett 1969; Hawley 1950; Eighth Southwestern Ceramics Seminar 1966; Honea 1968; Kidder and Shepard 1936; Lambert 1954; McKenna and Miles 1991; Mera 1933, 1935; Nordby 1990; Snow 1982; Warren and Snow 1976
Historic polychromes	Batkin 1987; Frank and Harlow 1974; Harlow 1973; Kidder and Amsden 1931; McKenna and Miles 1991; Mera 1932, 1939; Oppelt 1988; Snow 1982
Historic plain ware	Harlow 1973; Kidder and Amsden 1931; Kidder and Shepard 1936; Lambert 1954; Mera 1933, 1935; McKenna and Miles 1991; Oppelt 1988
White Mountain Red Ware	Carlson 1970; Kidder and Shepard 1936
Plains/Apache Ware	Brugge 1982; Gunnerson 1968, 1969; Habicht-Mauche 1988

Table 8.2. Total sherd frequencies for all ceramic types by vessel form.

Ware and Type	Jar	Bowl	Shouldered Soup Bowl	Plate	Other	Unknown	Total	Percent
GRAY WARE								
Unidentified gray ware	2,884	186	—	—	8	1,426	4,504	14.667
Plain gray	3,287	92	—	—	4	444	3,827	12.462
Corrugated	117	—	—	—	—	—	117	0.381
Blind corrugated	177	—	—	—	—	—	177	0.576
Indented corrugated	430	2	—	—	—	—	432	1.407
Indented blind corrugated, not further specified (nfs)	306	1	—	—	—	4	311	1.013
Indented blind corrugated, weak	2,265	5	—	—	—	6	2,276	7.412
Indented blind corrugated, strong	308	—	—	—	—	—	308	1.003
Clapboard corrugated	44	1	—	—	—	1	46	0.150

Micaceous plain	371	1	—	—	—	15	387	1.260
Micaceous blind corrugated	1	—	—	—	—	—	1	0.003
Micaceous indented blind corrugated	72	—	—	—	—	—	72	0.234
Cordova Micaceous Ribbed	1	—	—	—	—	—	1	0.003
Pecos Striated, nfs	1,073	25	—	—	—	—	1,098	3.575
Pecos Faint Striated	1,354	7	—	—	—	—	1,361	4.432
Pecos Heavy Striated	211	3	—	—	—	—	214	0.697
							15,132	49.28
WHITE WARE								
Unidentified white ware	70	781	—	—	4	480	1,335	4.347
Kwahe'e Black-on-white slipped	7	5	—	—	—	—	12	0.039
Kwahe'e Black-on-white unslipped	1	2	—	—	—	—	3	0.010
Chupadero Black-on-white	3	3	—	—	—	—	6	0.020
Santa Fe Black-on-white slipped	16	661	—	—	1	—	678	2.208
Santa Fe Black-on-white unslipped	23	465	—	—	2	9	499	1.625
Pindi Black-on-white	1	22	—	—	—	—	23	0.075
Galisteo Black-on-white	28	848	—	—	3	—	879	2.862
Rowe Black-on-white	7	25	—	—	—	—	32	0.104
Jemez Black-on-white	—	3	—	—	—	—	3	0.010
Wiyo Black-on-white	9	264	—	—	—	—	273	0.889
Biscuit A	5	279	—	—	1	5	290	0.944
Biscuit B	41	156	—	—	—	2	199	0.648
Biscuit unknown	6	65	—	—	—	71	142	0.462
Sankawi'i Black-on-cream	6	7	—	—	—	—	13	0.042
							4,387	14.29
RED WARE								
Unidentifed nonlocal red ware	3	18	—	—	1	2	24	0.07
Puerco Black-on-red	—	10	—	—	—	—	10	0.03
Wingate Black-on-red	—	2	—	—	—	—	2	0.00
St. Johns Black-on-red	1	13	—	—	—	—	14	0.04
St. Johns Polychrome	—	6	—	—	—	—	6	0.02
							56	0.18
GLAZE WARE								
Unidentified glaze ware	364	821	3	—	37	1,038	2,263	7.36
Unidentified glaze-on-red	308	933	3	—	4	12	1,260	4.10
Unidentified glaze-on-yellow	275	1,452	3	—	1	71	1,802	5.86
Unidentified glaze polychrome	141	465	21	—	—	5	632	2.05

Los Padillas Glaze Polychrome	1	8	—	—	—	—	9	0.02
Glaze I undifferentiated	1	47	—	—	—	—	48	0.15
Glaze I Agua Fria Glaze-on-red	59	393	—	—	—	—	452	1.47
Glaze I Cieneguilla Glaze-on-yellow	17	163	—	—	—	—	180	0.58
Glaze I Cieneguilla Glaze Polychrome	1	3	—	—	—	—	4	0.01
Glaze I Sanchez Glaze-on-red	—	2	—	—	—	—	2	0.00
Glaze I Sanchez Glaze-on-yellow	—	1	—	—	—	—	1	0.00
Glaze I Sanchez Glaze Polychrome	—	1	—	—	—	—	1	0.00
Glaze I San Clemente Glaze Polychrome	—	19	—	—	—	—	19	0.06
Glaze II undifferentiated	—	15	—	—	—	—	15	0.04
Glaze II Largo Glaze-on-red	—	28	—	—	—	—	28	0.09
Glaze II Largo Glaze-on-yellow	3	34	—	—	—	—	37	0.12
Glaze II Largo Glaze Polychrome	1	7	—	—	—	—	8	0.02
Glaze II Medio Glaze Polychrome	—	4	—	—	—	—	4	0.01
Glaze III Espinoso Glaze Polychrome	125	372	41	—	—	1	539	1.75
Glaze IV San Lazaro Glaze Polychrome	94	366	55	—	—	—	515	1.67
Glaze V undifferentiated	71	66	78	3	1	1	220	0.71
Glaze V Pecos Glaze Polychrome	188	594	116	2	1	—	901	2.93
Glaze V Puaray Glaze Polychrome	—	19	—	—	—	—	19	0.06
Glaze V Escondido Glaze Polychrome	—	8	—	—	—	—	8	0.02
Glaze V Late	3	9	1	12	—	—	25	0.08
Glaze VI undifferentiated	—	1	—	—	2	—	3	0.01
Glaze VI Kotyiti Glaze-on-red	—	11	—	—	—	—	11	0.03
Glaze VI Kotyiti Glaze-on-yellow	37	13	—	3	—	—	53	0.17
Glaze VI Kotyiti Glaze Polychrome	—	4	—	—	—	—	4	0.01
							9,063	29.51
HISTORIC POLYCHROME								
Unidentified historic polychrome	72	25	—	—	1	1	99	0.32
Sakona Polychrome	5	—	—	—	—	—	5	0.01

Tewa Polychrome	25	75	—	—	—	4	104	0.33
Tewa Black-on-red	—	2	—	—	—	—	2	0.00
Pojoaque Polychrome	1	—	—	—	—	—	1	0.00
Ogapoge Polychrome	3	4	—	—	—	—	7	0.02
							218	0.71
PLAIN WARE								
Los Lunas Smudged	2	—	—	—	—	—	2	0.00
Potsuwi'i Incised	1	—	—	—	—	—	1	0.00
Undecorated red	269	267	1	1	4	180	722	2.35
High polish undecorated red	41	49	—	—	—	1	91	0.29
Plain Red	15	165	—	—	—	8	188	0.61
Plain Black	236	216	—	—	1	16	469	1.52
Kapo/Tewa Black	26	4	—	—	—	—	30	0.09
Unknown plain polished	212	42	—	4	—	34	292	0.95
							1,795	5.85
OTHER								
Ocate Micaceous (PLAINS/APACHE)	27	—	—	—	—	13	40	0.13
Cimarron Micaceous (PLAINS/APACHE)	1	—	—	—	—	—	1	0.00
Majolica (SPANISH)	—	—	—	—	—	2	2	0.00
Jeddito/Sikyatki (HOPI)	—	2	—	—	—	13	15	0.04
Total Frequency	15,753	10,668	322	25	76	3,865	30,709	
Total Percent	51.298	34.739	1.049	0.081	0.248	12.586		

Ceramic Wares

Individual ceramic types may be subsumed within the more general heading of wares. At Pecos, wares recorded by the survey are as follows: Rio Grande Gray Ware (Colton 1953), Pajarito White Ware (Cordell 1998; Habicht-Mauche 1993), Rio Grande Glaze Ware (Mera 1933), Historic polychromes and plain ware (Batkin 1987; Harlow 1973), White Mountain Red Ware (Carlson 1970), Plains/Apache (Gunnerson 1968, 1969b), and an "Other" category. Table 8.3 summarizes Shepard's (1936) petrographic conclusions regarding the source of manufacture for ceramics found at Forked Lightning Pueblo and Pecos Pueblo. Kidder and Amsden (1931) and Kidder and Shepard (1936) have published thorough descriptions of the primary ceramic wares found at Pecos; they are recapped only briefly below for the reader unfamiliar with northern Rio Grande archeology, along with the survey findings for each ware.

Table 8.3. Shepard's (1936) findings regarding the source of manufacture for ceramics found at Forked Lightning Pueblo and Pecos Pueblo.

Ceramic Type	Source of Origin	Supporting Evidence

"Culinary wares"	Local and nonlocal. A portion of the cooking pots were obtained from the villages of the Pajarito Plateau during Black-on-white times, and in certain of the test cuts [at Forked Lightning] they make up 25% of the total culinary ware (p. 482).	The rock temper of these intrusive sherds "is invariably of the intermediate porphyritic type found on the west side of the Galisteo Basin" (p. 563).
Black-on-white: "Blue-gray type" (Santa Fe)	Nonlocal and local. Those of coarse tuff temper are likely intrusive from the Pajarito Plateau. Those of fine grained tuff may derive from local secondary deposits within the Pecos Valley (pp. 482-483). "It is beyond question that a good deal of pottery was obtained in trade from... [Galisteo and the Rio Grande] through out the Black-on-white period and at the same time both of the principal types, Blue-gray and Crackle, were probably copied at Pecos with local material" (p. 486).	Pumiceous tuff is characteristic of the Pajarito Plateau (pp. 482-483).
Black-on-white: "Crackle type" (Galisteo)	Nonlocal and local. The center of distribution is the Galisteo Basin southwest of Pecos, although some were probably made locally (p. 474).	"Vessels with rock-tempered culinary sherd temper were undoubtedly made in the Galisteo" (pp. 485-486).
Black-on-white: "Rowe type"	Local. Late Crackle (Rowe) is a distinctly local specialization which took place at Pecos and in its immediate vicinity (p. 474).	Siltstone temper is probably of local origin. Type is absent in the Galisteo Basin and in the Santa Fe region (p. 486).
"Biscuitoid" (Wiyo)	Nonlocal. Tuff temper indicates that it is probably intrusive.	Tuff temper is characteristic of the Pajarito Plateau.
Biscuit ware	Nonlocal. Probably originates from the Chama drainage and the northern part of the Pajarito Plateau (p. 490). Biscuit ware was always tuff tempered, and therefore intrusive at Pecos.	Highly vesicular tuff temper and volcanic ash are characteristic of the Pajarito Plateau. Unusual bentonite-like clay does not occur in the sedimentary formations of the Pecos region. Limited distribution of Biscuit ware at Pecos and high concentrations in areas where this type of clay and temper are found support interpretation as a trade ware (p. 486, p. 491).
Glaze I	Nonlocal at first, then local. Earliest red and yellow varieties are well-made and tempered with crushed igneous rock, the nearest formations of which are from 40-48 km (25-30 miles) away. Later, red variety is "technically inferior" and tempered with sand, siltstone, or fine sandstone (p. 517).	Change in raw materials and in quality of vessels suggests that Pecos potters copied trade vessels with locally available materials.
Glaze II	Local. Tempered with siltstone or stream sand which occurs in the vicinity of Pecos. A few specimens contain ground igneous rock (p. 517). "With the opening of Glaze II, Pecos entered upon the period of its greatest ceramic	Temper available locally. In contrast, glaze wares from the Galisteo Basin are all tempered

	independence, for from this time through Glaze IV, only 6 to 8% of the sherds were tempered with igneous rock" (p. 520).	with igneous rock (p. 519).
Glaze III	Local. Tempered with siltstone or stream sand which occurs at Pecos. Only a few specimens contain ground igneous rock (p. 517).	Temper available locally.
Glaze IV	Local. Tempered with siltstone or stream sand which occurs in the vicinity of Pecos. Only a few specimens contain ground igneous rock (p. 517). However, "the study of clays of the Pecos region has failed to reveal the source of Glaze IV slip clays, and it is possible that they were obtained in trade" (p. 522).	Temper available locally.
Glaze V	Local. "Always tempered with stream sand or crushed siltstone, no example of igneous rock temper having been found" (p. 517).	Temper available locally.
Glaze VI	Nonlocal. Igneous rock temper reappears, and sherd or sand tempered specimens are extremely rare (p. 517). The igneous rock temper indicates that Pecos ceased to make Glaze ware sooner than neighboring communities (p. 521).	"The eruptive breccia which outcrops near San Marcos pueblo has been definitely identified in Glaze VI sherds" (p. 518).
Plain Red	Local. Most vessels tempered with stream sand (p. 547).	Temper available locally.
Plain Black	Nonlocal (and local?). Half are tuff tempered (p. 547). "It is very improbable that the first Rio Grande Black ware was made at Pecos in view of the general evidence that Pecos potters were not ceramic leaders at this time. The large number of tuff-tempered specimens suggests that the ware may have been introduced from the Santa Fe area" (p. 549).	Tuff temper is characteristic of the Santa Fe area or the Pajarito Plateau.
"Painted Modern Ware" (Historic polychrome)	Nonlocal (and local). Tuff is present in the great majority of painted ware vessels (p. 547). "The sand-tempered subtype is probably a local product" (p. 551).	Tuff temper is characteristic of the Santa Fe area or the Pajarito Plateau.

Rio Grande Gray Ware

Pecos utility ware has received little attention aside from work by Habicht-Mauche (1987, 1988) on Southwestern-style culinary ware found on the Plains. Hence the sequence of utility ware is poorly understood, and types used for classification purposes are descriptive of surface finishes. From excavation data (Kidder 1958), we know that the earliest utility ware at Forked Lightning Pueblo is of a plain variety, followed by corrugated and indented blind corrugated ceramics. "Indented blind corrugated" is the type name favored by Kidder and still used by archeologists working in the Pecos area, although the term refers to the same surface treatment known as "smeared indented" in other parts of the northern Rio Grande region. Little temporal information exists for the utility ware types, with plain gray, corrugated, and indented blind corrugated all thought to have been produced from approximately A.D. 1100-1500, although these conventional dates are not well documented. Further clouding the picture, some whole Pecos pots in museum

collections display a variety of surface treatments on different parts of a single vessel.

Utility ware at Pecos shifts to a smoothed, striated surface treatment with highly polished vessel interiors around A.D. 1500. At first striations are fairly weak, gradually becoming heavier through time (Kidder and Shepard 1936:320). Striated sherds are typically associated with Glaze V ceramics.

As seen in Figure 8.1, based on sherd counts, 30 percent of all utility ware ceramics in the Pecos database are unidentified, partly due to the substantial number of very small, eroded utility sherds found on survey. Next most prevalent are plain gray varieties (25 percent), followed by indented blind corrugated (19 per cent), and striated sherds (18 percent). Small quantities of indented corrugated, corrugated, blind corrugated, and other types are also present, but comprise less than 3 percent each of the total assemblage (Figure 8.1).

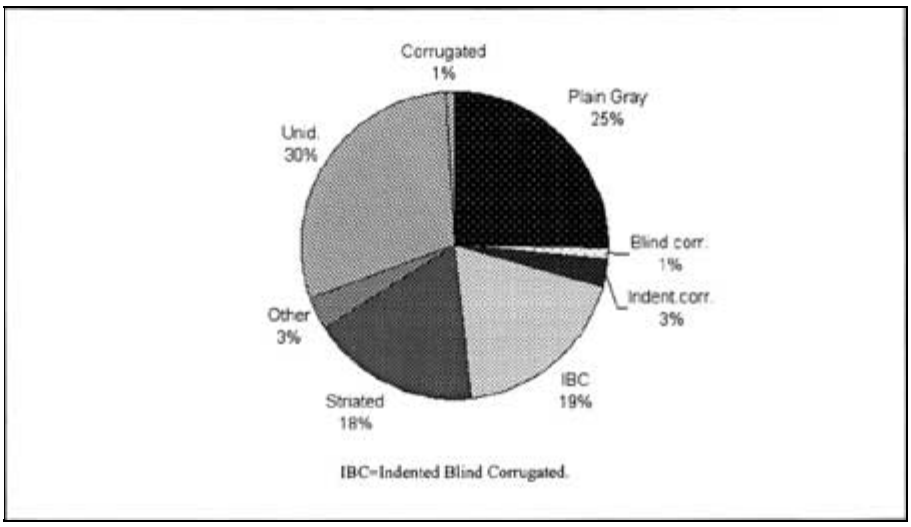


Figure 8.1. Percentages of utility ware ceramic types recorded by the survey.

Pajarito White Ware

The designation "Pajarito White Ware" is applied here to the Rio Grande white ware found at Pecos, following its usage for black-on-white ceramics by Habicht-Mauche (1993) at Arroyo Hondo Pueblo and by Cordell (1998) at Rowe Pueblo. Use of the term is not meant to imply that all of this pottery was produced on the Pajarito Plateau. Production of the various black-on-white ceramic types likely occurred in multiple locations throughout the northern Rio Grande region, as discussed in the second half of this chapter.

White ware ceramics found at the Pecos sites, in order of abundance are Santa Fe Black-on-white (27 percent), Galisteo Black-on-white (20 percent), Biscuit A and B (14 percent), and Wiyo Black-on-white (6 percent), all carbon-paint types (Figure 8.2). Approximately a third of all of the white ware sherds recorded by the survey (n=1,335) could not be classified by type. As with the Rio Grande Gray Ware, the large number of unidentifiable white ware ceramics is partly due to the very small, eroded, and exfoliated sherds found on survey at Pecos. White ware pastes —the primary diagnostic feature of the northern Rio Grande white ware ceramics—display tremendous variation, much of which cannot be pigeonholed neatly into the traditional typology. This problem and its implications for source of manufacture are addressed later in the chapter through compositional study of white ware sherds found at the pueblos preceding Pecos Pueblo.

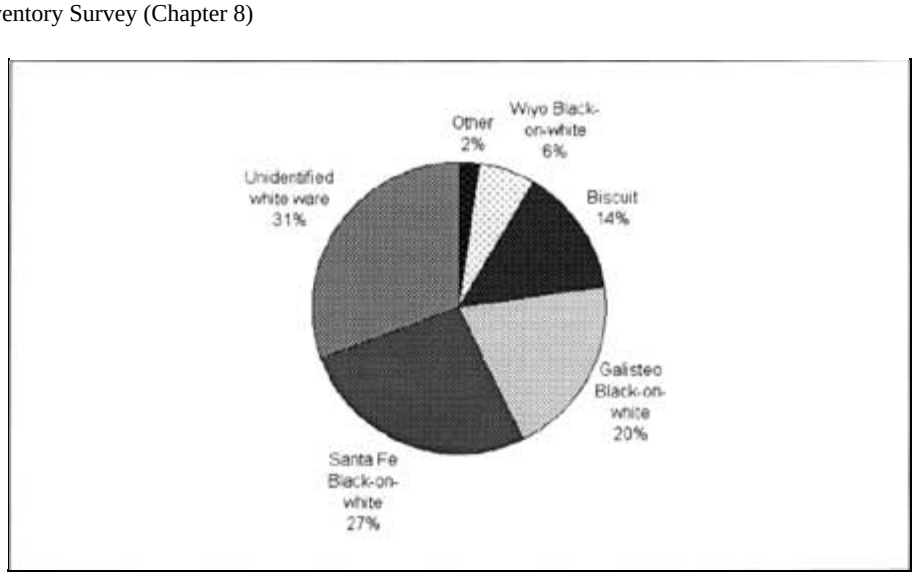


Figure 8.2. Percentages of white ware ceramic types recorded by the survey.

The earliest ceramic type in the black-on white series, and the only type with mineral paint, Kwahe'e Black-on-white, is conspicuously scarce at Pecos. Although 15 sherds of Kwahe'e Black-on-white were recorded, the numbers are significantly less than expected, signaling absence of occupation in the Upper Pecos Valley during the A.D. 1050-1250 period of Kwahe'e Black-on-white use. Other white ware sherds found in small quantities are Pindi Black-on white (n=23), Rowe Black-on-white (n=32), Jemez Black-on-white (n=3), Sankawi'i Black-on-cream (n=12), and Chupadero Black-on-white (n=6). The small quantities of Kwahe'e Black-on-white and Jemez Black-on-white in the survey area are in keeping with Cordell's (1998) findings from Rowe Pueblo.

The lack of Rowe Black-on-white at the Pecos sites is surprising, given the park's proximity to Rowe Pueblo, the type site for this pottery. However, Rowe Black-on-white is defined primarily as a "poor-quality variant" (Habicht-Mauche 1993:29) and a "late, degenerate form" (Kidder and Amsden 1931:26) of Galisteo Black-on-white. Noted for extreme cracking of its painted surfaces, Rowe Black-on white exhibits pastes very much like Galisteo Black-on-white, making classification of sherds into this category somewhat subjective. It is possible that some Rowe Black-on-white sherds may have been unrecognized within the range of variation for Galisteo Black-on-white, but it is more likely that Rowe Black-on-white saw little use at sites outside of Rowe or Pecos pueblos.

Rio Grande Glaze Ware

Glaze paint ware, ubiquitous at Pecos, has been the subject of much study in the northern Rio Grande. The temporal sequence of changing rim styles, modified after Kidder and Kidder (1917) and Mera (1933), is well documented in Kidder's excavations at Pecos, and serves as an excellent chronological indicator for surface assemblages. Rim forms become gradually thicker over time, changing from straight and direct profiles to bulging polliwog shapes by the later part of the sequence. In the interest of direct comparability with Kidder's published work from Pecos, glaze ware designations for the project follow Kidder's original nomenclature, Glaze I-VI, rather than the Mera series Glaze A-F used in other parts of the northern Rio Grande region.

Shepard's early petrographic work on glaze ware produced eye-opening results, particularly for Kidder, who had to revise his ideas about ceramic production at Pecos. Combining stratigraphic and petrographic evidence, Shepard was able to demonstrate that the earliest glaze ware ceramics found at Pecos were almost certainly nonlocal, since they were tempered with crushed igneous rock not found in the immediate vicinity (Shepard 1936, 1942). The source of igneous rock

closest to the Pecos Valley is the Galisteo Basin area, including the Cerrillos Hills, Ortiz Mountains, and San Pedro Mountains.

Shepard also observed "technically inferior" examples of Glaze I Red (A.D. 1315-1425) painted with thick, matte glaze and tempered with local sand, siltstone, and sandstone, which appeared slightly later in time (Shepard 1936:72, 73, 517). The change in raw materials and quality of the Glaze I vessels suggested to Shepard that Pecos potters copied trade ware vessels using locally available materials. In this explanation, the slightly later variant forms of Glaze I represent a period of learning to produce a new ceramic technology (Shepard 1936:520, 607). Another possible explanation may be that migrant potters versed in glaze ware technology began to manufacture glaze ware at Pecos using locally available, but unfamiliar and different raw materials.

Shepard (1936:520; 1942:181) found Glaze II through Glaze V (A.D. 1400-1700) sherds were tempered with local siltstone or stream sand, indicating a locally-made product. She contrasted the local Pecos Glaze II through IV ceramic sequence to the igneous rock-tempered glaze ware found at pueblos in the Galisteo Basin from the same time period. The Galisteo Basin pueblos appear to have been major producers of glaze ware pottery found in the northern Rio Grande region during the fifteenth century, but very little of this pottery occurs in deposits from Pecos Pueblo (Shepard 1942; Snow 1981; Warren 1969). This lack of trade ware ceramics coming into Pecos during Glaze II through Glaze V times may indicate that the Pecos community did not share a close relationship with its Galisteo neighbors. In addition, the early glaze ware types (Glaze I—Glaze IV) produced at Pecos do not appear to have been traded outside of the Upper Pecos Valley (Shepard 1942). Shepard characterized this as the time of the "greatest ceramic independence" at Pecos (Shepard 1936:520). However, later in time, some locally-made Pecos Glaze V (A.D. 1515-1700) ceramics with distinctive Pecos rim forms are found in deposits outside of the Pecos area, including Galisteo Basin sites, Rio Arriba, and near Jemez Canyon (Shepard 1942:154-155).

The pattern of local production of Pecos glaze ware pottery appears to have changed by Glaze VI times (A.D. 1625-1700) when glaze ware sherds were once again tempered almost solely with nonlocal igneous rock (Kidder and Shepard 1936). This change in raw materials indicates that the organization of ceramic production had shifted again by the seventeenth century, with the villagers of Pecos Pueblo now relying on external groups to supply them with glaze ware pottery. The reappearance of nonlocal igneous temper may signal renewed ties to the Galisteo Basin community at this time. By A.D. 1700, Rio Grande Glaze Ware pottery ceased to be produced altogether in the northern Rio Grande region, as the Spanish may have assumed control of the Cerrillos lead-ore sources by this time (Peckham 1990; Snow 1982).

Rim forms are the defining typological characteristic of the Rio Grande Glaze Ware sequence, although some surface treatments and glaze ware designs are also diagnostic. For this reason, body sherds generally cannot be classified confidently to type. Glaze body sherds were recorded by the survey as glaze-on-red, glaze on-yellow, glaze polychrome, or unknown glaze. Of the identifiable survey glaze ware sherds, 23 percent are Glaze I, 3 percent are Glaze II, 17 percent are Glaze III, 17 percent are Glaze IV, 38 percent are Glaze V, and 2 percent are Glaze VI (Figure 8.3). The Glaze II variant was never very common throughout the northern Rio Grande (Snow 1989), accounting for the low numbers seen here.



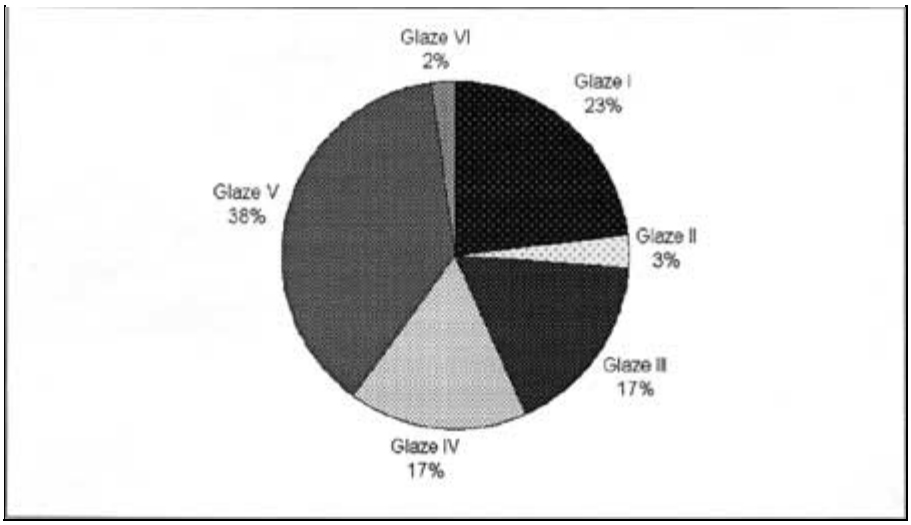


Figure 8.3. Percentages of identified glaze ware types recorded by the survey.

A distributional map of glaze ware and black-on-white sherds recorded by the survey reveals that both wares are abundant through out the park and tend to occur at the same sites, indicating reuse of locations through time (Figure 8.4). Glaze ware is the predominant ceramic type found east of the Pecos River. Presumably aggregation and increasing population led to the use of previously unexploited portions of the landscape (i.e., the northeast section of the park) by glaze ware times. An unexpected number of isolated glaze ware pot drops were recorded by the survey east of the Pecos River (n=40), also indicating a different land use pattern in this portion of the park during glaze ware times.

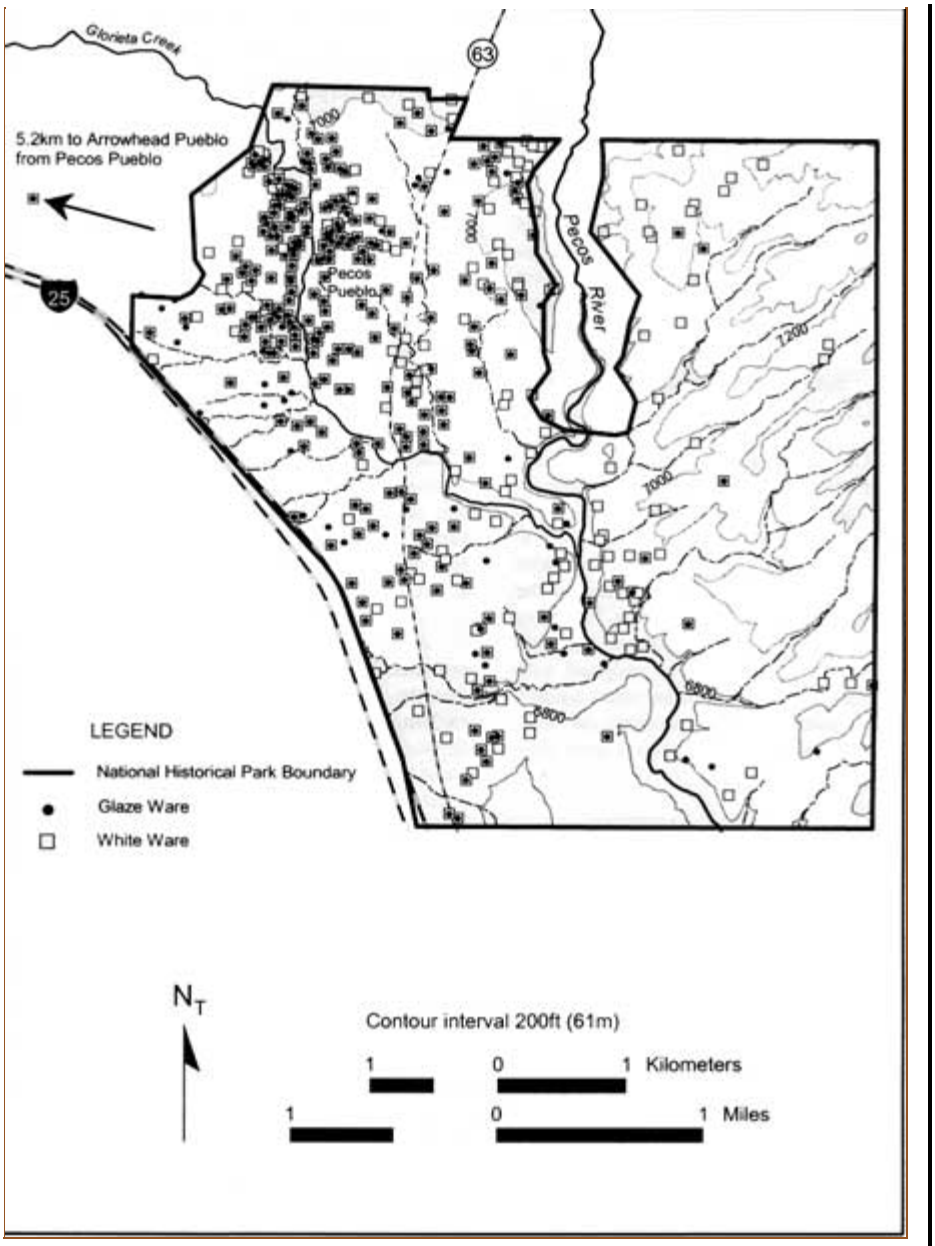


Figure 8.4. Distribution of black-on-white and glaze ware sherds. *(click on image for an enlargement in a new window)*

Historic Polychromes and Plain Ware

A new ceramic tradition emerged in the late seventeenth century. Vessels of this tradition, known as matte-paint polychromes and plain ware, are found on the survey only in small quantities outside of Pecos Pueblo. Tewa Polychrome is the most plentiful type (n=104), but smaller quantities of Tewa Black-on-red (n=2), Sakona Polychrome (n=5), Pojoaque Polychrome (n=1), and Ogapoge Polychrome (n=7), are also present. Historic Rio Grande Plain Ware found on the Pecos survey includes undecorated red (n=722), high polish undecorated red (n=91), Plain Red (n=188), Plain Black (n=469), Kapo/Tewa Black (n=30), and unknown plain polished (n=292). The high polish undecorated red sherds may be undecorated potions of polychrome vessels. Only two sherds of Los Lunas Smudged were observed.

Historic polychromes and plain ware ceramics continue the pattern of red slipping established in glaze ware ceramics, but the use of lead-based glaze is superseded by decoration with organic-based matte-paint. Potters also took advantage of their ability to control firing conditions: the

ferric oxide slip on the plain ware vessels turns red when fired in an oxidizing atmosphere, and black when fired under reducing conditions (Guthe 1925). Novel design elements such as flowers and birds were also introduced on decorated vessels.

Historic Puebloan-produced polychrome and plain ware ceramics were also used by Hispanic and Anglo settlers, leading to the development of new vessel forms to suit European purposes. Still formed using a coil-and-scrape method, the new historic ceramic shapes include soup plates, candlesticks, chamber pots, and large storage vessels. Specialized ceramic "bleeding bowls" with a channeled rim segment have also been identified in collections from Pecos Pueblo (Shawn Penman, personal communication 1998). With increasing trade via the Santa Fe Trail and the eventual arrival of the railroad, historic Puebloan ceramics in the northern Rio Grande region were gradually replaced by manufactured metal containers.

Plains/Apache

Contrary to expectations, only a few, small sherds of Plains/Apache affiliation were detected on survey, although ceramic analysts maintained a close watch for non-Puebloan pottery. Figure 8.5 plots the distribution of Apache ceramics within the park. Most occur at sites very near the course of the Pecos River, a likely route of travel through the valley. Forty sherds classified as Ocate Micaceous were recognized by their thin walls, micaceous paste, and laminated texture. One sherd of Cimarron Micaceous was observed. The survey noted only one example of Potsuwi'i Incised, a possible Plains-influenced type (Harlow 1973; Wendorf 1953).

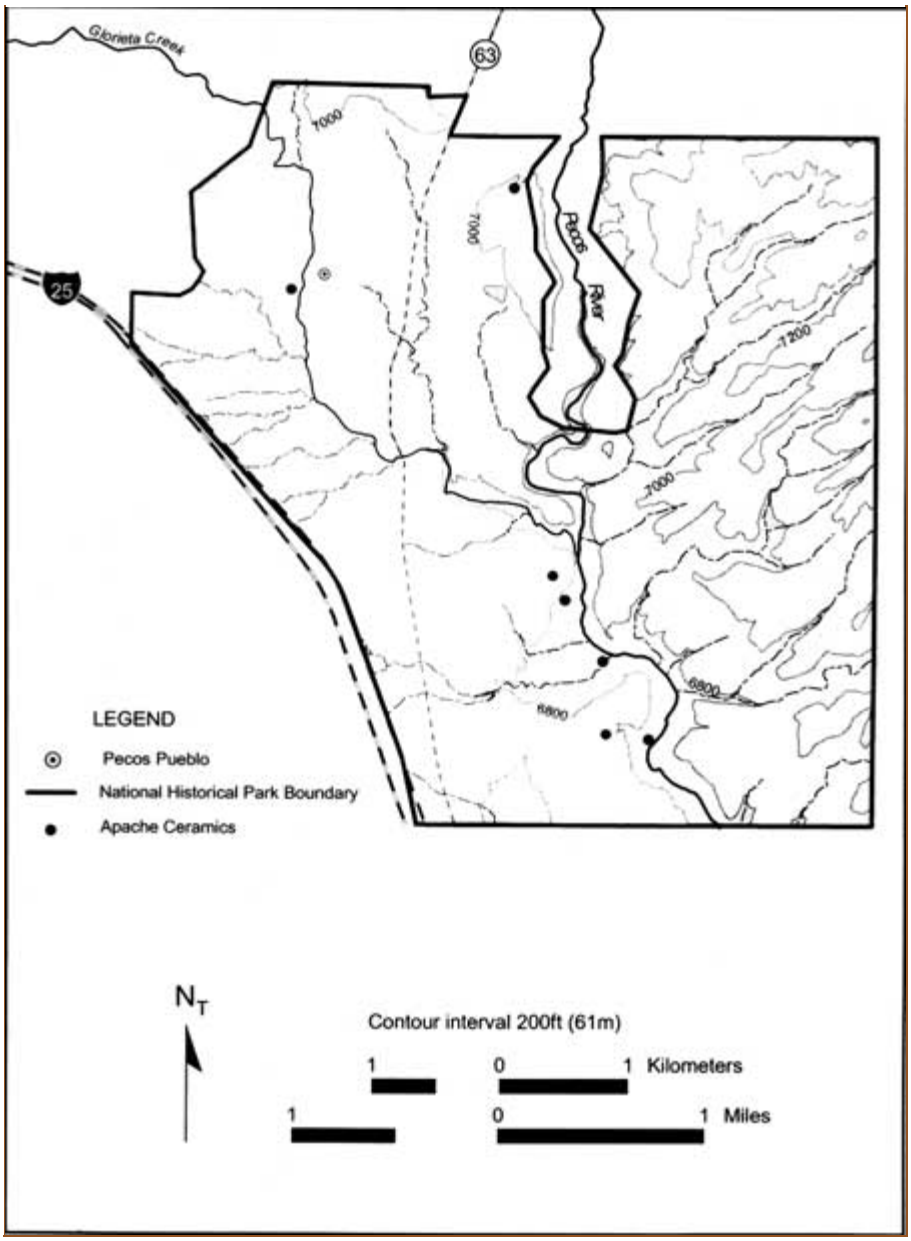


Figure 8.5. Distribution of Apache ceremaics. *(click on image for an enlargement in a new window)*

While Gunnerson's (1968, 1969b) excavations and numerous documentary sources (Hammond and Rey 1940; Kessell 1979; Schroeder and Matson 1965; Spielmann 1991a) support evidence for large-scale Pueblo-Plains trading at Pecos, only three sites recorded by the Pecos survey could be affiliated with Plains or Apache culture groups. Even in these instances the Plains cultural affiliation was assigned with low confidence because at least an equal amount of Puebloan material was present on site, probably indicating reuse of locations over time by different groups of people.

Two of the sites with Ocate Micaceous ceramics also have other diagnostic Plains/Apache traits. PECO 200—which dates to ca. A.D. 1475-1600—has a high proportion of obsidian and a metal projectile point. The second site (PECO 366), an extremely large artifact scatter dated to A.D. 1450-1838, includes an end scraper and a basal notched projectile point, often considered to be diagnostic Plains attributes. Aside from problems of identifying cultural affiliation using survey data, the dearth of Apache ceramics and other diagnostic materials on sites may result from a contact situation in which travelers from the Plains had little need to distinguish themselves

from the local inhabitants of Pecos in terms of material culture (Head 1998).

Other Trade Ware Ceramics

Despite the role of Pecos Pueblo as a center of commerce, surprisingly few trade ware ceramics from outside the northern Rio Grande region were encountered on survey. The most common trade ware is White Mountain Red Ware (n=55) from the Cibola series (Carlson 1970), including both St. Johns Polychrome and St. Johns Black-on-red. Figure 8.6 shows the distribution of White Mountain Red Ware sherds across the park, with many found in the vicinity of Forked Lightning Pueblo. Hopi sherds, including Jeddito Black-on-yellow and Sikyatki Polychrome, account for 15 of the trade ware sherds. Pecos Pueblo was the location of the only majolica sherd recorded on survey. Earlier in the century, Kidder found other unusual trade ware at Pecos in small quantities. Table 8.4 presents a comparison of the survey findings with Kidder's excavation data on trade ware sherds originating out side of the northern Rio Grande region and found at Pecos (Kidder and Shepard 1936).

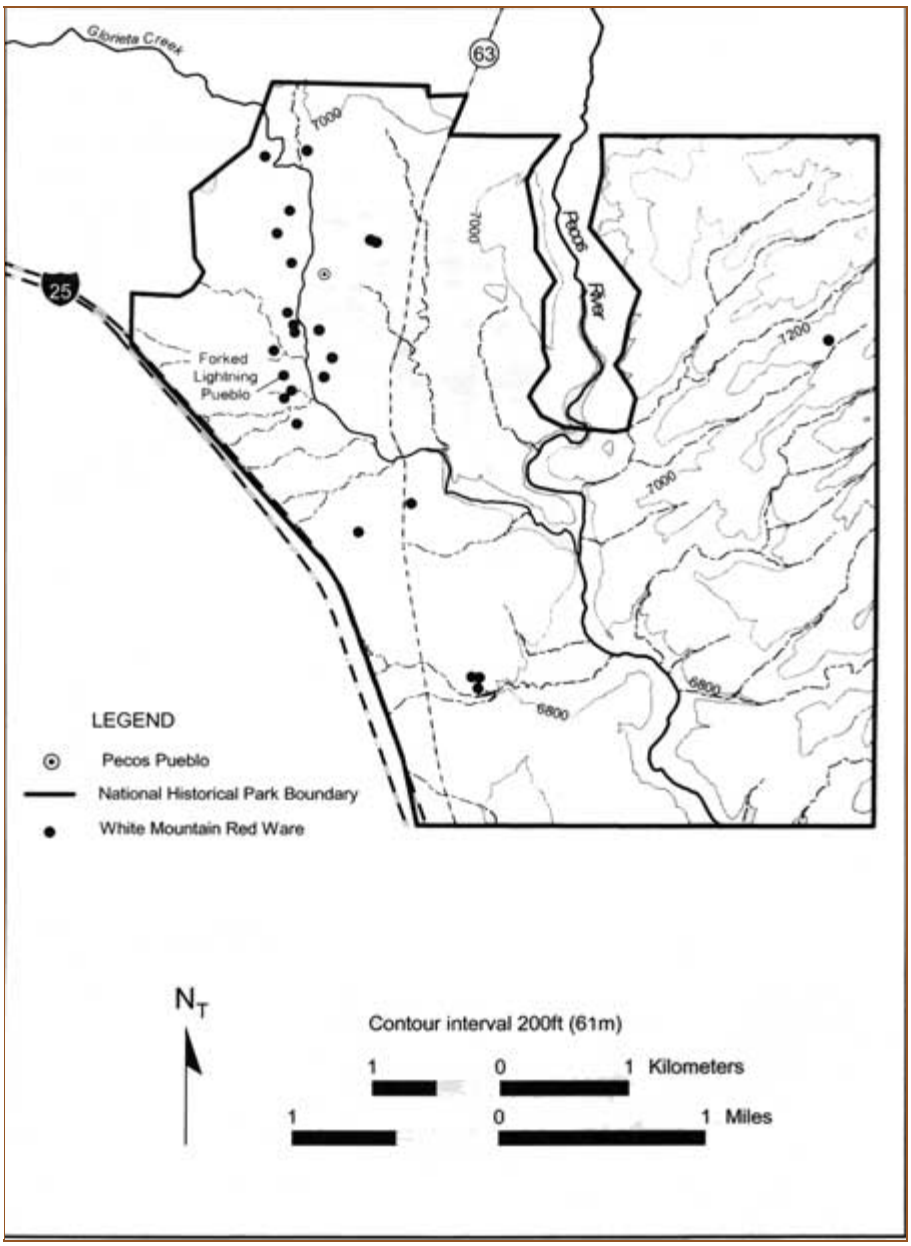


Figure 8.6. Distribution of White Mountain Red Ware sherds. *(click on image for an enlargement in a new window)*

Table 8.4. Comparison of survey findings and Kidder's (1936) excavation data on trade ware ceramics (originating outside of the Rio Grande region) found in the Pecos area.

	Kidder's Excavations				Survey		
Ceramic Type	Forked Lightning	Loma Lothrop	Rowe	Pecos	Forked Lightning	Pecos	Other
Mimbres Black-on-White (?)	1	—	—	—	—	—	—
Chaco Canyon Black-on-white	1	—	—	—	—	—	—
Mesa Verde Black-on-white	3	—	—	3	—	—	—
Chupadero Black-on-white	10	—	1	1	3	—	3
Tularosa Filleted	1	—	—	—	—	—	—
St. Johns Polychrome	195	—	—	6	5	—	—
Other White Mountain Red Ware	—	—	—	—	8	—	42
Chihuahua Polychrome	—	1	—	—	—	—	—
Heshotauthla Polychrome	—	—	12	40	—	—	—
Jeddito Black-on-yellow/Sikyatki Polychrome	—	—	—	165	—	—	15
Gobernador Polychrome	—	—	—	1	—	—	—
Hawikuh Recent Glaze	—	—	—	1	—	—	—
Zuni Polychrome	—	—	—	8	—	—	—
Zia Polychrome	—	—	—	75	—	—	—
Acoma Polychrome	—	—	—	2	—	—	—
Panhandle Paddled	—	—	—	1	—	—	—
"Central Mexico"	—	—	—	1	—	—	—

Note: The survey recorded no trade ware ceramics at Loma Lothrop.

Although the numbers from the survey data are small, nonlocal trade ware ceramics indicate that the Pecos community participated in broad exchange networks which at times extended far beyond the northern Rio Grande region. Trade ware ceramics are not restricted to Pecos Pueblo itself, but tend to cluster around the core monument area of the park and around Forked Lightning Pueblo (Figure 8.7).



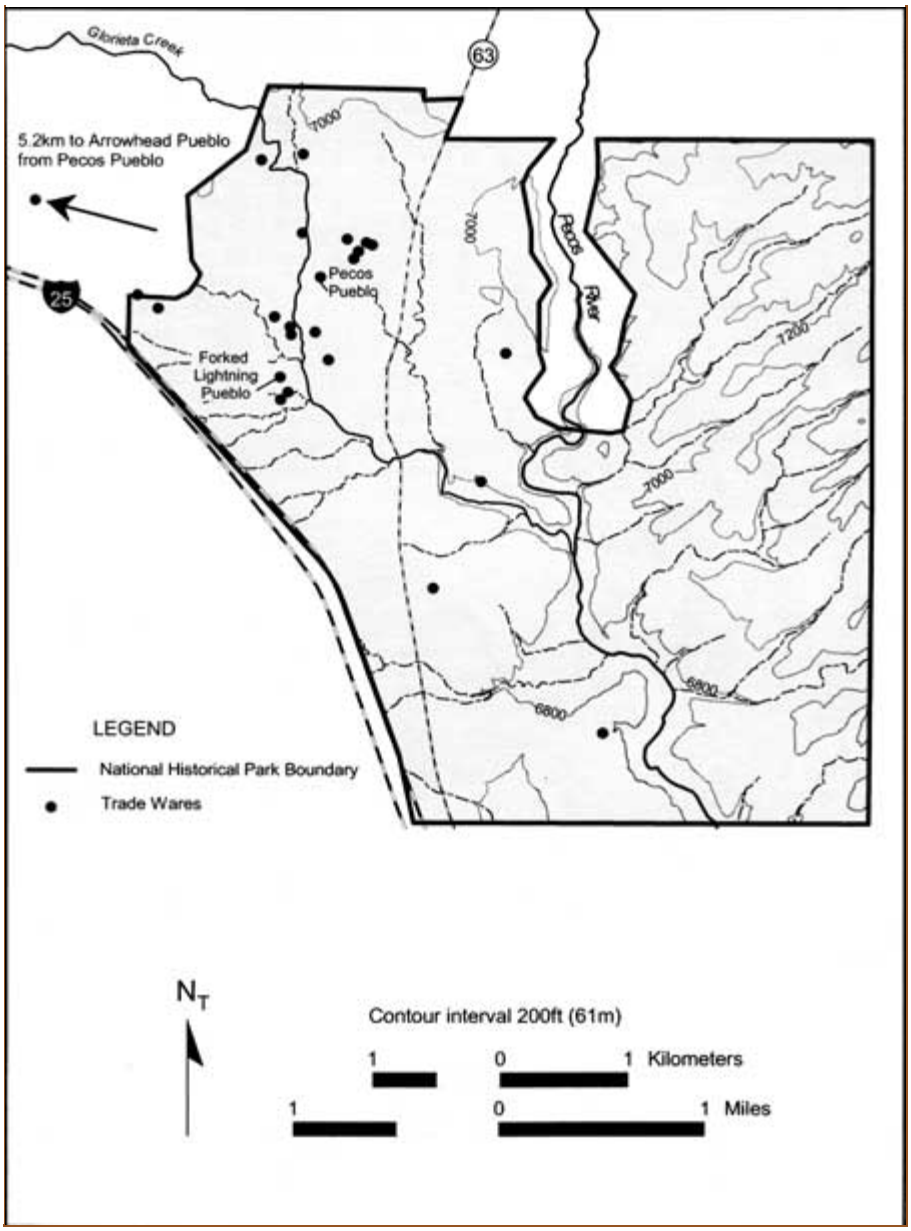


Figure 8.7. Distibution of trade ware sherds. *(click on image for an enlargement in a new window)*

Vessel Form

With regard to vessel form, 15,753 (51.3 percent) of the sherds recorded by the survey are jars, while 10,668 (34.7 percent) are bowls (Table 8.5). Sherds of unknown form are the next most frequent category, totaling 3,865 (12.6 percent) items. Shouldered bowls are represented by at least 322 (1.1 percent) of the sherds, although this number is unrealistically low because this particular morphological class can usually only be distinguished by sherds which come from the shoulder or rim portions of such vessels. Other ceramic forms are present in smaller quantities, including canteens, soup plates, ladles, handles, pipes, and miniature vessels, but each of these forms comprise less than 1 percent of the total survey ceramic assemblage (Table 8.5).

Table 8.5. Total frequencies of sherds by vessel form.

Form	Number of Sherds	Percent (%)
Jar	15,753	51.3
Bowl	10,668	34.7
Shouldered Bowl	322	1.1
Canteen	31	0.1
Soup Plate	25	0.1
Ladle	3	0.0
Handle	26	0.1
Pipe	1	0.0
Miniature	7	0.0
Other	8	0.0
Unknown	3,865	12.6
Total	30,709	100.0

Trends in Ceramic Wares

Quantities of ceramic wares were examined using three variables recorded by the survey, including sherd count, the weight in grams, and the estimated minimum numbers of vessels. Table 8.6 presents a comparison of these measures by ware class for all time periods. Two variables, sherd count and weight, provide support that utility ceramics are the most prevalent ware at Pecos (at 49.3 percent and 39.4 percent, respectively). The variation in percentages may be explained by the observation that utility sherds at Pecos tend to be smaller than decorated sherds, and thus weigh less; the mean weight of utility sherds is 4.2 grams vs. 5.8 grams for decorated sherds. This pattern is likely due to differential uselife and breakage patterns of ceramics (Mills 1989; Schiffer 1987). Estimating the minimum numbers of utility ware vessels proved much more difficult than estimating the number of the more distinctive decorated vessels, making this variable a less useful measure.

Table 8.6. Comparison of sherd counts, weights, and estimated vessels by ware.

Ware	Count	Count (%)	Weight (grams)	Weight (%)	Minimum vessel estimate	Vessel (%)
Rio Grande Gray Ware	15,132	49.3	47,560	39.4	2,143	28.7
Pajarito White Ware	4,387	14.3	20,730	17.2	1,661	22.2
White Mountain Red Ware	56	0.2	256	0.2	43	0.6
Rio Grande Glaze Ware	9,063	29.5	43,651	36.2	3,024	40.4
Historic Polychromes	218	0.7	1,088	0.9	88	1.2
Rio Grande Plain Ware	1,795	5.9	7,219	6.0	505	6.8
Other	58	0.2	156	0.1	16	0.2
Total	30,709	100.0	120,660	100.0	7,480	100.0

Rio Grande Glaze Ware follows utility ceramics in abundance, although the percentage ranges from 29.5 percent of the total sherd count to 40.4 percent of the total estimated vessels. The minimum estimated vessel percentage for glaze ware is relatively higher than other wares, probably due to the ease of distinguishing sherds from different glaze ware vessels. The next most common ceramic ware recorded by the survey is Pajarito White Ware. White ware makes up 14.3 percent of the overall assemblage based on simple count (17.2 percent based on weight, and 22.2 percent based on vessel estimates). Continuing in decreasing order of abundance are Rio Grande Plain Ware (5.9 percent by count), historic polychromes (0.7 percent by count), and White Mountain Red Ware (0.2 percent by count). Percentage differences between estimation methods for these types are small.

While all three variables provide broadly similar results, estimates of the minimum number of vessels appear to be more subjective and are greatly influenced by the type of ware analyzed. Sherd count and weight provided consistently closer percentages. There is no consensus in the archeological literature about which measure is more accurate. Some studies (Solheim 1960) advocate using both sherd count and weight for the benefit of more information in the case that the two measures provide dissimilar results. Others (Glover 1972:96, cited in Orton et al. 1993) have concluded that either measure "would be quite accurate as a measure of frequency." Since sherd counts and sherd weights for the Pecos data yielded percentages that are similar, the analyses presented here rely on sherd counts for simplicity, ease in statistical manipulation, and comparability with other studies.

Ceramic Wares through Time

Ceramic wares were divided into two categories, decorated and undecorated, in order to examine changes through time (Table 8.7; Figures 8.8 and 8.9). For this analysis, decorated ware is defined as all painted ceramics. Undecorated sherds outnumber decorated sherds in all time periods except Period 4 (A.D. 1450-1575), where decorated ware accounts for 51.9 percent of the overall assemblage. Most prehistoric Puebloan ceramic assemblages are dominated by utility ware (Colton 1953; Gifford and Smith 1978; Morris 1917; Stone 1986), so it is surprising to find that decorated ware is more numerous at Pecos in Period 4. This pattern suggests that the utilitarian functions assumed for undecorated pottery (primarily cooking) were not as important as the functions associated with decorated pottery (serving or storage) during A.D. 1450-1575.

Table 8.7. Frequency of decorated and undecorated wares by time period.

	Decorated Ware		Undecorated Ware		
Time Period	Count	(Row %)	Count	(Row %)	Total
1 (A.D. 1075-1200)	153	(38.4)	245	(61.6)	398
2 (A.D. 1200-1325)	1,934	(39.0)	3,030	(61.0)	4,964
3 (A.D. 1325-1450)	4,719	(47.6)	5,200	(52.4)	9,919
4 (A.D. 1450-1575)	3,262	(51.9)	3,027	(48.1)	6,289
5 (A.D. 1575-1700)	2,565	(43.9)	3,276	(56.1)	5,841
6 (post A.D. 1700)	933	(39.9)	1,403	(60.1)	2,336
Total	13,566	(45.6)	16,181	(54.4)	29,747

Note: Frequencies of sherds in this table have been weighted by the probability of occupation at

each site for each time period. This ensures that individual sherds are counted in only one time period, allowing for independence between cells in the table.

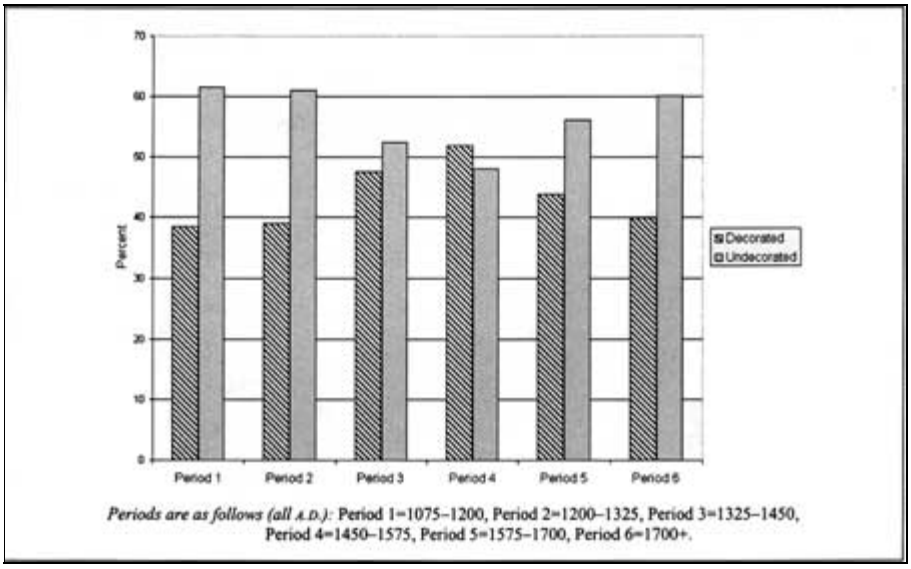


Figure 8.8. Percentages of decorated and undecorated sherds by time period.

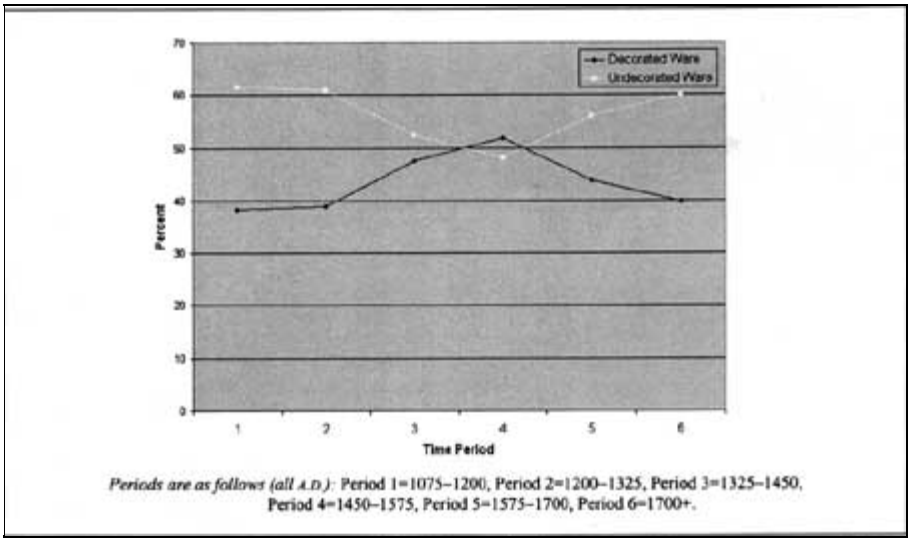


Figure 8.9. Decorated and undecorated wares by time period.

Gauthier (1982) notes a similar trend in proportions of decorated and undecorated ware for Pueblo IV sites in the northern Rio Grande. He finds that by the A.D. 1400s, decorated ware comprises 50 percent of the overall ceramic assemblage, even at field house sites. Gauthier (1982:7) suggests that the increased numbers of decorated ware at this time may be due to increased trade, redistribution, or craft specialization.

Rio Grande Gray Ware through Time

Because relatively little is known about the temporal sequence of utility ware ceramics at Pecos, a breakdown of utility ware types by Pecos time period was created (Table 8.8). Although there is some latent circularity in looking at utility ware by time period when the presence of these ceramic types was in some instances used to classify sites by time period, the shorter date ranges

of decorated types had a greater effect on the ceramic assemblage date assignment than did the longer utility ware production intervals. With this caveat, utility ware types display some interesting trends.

Table 8.8. Frequency of utility ware types by time period.

Utility Ware Type	Period 1 A.D. 1075-1200	Period 2 A.D. 1200-1325	Period 3 A.D. 1325-1450	Period 4 A.D. 1450-1575	Period 5 A.D. 1575-1700	Period 6 Post A.D. 1700	Total
	Count (Row %) (Column %)						
Unknown	71 (1.6) (29.7)	913 (20.6) (31.0)	1,454 (32.8) (30.6)	897 (20.2) (35.0)	701 (15.8) (28.4)	395 (8.9) (38.7)	4,431
Plain	45 (1.2) (18.8)	567 (15.3) (19.3)	1,416 (38.1) (29.8)	753 (20.3) (29.4)	677 (18.2) (27.5)	257 (6.9) (25.2)	3,715
Corrugated	117 (3.2) (49.0)	1,364 (37.7) (46.4)	1,424 (39.4) (30.0)	339 (9.4) (13.2)	285 (7.9) (11.6)	88 (2.4) (8.6)	3,617
Striated	6 (0.3) (2.5)	98 (4.4) (3.3)	456 (20.6) (9.6)	572 (25.8) (22.3)	803 (36.2) (32.6)	281 (12.7) (27.5)	2,216
Total	239	2,942	4,750	2,561	2,466	1,021	13,979

Chi-square=2181.096 (p value=.000, df=15).

Note: Frequencies of sherds in this table have been weighted by the probability of occupation at each site for each time period. This ensures that individual sherds are counted in only one time period, allowing for independence between cells in the table.

Periods 1 (A.D. 1075-1200) and 2 (A.D. 1200-1325) are dominated by corrugated ware, while in Period 3 (A.D. 1325-1450), plain and corrugated ceramics, along with unknown types, each make up a third of the assemblage. The trajectory of Plain Gray utility ware peaks in Period 3, although it is possible that some of these plain sherds may be small pieces of corrugated or striated vessels without distinguishing attributes. Unknown utility ware—usually sherds too small to be classified accurately—likewise peaks in Period 3. By Period 4 (A.D. 1450-1575), plain varieties account for most of the identifiable assemblage—an unexpected finding, given that striated ware is thought to be the dominant utility ware type by A.D. 1500. Perhaps striated ceramics do not come into vogue at A.D. 1500, but appear slightly later in the sequence, or possibly they do appear around A.D. 1500, but the transition is more gradual. As expected, striated ceramics make up the largest proportion of the total utility ware assemblage in Period 5 (A.D. 1575-1700).

Ceramic Ware by Site Type

One goal of this chapter is to evaluate whether differences in assemblage composition are

apparent between each of the three site types defined by the project typology: habitation, seasonal, and special-use. Based on the descriptions by Head (Chapter 5), sites defined as habitations are thought to be full-time residences with long occupations where a variety of domestic activities took place. At habitation sites, we expect to find a wide range of ceramic wares represented in large quantities. Given expectations concerning aggregation and increased trade (Head 1997a), we also expect to find the most trade ware ceramics at habitation sites.

Sites defined as seasonal are hypothesized to have been the locations of more limited activities by small groups of people, including sites that were part-time residences, field houses, or served other agriculture-related functions. Because seasonal sites are thought to have shorter durations of use and were the locations of fewer activities, we expect to find a more limited array of ceramic wares than at habitation sites. Trade ware is not expected to occur at seasonal sites.

Finally, sites defined as special-use are considered to have been the locations of small scale resource procurement or processing (Head, Chapter 5). Used only briefly, perhaps only on a single occasion, special-use sites are expected to contain a very limited range of ceramic wares. Trade ware ceramics should be absent.

Differences in site types were first explored through examination of ceramic wares found at each of the three site types (Table 8.9; Figure 8.10). The analysis began by testing the null hypothesis that there are no significant associations between site type and ceramic ware type. A chi-square test led to rejection of the null hypothesis, instead revealing significant associations between ceramic ware and site type (Table 8.9). Contributing to this pattern, Rio Grande Gray Ware was found to be the predominant ware at all three site types, which was unexpected given the differences in the site types posited above. Only at habitation sites did utility ware sherds comprise more than half of the composite assemblage, which is expected for long-duration sites. Rio Grande Glaze Ware is the second most common ware at all three site types. Glaze ceramics represent about a third of the composite assemblages of seasonal and special-use sites, and about 23 percent of the composite assemblage of the habitation sites. White ware and plain ware make up most of the remainder of the assemblage at all three site types. The trends in wares just described for habitation sites may be seen graphically in Figure 8.11, which plots the percentages of ceramic wares present at the early pueblos.

Table 8.9. Frequencies of ceramic wares by site type.

	Site Type			
	Habitation	Seasonal	Special-Use	
Ware	Count (Row %) (Column %)			Total
Rio Grande Gray Ware	6,039 (39.9) (56.4)	4,392 (29.0) (44.0)	4,702 (31.1) (46.9)	15,133
Pajarito White Ware	1,516 (34.6) (14.2)	1,661 (37.9) (16.6)	1,210 (27.6) (12.1)	4,387
White Mountain Red Ware	15 (31.3) (0.1)	18 (37.5) (0.2)	15 (31.3) (0.2)	48

Rio Grande Glaze Ware	2,445 (27.0) (22.8)	3,152 (34.8) (31.6)	3,459 (38.2) (34.5)	9,056
Historic polychromes	35 (16.1) (0.3)	85 (39.0) (0.9)	98 (45.0) (1.0)	218
Rio Grande Plain Ware	629 (35.1) (5.9)	635 (35.40) (6.4)	530 (29.5) (5.3)	1,794
Other	24 (32.9) (0.2)	41 (56.16) (0.4)	8 (11.0) (0.1)	73
Total	10,703	9,984	10,022	30,709

Chi-square=581.340 (p value=.000, df=12).

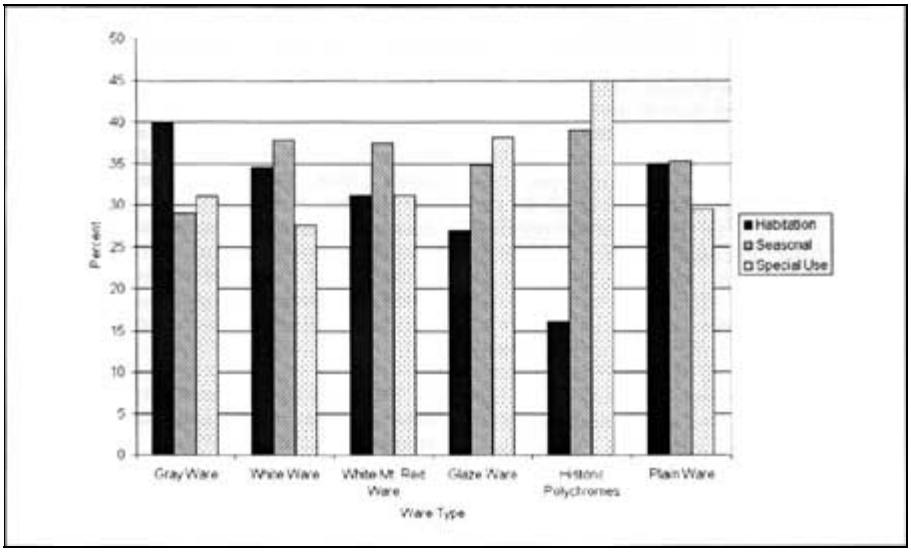


Figure 8.10. Percentages of ceramic wares by site type.

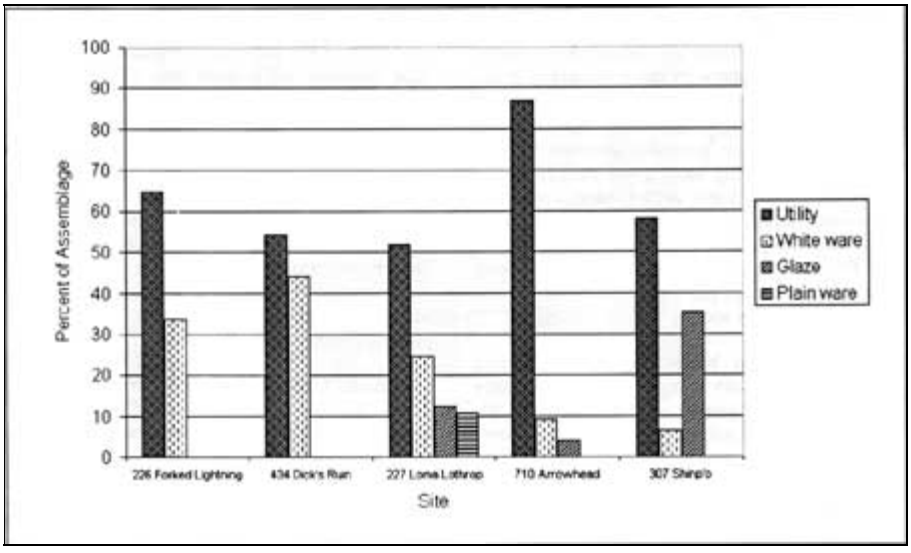


Figure 8.11. Percentages of ceramic wares recorded on the surface at the early pueblo sites.

Stronger trends are apparent in the distribution of each ware across the three site types (Table 8.9; Figure 8.10). Utility ware is most likely to be found at habitation sites. White ware and White Mountain Red Ware are more prevalent at seasonal sites. Glaze ware occurs in the highest numbers at special-use sites. Historic polychromes are most common at special-use sites and rare at habitation sites. More plain ware sherds are found at habitation and seasonal sites.

As expected, habitations are found to have a large amount of a variety of wares, reflecting many activities and a long span of use. Trade ware ceramics including White Mountain Red Ware are found at habitation sites, but contrary to expectations, they are also found in equal numbers at sites defined as seasonal and special use. Also counter to expectations, seasonal and special-use sites exhibit a variety of wares, perhaps indicating that the functions and duration of use at these sites were not as limited as expected.

Functional Analyses

In this section of the chapter, differences in site function are explored through analysis of vessel form and through evidence of how pottery was used at sites. Comparisons are made between assemblages found at the three site types. This portion of the analysis addresses whether the site types defined by the Pecos survey typology served different functions from each other, from the perspective of the ceramic evidence. Secondly, ceramic morphology is considered with regard to the Pecos chronology in order to evaluate whether ceramic functional classes and site function changed through time. Finally, drawing on both ceramic functional classes and on rim size data, vessel size is discussed, with implications for food preparation, serving, and vessel storage.

The functional classes used in this portion of the study are (1) decorated bowls, (2) decorated jars, and (3) undecorated jars. Undecorated bowls are not present in the Pecos ceramic assemblage, except in minute quantities. In the American Southwest, researchers often infer ceramic function based on vessel shape within these categories, although the relationship is not always direct. Single vessel forms were certainly used for a variety of purposes. Nevertheless, decorated bowls are generally assumed to have been used for serving food, given their relatively large and unrestricted orifice sizes, although short-term storage or mixing functions cannot be ruled out. The painted surfaces of bowls indicate that this vessel class was not used for cooking over a fire, since the paint decoration would have been obliterated by soot.

In contrast to bowls, jars have a more restricted orifice with a large volume-to-aperture ratio, as well as greater stability, making this vessel form more suitable for cooking and storage functions. For the purposes of the following analysis, undecorated jars are assumed to have been used for cooking. (The presence or absence of sooting on vessels was not a variable recorded by the survey.) This analysis also makes the assumption that decorated (painted) jars were used primarily for storage of liquid and dry goods.

Similar inferences regarding prehistoric vessel form and function have been employed in studies by Linton (1944), Henrickson and McDonald (1983), Mills (1985, 1989, 1999) and Smith (1985, 1988), based on cross-cultural ethnographic data. Bowls, as serving vessels, demonstrate the most direct relationship between ceramic morphology and use, while more variation in the relationship between form and function is present among cooking pots and storage jars (Henrickson and McDonald 1983; Mills 1985:3).

The following analyses also operate from the assumption that ceramic assemblage content is a reasonable indicator of the activities that occurred at a particular site. However, cultural formation processes, including differential breakage rates, ceramic uselife, and duration of site

occupation also condition assemblage content (Mills 1989; Schiffer 1987). For this reason, differences in the distributions of the three ceramic functional classes may not directly reflect the activities performed at the different site types. One important consideration is that sites occupied for a short time (fewer than 10 years) tend to differ greatly in assemblage content, despite having similar functions (Mills 1989). Proportions of ceramic functional types in long-duration assemblages will be more stable but may look different from short-duration assemblages at sites of similar function (Mills 1989). Despite the possible influences of these factors, this study lacks the data to control for short-duration occupations, given the nature of surface artifacts and the long ceramic type ranges present at Pecos (see Chapter 4).

Functional Classes through Time

Frequency distributions of the ceramic functional classes are expected to change through time given known changes in aggregation and in population size during the Puebloan occupation of the Pecos area. Aggregation and population size are linked to the intensification of agriculture, which we would expect to see reflected in the ceramic data. For example, with aggregation we may find increased storage capacity, as seen in greater quantities or proportions of decorated jars through time. In fact, quantities of sherds in all ceramic functional classes are expected to increase through time, as more people and agricultural intensification increased the need for cooking, serving, and storage.

Turning to the data, a rejection of the null hypothesis that there is no significant association between functional class and time is warranted by a chi-square test (Table 8.10). Contributing to this result, ceramic assemblages of all time periods are dominated by undecorated jars (Table 8.10; Figure 8.12). Undecorated jars occur in the highest numbers in Period 3 (A.D. 1325-1450), before leveling off in Periods 4 (A.D. 1450-1575) and 5 (A.D. 1575-1700). Decorated bowls are most numerous in Period 3, followed by Periods 4 and 5. The sharp increase in decorated bowls between Periods 2 (A.D. 1200-1325) and 3 is most notable. For decorated jars, the distribution increases steadily between Periods 3, 4, and 5.

Table 8.10. Frequencies of ceramic functional classes by time period.

	Decorated Bowls	Decorated Jars	Undecorated Jars	
Period	Count (Row %) (Column %)			Total
1 (A.D. 1075-1200)	124 (35.7) (1.2)	16 (4.6) (0.6)	207 (59.7) (1.7)	347
2 (A.D. 1200-1325)	1,571 (36.5) (15.4)	203 (4.7) (7.4)	2,526 (58.7) (20.6)	4,300
3 (A.D. 1325-1450)	3,699 (44.6) (36.3)	682 (8.2) (25.0)	3,919 (47.2) (31.9)	8,300
4 (A.D. 1450-1575)	2,289 (43.3) (22.4)	723 (13.7) (26.5)	2,276 (43.0) (18.5)	5,288

5 (A.D. 1575-1700)	1,770 (35.2) (17.4)	804 (16.0) (29.5)	2,460 (48.9) (20.0)	5,034
6 (post A.D. 1700)	748 (38.5) (7.3)	301 (15.5) (11.0)	892 (46.0) (7.3)	1,941
Total	10,201	2,729	12,280	2,5210

Chi-square=653.799 (p value=.000, df=10).

Note: Frequencies of sherds in this table have been weighted by the probability of occupation at each site for each time period. This ensures that individual sherds are counted in only one time period, allowing for independence between cells in the table.

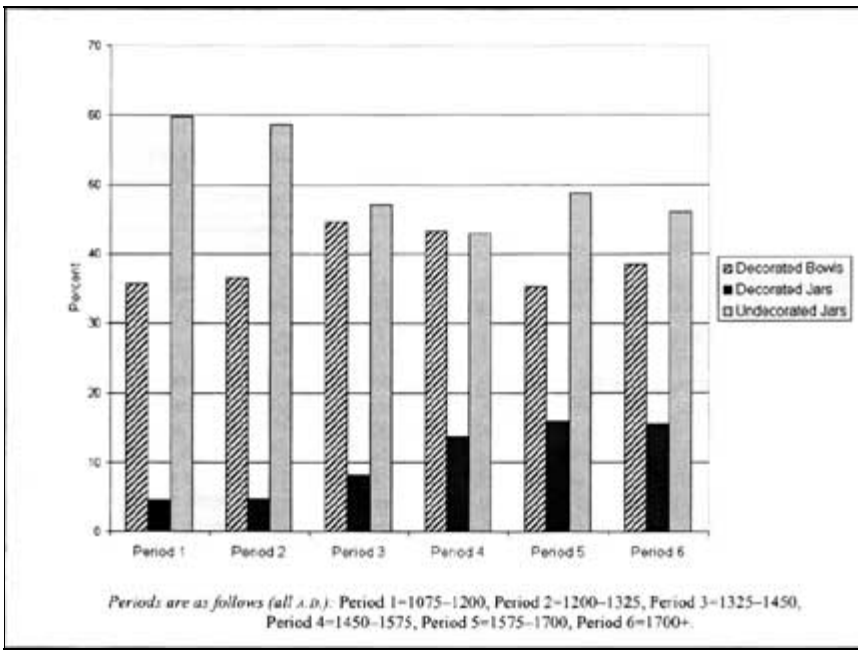


Figure 8.12. Percentages of ceramic functional classes by time period.

Looking at the proportions of the ceramic functional classes, undecorated jars approach 60 percent of the total assemblage in Periods 1 (A.D. 1075-1200) and 2 (A.D. 1200-1325), before dropping to 43-49 percent of the total assemblage in the later time periods (Figure 8.12). The proportion of decorated jars within the overall ceramic assemblage increases over time, from about 4 percent in Period 1 to 15.5 percent in Period 6 (post A.D. 1700) (Figure 8.12).

The functional interpretation for these data implies that cooking is the most vessel consumptive function overall, as seen in the numbers of undecorated jars (Table 8.10). However, serving vessels (decorated bowls) are most numerous in Period 3 (A.D. 1325-1450), followed by Periods 4 (A.D. 1450-1575) and 5 (A.D. 1575-1700). Based on quantities of decorated jar sherds alone, storage is greatest in Periods 3, 4, 5, and in particular, exhibits a dramatic increase between Periods 2 (A.D. 1200-1325) and 3. Cooking vessels (undecorated jars) are most prevalent in Period 3, although the numbers level off in Periods 4 and 5.

Revisiting the expectation that quantities of all ceramic functional classes will increase through time, we find that this holds true only for decorated jars, at least through Period 5 (A.D. 1575-1700). Increased quantities of storage vessels are in keeping with the requirements of

aggregation and the intensification of agriculture. As expected, quantities of decorated bowls (serving vessels) and undecorated jars (cooking pots) show an increase from Period 2 (A.D. 1200-1325) to 3. Contrary to expectations, the numbers of both decrease in Period 4 (A.D. 1450-1575). Quantities and proportions of decorated bowls continue to decline in Periods 5 and 6 (post A.D. 1700). Numbers of undecorated jars rise again in Period 5, before tapering off in Period 6. What these unexpected trends mean in terms of aggregation at Pecos is not certain. Sizes of vessels through time are examined later in the chapter to shed additional light on this problem.

Functional Classes by Site Type

Differences between site types were further explored through examination of the frequencies of ceramic functional classes by site type (Table 8.11; Figure 8.13). Long-duration, multiple activity habitation sites are expected to show high frequencies of all three ceramic functional classes. By contrast, limited-activity, short-duration seasonal sites should show less evidence of cooking (reflected in undecorated jars) and serving (reflected in decorated bowls). Seasonal sites, as possible field houses, may be expected to have greater quantities of decorated jars for stored provisions. Lastly, lightly used special-use sites are expected to lack decorated jars for storage.

Table 8.11. Frequencies of ceramic functional classes by site type.

	Decorated Bowls	Decorated Jars	Undecorated Jars	
Site Type	Count (Row %) (Column %)			Total
Habitation	2,816 (35.9) (27.3)	503 (6.4) (17.8)	4,525 (57.0) (35.6)	7,844
Seasonal	3,917 (42.8) (37.9)	1,332 (14.5) (47.2)	3,912 (42.7) (30.8)	9,161
Special-Use	3,602 (40.6) (34.9)	989 (11.3) (35.0)	4,281 (48.3) (33.7)	8,872
Total	10,335 (39.9)	12,718 (10.9)	25,877 (49.2)	

Chi-square=502.938 (p value=.000, df=4).

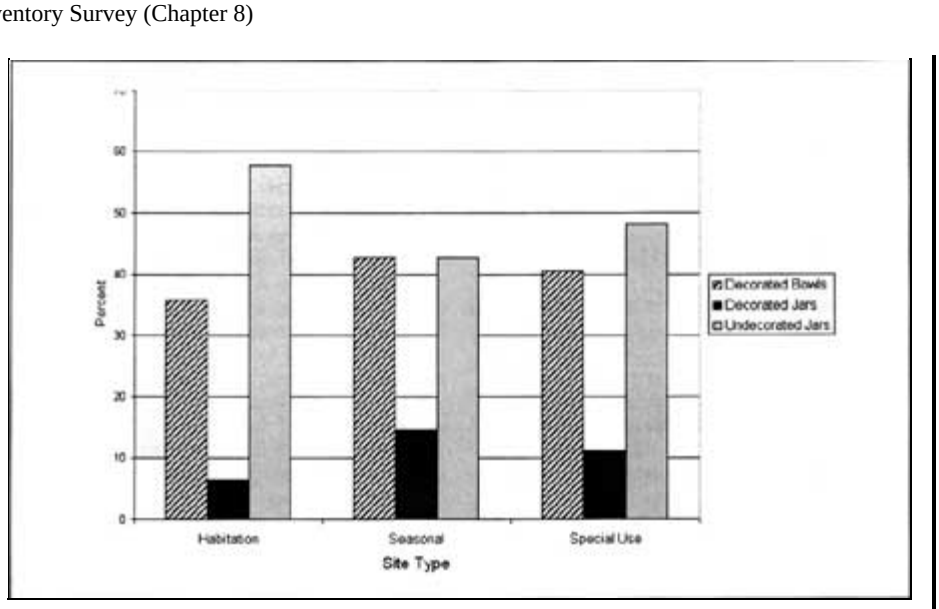


Figure 8.13. Percentages of ceramic functional classes by site type.

A chi-square test leads to the rejection of the null hypothesis that there is no statistically significant association between ceramic functional class and site type (Table 8.11). Supporting the significance of this result, the data show that as expected, undecorated jars make up the largest portion of the assemblage from habitation and special-use sites. At seasonal sites, however, undecorated jars and decorated bowls account for an equal proportion of the composite assemblage. Quite unexpectedly, decorated bowls are found in the highest numbers at seasonal sites (37.9 percent), followed by special-use (34.9 percent), and habitation sites (27.3 percent). Decorated jars are also most common at seasonal sites (47.2 percent), followed by special-use (35 percent) and habitation sites (17.8 percent). The low frequency of decorated jars (storage) at habitations is rather surprising. The distribution of undecorated jars looks different from the other two functional classes. Undecorated jars are most common at habitation sites (35.6 percent), followed by special-use (33.7 percent) and seasonal sites (30.8 percent).

Based on these data, cooking was the primary ceramic activity at habitation and special use sites. Cooking and serving were equally important at seasonal sites. In decreasing order of frequency, serving and storage appear to have been most prevalent at seasonal, special-use, then at habitation sites. While our expectations for cooking and serving were upheld for the habitations, quantities of storage vessels were unexpectedly lower at habitations than at special-use sites. Also contrary to expectations, seasonal and special-use sites exhibit relatively high frequencies of decorated serving bowls, a pattern which is inconsistent with the presumed short-term functions for these sites.

Habitation sites are generally thought to be the primary places where domestic activities such as cooking, serving, and storage occurred. However, based on the results of the ceramic functional analyses, it appears that all of these activities also took place at sites defined by this project as seasonal or special-use. It may also be that the inferred functions of each vessel class are too general to truly understand site function. Vessel forms may actually represent a compromise between several intended functions (Rice 1987), and assuming a decorated jar was only a storage container, for example, may be too simplistic. The low percentages of decorated jars, as seen in Table 8.11, may suggest that undecorated jars also served as storage containers. Other possible functions for ceramic vessels, such as resource or food processing, are largely ignored by the functional divisions used in this discussion.

However, it is also likely that the supposed limited-activity sites where these vessels are found were the locations of everyday domestic activities, including cooking, serving, and storage. In a

similar finding, Sebastian (1983) concluded that field house assemblages primarily reflect domestic activities. The lack of significant differences in the Pecos ceramic assemblages from the different site types as defined by architecture suggests that people carried ceramic vessels from their domestic inventory at habitation sites to use at other kinds of sites.

Vessel Size

Ceramic vessel size was examined using rim diameter. The categories of undecorated jars, decorated jars, and decorated bowls were maintained for this portion of the analysis in order to control for functional differences. The assumption is made that rim diameter is a useful proxy of overall vessel size for all form classes. While Mills (1999:106-107) finds a direct linear relationship between rim diameter and vessel size for bowls, she argues that vessel height is a better indicator of jar size. Despite Mills's findings, the sherd-based analysis conducted here does not have access to height data and necessarily relies on rim diameter as a measure of size for all vessel forms.

Since ceramics were certainly used as containers (Braun 1983), vessel size can provide meaningful information about the quantities of food or liquid used prehistorically. Size of vessels may provide data on storage capacity. The size of a social group who used particular vessels may also be indicated by vessel size, particularly of cooking and serving vessels (Turner and Lofgren 1966). Diet has also been linked to the size of ceramic vessels. Blinman (1986) found that larger vessel sizes were associated with a greater dependence on agricultural products. Greater emphasis on boiling as a cooking method may also be linked to increased cooking pot size (Wandsnider 1997).

Thus, larger ceramic vessels are associated with the intensification of agriculture and a greater reliance on agricultural products. According to Mills (1999), at least three interrelated factors account for this phenomenon: changes in the organization of food preparation, increases in household size, and feasting. It is difficult to sort out which of these factors is most directly linked to vessel size, and all three likely contribute to the pan-regional trend toward increased vessel sizes through time in the American Southwest (Mills 1999).

Vessel sizes at the Pecos sites were first approached through visual inspection of the rim diameter data. Histograms of orifice diameters by functional class do not support the existence of clear-cut size classes for each vessel form. A histogram of all decorated bowl diameters indicates a unimodal distribution (Figure 8.14). The histogram of undecorated jar diameters (Figure 8.15) shows peaks at 16 cm and at 28 cm. Larger undecorated jars (those 32 cm and greater) are represented in smaller frequencies (Figure 8.15), perhaps suggestive of a possible second size class to meet the cooking requirements of larger groups of people. The mode for decorated jars is 24 cm, with smaller quantities of decorated jars in the larger than 24 cm size range (Figure 8.16).



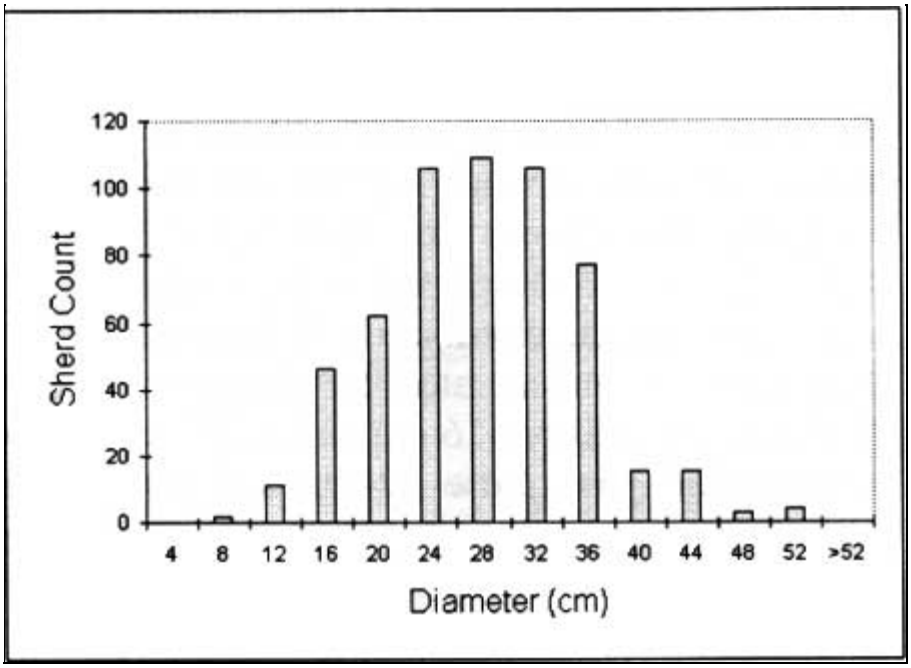


Figure 8.14. Histogram of bowl diameters.

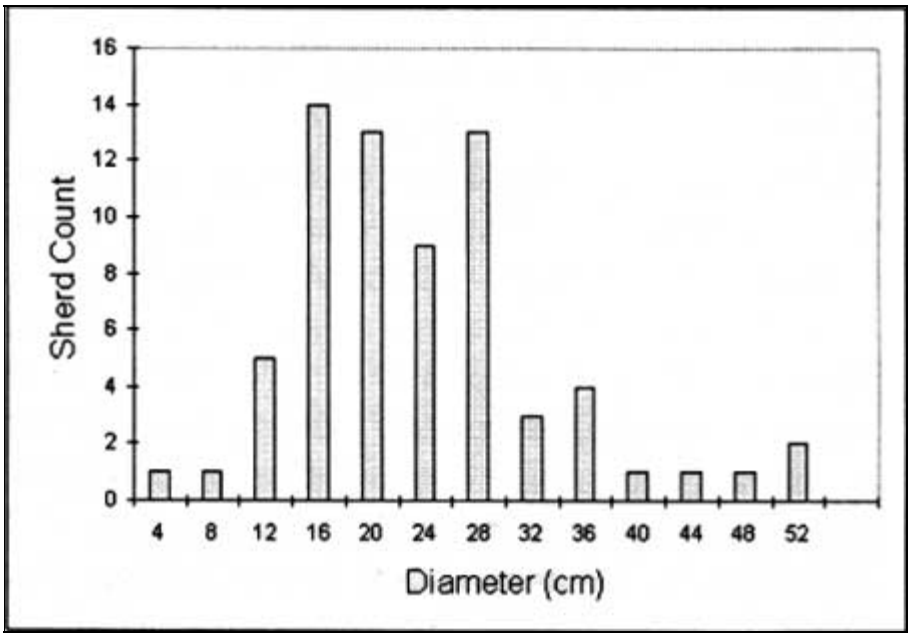


Figure 8.15. Histogram of undecorated jar diameters.

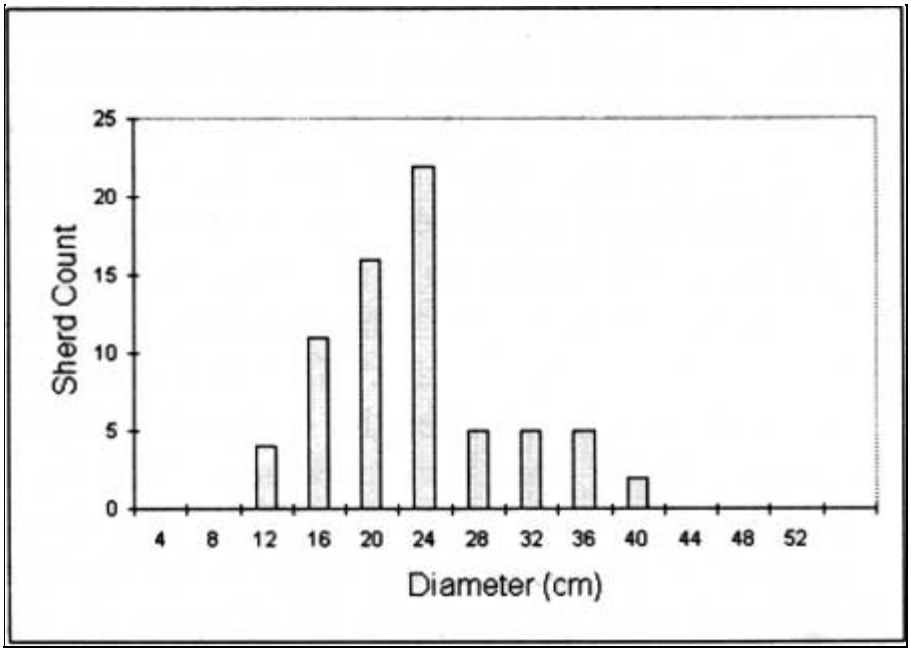


Figure 8.16. Histogram of decorated jar diameters.

Ceramic Vessel Size through Time

Vessel size at Pecos is expected to increase through time for all vessel classes, given greater aggregation through time. As population increased in the Pecos area, so did household size (Kidder 1958; Welker 1997). We expect to see larger cooking and serving vessels through time as an expression of this change in the commensal unit. Increased aggregation is also thought to be accompanied by agricultural intensification. Such intensification should be seen most clearly in greater storage capacity through time, although it may also be seen in cooking pot and serving bowl sizes.

The null hypothesis to be tested in this case is that the mean ranks of the rim diameters by ceramic functional class are not significantly different through time. Because the vessel size data were found to be nonnormal (through visual inspection and based on a Komolgorov-Smirnov test of normality) the nonparametric Kruskal-Wallis test is appropriate. The Kruskal-Wallis test essentially normalizes the data and compares observed mean ranks to expected mean ranks (Sokal and Rohlf 1981:429-432). The results reported at the bottom of Table 8.12 for each functional class do not allow us to reject the null hypothesis. Thus, the slight changes in rim diameter through time are not statistically significant.

Table 8.12. Mean vessel size in rim diameter by time period.

	Period					
Vessel Form	1 A.D. 1075-1200	2 A.D. 1200-1325	3 A.D. 1325-1450	4 A.D. 1450-1575	5 A.D. 1575-1700	6 post A.D. 1700
Bowls[a]	26.7 n=11	26.9 n=140	27.9 n=244	27.8 n=81	28.4 n=61	28.0 n=16

Decorated Jars[b]	24.0 n=2	23.8 n=19	22.2 n=24	21.9 n=12	25.0 n=10	26.2 n=2
Undecorated Jars[c]	21.9 n=1	22.0 n=15	23.8 n=27	23.7 n=9	24.4 n=7	21.9 n=3

Note: All dimensions in cm.

Note: Frequencies of sherds in this table have been weighted by the probability of occupation at each site for each time period. This ensures that individual sherds are counted in only one time period, allowing for independence between cells in the table.

Kruskal-Wallis tests:

[a]H=6.341 (p value=.274, df=5).
[b]H=5.996 (p value=.175, df=4).
[c]H=2.721 (p value=.605, df=4).

Table 8.12 and Figure 8.17 show the temporal changes in mean vessel size for each functional class. Although not a statistically meaningful finding, serving bowls do become slightly larger through time, from a 26.7 cm mean diameter in Period 2 (A.D. 1200-1325) to 28.4 cm in Period 5 (A.D. 1575-1700). Mean rim diameter of bowls drops slightly to 28 cm by Period 6 (post A.D. 1700). Unexpectedly, decorated jar size decreases during Periods 3 (A.D. 1325-1450) and 4 (A.D. 1450-1575) but then increases to 26.2 cm in Period 6. As predicted, undecorated utility jars steadily increase from 21.9 cm in Period 1 to 24.4 cm by Period 5, before decreasing in Period 6.

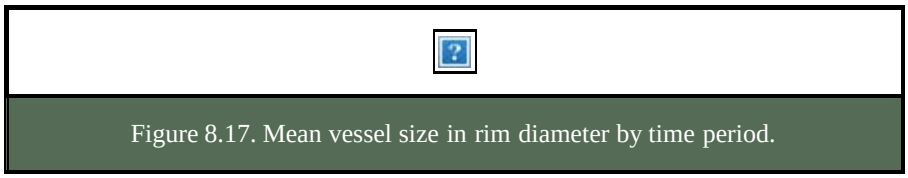


Figure 8.17. Mean vessel size in rim diameter by time period.

Although the results are not statistically significant, there is a pattern of slightly increased cooking jar and serving bowl size through time. However small, such an increase may be linked to a greater dependence on agricultural products and/or an increase in the size of the household unit. Slightly larger serving bowl sizes through time may be indicative of larger commensal units through time, although the 1.7 cm difference between Periods 2 (A.D. 1200-1325) and 5 (A.D. 1575-1700) is not great, given the long time span.

Decorated jars, likely to have been used for storage, display an unexpected decrease in size and hence storage capacity from Period 2 (A.D. 1200-1325) to Periods 3 (A.D. 1325-1450) and 4 (A.D. 1450-1575). However, a jump from 21.9 cm in Period 4 to 25 cm in Period 5 (A.D. 1575-1700) indicates a greater need for storage by A.D. 1575. There is also a continued increase in decorated jar diameter in Period 6 (post A.D. 1700), possibly indicating greater storage size.

Vessel Size by Site Type

Expectations for vessel size at the three different site types were also formulated. Vessel sizes are expected to be largest at the habitation sites, since these are primary residences and places where aggregation is most apparent. Larger decorated jars at habitations would indicate more storage. Larger undecorated jars and decorated bowls are also expected because habitation sites were the presumed locations of larger family groups and the likely places of group consumption, including possible feasting activities. Seasonal sites are expected to have smaller vessel sizes in all classes,

because they are thought to have been used by smaller groups of people. Special-use sites are expected to have the smallest vessel sizes of the three site types.

Kruskal-Wallis tests were performed for each of the ceramic functional types to test the null hypothesis that mean ranks of the rim diameters by ceramic functional class are not significantly different at different site types. None of the results (Table 8.13) allow us to reject the null hypothesis, and we must conclude that the site types do not differ statistically in vessel size.

Table 8.13 allows us to evaluate the individual expectations for size by site type. Mean vessel size in rim diameter for decorated jars is only slightly larger at habitations than at the other site types. This does indicate slightly greater storage capacity at habitations, as expected, but the statistical comparison with mean decorated jar sizes at other site types is not significant. Mean bowl size is surprisingly larger at seasonal sites by 1 cm (28.9 cm). Unexpectedly, seasonal sites equal habitation sites in undecorated jar rim diameter. The data for special-use sites match our expectations. The mean rim diameter for decorated bowls is 26 cm, 2.9 cm smaller than at seasonal sites. Decorated bowl, decorated jar, and undecorated jar rim diameter means are smallest at special-use sites, perhaps indicating slightly less serving, storage, and cooking capacity. While suggestive, these slight changes are not statistically significant, however.

Table 8.13. Mean vessel size in rim diameter by site type.

Vessel Form	Habitation	Seasonal	Special-Use
Decorated Bowls[a]	27.9 n=295	28.9 n=124	26 n=134
Decorated Jars[b]	24 n=32	23.0 n=23	21.5 n=15
Undecorated Jars[c]	23.8 n=36	23.8 n=12	22.4 n=21

Note: All dimensions in cm.

Kruskal-Wallis tests:

[a]H=9.454 (p value=.009, df=2).
[b]H=4.335 (p value=.114, df=2).
[c]H=.222 (p value=.895, df=2).

Vessel Size by Ceramic Type

A final size analysis compared the mean rim diameter of certain ceramic types (Table 8.14). This analysis divided samples by ceramic type and vessel form. Within the utility ware category, earlier Indented Blind Corrugated types (A.D. 1000-1500) were compared to later Pecos Striated vessels (A.D. 1500-1700), which were found to have a 2.8 cm larger mean rim diameter. However, a t-test of the null hypothesis that the mean rim diameters of Indented Blind Corrugated and Striated are samples of the same population required acceptance of the null hypothesis. Therefore, while striated vessels do have a larger mean rim diameter than Indented Blind Corrugated pots, this is not a statistically significant finding.

Table 8.14. Mean rim diameter by ceramic type.

Ceramic Type	Vessel Form	Mean Rim Diameter	*n*
Indented Blind Corrugated	Jar	21.9	18
Pecos Striated	Jar	24.7	2
		t-test: p=-.822, df=28, alpha=.05	
Santa Fe Black-on-white	Bowl	27.2	156
Galisteo Black-on-white	Bowl	26.7	46
Biscuit A and B	Bowl	31.3	47
Glaze I	Bowl	27.5	72
Glaze II	Bowl	28.0	13
Glaze III	Bowl	28.3	28
Glaze IV	Bowl	26.3	32
Glaze V	Bowl	31.0	77
Glaze VI	Bowl	21.6	5
		ANOVA: SS=1673.386, df=8, F=3.840, p>F=.000, alpha=.05.	

Note: All dimensions in cm.

n=rim sherds measured by the survey.

Decorated bowls, listed roughly chronologically by type in Table 8.14, were also compared by mean rim diameter. As in the previous analyses, larger vessel sizes were expected through time, given increasing aggregation, household size, and agricultural intensification. An ANOVA to test the null hypothesis that there are no significant differences between mean rim diameters of different ceramic types led to rejection of the null hypothesis. On visual examination of the data, two larger-sized ceramic types stand out: Biscuit ware bowls (A.D. 1375-1550) and Glaze V bowls (A.D. 1515-1700), both over 30 cm in mean rim diameter. The statistical results lend support to the observation that Biscuit and Glaze V mean rim diameters are larger than other ceramic types. Other white ware types and earlier glaze ware ceramics are smaller and roughly the same size as one another.

Spielmann (1998) has argued that the introduction of Glaze I Red ceramics in the Eastern Pueblos was tied to participation in a new ceremonial context involving communal feasting. She finds that larger vessel sizes for Glaze I compared to earlier black-on-white ware support this interpretation. However, based on the Pecos survey data, Glaze I bowls are not significantly larger than the earlier black-on white types (Table 8.14). They certainly represent a departure from the earlier black-on-white tradition in appearance and in ceramic technology. But in terms of size, contemporaneous Biscuit ware vessels were larger and may have been more likely to have been used in a communal context at Pecos.

The size of Glaze V ceramics also indicates a change from earlier glaze ware vessels. It is significant that large Glaze V bowls (A.D. 1515-1700) are produced locally at Pecos at a time when imported Biscuit ware was in decline. It is possible that Glaze V bowls replaced Biscuit

ware as a communal serving vessel at Pecos. Compared to the earlier glaze ware vessels, Glaze V bowl sizes may signal an increase in the size of the commensal unit after A.D. 1515, either by large households or suprahousehold groups.

The Organization of Ceramic Production

This portion of the chapter examines the organization of production of utility and white ware ceramics at the early aggregated sites preceding Pecos Pueblo. Of interest is whether the pueblos manufactured their own ceramics from locally available materials, or if there is evidence for trade. The extent of trade and regional exchange during the late Coalition and early Classic periods and what this implies about social interaction are important issues.

Pecos Pueblo has long been recognized as an important trading center, yet aside from Shepard's (1936, 1942, 1965) pioneering work on ceramic sourcing of glaze ware, little material evidence exists to document Pecos' external contacts for the early time periods. The type and intensity of the relationships the Pecos community maintained with other cultural groups is pursued through the study of the organization of ceramic production and distribution.

One influential model for the interaction of social groups in the northern Rio Grande has been put forth by Habicht-Mauche (1993, 1995), based on her work at the nearby Galisteo Basin site of Arroyo Hondo Pueblo. In her view, developing ethnic groups during the Coalition period sought to express different cultural identities through locally and stylistically diverse white ware ceramics. These goods were traded between neighboring communities as part of regularized social interaction involving general reciprocity. Habicht-Mauche argues that the dramatic shift from localized production of white ware ceramics to centralized production of Rio Grande glaze ware around A.D. 1350 was a means of integrating these competing ethnic groups within a "tribal network" of social alliances. The widespread exchange of glaze ware is thought to have functioned as a stabilizing force that united competitive ethnic factions.

Although Habicht-Mauche explains the adoption of glaze ware ceramics within the context of northern Rio Grande developments, Crown (1994, 1996) maintains that it is more appropriate to consider the shift at a pan-regional scale. According to Crown, changes in the makeup of pottery production groups at this time likely relate to the widespread appearance in the Southwest of the new polychrome ceramics, which also had symbolic meaning within an emerging religious ideology. Based on design elements (Graves and Eckert 1998) and on vessel size (Spielmann 1998), other researchers find support for Crown's interpretation. They argue that the distribution of glaze ware ceramics crosscuts ethnic boundaries and economic alliances in the northern Rio Grande and may signal participation in a wider system of shared belief and ritual.

All of these researchers view the Coalition to Classic transition as characterized by a shift to specialized production of decorated ceramics in the northern Rio Grande region. But the question remains whether this was preceded by a slow, gradual change in the organization of production, or a dramatic, rapid shift. Ceramic compositional data have the potential to provide information about the organization of ceramic production and the nature of social interaction before glaze ware ceramics were introduced to the area. Only by understanding the organization of production and distribution of the earlier utility and white ware ceramics as a baseline can we fully assess the possible meanings and impacts of the shift to specialized glaze ware technology in the fourteenth century.

Prehistoric ceramics are particularly well suited to shed light on the nature of contact between the Pecos community and external groups through time. Pottery and other goods traded between groups likely served to cement reciprocal relationships between people, perhaps with trading partners who could be relied upon in times of resource stress or environmental uncertainty (Braun and Plog 1982; Ford 1972). In addition, ceramics almost certainly functioned as

containers for the transport of foodstuffs or other goods between distant settings (Toll 1991). Building on Shepard's findings for the Rio Grande Glaze Ware, this research contributes to the knowledge of ceramic technology and the organization of ceramic production at Pecos.

Direct Evidence

The production, distribution, and consumption of ceramics are all part of the organization of ceramic production, but rarely do we find direct archeological evidence for any of these stages. No direct evidence for ceramic production is present at Pecos. Kidder's excavations noted isolated polishing stones and worked sherds, which could have been used in pottery manufacture. Concentrations of other items related to ceramic manufacture (Sullivan 1988), such as raw materials, wasters, high concentrations of tools such as scrapers, and unworked clay are absent. However, Guthe (1925:55) reports that worked, spongy animal bone fragments found at Pecos may have been used for smoothing. Kilns or other ceramic production facilities are unknown, despite test excavations to determine the function of four sites with burned and fire-cracked rock features, selected as possible candidates for kilns (Judy Reed, personal communication 1998). Limited magnetometer surveys at the park (including Korsmo 1983), have recognized pithouses but have failed to identify prehistoric pottery firing locations.

The only formal ceramic firing feature documented for the entire northern Rio Grande region is a pit kiln associated with Santa Fe Black-on-white ceramics in the Las Campanas area northwest of Santa Fe (Post and Lakatos 1995). Its location nearly 8 km (5 mi) from the nearest pueblo suggests that access to fuelwood was an important consideration for firing activities. Some surface evidence of pottery firing kilns at San Lazaro Pueblo in the Galisteo Basin has also been noted, although the potential areas have not been systematically excavated or published (Maxwell et al. 1994) (Orcutt, personal communication 1999).

It is possible that site-oriented research has overlooked other firing features in the northern Rio Grande area, although none have been located by this survey or other recent, intensive surveys (Cordell 1998; Powers and Orcutt 1999; Snead 1995). Alternately, firing regimes in the northern Rio Grande may have been more informal and less specialized than those represented by the Mesa Verde trench kilns (Blinman and Wilson 1993), creating a more indistinct archaeological pattern.

Indirect Evidence

At Pecos we are thus limited to examining indirect evidence for the organization of ceramic production. These measures primarily inform on the scale and intensity of ceramic production (Costin 1991). Indirect evidence available to us here includes the identification of possible production locations using compositional data. Compositional analysis is useful for distinguishing local and nonlocal ceramics in order to identify possible exchange networks. Petrography is widely used, often in combination with other characterization techniques. At a basic level, these methods determine variability in ceramic raw materials, which is often inferred to represent the size or extent of a potting group. In this way, compositional data may be used to infer the degree of craft specialization.

Producer specialization is defined as "an individual who gains part or all of their livelihood through participation in a specialized activity" (Costin 1991:4). Specialization implies production beyond the needs of an individual household for exchange (Costin 1991; Rice 1981, 1984; Stark 1995). Degree of specialization must be considered along a relative continuum. The concept of specialization is most meaningful when comparisons of production are employed—for example, between two different wares or a single ware through time (Costin 1991).

Standardization and Specialization

Standardization is linked to craft specialization, although Stark (1995) has demonstrated that the relationship is not always a direct one and may be influenced by many variables. Standardization (reduction of variability) is best considered as a process related to economic intensification (Rice 1996:178-179). In a basic sense, standardization may be regarded as a measure of the ratio of producers to consumers. Low standardization will generally indicate a low level of specialization, where many potters are involved in the production process. Higher standardization may signal greater specialization in a situation where fewer potters are present, thus introducing less variation into the finished products (Mills and Crown 1995; Rice 1984, 1991, 1996).

Standardization in compositional makeup or in various attributes of the finished products may be interpreted as evidence for craft specialization. Fewer potters will simply introduce less individual variation. In addition, because specialist potters spend more time at their craft, they possess greater skill in production, which in turn translates into less variation in the finished product (Costin 1991; Stark 1991). Routinized production and greater efficiency also contribute to the pattern of less variation (Arnold and Nieves 1992; Hagstrum 1985). Analysis of compositional data, gestures, morphological attributes, the production-step measure, the quality of design execution, and the frequency of misfired vessels have all been used as measures of standardization (Mills and Crown 1995). Of relevance to this study, Hagstrum (1985) analyzed brushstroke gestures apparent in the design elements of black-on-white ceramics from the northern Rio Grande. While based on a small sample (n=20), her results indicate these ceramics became more standardized by the Classic period.

The present research examines evidence for ceramic compositional standardization as an indicator of the relative size and makeup of the potting groups at the early pueblos. The organization of ceramic production may have been quite different for the utility ware and the white ware at Pecos. The overall goal is to distinguish local and nonlocal raw materials used in the manufacture of ceramics found at Pecos.

This study focused in part on utility ware, which has received regrettably little attention from Southwestern archeologists, despite being the most ubiquitous class of ceramics in most assemblages. Utilitarian ceramics are traditionally viewed as products of individual households, with each family group producing pottery to meet its own needs. Although often assumed to have been locally manufactured, utility ware in the Southwest was not always produced for household consumption. Various studies have documented evidence for the exchange of culinary ware (Crown 1981; Glowacki 1995; Shepard 1939; Stark and Heidke 1998; Van Keuren et al. 1997). As Shepard (1939:281) noted, "Assuming a large volume of trade in culinary ware is contrary to accepted ideas, but it seems less improbable when we consider that the making of indented corrugated pottery required a very high degree of skill, and consequently there may well have existed centers where potters specialized in the technique." Nearly 60 years later, Shepard's insight appears to have been overlooked by most archeologists (Cordell 1991).

The present study was designed to investigate change in Pecos utility ware and white ware through time, with respect to compositional at tributes and source of manufacture. The Upper Pecos Valley is an ideal location for this type of compositional and sourcing study, given the great geological variation in the surrounding region. At a basic level, the study was designed to demonstrate whether ceramics were produced locally or nonlocally. In addition, a distinctly different compositional signature for the sherds tentatively identified as Plains ceramics would strengthen our interpretation of these artifacts as trade items.

The early aggregated sites in the Upper Pecos Valley have been little investigated, and their sequences of occupation and relationship to one another are incompletely understood. Of interest to this research was whether the inhabitants of the early pueblos made their ceramics from locally available clays, or if there is evidence for nonlocal production of some of the pottery. This ceramic data has the potential to provide insight into the degree of social and economic

interaction that existed between the pueblos.

Ceramic Resources in the Rio Grande Region

The geological diversity of the northern Rio Grande Valley and surrounding region permits study and sourcing of ceramic raw material resources. Important geological features (Figures 1.1 and 9.1) include the Sangre de Cristo Range, a Pre-Cambrian formation that borders the eastern Pecos Valley. Glorieta Mesa, composed of Permian sediments, separates Pecos from the Galisteo Basin to the southwest. To the northeast, exposures of Pennsylvanian limestone are prevalent in the Tecolote Range (Bezy 1981). The Pecos River and Glorieta Creek are the source of secondary deposits of cobbles of granite, pegmatite, amphibole, gneiss, mica schist, quartzite, limestone, and shale, each ground as tempering materials in locally produced prehistoric ceramics (Shepard 1936). Local sands and sandstones were also used for this purpose.

In terms of locally available raw material resources for pottery-making, the shale underlying the Pecos Pueblo mesilla is a likely source for ceramic clays (Nordby 1990:15). Pockets of clay beds are also seen in arroyos cut through the sandstones, siltstones, and shales of the Sangre de Cristo formation. Below the mesilla to the northeast of Pecos Pueblo is a possible collecting and processing work site for sandstone, which was used for temper in some Pecos Pueblo utility ware ceramics (Habicht-Mauche 1988:410). Numerous small ground cupules recorded by the Pecos survey on bedrock outcrops near the Pecos Pueblo mesilla may have also been used as ceramic temper processing areas.

Further west of the Pecos Valley (Figures 1.1 and 9.1), the Jemez Mountains and the Pajarito Plateau are the source of volcanic ash and rhyolite tuff, common ceramic tempers. Basalt, another prevalent inclusion, originates within the Rio Grande rift valley. In addition, the Ortiz Mountains are composed of igneous rock, from which andesite and other feldspathic rocks originate. Lead ore for glaze paint likely came from the Cerrillos Hills and the Ortiz Mountains, although lead ore also may be found in the mountains east of Albuquerque (Shepard 1942).

Certain ceramic clays are specific to sub areas of the Rio Grande. The Pajarito Plateau is characterized by montmorillonitic clays which originate from volcanic glass. Bentonite-like clays found in the northern part of the Pajarito Plateau have been identified as the source for Biscuit ware pottery (Shepard 1936). Along the Rio Grande, sedimentary clays are common. In the immediate vicinity of Pecos Pueblo, Permian sediments contain nonrefractory clays. Shepard (1936:576; 1965) noted that such clays are red-firing, in contrast to the buff-firing Cretaceous clays of the Galisteo Basin. The major geological exposures of clays in the Galisteo Basin occur within the Dakota Sandstone, Mancos Shale, Mesa Verde, and Chinle formations, which are not present in the Pecos Valley (Blinman and Price 1998).

Goals of the Compositional Study

The compositional study was structured to answer the following questions:

1. Is there evidence for the use of nonlocal raw materials in the manufacture of ceramics found at Pecos? Can tempers or clays be matched to raw material samples collected from potential source areas in the Pecos Valley?

2. Is temper and/or paste variability in the ceramics a function of multiple production loci? (Are many compositional groups present, or few?)

3. Is there interior intrasite variation between the early pueblos in composition of the ceramics?

4. How variable are the traditionally defined white ware types? Are Santa Fe Black-on-white and Galisteo Black-on-white compositionally homogeneous or is there more variation within types

than between them?

5. Do the tentatively identified Plains ceramics have a distinctly different compositional signature, suggesting a nonlocal origin?

6. Do the pithouse ceramics match the utility ware ceramics from the later pueblos in composition, or is there evidence for manufacture in a different area?

Assumptions of Compositional Analysis

Any compositional study of ceramics requires acceptance of several assumptions. The "provenience postulate," a common archeological assumption in the analysis of compositional data, states that "identifiable...differences exist between sources of a raw material, and the analytical approach can recognize these differences" (Bishop et al. 1982:301; see also Rands and Bishop 1980:19; Rice 1987:414; Weigand et al. 1977:24). Thus, ceramic compositional data may be used to distinguish between raw material sources. A concomitant assumption of the provenience postulate is that there is less variation within a raw material source than between sources.

A significant factor that may complicate the interpretation of compositional data is that, unlike lithic artifacts, ceramics are an additive technology that may blur the "match" between raw clay sources and finished products. Potters often sift clays, add temper and water, or blend several types of clays with different properties together, all affecting the mineralogy of clays (Blackman 1992). Firing, actual use, and post depositional processes may also alter the compositional signature of pottery (Arnold et al. 1991:71; Bishop et al. 1982; Rice 1987). Clay beds within a single geological formation are often internally heterogeneous, even within a short distance. Another possibility is the depletion of clay beds used prehistorically. The weathering of clays also causes transformations to occur.

Thus, ceramic composition is affected by both natural and cultural variables. Despite these complicating factors, the provenience postulate still holds true: ceramics made in the same production areas from the same raw material sources will have a similar composition (Arnold et al. 1991; Bishop et al. 1982).

One long-standing assumption in ceramic analysis that should be applied cautiously is the "Criterion of Abundance" (Bishop et al. 1982:300-302; Rands and Bishop 1980:19-20; Rice 1987:177), which holds that the geographic vicinity with the highest occurrence of a particular ceramic type is likely the production locale for that ceramic type. The fallacy of the Criterion of Abundance principle, however, is that it assumes that most pottery was locally produced, an assumption which Shepard's work has certainly demonstrated does not always hold true.

The Sample for Compositional Analysis

The bulk of the ceramic collection for the compositional study is drawn from surface proveniences at the early pueblos (Table 8.15). Sherds were selected randomly by ware, without reference to specific ceramic type. This was done in order to sample a range of variation within each ware, rather than exclude sherds which could not be classified easily. Approximately 20 utility and 20 white ware sherds were selected for analysis from each of the early pueblos—Dick's Ruin (PECO 434), Forked Lightning (PECO 226), Loma Lothrop (PECO 227), and Arrowhead (PECO 710). A sample of 10 sherds from Black-on-White House, an early component of Pecos Pueblo (PECO 228), was also included in the analysis. In addition, five Plains sherds identified as Ocate Micaceous, found at smaller sites within the valley, were included for comparison to the Puebloan ceramics. A few utility ware sherds recovered from Gunnerson's (1968, 1969b) excavations and from Nordby and Creutz's (1993a) pithouse excavations were also included in the analysis. Table 8.15 lists the sites sampled for

compositional analysis, the number of samples submitted, and the assigned specimen numbers; Figure 8.18 displays a map of the sites sampled for the compositional study.

Table 8.15. Sites sampled for compositional analysis.

Site	No.	Specimen numbers	Collected by
Arrowhead PECO 710, LA 251	U=21	689-709	Pecos survey
Dick's Ruin PECO 434, LA 276	U=22 W=20	625-646 853-872	Pecos survey
Loma Lothrop PECO 227, LA 277	U=20 W=20	647-664, 740-741 833-852	Pecos survey
Forked Lightning PECO 226, LA 672	U=24 W=21	665-688 812-832	Pecos survey
Pecos Pueblo/Black-on-white House PECO 228, LA 625	U=29 W=10	712-742 Catalog # 15958	Pecos survey Kidder
Sewerline Site PECO 207, LA 118808	U=3	27260, 27261, 28562	Nordby
Hoagland's Haven PECO 53, LA 14154	U=1	22248	Nordby
Apache House 29Sml	U=3	29Sm1-c F16, 29Sm1-c F2a, 29Sm1-c F2b	Gunnerson
PECO 121, LA 118764	U=l	521	Pecos survey
PECO 151, LA 69296	U=1	383	Pecos survey
PECO 175, LA 118789	U=1	384	Pecos survey
PECO 200, LA 118802	U=1	380	Pecos survey
PECO 366, LA 69282	U=1	178	Pecos survey

Note: U=Utility ware, W=White ware. No white ware sherds were collected from Arrowhead due to the small surface assemblage. All sherds and thin sections are curated at Pecos National Historical Park.



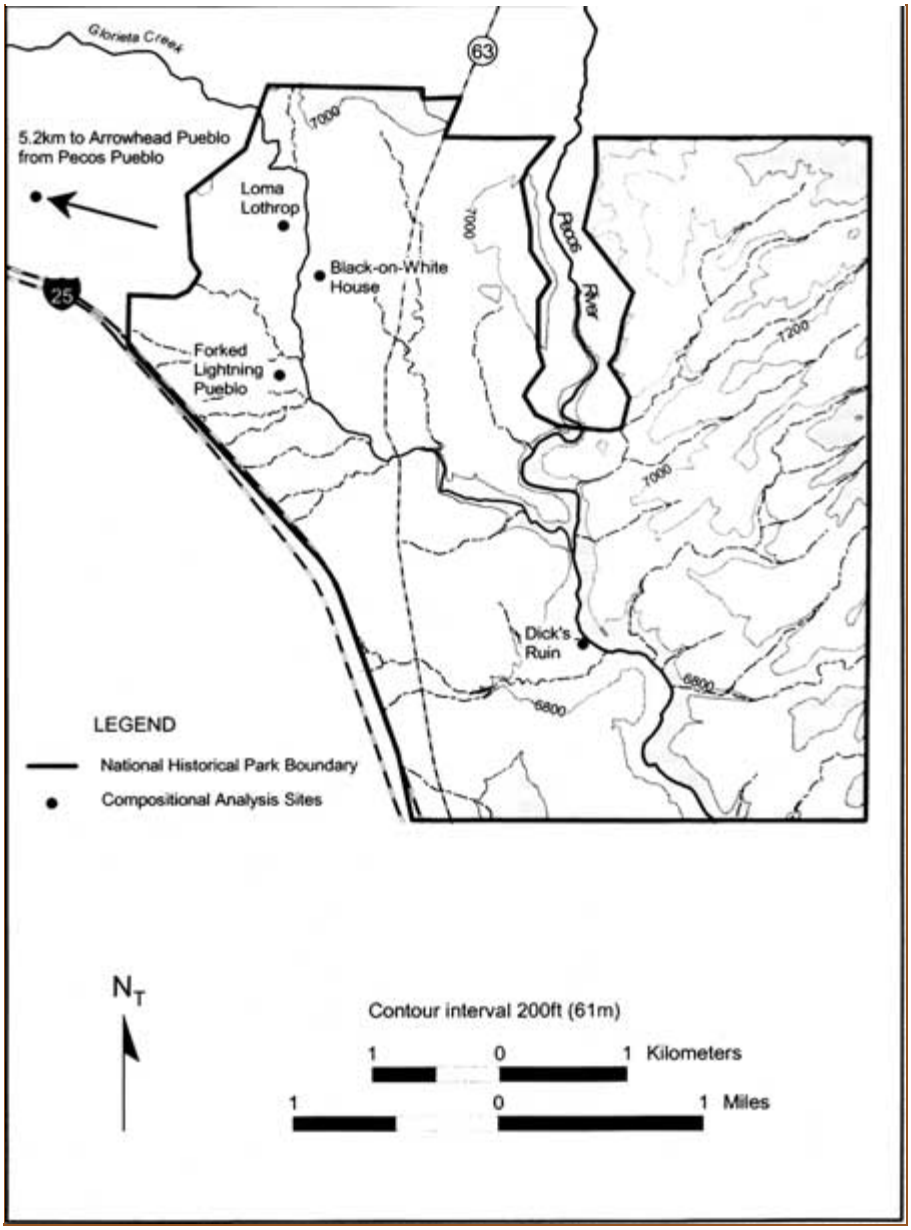


Figure 8.18. Locations of sites sampled for compositional analysis. *(click on image for an enlargement in a new window)*

Rio Grande Gray Ware

Traditionally, utility ware at Pecos is divided into a sequence of three main types, whose production spans are little understood. These poorly dated types are known as Plain Gray (A.D. 1100-1500), Indented Blind Corrugated (A.D. 1100-1500), and Pecos Striated (A.D. 1500-1700). The sequence of utility ware types found at Forked Lightning Pueblo is mirrored at Pecos Pueblo, and these types have been noted in surface assemblages for the smaller sites within the Pecos Valley.

Aside from their relative chronological ordering, little is known about utility ware at Pecos. It is not understood whether utility ware types were manufactured locally or if some utilitarian pottery was obtained in trade from other sources in the Southwest. Early on, Shepard (1936) hypothesized that the plain and corrugated types represented distinct traditions and suggested that, due to the abrupt technological change, the first corrugated ware found at Forked Lightning may have been imported to the site.

Shepard (1936:561) also found little correspondence between types of raw materials and formation methods in Pecos utility ware pottery. She noted that "while there are important differences in pastes, they are of *chronological or geographic significance* and are seldom constant in the types defined by workmanship," meaning that surface treatment is independent of paste (Shepard 1936:561, emphasis mine).

Pajarito White Ware

White ware ceramics at Pecos encompass great diversity in paste color and texture, the primary classificatory criteria. After the sherds were randomly selected, they were classified to type when possible. The types of relevance to this portion of the analysis are Santa Fe Black-on white (A.D. 1175-1350 or later), Galisteo Black on-white, and Wiyo Black-on-white (both A.D. 1300-1400). While Biscuit ware sherds are present at some of the pueblos, they were not included in the compositional study because of Shepard's (1936:490) demonstration that Biscuit ware is nonlocal to Pecos. The tuff used to temper these sherds originates from the Chama and Pajarito Plateau areas. Figure 8.19 shows the scanned images of representative black-on-white sherds submitted for compositional analysis.

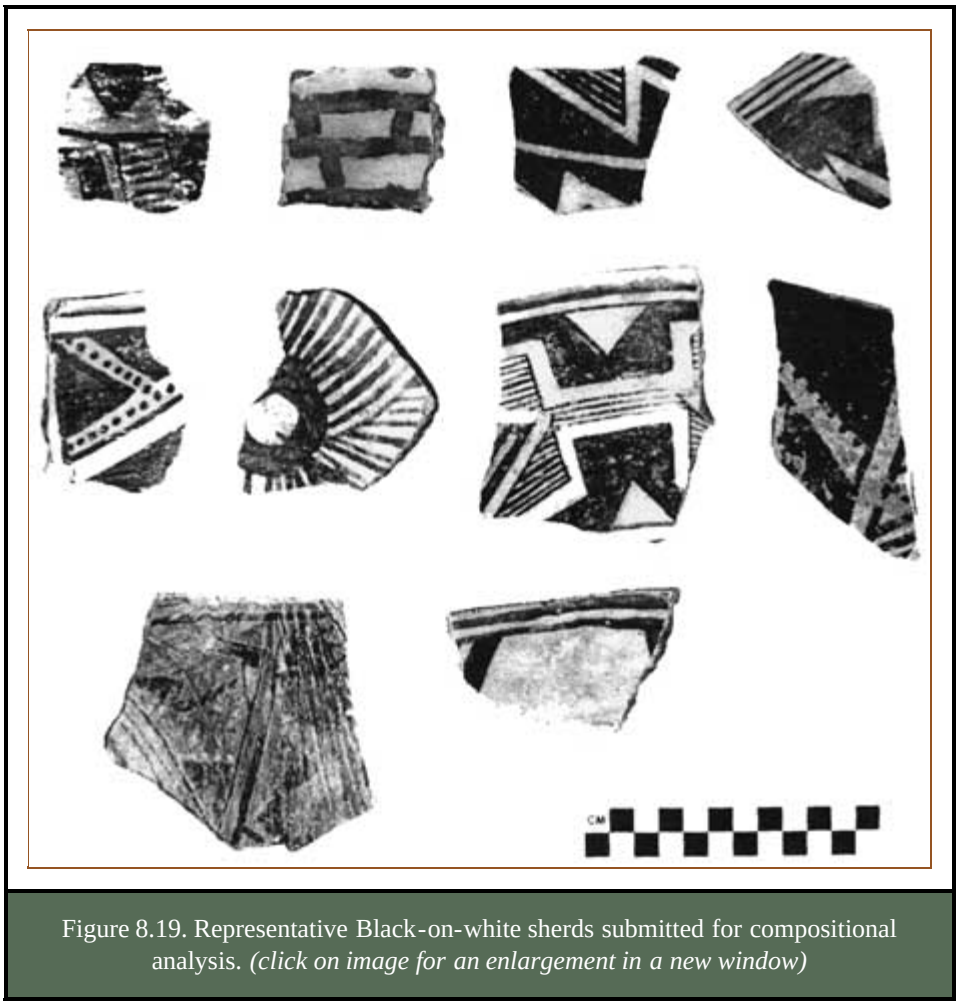


Figure 8.19. Representative Black-on-white sherds submitted for compositional analysis. *(click on image for an enlargement in a new window)*

Analytic Methods

Clay sources within the park (noted by the survey) that were potential sources of raw materials for prehistoric potters were sampled (n=10) (Figure 8.20). The clays and sherds were refired in order to examine differences in compositional makeup. Refiring small portions of sherds and the clays at a constant temperature (850 degrees Celsius) for fifteen minutes controlled for differences in original firing temperature, burned off excess soot, and allowed recognition of

broad similarities and differences in paste. The next stage of analysis involved petrographic study of sherd thin sections with a low-power stereo microscope.

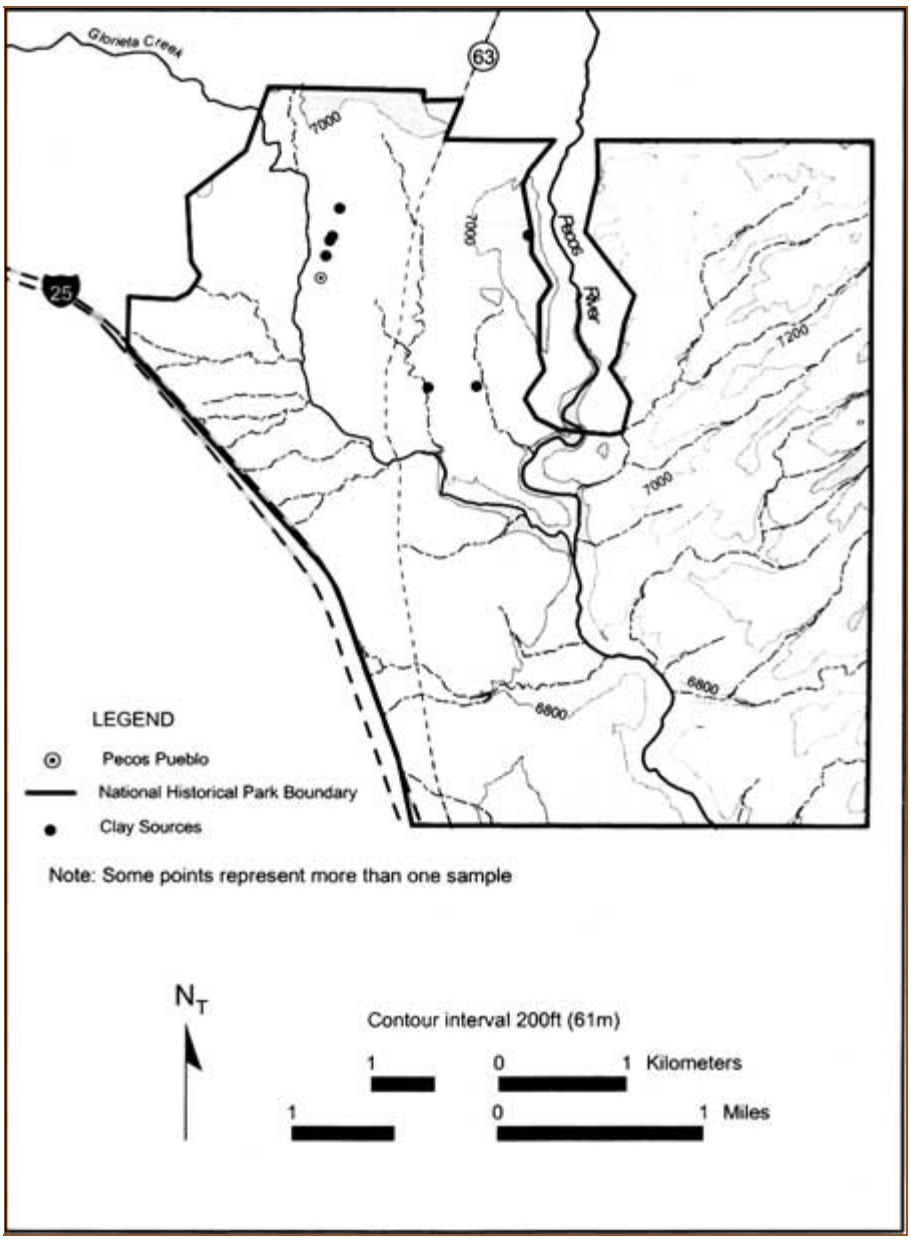


Figure 8.20. Clay sources sampled at Pecos National Historical Park. *(click on image for an enlargement in a new window)*

Results of Refiring

Munsell (1998) color values were recorded for the oxidized paste of each ceramic chip after refiring; these values were then grouped by color categories using the Munsell color name designations (Tables 8.16 and 8.17). It was immediately apparent that most of the chips refired to a light red color, with slight variation in color ranging from reddish-brown to reddish-yellow (Tables 8.16 and 8.17). Ceramic pastes that refire to a red color are indicative of clays with a high iron content (Rice 1987:343). The light red oxidized color predominates in both the utility ware and white ware samples, although the white ware sherds more often display a reddish-yellow oxidized paste. A significant finding is that 17 percent (n=12) of the white ware sherds refired to a much lighter shade (Munsell colors white, pink, and very pale brown), designated

here as "buff" colors (Table 8.17). From Shepard (1936:576), we know that Permian clays from the Pecos area are nonrefractory and typically fire to a red color, in contrast to clays from the Galisteo Basin which fire to a light color. From the oxidation data for the Pecos sherds, we may infer that at least some of the white ware ceramics are constructed from nonlocal, buff-firing clays and likely originate from a different ceramic production area. No clear patterning by ceramic type is apparent in the refired colors (each type encompasses several oxidized colors), but it may be significant that all of the "buff" firing sherds (n=12) are typed as Galisteo Black-on-white.

Looking at the refiring data by site, it appears that for the utility ware sample (Table 8.16), Dick's Ruin, Loma Lothrop, and Arrowhead each have at least one unique oxidized color value, perhaps indicating the use of a unique local clay by the potters at these sites. In contrast, the oxidized colors of utility ware sherds from Forked Lightning and Pecos Pueblo are found in the pastes from the sherds at all of the other pueblos as well. Interestingly, the utility ware sample from Gunnerson's Apache House and from the possible Plains sherds refired to the same light red color as one another, suggesting use of a similar clay source. The Pecos pithouse utility ware sample is not unique but appears to match the reddish-yellow color found in other oxidized sherds from the pueblos at Pecos, a finding which may signal continuity in resource use through time from the Developmental period to the Coalition and Classic periods. However, the overall homogeneity in refired colors for the utility ware sample does not permit the definition of exact production locations.

Table 8.16. Oxidized colors of the utility ware sherds by site.

Oxidized Color	Munsell Color Value	Forked Lightning	Dick's Ruin	Luna Lothrop	Pecos Arrowhead	Pecos Pueblo	Pecos Pithouse	Apache House	Possible Plains	Total
Reddish Brown	2.5YR 5/4	—	1	—	—	—	—	—	—	1
Red	2.5YR 5/6 2.5YR 5/8	2	2	5	3	1	—	—	—	13
Light Red	2.5YR 6/6 2.5YR 6/8	15	14	6	4	22	—	3	5	69
Yellowish Red	5YR 5/6	—	—	2	—	—	—	—	—	2
Light Reddish Brown	5YR6/4	—	—	—	1	—	—	—	—	1
Reddish Yellow	5YR6/6 5YR 7/6	7	5	7	13	6	4	—	—	42
Total		24	22	20	21	29	4	3	5	128

For the white ware ceramics (Table 8.17), the Pecos Pueblo sample shows less variation (more

standardization) in oxidized clay color, although it must be kept in mind that the sample is small. All of the sherds from Pecos Pueblo refire to either a reddish-yellow or to a light, "buff" color. As stated above, the light-firing white ware sherds may be nonlocal. In addition to Pecos Pueblo, light-firing sherds also occur at the sites of Forked Lightning and Loma Lothrop, but not at Dick's Ruin. Most of the utility ware and white ware samples refire to the same reddish hues (Table 8.16; Table 8.17), which may result from the use of the same clays to construct both wares. However, the different appearance in paste of the two wares before refiring indicates different original firing conditions, with a reducing atmosphere for the utility ware and an oxidizing atmosphere for the white ware.

Table 8.17. Oxidized colors of the white ware sherds by site.

Oxidized Color	Munsell Color Value	Forked Lightning	Dick's Ruin	Loma Lothrop	Pecos Pueblo	Total
Red	2.5YR5/6 2.5YR 5/8	1	1	1	—	3
Light Red	2.5YR 2.5YR 6/8 6/6	6	9	6	—	21
Yellowish Red	5YR 5/6	1	1	1	—	3
Light Reddish Brown	2.5YR 6/4 5YR 6/4	2	2	—	—	4
Reddish Yellow	5YR 5YR 6/8 5YR 7/6 7.5YR 7/6 6/6	7	7	8	6	8
"Buff" Colors (White, pink, very pale brown)	5YR 7/4 7.5YR 8/1 7.5YR 8/3 7.5YR 8/4 10YR 8/2 10YR 8/3	4	—	4	4	12
Total		21	20	20	10	71

The raw clays collected from the Pecos area were also fired under the same conditions as the chips from the prehistoric sherds. The clays display a wide range of variability in oxidized colors (Table 8.18), although most are some variant of red. The colors of the local clays may be a match for some of the prehistoric ceramics. Surprisingly, some of the local clays fired to a pink color, close to some of the "buff" colors, which may contradict the traditional belief that Pecos clays are only red-firing. Thus, the light-firing ceramics may not necessarily have been produced outside of the local area. Other evidence is needed to address the question of source, including petrographic data on local and nonlocal ceramic tempers, as seen later in the chapter.

Table 8.18. Oxidized colors of the clay samples from the Pecos area.

Clay	Munsell Color

Sample	Oxidized Color	Value
1	Light Brown	7.5YR 6/4
2	Red	2.5YR5/6
3	Reddish Yellow	5YR 6/6
4	Light Reddish Brown	5 YR 6/4
5	Red	2.5YR5/6
6	Light Red	2.5YR 6/6
7	Pink7.5YR 7/3	
8	Light Reddish Brown	5YR 6/4
9	Light Reddish Brown	5YR 6/4
10	Pink	7.5YR 7/4

Note: Clay samples 1-10 collected in 1998; list of clay source locations on file at Pecos National Historical Park.

Inferences derived from the oxidized colors of the ceramics must allow for the possibility that clays from different sources may refire to the same color. The iron content of clays, in particular, greatly influences the resulting oxidized colors and may obscure the patterning of clays from different production areas. The initial observations from the refiring data offered here undoubtedly are derived from somewhat subjective visual differences in ceramic paste color but serve as useful (and inexpensive) indicators of the variation that may be expected from the petrographic analysis.

Results of Petrography

A total of 209 ceramic samples, including 10 fired clays, were submitted for thin sectioning to Ray Lund, Quality Thin Sections, Tucson, Arizona. The thin sections were sent for petrographic analysis to Tammy Burns of the University of Notre Dame, Department of Civil Engineering and Geological Sciences (Burns 1999). Using a petrographic microscope, the analyst performed mineral and petrographic identification to classify the samples by temper and paste categories within each ceramic ware. One component of the temper analysis sorted the nonplastics into size groupings. In addition to mineralogical identification, analysis of the texture of the ceramic paste played a key role in sorting the samples into paste groupings.

Temper is defined here as an additive material that was used by potters to improve the workability of the raw clay and to construct vessels with desired performance characteristics. The use of temper in pottery making "counteracts shrinkage and facilitates uniform drying, thus reducing strain and lessening the risk of cracking" (Shepard 1985:25). The use of the term "temper" is confined here to those instances when material clearly appears to be added by potters, as opposed to the naturally occurring constituents of the raw clays (i.e., accessory minerals).

To account for the variation present in the samples, the final petrographic analysis produced 9 different utility ware temper groups and 16 utility ware paste groups. Likewise, 7 white ware temper groups and 8 white ware paste groups were identified. The resulting petrographic temper and paste groups of each ware are described below and defined more completely in the following tables. The individual ceramic thin section descriptions and group assignments appear in Burns (1999). The following discussion summarizes and interprets the salient findings of the technical petrographic report submitted to the National Park Service (Burns 1999).

Utility Ware Temper and Paste Categories

Tempering materials are relatively homogeneous among the utility ware samples, with most (n=93, 75.6 percent) tempered with a quartz-feldspar sand (Table 8.19; Figure 8.21). A fluvial source for the sand is indicated by weathering, grain shape, and mineralogy. Most of the other utility ware petrographic temper groups (4-9) are iterations of Utility Ware Temper Group 1 with additional minerals besides sand (Table 8.19). The slight differences in utility ware temper groups 4-9 also likely indicate variation within a fluvial source. The other petrographic utility ware temper categories include feldspars (Utility Ware Temper Group 7) and claystones (Utility Ware Temper Group 2), both of which may be found locally.

Table 8.19. Utility ware petrographic temper groups.

Group 1	The most common temper group. Although temper grain size and amount both range widely, the same minerals reiterate. Individual mineral clasts consist of subrounded to subangular quartz, plagioclase, and K-feldspar (usually microcline). Nondiagnostic polycrystalline grains are common. Identifiable rocks are weathered clasts of the parent source, often deriving from several different materials (see Group 4). Most of the larger plagioclase grains exhibit characteristic strain of the twins, suggesting a metamorphic source for at least some of the mineral clasts. Extrusive igneous material (a tuft) is present in five of the Pecos Pueblo sherds. Weathering, grain shape, rock associations, and mineralogy indicate a fluvial source.
Group 2	Laminated golden brown or brown clay and mudstones (clay/mudshales), individual mineral clasts, and granitic/metamorphic rocks. Distinctive differences in texture indicate that the mudrocks are not from the same source as the clay.
Group 3	Subhedral clasts (<=2.25mm) of sanidine, plagioclase, and quartz (nonundulose). The sanidine typically lacks weathering features. In rare cases, grains of porphyritic rhyolite lava are also present. The lava is the likely source for the phenocrysts. The near absence of the rhyolite groundmass indicates some sort of preferential sorting mechanism for the phenocrysts, whether of natural or anthropogenic means (Shepard 1936:564).
Group 4	Although a subset of Group 1, relatively abundant rock fragments may be potentially diagnostic. Granitic and metamorphic material (a phyllite or schist) are often found together in the same sherd.
Group 5	Elongated and equidimensional, subrounded to subangular calcareous marls, with lesser amounts of individual mineral clasts and rocks.
Group 6	Large mineral clasts and a few metamorphic rocks dominate, but the temper is distinguished by several unusual large (<=3mm) mineral clasts that have been completely altered to calcite/dolomite. Medium-size grains are absent.
Group 7	Large subhedral to euhedral plagioclase feldspars (<=4mm) distinguish this temper group. Large anhedral quartz and microcline are also present, as well as metamorphic rocks and nondiagnostic polycrystalline material. Smaller grain sizes are nearly absent.
Group 8	Fine to medium sand-size grains of quartz and feldspar; larger grains are present in some sherds but are not abundant. Twinning features are uncommon in the small feldspar grains.
Group 9	A mixture of individual mineral clasts and laminated claystones and siltstones. The mudrocks may be grog, although shape is rather irregular.

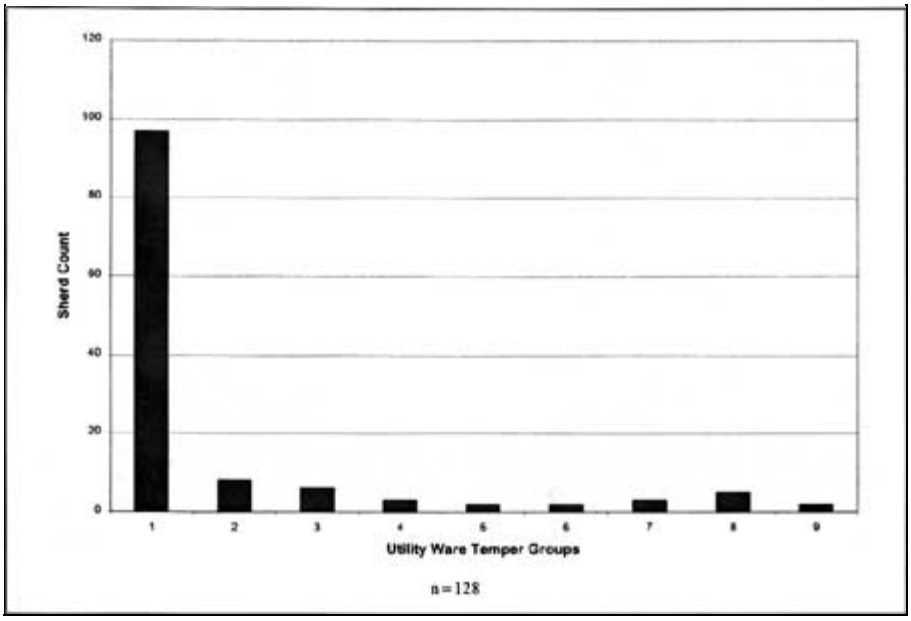


Figure 8.21. Total number of utility ware sherds per petrographic temper group.

Utility Ware Temper Groups

Of the nine utility ware temper groups identified through petrographic analysis, only Utility Ware Temper Group 3 (sanidine, plagioclase, and quartz) is mineralogically distinct. Utility Ware Temper Group 3 is of particular interest because the temper type contains sanidine, a form of alkali feldspar almost completely restricted to felsic volcanic rocks. In addition to sanidine, other materials present in Utility Ware Temper Group 3 are volcanic glass shards and euhedral, nonundulose quartz grains almost certainly derived from a felsic volcanic rock or deposit (Gary Smith, personal communication 2001). Sanidine is definitely nonlocal to the Pecos area (Burns 1999:5; Shepard 1936:563-564). The closest source to Pecos of sanidine-bearing volcanic rocks is the Cerrillos-La Cienega-Santa Fe area, but the overall mineralogy of the volcanic rocks found there does not line up with the mineralogy of the ceramics. Unlike the archeological samples, the volcanic rocks from the La Cienega and the Santa Fe area do not contain volcanic quartz or glass shards and so could not be the source area for Utility Ware Temper Group 3 (Gary Smith, personal communication 2001). These geological sources also exhibit abundant biotite and pyroxene, minerals which are not present in the ceramic samples.

Utility Ware Temper Group 3 most likely originates from the rhyolites of the Jemez Mountains and Pajarito Plateau, which do have abundant quartz, sanidine, and volcanic ash shards, and are a much closer match for the ceramic mineralogy of the prehistoric ceramics (Gary Smith, personal communication 2001). The Jemez rhyolites seldom exhibit mafic minerals, which are also notably absent in the ceramic samples. The lack of rhyolitic ground-mass rock fragments in the thin sections points to a source area near "one of the Quaternary ignimbrites (Bandelier Tuff) or alluvium derived from erosion of the ignimbrites" (Gary Smith, personal communication 2001). Thus, the mineralogy of this ceramic temper seems to fit best with a source in the southeast Jemez Mountains. Significantly, Utility Ware Temper Group 3 is found exclusively at Forked Lightning Pueblo (PECO 226) (n= 6), one of the earliest occupied pueblos in the Upper Pecos Valley.

The majority of the petrographic utility ware temper groups are not specific to any one site at Pecos (Figure 8.22), although Utility Ware Temper Group 3, just discussed, and Utility Ware Temper Group 6 are found only at Forked Lightning Pueblo (Table 8.20). Five utility ware sherds (17 percent) from Pecos Pueblo have temper from Utility Ware Temper Group 1, but also

contain an extrusive igneous material (tuff), nonlocal to the Pecos area. The pithouse, Apache, and possible Plains samples are all tempered with Utility Ware Temper Group 1, which is in distinguishable from the temper of the Puebloan samples in this group.

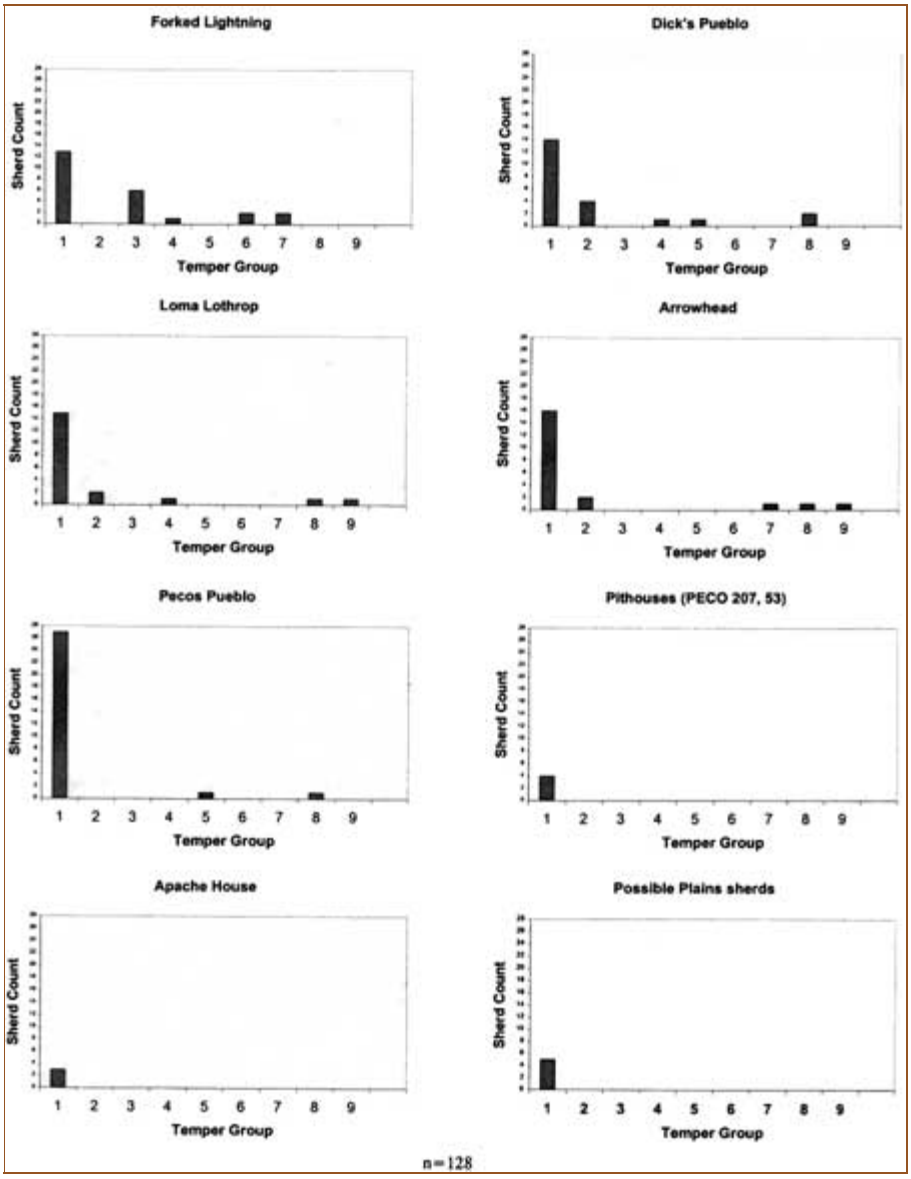


Figure 8.22. Total number of utility ware sherds per petrographic temper group. *(click on image for an enlargement in a new window)*

Table 8.20. Summary of utility ware temper groups by site.

	Temper Group									
Site	1	2	3	4	5	6	7	8	9	Total
Forked Lightning	13	—	6	1	—	2	2	—	—	24
Dick's Ruin	14	4	—	1	1	—	—	2	—	22

Loma Lothrop	15	2	—	1	—	—	—	1	1	20
Arrowhead	16	2	—	—	—	—	1	1	1	21
Pecos Pueblo	27	—	—	—	1	—	—	1	—	29
Pithouses PECO 207, PECO 53	4	—	—	—	—	—	—	—	—	4
Apache House	3	—	—	—	—	—	—	—	—	3
Possible Plains sherds	5	—	—	—	—	—	—	—	—	5
Total	97	8	6	3	2	2	3	5	2	128

Utility ware clay pastes were found to be more diverse than the utility ware tempers in mineralogy and in texture (Table 8.21; Figure 8.23). Utility Ware Paste Group C is the most common (n=36; 28 percent). Four utility ware paste groups (A, B, M, and S) are distinguished by the presence and shape of mica. In these instances, there is no indication that a micaceous wash was applied as a slip, as described by Warren (1981), for some northern Rio Grande utility ware. The accessory minerals found in Utility Ware Paste Group A, in particular, are likely derived from a nonlocal high-grade metamorphic facies (Burns 1999:6). Other utility ware paste groups are distinguished by quantities of silt and sand. It is possible that some of the differences between the utility ware paste groups are due to differences in processing the same clay, which may alter the texture and appearance. Some of the utility ware paste groups (K, L, N, and P) were created to describe individual sherds with unusual paste characteristics.

Table 8.21. Utility ware petrographic paste groups.

Group A	Very poorly to poorly sorted orange/brown micaceous clay, consisting primarily of platy biotite and white mica (muscovite or talc) mixed with silt to fine sand-size quartz, feldspars, and minor iron oxides. The accessory minerals (hornblende, anthophyllite, zircon, epidote, chlorite, and garnet) are indicative of a medium- to high-grade metamorphic source.
Group B	Very poorly sorted brown micaceous clay, consisting of acicular biotite and white mica; accessory minerals (chlorite and garnet) are uncommon.
Group C	Very poorly sorted silt/sandy brownish clay. A complete range of grain sizes is present, with abundant silt and very fine sand-size grains. The surfaces of the smaller feldspar grains appear cloudy due to weathering. Accessory minerals are ubiquitous (81% of the sherds contain amphibole, 56% contain zircon). Calcareous marls and calcite/dolomite present in several of the sherds are probably caliche in the soil. Note the cryptocrystalline nature of several of the Peco 228 (Pecos Pueblo) sherds as well as the slightly laminated appearance of most of the Peco 228 sherds.
Group D	Very poorly to moderately sorted reddish-tinged clay. Silt-size grains are less abundant and finer than Group C. Accessory minerals are very common (63% contain amphibole, 45% contain zircon).
Group E	A dark dense very poorly to moderately sorted brown or reddish-brown clay. Silt-size grains are rare and accessory minerals are relatively uncommon.
Group F	Very poorly sorted reddish, golden brown or dark brown sandy paste. Laminated golden brown or brown claystones (clayshales) are common (see Temper Group 2). Accessory minerals are relatively uncommon.
Group G	Poorly to moderately sorted silty clay in a wide variety of colors; silt-size grains are

weathered. Similar in appearance to Group C but better sorted (lacking the very-fine and fine sand-size grains—larger grain sizes are additives). Amphibole-group minerals are quite common accessory minerals (88% of the sherds). Two sherds contain volcanic ash.

Group H Very poorly to moderately sorted brownish clay with a moderately silty and/or sandy texture. Similar in appearance to Group D except 3-5% of the total volume consists of small opaques (<0.3mm). Accessory minerals are relatively common but not frequent.

Group J Well sorted, dense tan or golden brown clay marked by the presence of large (&tl;0.7mm) subhedral or anhedral black opaques, as well as claystones and large granules (<=3mm) altered to calcite/dolomite (probably natural inclusions).

Group K Well sorted, dense dark brown clay. Silt-size grains are extremely fine. Two large siltstones are probably natural inclusions.

Group L Very poorly sorted, dense, extremely silty clay. Several laminated silt or claystone inclusions are natural to the paste.

Group M Very poorly sorted mica-rich silty clay. Color ranges from tan to dark brown. Platy mica (biotite and white mica) makes up 3-10% of the total volume. Zircon and calcite/dolomite are common.

Group N Moderately sorted slightly laminated dark red clay. Very fine silt and sand make up the body of the paste. The texture, along with unusual inclusions (i.e., large elongated opaques (<l=1.5mm), and large clay and siltstones (<=3mm) (possibly grog)] characterize the paste.

Group P Very poorly sorted, dense, brown sandy paste. Very fine to medium sand-size grains make up a large proportion of the body (~35%).

Group R Poorly sorted silty/sandy clay in various shades of red or brown. Clay texture is slightly to moderately silty with typically small amounts of sand. The majority of the sherds contain at least one type of mudrock and/or sandstone (71%). Amphibole-group minerals and zircon are common accessories.

Group S Poorly sorted micaceous red clay with acicular white mica and lesser biotite comprising most of the groundmass. The shape of the mica and lack of accessory minerals characterize this group.

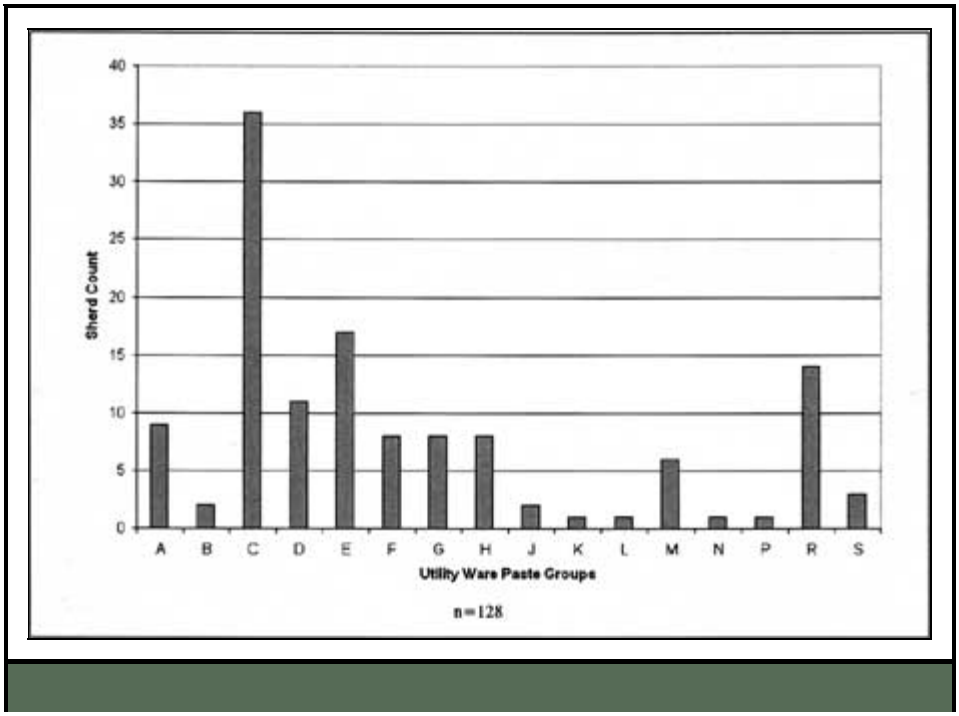


Figure 8.23. Total number of utility ware sherds per petrographic paste group.

Figure 8.24 and Table 8.22 summarize the utility ware paste groups by site. The sherds from the unique paste groups (J, K, L, N, and P) come from different sites (Table 8.22), perhaps indicating the use of nearby local resources at each site. Utility Ware Paste Groups J and K are exclusive to Forked Lightning. Utility Ware Paste Group L is exclusive to Loma Lothrop. Utility Ware Paste Group N is exclusive to Arrowhead. Utility Ware Paste Group P is found only at Pecos Pueblo. Finally, Utility Ware Paste Group B, with mica, is unique to Gunnerson's Apache House sherds.

Table 8.22. Summary of utility ware paste groups by site.

	Paste Group															
Site	A	B	C	D	E	F	G	H	J	K	L	M	N	P	R	S	Total
Forked Lightning	—	—	6	2	—	—	7	3	2	1	—	2	—	—	1	—	24
Dick's Ruin	2	—	1	4	8	4	—	1	—	—	—	—	—	—	2	—	22
Loma Lothrop	3	—	1	3	3	2		1	—	—	1	—	—	—	6	—	20
Arrowhead	1	—	4	2	4	2	1	1	—	—	—	—	1	—	5	—	21
Pecos Pueblo	—	—	24	—	2	—	—	2	—	—	—	—	—	1	—	—	29
Pithouses PECO 207, PECO 53	—	—	—	—	—	—	—	—	—	—	—	4	—	—	—	—	4
Apache House	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3
Possible Plains sherds	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3	5
Total	9	2	36	11	17	8	8	8	2	1	1	6	1	1	14	3	128

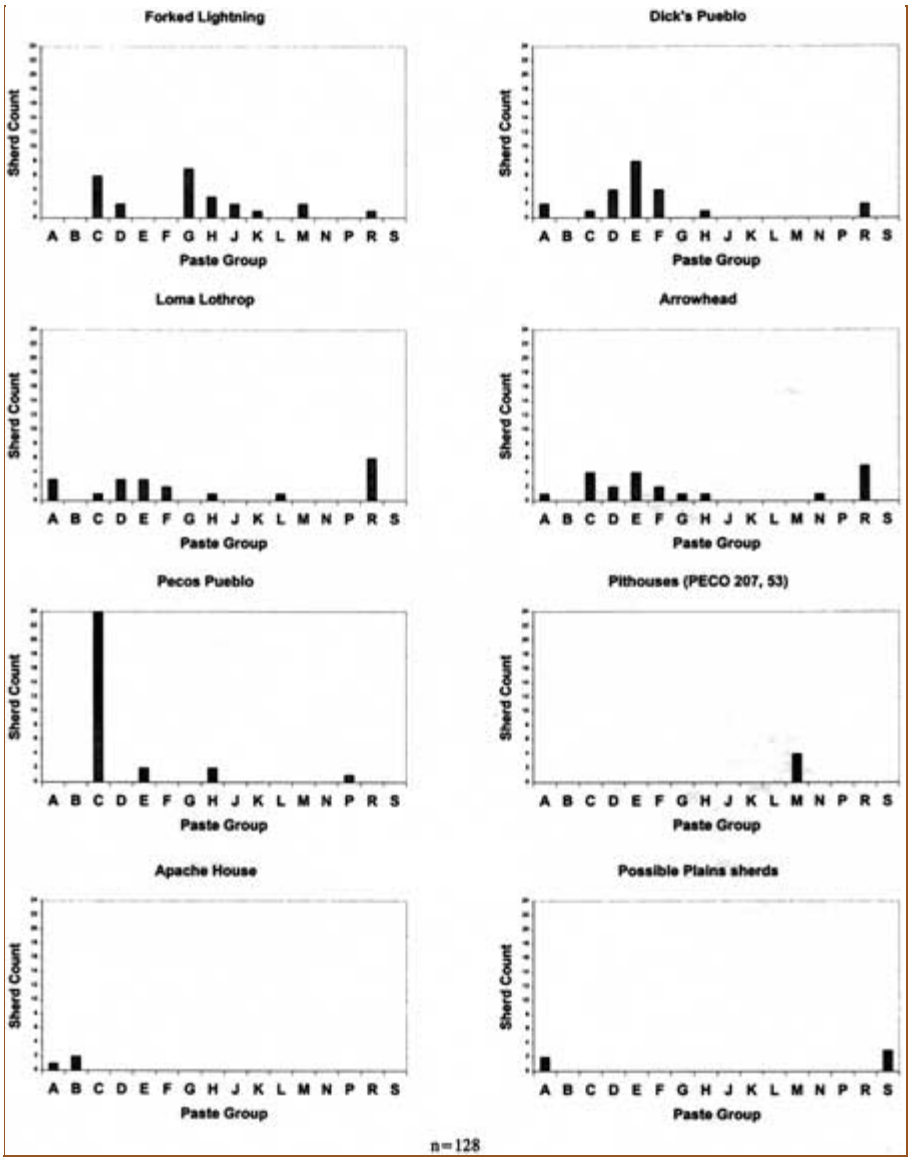


Figure 8.24. Summary of utility ware paste groups by site. *(click on image for an enlargement in a new window)*

The most common paste group, Utility Ware Paste Group C, appears at five sites (Table 8.22). The majority of the sherds from Pecos Pueblo (n=24; 83 percent) are composed of Utility Ware Paste Group C, perhaps indicating greater standardization in raw material use. In contrast, the utility ware samples from the other pueblos are spread over a greater number of paste categories, indicating greater diversity in raw material composition (Figure 8.24).

As seen in a cross-tabulation of utility ware temper and paste groups (Table 8.23), most of the utility ware temper groups are not specific to any one petrographic paste grouping, with two exceptions. The exceptions are Utility Ware Temper Group 2 (mudstones), associated with Utility Ware Paste Group F, and Utility Ware Temper Group 3 (sanidine, plagioclase, and quartz), associated with Utility Ware Paste Group G. The most common utility ware temper (Utility Ware Temper Group 1), a quartz feldspar sand, appears in association with nearly all of the utility ware paste groups (Table 8.23). The unique utility ware paste groups (J, K, L, N, and P) are also associated with unique tempers (Table 8.23).

Table 8.23. Cross-tabulation of utility ware paste and temper groups.

	Temper									
Paste	1	2	3	4	5	6	7	8	9	Total
A	7	—	—	2	—	—	—	—	—	9
B	2	—	—	—	—	—	—	—	—	2
C	32	—	—	1	—	—	1	2	—	36
D	11	—	—	—	—	—	—	—	—	11
E	13	—	—	—	1	—	—	3	—	17
F	—	8	—	—	—	—	—	—	—	8
G	2	—	6	—	1	—	—	—	—	9
H	7	—	—	—	—	1	—	—	—	8
J	—	—	—	—	—	1	—	—	—	1
K	—	—	—	—	—	—	1	—	—	1
L	—	—	—	—	—	—	—	—	1	1
M	5	—	—	—	—	—	1	—	—	6
N	—	—	—	—	—	—	—	—	1	1
P	1	—	—	—	—	—	—	—	—	1
R	14	—	—	—	—	—	—	—	—	14
S	3	—	—	—	—	—	—	—	—	3
Total	97	8	6	3	2	2	3	5	2	128

White Ware Temper and Paste Categories

As observed petrographically, the temper of the white ware ceramics is more geologically diverse than that of the utility ware. Seven white ware temper groups are represented (Table 8.24; Figure 8.25). The white ware sherds are tempered primarily with sand (White Ware Temper Groups C, E, and F; n=24; 34 percent), vitric welded tuff/consolidated ash (White Ware Temper Group B; n=11; 16 percent), or grog (White Ware Temper Group D; n=10; 14 percent). Nonlocal, rhyolitic volcanic ash characterizes one of the white ware temper categories (White Ware Temper Group A; n=7; 10 percent). Grog (crushed sherds), a common temper (White Ware Temper Group D), is itself often tempered with nonlocal volcanic material. In some cases sand appears as temper in addition to the grog. White Ware Temper Group G, a felsitic volcanic, is represented by only one example and is likely a nonlocal sherd. Surprisingly, 25 percent (n=18) of the extremely silty black-on-white sherds are not tempered at all (Figure 8.25). Warren's (1971) brief, unpublished notes from an examination of white ware sherds at Forked Lightning Pueblo also mention the presence of a variety of tempering materials as well as the silty quality of many of the black-on-white sherds.

Table 8.24. White ware petrographic temper groups.

Group A	Abundant volcanic ash of rhyolitic composition. Clasts of plagioclase, quartz, hornblende, augite, zircon, and an iron oxide are typically present. This mineralogical assemblage matches that of the microphenocrysts in the welded tuff. Small grains of welded tuff are also present in most of the sherds.

Group B Mainly vitrophyric welded tuff (consolidated ash) of rhyolitic composition. Individual sherds may contain grains of trachyte and/or fibrous devitrified lava (sometimes containing microphenocrysts or gaseous phase quartz). The following microphenocrysts are typical (in decreasing abundance): euhedral and subhedral plagioclase, quartz, hornblende, augite, biotite and/or white mica, zircon, and an iron oxide. Sanidine is present in some sherds. The ratio of quartz to plagioclase feldspar varies per sherd, and in a few sherds sanidine is more abundant than plagioclase. Due to chemical zoning, estimate of the chemical composition of the plagioclase feldspars using the Michel-Levy test was limited to a few sherds (with six or more grains measured). The results indicate the plagioclase in the sherds is of an oligoclase composition.

Group C Poorly sorted quartz and feldspars in the fine and medium sand-size range.

Group D Grog temper. Ranges from light brown to black in color (some are isotropic). The temper in the grog also varies but is either volcanic or is itself grog tempered. Associated with white ware Paste Group 2.

Group E Sand (consisting of subrounded to subangular quartz, plagioclase, and K-feldspars) and grog. The grog ranges from light brown to black in color (some are isotropic), silty/sandy (poorly sorted), and somewhat laminated.

Group F Very poorly sorted sand consisting of quartz and feldspars with a full range of grain sizes.

Group G Porphyritic felsitic volcanic, containing microphenocrysts of altered plagioclase, amphibole, and pyroxene. Both the plagioclase and the ferro-magnesian minerals are being replaced. The pyroxene and amphibole is being replaced by a specular cryptocrystalline brown or reddish-brown mineral, non-pleochroic. In dense concentrations the mineral appears opaque (possibly hematite).

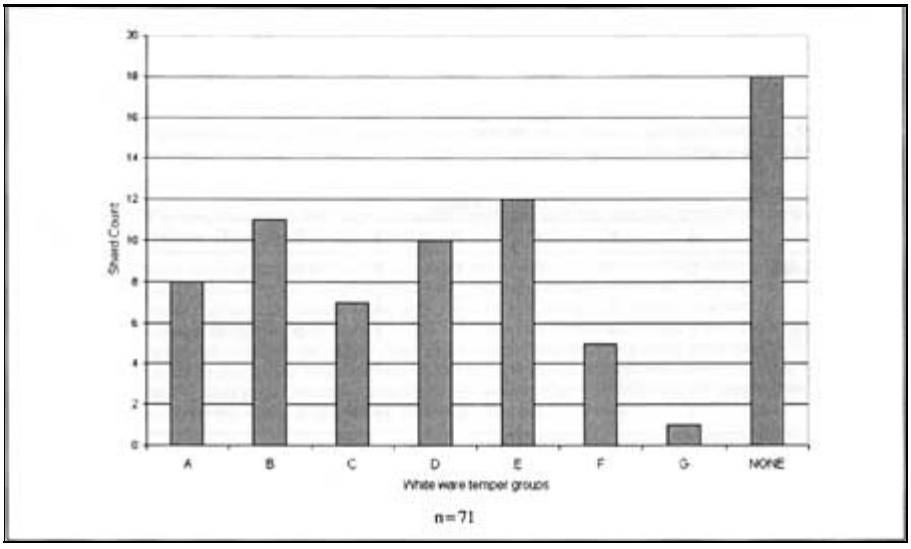


Figure 8.25. Total number of white ware sherds per petrographic temper group.

Summaries of the white ware temper groups by site (Figure 8.26; Table 8.25), show that most of the white ware temper groups are found at all of the pueblos, in relatively equal numbers, including at Pecos Pueblo. The unique White Ware Temper Group G (n=1) is found only at Loma Lothrop.

Table 8.25. Summary of white ware temper groups by site.

Site	Temper								
	A	B	C	D	E	F	G	No Temper	Total
Forked Lightning	2	2	2	2	5	2	—	6	21
Dick's Ruin	1	4	4	3	1	—	—	7	20
Loma Lothrop	2	4	1	3	3	2	1	4	20
Pecos Pueblo	2	1 (A/B)	—	2	3	1	—	1	10
Total	7	11	7	10	12	5	1	18	71

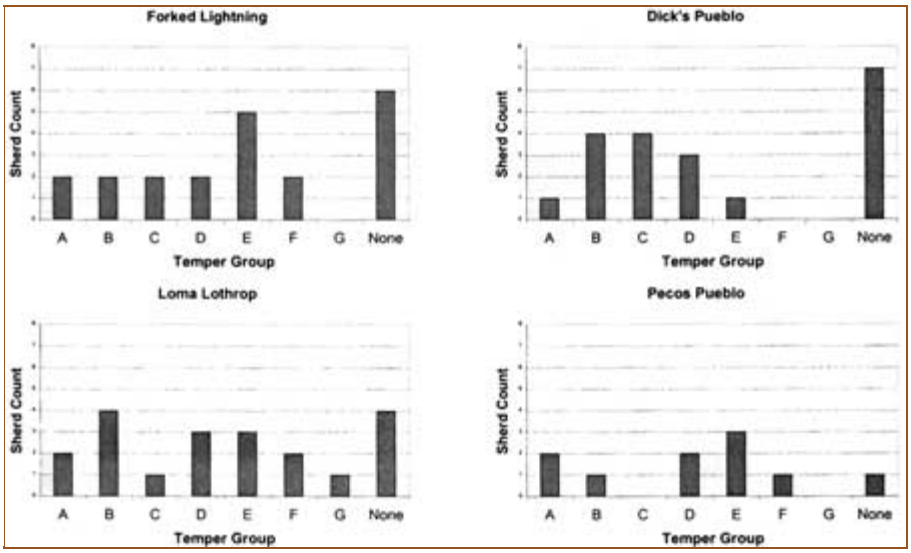


Figure 8.26. Summary of white ware temper groups by site. *(click on image for an enlargement in a new window)*

The eight white ware petrographic paste groups are more restricted in number than the utility ware paste groups (Table 8.26; Figure 8.27). Important differences in texture observed petrographically were key to distinguishing between the white ware pastes, which range from nonsilty to silty/sandy (Table 8.26). White Ware Paste Groups 1, 2, and 3 are most common, accounting for 83 percent of the overall variation in the white ware sample.

Table 8.26. White ware petrographic paste groups.

Group 1	Moderately sorted nontempered silty/sandy paste. Good tartan and albite-twinning down to silt-size; weathering of the feldspars, and the presence of small calcareous marls gives the clay a somewhat marled appearance. Three variations of this paste: (1) It may contain numerous silt or very fine sand-size rounded and elongated opaques (Group 1.1). (2) It may contain almost no opaques but a couple of percent of platy

mica (mainly biotite) (Group 1.2). (3) It contains only a minor amount of mica or opaques (Group 1.3). Other common mineral inclusions are quartz, plagioclase, and microcline. Small grains of quartz arenite with calcite/dolomite or clay cement are common inclusions. Many of the sherds contain claystones or siltstones that appear to be unkneaded clay. Accessory minerals include typically amphibole, zircon, chlorite, and a few cases of epidote and garnet. The absence of grains larger than very fine sand size suggests the paste may not contain temper. Sherds are only slightly porous.

Group 2 Moderately sorted slightly to moderately silty dense paste, with 1-2% oxides/sulfides when visible. Most of the sherds are marked by an unusual cloudy appearance that is probably the result of unfired organics in the paste. These grayish-black patches appear to be removed upon firing. This suggests that the "patches" are concentrations of organic matter that are oxidized and therefore removed by firing. The organic material makes it difficult to identify the temper. Most of the temper consists of grog (paste color ranging from light brown to black) that is itself tempered with a variety of igneous and metamorphic materials. When the grog has a black-colored paste, volumetric estimates of the amount of grog does include the opaque minerals. Accessory minerals appear to derive from the temper. Porosity is variable.

Group 3 Well sorted nonsilty dense paste. Many of the sherds contain claystones that represent the raw (untempered) clay. Tempered with abundant vitrophyric felsitic welded tuff or volcanic ash. Accessory minerals appear to derive from the temper. Nonporous. While at times superficially similar, Paste Groups 2 and 3 look quite distinct in cross-polars.

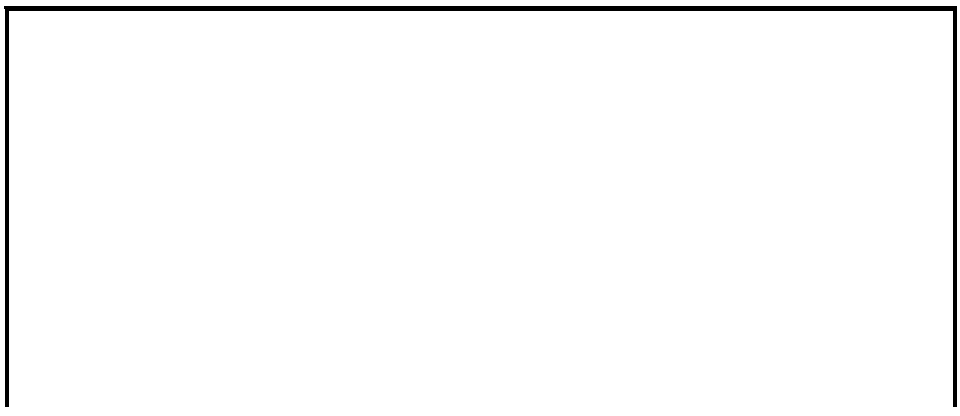
Group 4 Moderately silty paste. Contains small claystones and tiny opaques. Paste Group 1 is much more silty. Associated with fine and medium sand-size temper.

Group 5 Well sorted dense silty paste. Characteristic of this paste is abundant tiny silt-size grains of mica, opaques (rounded), and quartz/feldspars. Several sherds contain claystones (unkneaded clay). Tempered with volcanic ash or sand. Accessory minerals appear to derive from the temper. Nonporous.

Group 6 Moderately sorted dense silty golden-brown paste. The silt-size grains are unusually tiny and sand-size grains are almost absent (the largest grains are a couple of calcareous marls). Calcareous marls are quite common, as well as tiny silt-size opaques (<=0.2mm). Chlorite appears as an accessory mineral.

Group 7 Very porous slightly sandy paste. Silt-size grains are almost absent. Claystones and discrete round calcareous marls are common in this paste group. Associated with sand temper. High porosity.

Group 8 Very poorly sorted, moderately silty paste with abundant rounded and elongated opaques and tiny silt-size mica. Small (<0.2mm) round calcareous marls are present. Distinguished from Paste Groups 1.1 and 5 by having a lot less silt-size grains but greater representation in the sand sizes and distinguished from Group 4 by having more opaques and less claystones. May be derivative of Paste Group 1.1. Low porosity.



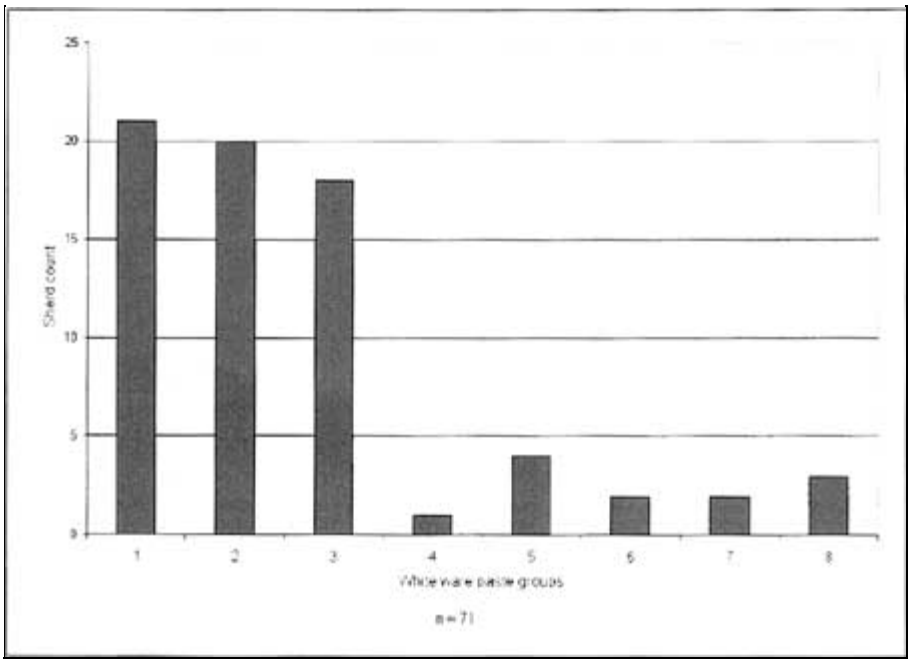


Figure 8.27. Total number of white ware sherds per petrographic paste group.

In terms of patterning among the sites (Figure 8.28; Table 8.27), White Ware Paste Group 4 is exclusive to Loma Lothrop, which again, may indicate the use of a unique local clay in the vicinity of the site. White Ware Paste Group 5 (with mica) is exclusive to Forked Lightning. White Ware Paste Groups 1-3 are distributed equally among the pueblo samples. The white ware sherds from Forked Lightning Pueblo and Loma Lothrop appear to have relatively more variability in petrographic paste composition than the samples from Dick's Ruin and Pecos Pueblo (Figure 8.28).

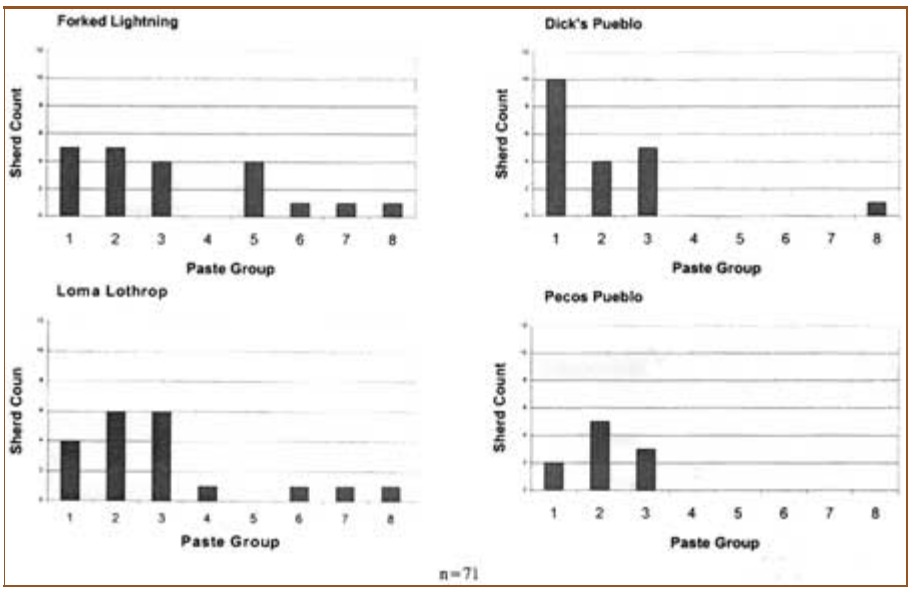


Figure 8.28. Summary of white ware paste groups by site. *(click on image for an enlargement in a new window)*

Table 8.27. Summary of white ware paste groups by site.

	Paste								
Site	1	2	3	4	5	6	7	8	Total
Forked Lightning	5	5	4	—	4	1	1	1	21
Dicks Pueblo	10	4	5	—	—	—	—	1	20
Loma Lothrop	4	6	6	1	—	1	1	1	20
Pecos Pueblo	2	5	3	—	—	—	—	—	10
Total	21	20	18	1	4	2	2	3	71

Unlike the utility ware pastes and tempers, the white ware paste groups correlate closely to the white ware temper groups (Table 8.28). For example, vitrophyric welded tuff temper (White Ware Temper Group B) is associated with a particular white ware clay (White Ware Paste Group 3; n=11). White Ware Temper Group D (n=10), grog temper, is associated with White Ware Paste Group 2. White Ware Temper Group G (n=1), a felsitic volcanic, is associated with White Ware Paste Group 6. White Ware Paste Group 4 is correlated with White Ware Temper Group F (sand). However, the most plentiful white ware paste groups (1, 2, and 3) are seen in association with several kinds of tempering materials. In addition, sherds with no added temper are found in four different paste groups, but no added temper occurs most frequently (n=15; 83 percent) with the most common white ware paste (White Ware Paste Group 1).

Table 8.28. Cross-tabulation of white ware paste and temper groups.

	Temper								
Paste	A	B	C	D	E	F	G	No Temper	Total
1	—	—	2	1	1	2	—	15	21
2	—	—	1	9	9	—	—	1	20
3	5	11	1	1	—	—	—	18	
4	—	—	—	—	—	1	—	—	1
5	2	—	—	—	1	—	—	1	4
6	—	—	—	—	—	—	1	1	2
7	—	—	1	—	—	1	—	—	2
8	—	—	2	—	1	—	—	3	
Total	7	11	7	10	12	5	1	18	71

Between the two ceramic wares, some of the white ware pastes correspond to utility ware pastes, although the utility ware ceramics are more often tempered (Table 8.29). White Ware Paste Group 5 has abundant mica, probably signaling a nonlocal product. Significantly, this paste group is similar in composition to Utility Ware Paste Group G, which contains two examples of volcanic ash temper and six examples of sanidine temper—substantially strengthening the interpretation that these two paste groups are nonlocal to the Pecos area. No definite conclusions can be drawn about the local or nonlocal origin of the other paste groups, based on the

petrographic descriptions or their associations with specific temper groups. However, these overall paste correspondences between the two wares do suggest that Pecos potters used similar clays to make some of the utility and white ware pottery.

Table 8.29. Corresponding petrographic paste groups between the utility ware and white ware ceramics.

Utility Ware Paste Group	White Ware Paste Group
Group C	Group 1.3[a]
Group F	Group 8
Group G	Group 5
Group J	Group 2
Group P	Group 7
Group R	Group 3

[a]See Table 8.26.

The Raw Clays

Petrography reveals the raw clay samples (formed into briquettes, fired, and thin-sectioned) to be very distinct from one another, yet different from both the utility and white ware ceramic pastes (Burns 1999). The raw clay samples do not resemble the sherds in accessory minerals, which are nearly absent in the clays. Unlike the archeological samples, the raw clays exhibit iron oxides and calcareous marls—probably a derivative of caliche. Only Raw Clay Sample 5, while not a close match, has a silty paste suggestive of some of the clays in the prehistoric sherds. The mineralogical diversity of the raw ceramic clays is a reflection of the great variation within alluvial clay sources from the Upper Pecos Valley, although the clays were all collected within 2 km (1.2 mi) of one another. The raw clays were not tempered before firing, which may account for some of the observed differences between the raw clays and the prehistoric sherds. Another contributing factor may be that the raw clay sampling was not extensive enough for a closer match to be found to the prehistoric sherds. The mixing of clays by potters may also obscure the relationship between raw clays and finished pottery.

Addressing the Research Questions

Returning to the goals of the ceramic compositional study, the refiring and petrographic results can be used to address the original research questions presented earlier in the chapter (see pp. 275-276). These issues are concerned with distinguishing ceramic production areas, whether local or nonlocal (Questions 1 and 2), and quantifying the degree of compositional variation among the pueblos (Question 3). Describing the variation among ceramic types is also a primary goal (Questions 4-6).

Production Areas

A variety of compositional sources and production areas for the Pecos pottery is indicated by the great degree of variation in refired sherd colors and petrographic temper and paste groups within each ware category. This compositional variation probably reflects two things: the geological diversity of the northern Rio Grande region and the prevalence of trade in ceramic vessels.

Four of the utility and white ware petrographic temper groups contain nonlocal volcanics (including ash, welded tuff, and sanidine). These materials do not appear weathered, and likely originate from extensive rhyolitic welded tuff and ash deposits in the Jemez Mountains. Of all ceramic raw materials, temper is least likely to have been traded (Shepard 1985:337). While it is not outside the realm of possibility that temper was brought or traded to Pecos, cross-cultural ceramic studies indicate that tempering materials are seldom transported over 9 km (5.6 mi) (Arnold 1985:45-46). Thus, the volcanic tempered pottery is likely a result of trade with groups from the Pajarito Plateau, roughly 85 km (52.8 mi) west of the Pecos Valley, or from exchange with closer neighbors in the Galisteo Basin approximately 24 km (14.9 mi) west of the Pecos Valley, who in turn may have traded with Pajarito Plateau groups.

While constituting less direct evidence of a nonlocal source, the petrography shows that some of the grog in the white ware grog-tempered pottery found at the Pecos sites is itself tempered with volcanic rock. The presence of volcanic sherd-temper may suggest that the pottery was also traded from the Pajarito Plateau (Shepard 1985:383-384). Burns (1999:11) correctly points out that local Pecos potters could have preferentially selected trade ware (containing volcanics) for use as grog temper in their own products. Nonetheless, there is no evidence (i.e., the use of recognizable local clays with the addition of volcanic grog temper) to rule out the likelihood that these volcanic-grog-tempered ceramics are trade ware.

The three mica-rich paste groups (Utility Ware Paste Groups A, B, and M) are also likely from trade ware vessels, due to the absence of micaceous clay resources in the Pecos vicinity. The clays of Utility Ware Paste Group A could originate from the Picuris Mountains to the north, based on the presence of mica and medium to high-grade metamorphic accessory minerals (Burns 1998, 1999:13).

Variation among Sites

Most of the petrographically identified paste and temper groups appear in sherds from all of the pueblos. In particular, the sherds from Forked Lightning Pueblo (PECO 226), the earliest site, are petrographically similar to those found at Dick's Ruin (PECO 434), Loma Lothrop (PECO 227), and Arrowhead (PECO 710) in temper and paste composition. Interestingly, only samples from the earliest sites, the Pecos pithouse (PECO 207) and Forked Lightning Pueblo, have mica-rich sherds. For the utility ware sample, only Forked Lightning Pueblo has sanidine-tempered sherds. A few nonlocal utility sherds from Pecos Pueblo (n=5; 17 percent) have an extrusive igneous temper (tuft), not found at the other sites.

A comparison of the nonlocal and local utility and white ware ceramics—as defined by the presence or absence of nonlocal pastes or tempers—from each of the pueblos may be found in Figures 8.29 and 8.30. The plots show that for the utility ware sample, Forked Lightning Pueblo and Pecos Pueblo, the earliest and latest sites, are the only sites with ceramics containing nonlocal tempers (Figure 8.29). Utility ware sherds with nonlocal micaceous paste are found in small quantities at all of the pueblos except Pecos Pueblo. Nonlocal white ware is found at all of the pueblos sampled for analysis, with the prevalence of nonlocal white ware paste or tempers increasing through time (Figure 8.30), although the sample is admittedly small. If sherds tempered with volcanic-tempered sherds are considered trade ware (which I argue they should be), the total percentage of nonlocal white ware sampled from each site approaches approximately 50 percent of the total. In addition, the un-sampled Biscuit ware ceramics at each site must also be considered, because they are certainly nonlocal indicators of trade and would further increase this percentage.



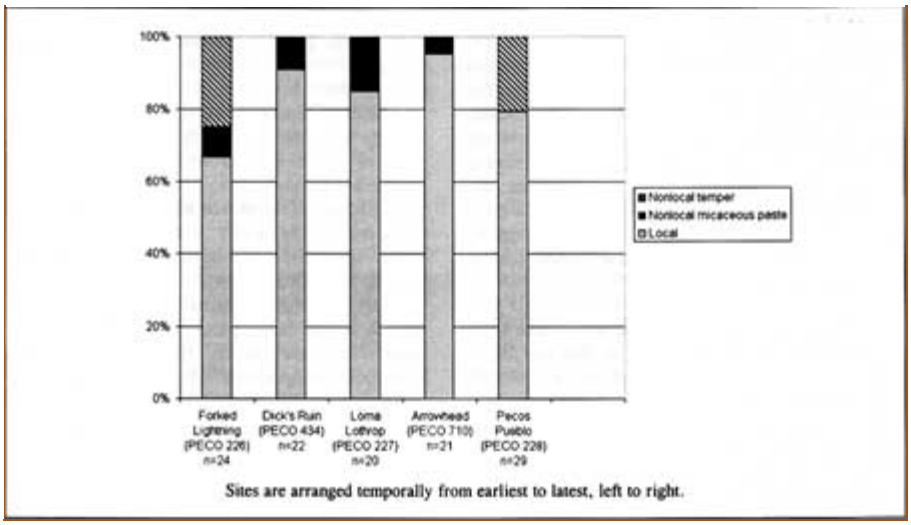


Figure 8.29. Percentages of local and nonlocal utility ware ceramics at the pueblos, based on petrographic results. *(click on image for an enlargement in a new window)*

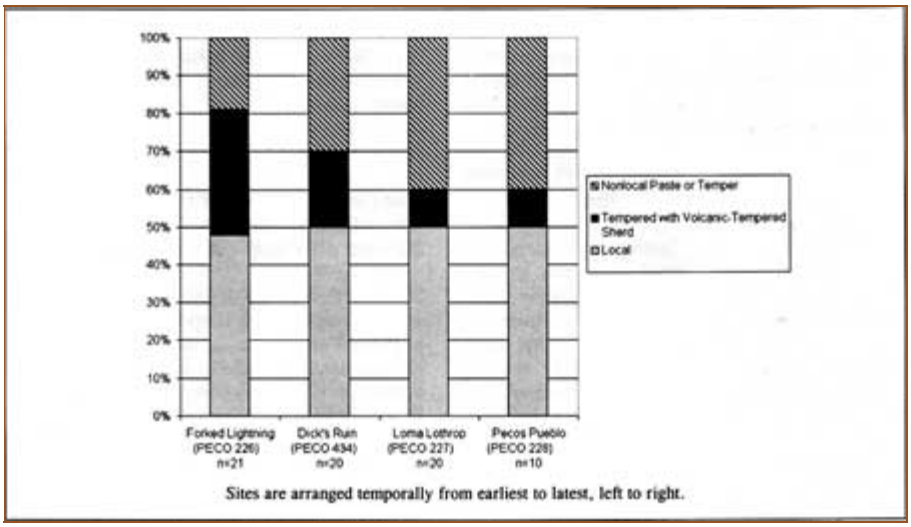


Figure 8.30. Percentages of local and nonlocal white ware ceramics at the pueblos, based on petrographic results. *(click on image for an enlargement in a new window)*

Based on these petrographic data, there is no archeological evidence to indicate that any Pecos site enjoyed preferential access to ceramic resources, whether locally produced or the result of regional exchange. Although Forked Lightning is the only pueblo site with traces of nonlocal White Mountain Red Ware, a common trade ware ceramic in the American Southwest, this could be the result of the earlier timing of the site's occupation span compared to the other pueblos. There is no indication that any one site controlled the distribution of utility or black-on-white trade ware ceramic goods coming into the Upper Pecos Valley. This pattern of almost all paste and temper groups present at all of the early pueblos in relatively equal numbers is consistent with a cooperative strategy in which trade in utility and white ware pottery was common throughout the valley.

Compared to the ceramics from the earlier pueblos, sherds sampled from Pecos Pueblo (PECO 228) exhibit less petrographic variability in temper and paste overall, especially for the utility ware sample. Only four utility ware paste groups are present at Pecos Pueblo, compared to 7-9 utility ware paste groups found at the other pueblos. Similarly, only three utility temper groups

are found at Pecos Pueblo, compared to 5-6 utility ware temper groups from samples at each of the other pueblos. The same decrease in the number of compositional groupings is true of the white ware from the Pecos Pueblo sample, although the patterning is not quite as strong and may be a product of the smaller sample size for Pecos Pueblo. Pecos Pueblo has 3 white ware paste groups and 6 white ware temper groups, while the other pueblos have between 4-8 white ware paste groups and 6-8 white ware temper groups.

Such a decrease in compositional hetero geneity from the time of the early pueblos to the time of Pecos Pueblo would be expected with increasing standardization in ceramic production. This finding of decreased variation is particularly apparent in the utility ware ceramics, which, based upon the absence of nonlocal materials, appear to be predominantly locally produced. At the early pueblos, the great variation in the number of utility ware paste groups is in keeping with very low levels of standardization in ceramic composition and low productive specialization. This is the pattern we might expect if each household produced its own utility ware pottery. However, the several examples of nonlocal utility ceramics at each pueblo indicate that at least some of the vessels were not produced there and were traded or transported to the Pecos area.

With increased aggregation at Pecos Pueblo, a decreased number of practicing potters may be responsible for the pattern of less compositional variation seen in the ceramic petrographic data from that site. This may indicate that some Pecos potters produced beyond the needs of their own household, possibly in a situation of emergent craft specialization. Greater standardization in raw materials at Pecos Pueblo is apparent for the utility ware, and to a lesser extent for the white ware. However, the amount of trade ware within the white ware sample obscures the patterning.

Nonetheless, the degree of variation in white ware and utility ware temper and paste groupings at Pecos Pueblo does signal a change in compositional standardization in the ceramics from the earlier pueblos. However, the overall level of standardization in utility and white ware ceramics certainly does not match the level of standardization reflected in the later glaze ware production process documented elsewhere (Bower et al. 1986; Kidder and Shepard 1936; Motsinger 1997; Warren 1969, 1970, 1979b). Another possible explanation for the decrease in compositional variation in the utility and white ware ceramics from Pecos Pueblo is that increasing population aggregation led to greater social cohesion and a more limited "teaching framework" among potters (Burns 1999:14; Schiffer and Skibo 1987). These observations regarding possible emergent ceramic standardization are based on a relatively small sample of sherds. Other lines of evidence such as chemical characterization and measurement data from whole vessels are needed to truly understand the organization of pottery production at Pecos.

Variation between Santa Fe Black-on-white and Galisteo Black-on-white

The two predominant white ware types included in this study, Santa Fe Black-on-white and Galisteo-Black-on-white, may be generally distinguished based on temper, in conjunction with surface treatment. Many Santa Fe Black-on-white sherds are composed of local White Ware Paste Group 1 (Table 8.26) with no temper added—probably indicating a locally-made product. Other common tempers in Santa Fe Black-on-white are volcanic ash (nonlocal) and quartz/feldspar sand (Figure 8.31). Welded tuff (of nonlocal origin) and grog (crushed sherd) are less often present as temper in the Santa Fe Black-on-white sherds.



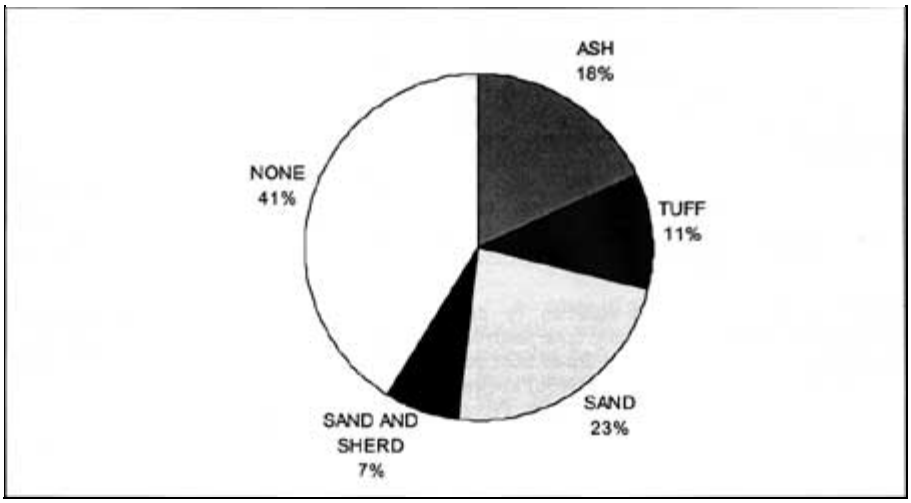


Figure 8.31. Santa Fe Black-on-white petrographic temper categories.

In contrast, Galisteo Black-on-white sherds are primarily sherd-tempered, a key classificatory criteria for defining sherds as Galisteo Black-on-white in macroscopic identification (Figure 8.32). Petrographic analysis shows that some Galisteo Black-on-white sherds also contain sand and vitrophyric welded tuff tempers. The crushed grog in the Galisteo Black-on-white sherds is itself often tempered with volcanic material.

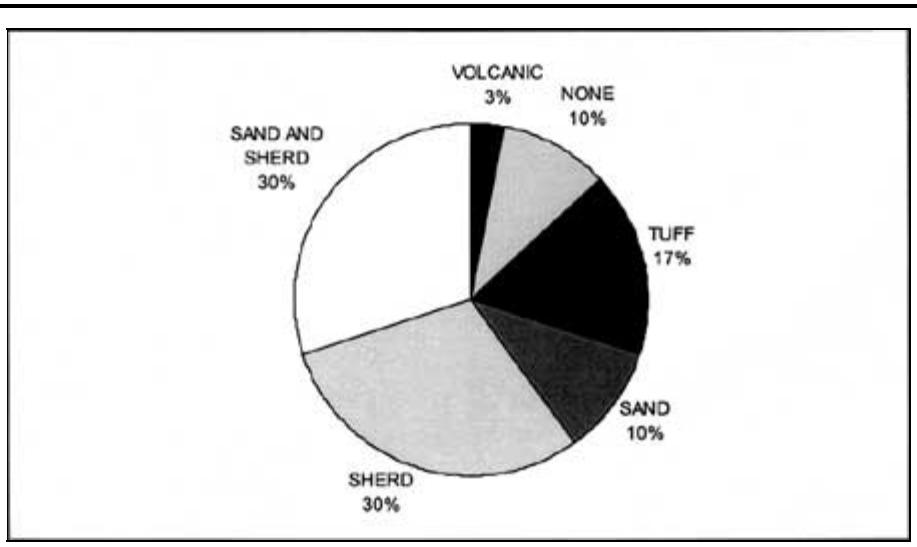


Figure 8.32. Galisteo Black-on-white petrographic temper categories.

The petrographic results demonstrate that Santa Fe Black-on-white and Galisteo Black-on-white are compositionally heterogeneous types. The two traditional types also overlap in some temper categories. Some sherds of each type are tempered with tuff and sand (Figures 8.31 and 8.32). While Galisteo Black-on-white sherds are more often sherd tempered (60 percent), a small quantity of Santa Fe Black-on-white sherds also contain crushed sherd temper (7 percent). Significantly, fine ash temper appears only in the Santa Fe Black-on-white sherds (18 percent). Finally, the majority of the Santa Fe Black-on-white sherds sampled here (41 percent) are not tempered at all, other than with naturally occur ring components of the ceramic clay. Although Galisteo Black-on-white is often particularly considered a trade ware ceramic in the northern Rio Grande (Collins 1975; Lang 1982; Shepard 1965), the petrographic data show that at least 30 percent of the sherds in the Santa Fe Black-on white sample from the Pecos sites are also of nonlocal origin.

Comparisons to Apache and Pithouse Ceramics

Five possible Plains sherds collected by the survey were submitted for petrographic analysis to evaluate whether they could be drawn from the same population as Gunnerson's (1969b) known Apache ceramics (from collections at Pecos National Historical Park), or if they are more similar to the Puebloan utility ware sherds from the early pueblos. Sherds from Gunnerson's Apache House positively identified as Ocate Micaceous contain two of the micaceous utility ware paste groups (A and B) and are tempered with sand. Utility Ware Paste Group A is a paste with platy mica, while Utility Ware Paste Group B contains an acicular mica with more biotite. Utility ware Paste Group B is specific to Gunnerson's Plains sherds.

Two of the potential Plains survey samples are classified as Utility Ware Paste Group A, indicating a close match to the known Ocate Micaceous sherds. However, sherds from Utility Ware Paste Group A are also found at Dick's Ruin, Loma Lothrop, and Arrowhead. Based on thickness, macroscopic appearance, and surface treatment, the sherds from the pueblos are indented blind corrugated and not southern Plains ceramics. That both ceramic types are constructed from similar clays may indicate an overlap in prehistoric resource procurement zones for Puebloan and southern Plains potters.

Three other tentatively identified Plains samples are classified by the petrographic analysis as Utility Ware Paste Group S, having more acicular white mica and no accessory minerals. Utility Ware Paste Group S is not found in any other of the ceramic types or at any of the other Pecos sites of Puebloan affiliation indicating a distinctly different compositional source for these sherds. This unique paste group (Utility Ware Paste Group S) would appear to support the interpretation of these items as southern Plains/Apache ceramics.

While the pithouse ceramics (n=4) also have mica inclusions, they come from Utility Ware Paste Group M, which is distinguished by distinct accessory minerals and a lesser abundance of mica. Utility Ware Paste Group M is more accurately termed "mica-rich," rather than micaceous, following Habicht-Mauche's (1988:256) caution about labeling ceramic pastes micaceous when only very small amounts of mica are present. Given the lack of known micaceous clays from the Pecos area, Utility Ware Paste Group M is likely nonlocal. Utility Ware Paste Group M is not specific to the pithouses, however. Two sherds from Forked Lightning Pueblo also fall into this category, indicating use of a similar clay resource even though the sites are separated by at least 300 years.

Conclusions

This chapter has described the Pecos survey ceramic data and evaluated how increasing aggregation, the intensification of agriculture, and changes in regional interaction in the Pecos area affected ceramic technology through time. Given known changes in settlement aggregation and population size at Pecos, accompanying changes in ceramics were also expected. Social changes often associated with aggregation, such as an increase in household size or the intensification of agriculture, may be reflected in larger vessel sizes through time or in the need for greater storage vessels. These expectations were not always matched by the Pecos ceramic data, how ever.

The functional analysis of ceramic assemblages provides slight evidence for greater reliance on agricultural products and/or an increase in the household commensal unit, as seen in increased cooking jar and serving bowl size through time. However, these modest changes in vessel size through time are not statistically significant. The exceptions are Biscuit Ware and Glaze V ceramics, which are found to be larger than other ceramic types based on rim sherd diameter. Statistically significant evidence for increased quantities of storage vessels through time likely reflects the requirements of agricultural intensification.

The site types defined by the survey (based on architectural differences) do not differ appreciably in proportions of ceramic functional classes or in vessel size. Contrary to expectations, seasonal and special-use sites exhibit a variety of wares and functional classes, indicating that the functions and duration of use at these types of sites were not as limited as expected. The analyses indicate that overall ceramic assemblage composition at Pecos did not change substantially through time. The enduring pattern of assemblage composition through time and at all site types is suggestive of a conservative technology in which ceramics served generalized functions.

Evidence for the organization of pottery production at Pecos was investigated using refiring and petrographic data for utility and white ware ceramics, focusing on the Coalition-period pueblos. The resulting diversity of compositional groupings denotes a lack of standardization in raw material use and points to the existence of many ceramic production areas, in keeping with a pattern of unspecialized household production of ceramics. The traditionally defined ceramic types were also found to contain a wide range of variability.

A variety of compositional sources for both the utility ware and white ware are indicated, reflecting both the geological diversity of the region as well as trade in ceramic vessels. Most of the ceramics were produced locally using readily available silty clays and stream sand, although no one-to-one match could be demonstrated between the prehistoric ceramics and the local clays. However, approximately half of the white ware vessels sampled from the pueblos appear to have been trade ware. A few utility ware vessels from Forked Lightning Pueblo and from Pecos Pueblo, the earliest and latest sites in the sample, are also nonlocal. For some of the ceramic vessels, the presence of nonlocal tempering materials such as tuff, sanidine, and other volcanics indicates a source of origin near the Jemez Mountains. Compared to the earlier pueblos, the Pecos Pueblo sherds exhibit more standardization in ceramic composition, signaling greater specialization in the organization of ceramic production through time.

No one pueblo site at Pecos appears to have held preferential access to local or nonlocal ceramic resources or to have controlled the distribution of ceramic goods, implying that a cooperative economic strategy was in place prior to the main episode of aggregation at Pecos Pueblo. Significantly, the role of the Pecos community as a center of commerce and trade did not arise with the development of Pecos Pueblo but appears to have been foreshadowed in the long-distance ceramic trade relationships maintained by the earliest aggregated pueblos in the valley.

<<< Previous <<< Contents>>> Next >>>

PECOS

From Folsom to Fogelson:
The Cultural Resources Inventory Survey of Pecos National Historical Park

CHAPTER NINE:
LITHICS

J. David Kilby and Joseph Vásquez Cunningham

The lithics of Pecos National Historical Park represent a largely unexploited source of information about the prehistoric inhabitants of the Upper Pecos River Valley. Few published studies have examined either flaked or ground stone from this area in any systematic fashion. While Alfred Kidder (1932) did present some descriptions of projectile points, manos, and metates, his volume focused on the rare items at Pecos Pueblo—although he suggests that he should have paid more attention to the changes in mano types (Kidder 1932:128). In her analysis of aggregation at Rowe Pueblo, Linda Cordell (1998) investigates flaked stone in regard to specific sites located by the survey and obsidian hydration. However, substantial discussions or analyses of changes through time in flaked stone or ground stone technology are not presented.

This chapter is a step toward filling the gap in our understanding of lithic use in the Upper Pecos Valley. We first present the parameters of the lithic data derived from the Pecos survey. We then attempt to address the affects of population aggregation and trade upon the organization of lithic technology using this data. We expect the affects of these processes to be particularly well reflected in patterns of lithic raw material utilization. Thus, considerable attention is given to the recognition of patterns that reflect variation in organizational strategies for the use of different flaked stone raw material classes. Though perhaps less affected by trade, changes in nonflaked lithic technology, particularly for ground stone, are expected with increasing aggregation. Changes are expected to be manifested in both ground stone tool form and intensity of use.

This chapter is divided into two main parts that address the flaked and nonflaked lithic assemblages from the Pecos survey. The flaked stone section begins with a review of available lithic raw materials followed by a general presentation of the variability in the data. Next a series of expectations are evaluated. The expectations concern changes in technological organization in regard to raw materials (including the results of an obsidian sourcing study), technology, and site types. The primary focus of the chapter is on the prehistoric and historic Puebloan occupation of the valley (A.D. 1200-1700). Earlier (Paleoindian, Archaic, and Developmental) sites were not abundant in the survey area.[1] Further, the majority of these earlier assemblages are obscured by those from later occupations that are more extensive. The data from these earlier sites are therefore not easily compared with the Puebloan data.

The structure of the nonflaked lithic section follows a pattern similar to that of the flaked stone. First, the variability in nonflaked lithic data from the survey is presented in a general summary, and then a specific artifact class, manos, is examined with regard to the affects of aggregation. This more detailed analysis is possible owing to the relatively large numbers of manos recorded during the survey. Other ground stone types were characterized by much lower frequencies and were not amenable to finer-grained analyses. In the final section of the chapter, we summarize the results from each of these subsections and draw some conclusions regarding the nature of lithic technology within the Upper Pecos Valley in general, as well as some specific affects of aggregation and trade.

The Flaked Stone Assemblage

The area of what is now Pecos National Historical Park is not unlike many other parts of the southwestern United States in that lithic raw materials are locally available but not terribly abundant nor of particularly high quality for lithic reduction.[2] Also like many other areas, sources of abundant, high quality raw material occur within a relatively short distance and often make a substantial contribution to local artifact assemblages. This geological situation, coupled with

the substantial and intensive survey data recorded for Pecos, provides an opportunity to monitor the frequency and use of local versus nonlocal raw materials through time in order to identify changes in organizational strategies and to associate these changes with known socioeconomic trends (in particular, aggregation and trade).

Regional Sources of Lithic Raw Materials

With minor exceptions, the immediate area of Pecos National Historical Park is impoverished with respect to high quality lithic raw materials. However, the park is located at the juncture of three major physiographic provinces, and each of these provinces contains sources of lithic raw materials that were exploited by the prehistoric inhabitants of Pecos (Figure 9.1). Pecos lies in the extreme southern portion of the Rocky Mountain province, with the discontinuous mountain and valley terrain of the Basin and Range to the southwest and the expansive Great Plains to the southeast. The differing histories of geologic formation and exposure processes in these provinces have led to several sources of unique, and often easily distinguished, lithic raw materials. Some lithic sources, such as those of the Jemez Mountains, may have been exploited directly in some time periods, while trade surely played an important role in the use of other, more distant, sources.

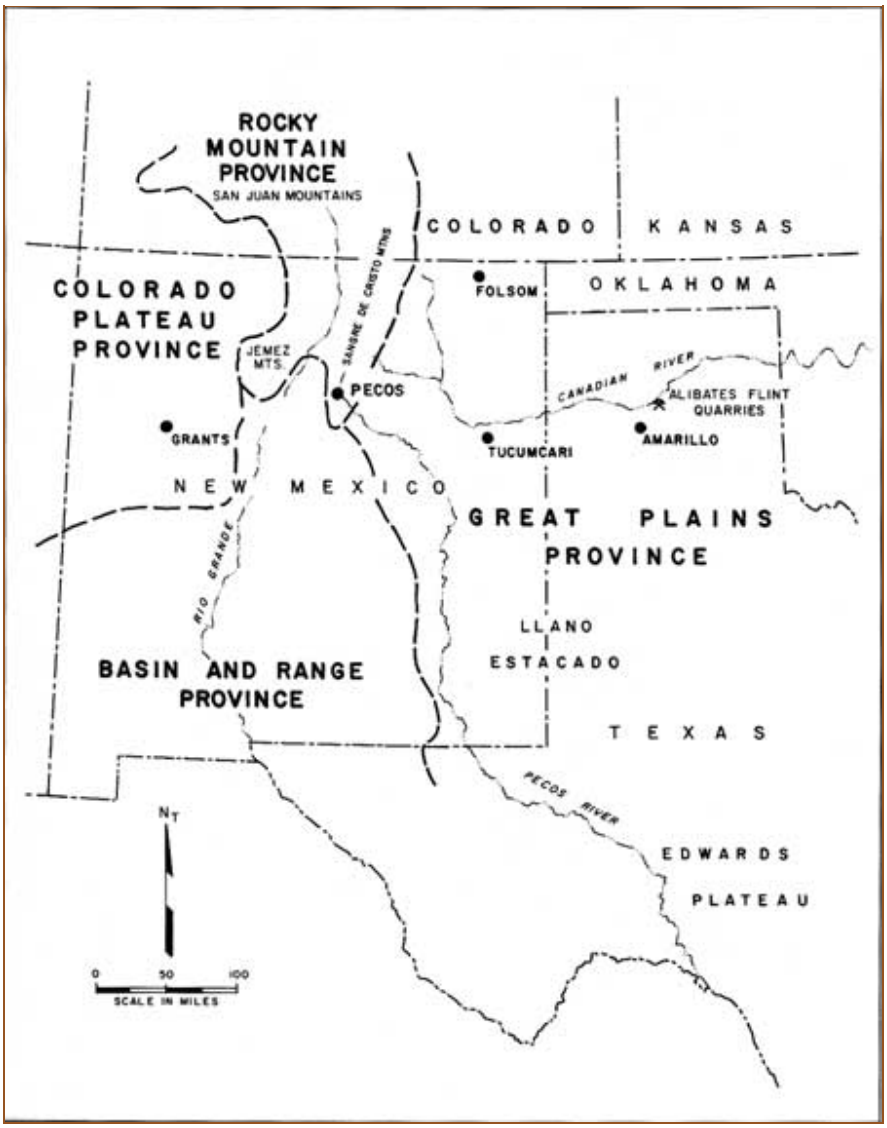


Figure 9.1. New Mexico and the Southern Plains. *(click on image for an enlargement in a new window)*

The goal of this section is to briefly review the major sources of lithic raw materials that were available, through either direct procurement or trade, to the prehistoric inhabitants of the Upper Pecos Valley. The section is organized by

physiographic province. For each province, major lithic raw material sources are described according to location of primary source (Figures 9.1 and 9.2), potential for secondary sources, physical description, and identification.

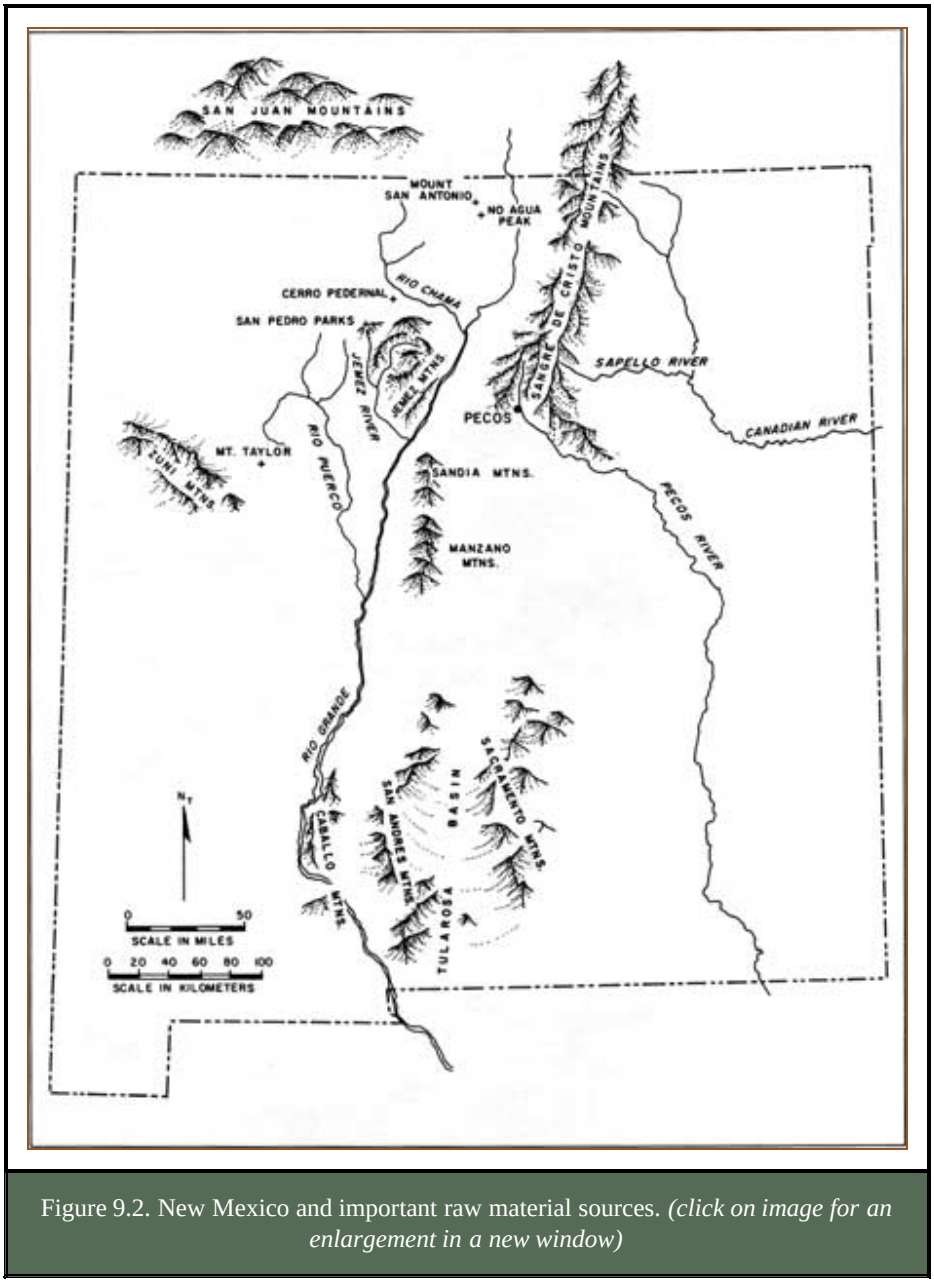


Figure 9.2. New Mexico and important raw material sources. *(click on image for an enlargement in a new window)*

Rocky Mountains

The Rocky Mountain province in New Mexico includes the Sangre de Cristo Range and the Jemez Mountains, as well as the southern portion of the San Juan Range. The Sangre de Cristo and San Juan are true ranges of the Rocky Mountains, created in the Rocky Mountain orogeny of the late Mesozoic and early Cenozoic Eras. The Jemez Mountains are the result of a series of Quaternary volcanic events culminating in explosive eruptions and caldera collapse about one million years ago.

Jemez Mountains Sources

The Jemez Mountains are a volcanic range that produced igneous flows and eruptions periodically from the Pliocene to the Middle Pleistocene. The obsidian sources of the Jemez Mountains are located 80-100 km (50-60 mi) northwest of Pecos (Figure 9.2); however, it is important to note that the Rio Grande and its tributaries that drain the Jemez Mountains (including the Chama and Jemez River systems) are potential sources for archeological obsidian from the Jemez as well. The raw material sources of the Jemez Mountains, particularly the obsidian sources, have received

considerable attention due to their importance to prehistoric and protohistoric groups throughout the Southwest and Southern Plains. Although older igneous rock units are exposed, those formed in the Pleistocene are generally of the highest quality for lithic reduction. Of these, there are three varieties that appear to have been the most important for lithic raw material: El Rechuelos, Cerro Toledo, and Valle Grande (Figure 9.3). These varieties have been chemically distinguished through X-ray florescence (Baugh and Nelson 1987) and neutron activation (Glascock and Neff 1993).

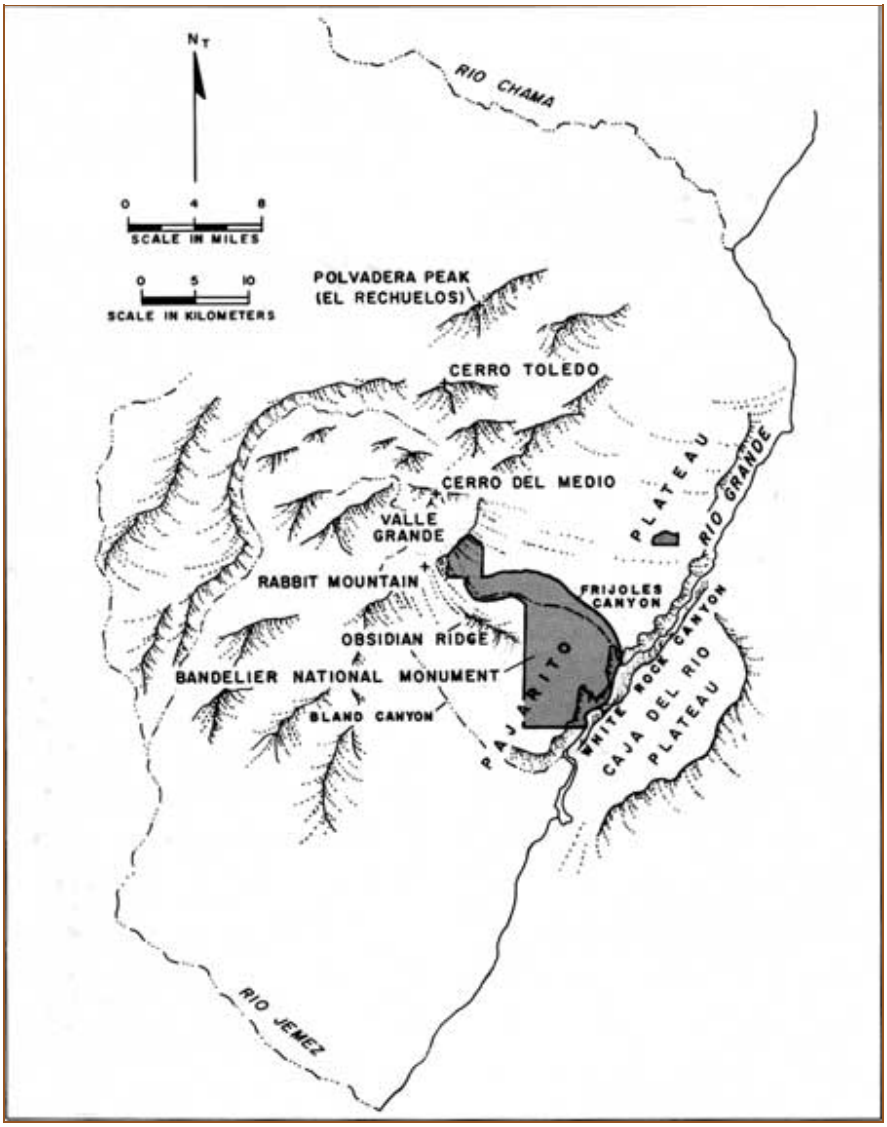


Figure 9.3. Specific obsidian sources in the Jemez Mountain area. *(click on image for an enlargement in a new window)*

Obsidian from the El Rechuelos source is often referred to as Polvadera obsidian in reference to this peak, located northeast of the Valles Caldera, which is the main vent for the El Rechuelos locality complex (Baugh and Nelson 1987:318). Obsidian is moderately abundant as blocks and clasts around the base of this peak but is often limited in size by hydration and devitrification (Shackley and White 1998:4). Polvadera obsidian can often be distinguished in hand specimens by its smoky gray color and tiny ash inclusions (Head 1999:471-472).

The Cerro Toledo complex includes the Obsidian Ridge and Rabbit Mountain sources and is also available in several of the surrounding canyons. Rabbit Mountain may be the ultimate source of the material (Baugh and Nelson 1987:318). Obsidian Ridge/Rabbit Mountain obsidian ranges in color from black to brown to gray-green and is typically translucent, although it is occasionally opaque black. This variety of obsidian was used extensively for lithic raw material, and in particular Obsidian Ridge, a narrow ridge southeast of the Valles Caldera just west of Bandelier National Monument, shows evidence of intensive prehistoric collecting.

The Valle Grande complex consists of at least four igneous domes, the most archeologically important being Cerro del Medio on the eastern edge of the Valles Caldera (Baugh and Nelson 1987:318). Obsidian from Cerro del Medio is gray to black in color and often has a characteristic internal sheen on weathered surfaces (Vierra, in Head 1999:472). It is available in larger sizes relative to other obsidian sources in the Jemez Mountains (Baugh and Nelson 1987:319). Like that of Obsidian Ridge/Rabbit Mountain, the Cerro del Medio source was heavily utilized prehistorically. It appears to have been the most important source of obsidian for the Protohistoric period on the Southern Plains, presumably made available through trade with Puebloan groups (Baugh and Nelson 1987:319; Spielmann 1982, 1983), and is a common component of archeological assemblages as far north as northern Nebraska (Hughes and Roper 1999). Other studies have demonstrated the importance of Jemez obsidian tool stone for Folsom (LeTourneau et al. 1998), Archaic hunter/gatherers (Baugh 1997), and Puebloan groups (Cameron and Sappington 1984; Glascock and Neff 1993; Glascock et al. 1999; Harro 1998; Head 1999; Root and Harro 1993).

Extensive basalt and basaltic andesite flows are also associated with the Jemez volcanics, and range from relatively coarse and vesicular to useful fine-grained material. These igneous materials are common throughout the Jemez Mountains region, including the Caja del Rio Plateau just west of Santa Fe (Head 1999). This latter area lies as little as 35 km (22 mi) from Pecos (Figure 9.3). Basalt and andesite from this area undoubtedly were important prehistorically for the production of both flaked and ground stone tools.

Pedernal Chert

Pedernal chert occurs within silicified limestone beds of the Miocene Abiquiu Tuff (Banks 1990:67). The term "Pedernal chert" is traditional to archeological discussions and although the material is more accurately referred to as a chalcedony, the traditional use is retained here.[3] One of the first descriptions of the material appears in Bryan, who describes it as easily worked, with few internal or natural flaws (Bryan 1939:17-18). The primary source for this raw material is often attributed to Cerro Pedernal, a flat-topped peak west of the town of Abiquiu, where it is available in relatively large sizes (Figure 9.2). However, lenses outcrop over much larger areas in the San Pedro Parks about 20 km (12 mi) to the west/southwest of Cerro Pedernal and are discontinuously exposed between these two areas. Quarrying activities are abundantly evident along the slopes of Cerro Pedernal and at least one locality in the San Pedro Parks (Bryan 1938). Pedernal chert occurs in secondary contexts in the Rio Chama, Rio Puerco, and Jemez River as well, with cobble-sized particles available along the Rio Chama (Banks 1990:69). It follows that Pedernal chert can be expected to occur in the alluvium of the Rio Grande as well, but whether it occurs inadequate size ranges for lithic reduction has not been reported (Phagan 1985; Warren 1979a:57). The closest primary sources of this material are located about 80 km (50 mi) northwest of Pecos, while secondary sources are at least 55 km (34 mi) away.

Pedernal chert is typically translucent and varies in color from white to gray with dendritic and amorphous discolorations ranging from black to red, blue, and yellow. The colors vary widely across small areas of the material and may all be visible within a single small specimen. Pedernal chert is of high quality for lithic reduction and tool production, but useful pieces are occasionally limited in size due to vugs and internal fractures. Pedernal chert was apparently a consistently favored lithic raw material in the northern Rio Grande area, and sources were exploited from the Paleoindian through the early Historic periods.

Other Sources in the Rocky Mountains

The Upper Pecos Valley is located at the southern tip of the Sangre de Cristo Mountains. Despite the large areal extent and complex geology of this range, only two formations are reported as containing sources of useful lithic raw material (Banks 1990:71-72). The Madera Formation outcrops extensively along the eastern edge of the Sangre de Cristos and contains cherts that vary in both color and quality. The color is mostly gray but may have red, orange, white, and yellow coloration, sometimes within the same piece. Quality in the same sample can grade from cryptocrystalline to poor quality, medium-grained material. Numerous outcrops occur about 28 km (17 mi) east of Pecos near Las Vegas, New Mexico, including a brittle opaque gray chert that is well represented among the artifacts from the survey. Secondary sources of chert from the Madera formation can be found in both the Pecos and Sapello rivers (Figure 9.2). Limestone associated with the Madera Formation is available throughout this same area and was noted as an occasional component of the Pecos flaked lithic assemblage. The Dakota Formation outcrops in the same general areas as the Madera and contains relatively coarse quartzitic chert, quartzites and sandstones that may have been useful for heavier stone tools (Banks 1990:90).

The San Juan Mountains begin just north of the Jemez Mountains and continue northward into southern Colorado (Figure 9.2). As with the Sangre de Cristos, few sources of useful lithic raw material are known relative to the extent and geological complexity of the range. Basalt (possibly with some associated obsidian), petrified wood, and several varieties of "jasper" are reported for the northern part of the range (Banks 1990:66). Raw materials fitting the descriptions of these sources are reported from archeological contexts in the northern Rio Grande Basin of Colorado (Spero and Hoefer 1999). Due both to the sparseness of useful raw materials in the San Juans and the distance of the range from Pecos, these mountains are not expected to have been an important source of lithic raw materials for the prehistoric cultures of the Upper Pecos Valley.

Between the Sangre de Cristo and San Juan Mountains just south of the New Mexico-Colorado border lie a series of volcanic domes. Basalt flows associated with these comprise the Taos Plateau through which the upper Rio Grande flows. Two domes that lie on the west side of the river, Mount San Antonio and No Agua Peak, have associated obsidian outcrops (Figure 9.2). Obsidian from these sources also occurs in a secondary context in adjacent streambeds (Findlow and Bolognese 1982). Despite the high quality and adequate sizes of obsidian from this area, it does not appear to have been widely exchanged beyond the Rio Grande Valley (Baugh and Nelson 1987; Findlow and Bolognese 1982).

Basin and Range

The Basin and Range portion of New Mexico consists of a series of north-south trending mountains separated by relatively wide valleys or basins (Figure 9.1). With a few exceptions, these are mostly fault-block mountains associated with Tertiary crustal tension (Chronic 1987). Relative to the adjacent physiographic provinces, the Basin and Range contains few important sources of lithic raw materials.

Madera and San Andres Formations

Due to the common origin for many of the mountains, an individual rock formation is often represented in many ranges. The Madera, first presented above as occurring in the Sangre de Cristos, is one such formation that includes economically useful chert. The opaque gray chert is found in nodules and lenses in the Manzano Mountains (Banks 1990:78) and also occurs in the Sandias to the north in smaller sizes, often with numerous internal planes of weakness, and in the Caballos to the south (Figure 9.2). In these areas the chert outcrops along the eastern faces of the ranges and grades from gray to pale blue.

A white and gray finely banded chert occurs within the San Andres Formation of south-central New Mexico. Like the Madera, the San Andres Formation is represented in numerous ranges including the San Andres, Zuni, and Sacramento Mountains (Figure 9.2). This chert, sometimes referred to by archeologists as "fingerprint chert," is available in relatively small sizes but is common on archeological sites in central and southern New Mexico.

The closest outcrops of the Madera Formation in the Manzanos occur about 100 km (60 mi) south of Pecos, and the San Andres chert of the Zunis and Sacramentos is over 160 km (100 mi) away. Owing to the distances of these sources, and the fact that chert of comparable quality to these is found locally in the Madera Formation of the Sangre de Cristo Mountains, these chert sources in the Basin and Range are not expected to have played an important role in the lithic industries of the Upper Pecos Valley.

The Rio Grande

One potential source of a variety of lithic raw materials that should not be overlooked is the alluvial deposits of the Rio Grande. Secondary sources of many of the raw materials described above can be expected downstream from their primary sources in both the current bedload and Pleistocene terraces associated with the river. It is not uncommon to encounter dispersed evidence of cobble testing along river terraces. These secondary sources of raw materials appear to have been important prehistorically as far north as Bandelier National Monument (Head 1999) and as far south as the Tularosa Basin, where Jemez obsidian pebbles and cobbles were extracted from the Pleistocene Santa Fe Formation (Carmichael 1986). The Rio Grande provides a closer source of some important materials (such as those of the Jemez Mountains) to the inhabitants of the Upper Pecos Valley. It is difficult, however, to evaluate the degree to which these secondary sources were exploited prehistorically.

Mount Taylor

Mount Taylor is a volcanic range located just north of Grants, New Mexico (Figure 9.2). Obsidian derived form this Tertiary volcano occurs on the mountain itself as well as on the surrounding foothills (Findlow and Bolognese 1982:56) and among the alluvium of the Rio Puerco to the southeast (Shackley 1998). Mount Taylor obsidian is typically black and opaque, occasionally with small gray flecks. Although it is not actually located within the Basin and Range province, but on the edge of the adjacent Colorado Plateau to the west, it is included in this section because secondary sources along the Rio Puerco occur in the Basin and Range and are here closest to Pecos. Mount Taylor is located 160 km (100 mi) from Pecos, with the secondary alluvial deposits occurring within 110 km (68 mi).

Great Plains

To the south and east of Pecos lie the Great Plains. The portion of the plains adjacent to New Mexico is a remnant Tertiary landform occasionally interrupted by erosional and volcanic features (Trimble 1980). Erosional features, including the Pecos, Canadian, and other smaller rivers, have served to expose underlying bedrock that includes important sources of lithic raw material. Despite relatively great distances, some of these materials are fairly common in the archeological record of Pecos National Historical Park.

Alibates Flint

Alibates flint, more accurately an agatized dolomite (Holliday 1997:245), is one of the most widely known lithic raw material sources in North America.[4] It occurs within the Permian Quartermaster Formation as lenses and nodules in relatively massive ledges and residual blocks (Tunnell 1978:7). Outcrops of Alibates, along with associated quarries, are best known from the area now preserved as Alibates Flint Quarries National Monument but are found along the north and south sides of the Canadian River in several locations northeast of Amarillo, Texas (Figure 9.1). This material is found in secondary contexts east of the outcrops along the Canadian River (Banks 1990:91).

The Alibates material is characterized by bands, speckles, or mottles of a variety of colors including white, red, brown, purple, and gray. Multiple colors are typically represented on a single small specimen. The material is very well suited for lithic reduction but often contains large vugs with quartz crystals (Tunnell 1978:7). The prehistoric desirability of Alibates, perhaps due to its beauty as well as its technical qualities, is indicated by its recognition in archeological contexts as far away as northern Colorado (Stanford and Jodry 1988). Similarly, although it occurs more than 350 km (220 mi) east of Pecos, Alibates is not uncommon in the archeological collections from there.

Tecovas Chert

Tecovas chert, commonly referred to as Tecovas or Quitaque jasper due to its iron-stained color, occurs in the Tecovas Formation of the Triassic Dockum Group. The Tecovas formation outcrops as the lowest exposed unit on the northwestern, northern, and eastern edges of the Llano Estacado, including a portion of the Canadian River Valley near Alibates National Monument. Outcrops along the northwestern edge of the Llano Estacado occur about 160 km (100 mi) from Pecos (Figure 9.1). A lateral equivalent of the Tecovas formation (Holliday 1997:249), known as Baldy Hill, occurs across the Canadian River drainage about 15 km (9 mi) east of Folsom, New Mexico.

Both the Tecovas and Baldy Hill materials are problematic in that they can be difficult to distinguish from Alibates in hand specimens, although the former are not banded and are not typically mottled. Tecovas is typically a fairly uniform dark red to yellow color with abundant small vugs with quartz crystals. It can be distinguished from Alibates under low magnification by its greater opacity, smaller and bluish quartz crystals, and less waxy luster (Holliday 1997:249). It has also been reported that Alibates is available in larger size ranges (greater than 8 cm) than Tecovas (Banks 1990:93), although boulder-sized specimens of Tecovas have been reported (Boldurian and Cotter 1999:25).

Edwards Plateau Chert

Another widely recognized and widely used source of chert is the Lower Cretaceous limestone of the Edwards Formation. "Edwards Plateau chert" actually refers to any of several sources of chert that outcrop and were occasionally quarried (excavated) along the edges and erosional features of the Edwards Plateau in central Texas. Banks (1990:60) argues that at least some geographic distinction can be based upon color.

Edwards Plateau chert occurs in lenses and nodules, the largest of which can exceed 40 cm in diameter (Tunnell 1978:7). The material ranges from dark brown to gray to blue through white in color and is characterized by white or cream colored cortex. The chert is typically fine grained and is very well suited for lithic reduction. Sources of high quality Edwards Plateau chert occur about 480 km (298 mi) from Pecos. Secondary sources occur mainly to the east and south of the plateau and therefore do not provide any closer alternatives. Despite the distance, Edwards Plateau chert is recognized from archeological assemblages within Pecos National Historical Park.

Other Sources on the Great Plains

Two areally extensive but more heterogeneous sources of lithic raw material in the southern portion of the Great Plains deserve mention. The Ogallala Formation is a Tertiary alluvial unit that underlies all of the Southern High Plains (Holliday 1997:250). The Ogallala was formed as outwash from the Rocky Mountains to the north and west and therefore contains a wide variety of lithologically distinct sediments. Numerous varieties of quartzite occur, including a common medium-grained purple quartzite, as well as several varieties of chert ("jasper") and opal (Banks 1990:95). These materials occur in gravel to cobble size ranges and occur along all of the escarpments of the Llano Estacado.

The Dakota Formation, described above in reference to the Sangre de Cristo Mountains, discontinuously outcrops from Tucumcari, New Mexico north to Nebraska. Large amounts of a wide variety of quartzites occur in the Dakota Formation in the vicinity of northeastern New Mexico. In places the quartzite has metamorphosed to chert, and at least one such source near Fort Union National Monument is reported to show extensive evidence of prehistoric quarrying (Banks 1990:90). Both the Ogallala and Dakota Formations, and the materials within them discussed above, occur less than 100 km (60 mi) from Pecos. The great variety of materials found within them, and the difficulty in differentiating them from other materials, makes it difficult to evaluate the extent to which they are represented in archeological assemblages.

Summary

Differentiation between what can be considered local versus nonlocal raw material is typically a subjective judgement based upon assumptions of group mobility and land use. Fortunately for our purposes, the location of Pecos is such that there is a limited number of raw material sources that are immediately available on the landscape. The variously colored cherts, and possibly chalcedonies, of the Madera formation and the sandstone and quartzite of the Dakota formation outcrop in the hills and canyons of the Tecolote range within the park and the surrounding area. Primary deposits of these occur within a 30 km (19 mi) radius of any part of the park (Table 9.1) and are available as secondary deposits in most major streambeds.

The group of raw material sources considered here to be nonlocal includes those of the Jemez Mountains (including Pedernal chert), the Rio Grande, and the Ogallala gravels. These sources range from 40-100 km (25-60 mi) from the Pecos (Table 9.1) and therefore require considerable travel for transport into the valley. The remaining sources, Mount Taylor, Tecovas, Alibates, and Edwards, occur at distances greater than 160 km (100 mi) from Pecos and are considered here to be truly exotic. With the possible exception of the Paleoindian Period (Amick 1996), the transportation of lithic raw materials over this distance likely represents purposeful and planned movement of goods in the form of trade. Distances to individual sources from Pecos are presented in Table 9.1. Additional sources described above are less easily recognized in the assemblage and are typically assigned to an "Other" or "Undifferentiated" category in the following analyses.

Table 9.1. Distance to major raw material sources.

Source	Distance km	Distance mi	Availability
Madera chert	28	17	Local
Dakota sandstone and quartzite	28	17	Local

Rio Grande gravels	40	25	Nonlocal
Jemez obsidians	80	50	Nonlocal
Pedernal chert	80	50	Nonlocal
Ogallala gravels	100	60	Nonlocal
Mount Taylor obsidian	160	100	Exotic
Tecovas jasper	160	100	Exotic
Alibates agate	350	220	Exotic
Edwards chert	480	300	Exotic

Flaked Stone Assemblage Parameters

Flaked stone artifact data were collected during the Pecos survey in order to record information relevant to both technology and function. The majority of the data was recorded in the field in an attempt to maximize sample size while minimizing both the impact to site integrity and the curation costs associated with collection. Twelve basic attributes were recorded for 21,088 items, resulting in 253,056 individual data points. A coding manual (Appendix C) was used in the field to ensure the consistent measurement of the twelve attributes.

The attributes consist of material type, raw material color, amount of cortex, platform type, condition (debitage type or tool completeness), thermal alteration (heat treatment), edge damage (use wear), technological type, functional type, and size (length, width, and thickness). Raw material type and color enable measurement of the frequency and relative diversity of stone tool resources in a given assemblage. Coupled with information regarding the natural distribution of these sources (presented above), raw material data provide a basis for inferring social interaction and landscape use among prehistoric groups. Cortex, platform type, condition, thermal alteration, and size are attributes capable of informing on lithic reduction represented by a given specimen. An understanding of the level of reduction is important for inferring general reduction strategies, including core maintenance and degree of material conservation, as well as tool manufacture, use, and maintenance. The remaining attributes, edge damage, technological type, and functional type, provide information on tool use and may reflect specific activities and tasks carried out on a site or within a given area.

Each of these attributes is presented in more detail below. Specific details concerning their measurement are available in Appendix C. Patterning in selected attributes is highlighted to provide a general description of the nature of the overall Pecos survey assemblage. While random, systematic, and judgmental sampling methods were used in the field to collect lithic data (Appendices B and C), data descriptions and analysis, unless otherwise noted, are based upon the random samples only. Finally, a simple tool classification is analytically derived based upon the attributes listed above. The analytical classification is used in the subsequent investigation of the organization of flaked lithic technology.

Raw Material Type

Material type refers to the lithic raw material from which an artifact was made. This attribute was coded in such a way that various levels of specificity were available to ensure accurate field recording. Thus one might record a material type as "Sedimentary, undifferentiated," "Chert, undifferentiated," or "Pedernal Chert" depending upon the level of confidence one had in recognition of specific type. Raw material color was recorded to help in the later identification of and distinction among types. This was especially important for varieties of chert and chalcedony.

The material type data are summarized in Table 9.2. This summary describes an assemblage that is dominated by local raw materials but has a specific, and seemingly patterned, array of nonlocal and exotic varieties. Local chert and chalcedony together make up just over 80 percent of the total sample. Quartzite, comprising 5.5 percent of the sample, is probably of mostly local origin as well. The remaining 14 percent can be considered nonlocal or exotic. Obsidian is the only nonlocal material that contributes a substantial portion, 9.1 percent, to the sample. For the Pecos survey, obsidian identification was based on visual criteria and comparison with a type collection. X-ray fluorescence characterization of a small sample of items provides specific identification of sources and is presented later in this chapter. Other nonlocal and exotic raw materials, including Pedernal chert and Alibates flint, contribute less than 1 percent each. The final 3 percent were classified as "Other" due either to an inability to confidently associate them with

a specific source or a very low frequency. For example, the very few items that were classified as Edwards chert (n=22; 0.1 percent), are subsumed within this category.

Table 9.2. Flaked stone raw materials.

Raw Material	Count	Percent
Chert, local	13,180	62.5
Chalcedony	3,833	18.2
Obsidian, nfs	1,929	9.1
Quartzite	1,162	5.5
Other	643	3.0
Chert, nonlocal	132	0.6
Flint, Alibates	120	0.6
Chert, Pedernal	89	0.4
Total	21,088	100.0

Size

Length, width, and thickness were recorded for each flaked lithic item. These size measurements were recorded in millimeters using calipers. The definition and technique of measuring maximum dimensions can be found in Appendix C.

Cortex

Cortex is the natural outer surface of a piece of raw material and may be primary, a reflection of the bedrock matrix in which the material formed, or secondary, a result of weathering due to sediment transport. Cortex amount and condition varies according to distance from the primary source of the raw material and the item's stage in a reduction sequence. It is increasingly realized that traditional stage typologies relating cortex amount to reduction stage are overly simplistic (Sullivan and Rozen 1985; Shott 1994). For example, experimental research indicates that flakes removed near the completion of a trajectory from generalized core to biface may still retain some cortex (Shott 1996). However, in a general sense, larger amounts of cortex can be expected to characterize the earliest flakes removed in a reduction sequence, and cortex can thus be seen as an imperfect but useful correlate of level of reduction.

Typically, in measuring cortex on debitage, only an item's exterior, or dorsal face, is examined. In order to effectively record information about such artifacts as tested cobbles and large choppers that do not really have an exterior face, the Pecos survey analysts included the entire surface area of an artifact in calculating the amount of cortex. Thus a piece recorded with 91-100 percent cortex has cortex on 91-100 percent of its total surface area. Few flakes have more than 50 percent cortex, but exceptions include flakes with cortical platforms and pronounced curvature, and angular debris. Cortex amount was recorded in relation to five ordinal percentage classes: 0, 1-25, 26-50, 51-90, and 91-100 percent. These classes were chosen to provide enough detail to be meaningful, while remaining general enough to facilitate reliable measurements in the field. The amount of debitage with cortex for raw materials are presented in Table 9.3.

Table 9.4 presents the breakdown of cortex amounts for all debitage. The overwhelming majority of debitage (81 percent) exhibits no evidence of cortex. Only 1.2 percent of debitage exhibit more than 50 percent cortex. Thus, very early stage reduction is poorly represented in the overall assemblage, indicating that this aspect of reduction typically took place elsewhere (perhaps at the locus of acquisition). The implications of relative differences in cortex occurrence for different raw materials are explored later in this chapter.

Table 9.3. Material types of debitage with cortex.

Material Type	Count	Percent
Chert, local	2,423	67.9
Chalcedony	476	13.3
Quartzite	341	9.5
Obsidian, nfs	120	3.4
Siltstone	34	1.0
Chert, nonlocal	19	0.5
Chert, Pedernal	19	0.5
Alibates	7	0.2
Orthoquartzite	5	0.1
Other	127	3.6

Table 9.4. Cortex amounts for debitage.

Cortex Amount	Count	Percent
None	15,415	81.2
1-25%	2,059	10.8
26-50%	1,290	6.8
51-90%	219	1.2
91-100%	3	0.0
Total	18,986	100.0

Platform Type

Many believe that platform attributes give the most reliable indication of the degree of reduction prevalent in a lithic assemblage, which also can help identify the range of activities the assemblage represents (Callahan 1990; Dibble 1997; Odell 1989; Whittaker 1994). Further, along with exterior flake attributes, platform morphology provides a view of a portion of the core, thus providing information concerning core state at a particular level of reduction (Teltser 1991). Platform type (technically the platform remnant remaining on a flake after it is detached from a core) was recorded for all flaked lithic items examined during the survey. The recording system allowed one or a combination (up to three) of the following types: not applicable/absent, single faceted/flat, multifaceted, abraded, cortical, retouched, crushed, collapsed, lipped, and unknown. For items lacking platform remnants, such as distal flake fragments or cores, platform type was recorded as not applicable/absent.

Table 9.5 presents the frequencies for platform types on all debitage. The largest class of the material (47 percent) had no discernible platform. Missing platforms indicate that the debitage was broken either in manufacture or by post-manufacture processes. Of the discernible platforms, the vast majority were single faceted, representing over 30 percent of the total assemblage. Only about 9 percent of the debitage exhibits two or more platform facets. These patterns, along with the frequency of collapsed platforms (almost 5 percent), are expected for debitage resulting from generalized core reduction strategies, where the production of flakes (as opposed to the shaping of the core) is the goal.

While the recording system allowed for multiple entries, only a little over 2 percent of the total pieces exhibited multiple platform types. Examining the database, a large number of the "multifaceted with other" category include lipped platforms. In experimental studies, lipped platforms are shown often to be associated with a high angle of force and a soft indentor (such as antler) (Cotterell and Kamminga 1987; Crabtree 1982). The use of a soft indentor at a high angle of force is appropriate for reducing relatively thin edged cores such as bifaces. Thus, only a small percentage of the sample fits the profile that would be expected to result from formalized (e.g., bifacial) core reduction.

Table 9.5. Platform types of flaked stone.

Platform Type	Count	Percent
None/not applicable	8,809	47.4
Single faceted/flat	5,490	29.5
Single faceted with other[a]	218	1.2
Multifaceted	1,508	8.1
Multifaceted with other[a]	222	1.2
Collapsed	915	4.9
Cortical	878	4.7
Unknown	549	3.0

[a]"Other" includes abraded, retouched, lipped, and crushed.

Debitage Type/Condition

The field recorders employed the debitage typology developed by Sullivan and Rozen (1985) for the collection of data. This formal approach provides the advantage of a systematic framework for collecting reliable (replicable) data on lithic debitage (Prentiss 1998). The framework is based upon flake completeness, and its use results in debitage categories whose proportions within an assemblage are argued to correspond to specific reduction modes. The validity of the proposed correspondence between flake completeness and mode of reduction is discussed further below.

The Sullivan and Rozen typology is implemented as follows. Debitage is categorized according to a hierarchical decision tree into one of the following debitage types: a complete flake, a broken flake, a flake fragment, or angular debris/shatter. The decision tree for debitage classification is based upon technological attributes presented in Figure 9.4. The following steps are used for debitage classification:



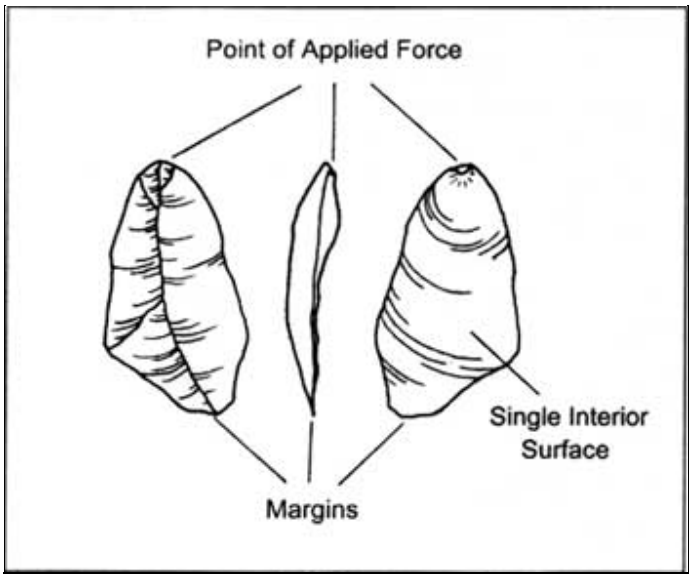


Figure 9.4. Flake attributes used in debitage classification.

1. Is there a single interior surface?
No=debris,
Yes=continue to question 2.

2. Is the point of applied force present?
No=flake fragment,
Yes=continue to question 3.

3. Are the flake margins intact?
No=broken flake,
Yes=complete flake.

Sullivan (1987:Figure 2) later added a step between steps 2 and 3:

2b. Is there a sheared axis of flaking?
Yes=split flake,
No=continue to question 3.

In this same article, Sullivan argued that a high incidence of split flakes corresponds to bipolar reduction. Although our recording strategy relied upon Sullivan and Rozen's (1985) original formulation of the typology and therefore omitted this "split flake" category, field analysts often included this category within the comments. It should be noted that, in order to be tallied as debitage, the lithic item could not show evidence of use. Because only about 3 percent of flakes and angular debris showed any evidence of use, the effect of their exclusion is expected to be negligible for the debitage analysis. Used flakes are discussed in a following subsection.

The Sullivan and Rozen classification scheme has had the positive effect of inspiring systematic experimentation toward defining the quantifiable relationships between debitage variability and mode of reduction (Shott 1994:78). The results of this experimentation have identified some specific validity problems with its use as an inferential tool (Amick and Mauldin 1989; Ensor and Roemer 1989). Specifically, it has been demonstrated that raw material (Amick and Mauldin 1997), flake size (Prentiss 1998), and flintknapper experience play major roles in the variability in flake completeness, regardless of reduction mode. As a data collection tool, it has been demonstrated to provide comparability among different data collectors (Prentiss 1998) but has limited utility as a tool for inference. In a well-constructed test of the reliability and validity of the Sullivan and Rozen typology, Prentiss (1998) found its fundamental limitation as a tool for inferring reduction mode to be its simplicity. Simplicity and replicability make the system very useful for data collection and organization, however, and provide a foundation upon which to incorporate additional data for forming inferences regarding lithic reduction.

Debitage class frequencies and relative percentages for the Pecos survey are presented in Table 9.6. The single largest category (41 percent) is that of "flake fragment" (medial or distal portions). Complete flakes are fairly common and comprise almost 30 percent of the sample. Broken flakes (proximal portions) and angular debris each make up less than 20 percent of the sample.

Table 9.6. Debitage classes.

Flake Class	Count	Percent
Complete flake	5,667	29.9
Broken flake	3,152	16.6
Flake fragment	7,788	41.0
Angular debris	2,378	12.5

Raw material appears to contribute to the overall pattern seen for debitage recorded at Pecos. An exploration of specifically how raw materials relate to flake completeness in the Pecos survey data is presented in Table 9.7. In this table raw materials are cross-tabulated with debitage class. When compared to expected debitage category proportions for each raw material type derived from Table 9.6, specific patterns become apparent. More vitreous materials such as obsidian produce relatively more flake fragments while coarser materials such as quartzite and siltstone produce comparatively more complete flakes. These results support experimentally derived arguments (Amick and Mauldin 1989; Prentiss 1998) that raw material plays an important role in patterns of flake completeness.

Table 9.7. Cross-tabulation of material type by debitage class.

	Debitage Classes				
Material Type	Complete Flake	Broken Flake	Flake ragment	Debris	Total
Chert, local	3,419 (28.17%)	2,095 (17.26%)	4,919 (45.59%)	1,705 (8.98%)	12,138
Chalcedony	1,127 (31.49%)	611 (17.07%)	1,479 (41.33%)	362 (10.11%)	3,579
Obsidian	335 (22.42%)	201 (13.45%)	839 (56.37%)	116 (7.76%)	1,494
Quartzite	445 (42.26%)	152 (14.43%)	315 (29.91%)	141 (13.39%)	1,053
Other	103 (49.05%)	20 (9.52%)	64 (30.48%)	23 (10.95%)	210
Chert, nonlocal	31 (31.00%)	21 (21.00%)	41 (41.00%)	7 (7.00%)	100
Alibates	37 (39.36%)	13 (13.83%)	41 (43.62%)	3 (3.19%)	94
Siltstone	45 (52.33%)	14 (16.28%)	24 (27.90%)	3 (3.49%)	86

Chert, Pedernal	31 (38.75%)	6 (7.50%)	36 (45.00%)	7 (8.75%)	80
Orthoquartzite	22 (42.31%)	9 (17.31%)	18 (34.62%)	3 (5.77%)	52

Due to the limitations of the Sullivan and Rozen typology for inferring reduction mode cited above, we combine debitage category with platform characteristics to create classes for the exploration of variability in debitage as it may relate to reduction mode. Complete and broken flakes that displayed single, cortical, or split platforms, along with angular debris form a fairly internally consistent debitage class in the Pecos survey sample (Class 1). These attributes are expected to relate to generalized core reduction (Teltser 1991). Alternately, complete flakes and broken flakes with one of the following platform types: multifaceted, multifaceted with other (abraded, retouched, lipped, or crushed), collapsed platforms, or single faceted with other (abraded, retouched, lipped, or crushed) comprise another class (Class 2). These attributes are expected to be associated with formal reduction (e.g., bifacial or formal tool). Unknown/ambiguous debitage (Class 3) includes all flake fragments and angular debris without an observed platform. Table 9.8 presents the totals for each of these debitage classes. These results are comparable to those derived from the examination of platform alone, suggesting that the overall Pecos survey sample is dominated by generalized core reduction debris.

Table 9.8. Debitage classes derived from post-field analysis.

Debitage Class	Count	Percent
Class 1	6,620	36.2
Class 2	2,751	15.0
Class 3	8,933	48.8
Total	18,304	100.0

Thermal Alteration

All flaked lithic artifacts were examined for evidence of thermal alteration, which may be intentional or unintentional. Intentional thermal alteration (heat treatment) is known to increase the quality of some raw materials for lithic reduction. Although the physical process of thermal alteration is poorly understood (Luedtke 1992), it is believed that the application of heat to a siliceous material may (1) strengthen the mineral bonds through silica fusion, (2) create microscopic fractures that allow for easier fracture propagation, or (3) change the amount of water contained within the crystalline structure of the stone. The result is an increase in the ease with which a material is fractured during the flintknapping process. Sedimentary (e.g., chert, siltstone, sandstone) and possibly some metamorphic (e.g., quartzite) raw materials respond particularly well to intentional thermal alteration. Knowledge and use of this process allows flintknappers to more accurately control and more easily flake certain raw materials. The presumed goal is to alter the stone such that it is easier to reduce, either by free-hand percussion or pressure flaking.

Not all thermally altered artifacts are the result of successful or even intentional heat treatment. Unintentional thermal alteration may result from discard into a thermal feature or from natural fires. Unsuccessful heat treatment often results in flaws that make flaking more difficult to control. Potlid scars, circular conchoidal depressions, result when water within the stone is heated too quickly. A crazing pattern, a network of fine cracks resulting from heat stress, results when stone heats and cools too quickly or is raised to a temperature that exceeds the limitations of the mineral bonds. Oxidation may in some cases cause discoloration of the raw material's natural state. Differential luster is an indication that the material was properly heat treated and subsequent flaking has exposed the visually altered inner portion of the chert.

Lithic analysts noted that 809 pieces (3.8 percent) of flaked stone out of 21,088 total recorded pieces from the Pecos survey had evidence of thermal alteration. Four types of thermal alteration were recorded—crazing, potlidding, luster, and discoloration. Criteria for the identification of these attributes are presented in Appendix C. All alterations identified on a single piece were recorded. Luster was the most frequently recorded type, with crazing the next most recorded (Table 9.9).

Table 9.9. Thermal alteration for all flaked stone.

Heat Treatment	Count	Percent
None	20,280	96.168
Luster	347	1.645
Crazing	171	0.811
Potlidding	62	0.294
Crazing/luster	46	0.218
Crazing/discoloration	42	0.199
Crazing/potlidding	33	0.156
Discoloration	31	0.147
Luster/discoloration	16	0.076
Crazing/luster/discoloration	14	0.066
Potlidding/luster	14	0.066
Potlidding/discoloration	11	0.052
Crazing/potlidding/luster	10	0.047
Crazing/potlidding/ discoloration	6	0.028
Potlidding/luster/discoloration	5	0.024
Total	21,088	100.000

In order to address the role that heat treatment played in reduction strategies at Pecos, we examined the sizes of lithic items subjected to intentional thermal alteration. Luster is used here as an indicator of successful and intentional thermal alteration. When compared with unaltered flaked stone objects using a t-test, thermally altered stone is found to be significantly thicker (Table 9.10). That all thermally altered items tended to be large suggests that thermal alteration was attempted relatively early in the reduction process before great energetic investment was made in a particular item. Further examination of thermal alteration as it relates to aggregation and trade at Pecos is discussed later in this chapter.

Table 9.10. Student's T-comparison of thermal alteration by thickness.

Condition	n	mean	s.d.	T	d.f.	p>T
Unaltered	20,274	8.187	8.202			
				-2.149	936	.032
Altered	809	8.650	5.914			

Edge Damage

Edge damage for this survey is defined as damage that can be seen with either the naked eye or a 10x-power hand lens. This technique allowed the identification of microflaking, edge rounding, polish, striations, battering, and edge frosting. Up to three of these edge damage patterns in any combination were recorded for each flaked lithic item.

The interpretation of macroscopic edge damage as resulting from human use is problematic. Noncultural processes may also be responsible for edge damage patterns. Several geological (e.g., colluvial and alluvial) and biological (e.g., trampling) processes may cause damage to flaked stone objects that could be mistaken for use-wear due to human implementation. Because most of the park was once a cattle ranch, lithic artifacts are expected to be particularly susceptible to microflaking as a result of animal trampling. Presently, there is no simple way to quantify the impact of noncultural processes on artifacts. The alternative adopted here is to proceed as if all recorded edge damage represents use-wear, with the assumption that noncultural processes have an equal chance of affecting any individual item and so do not obscure patterning due to human use. Thus, as is further discussed below, all flaked lithic items exhibiting some form of edge damage are considered tools.

Table 9.11. Flaked stone use-wear.

Use-Wear	Count	Percent
None	19,912	94.423
Microflaking	780	3.700
Microflaking/edge rounding	150	0.711
Edge rounding	87	0.413
Battering	61	0.289
Edge rounding/battering	22	0.104
Microflaking/battering	8	0.038
Striations	8	0.038
Microflaking/edge frosting	7	0.033
Polish	7	0.033
Microflaking/polish	6	0.028
Microflaking/edge rounding/battering	5	0.024
Microflaking/striations	5	0.024
Edge frosting	5	0.024
Microflaking/edge rounding/edge frosting	2	0.009
Edge rounding/polish	2	0.009
Polish/battering	2	0.009
Microflaking/edge frosting/battering	1	0.005
Microflaking/polish/battering	1	0.005
Edge rounding/polish/striations	1	0.005
Edge frosting/polish	1	0.005
Other	15	0.071
Total	21,088	100.000

Table 9.11 presents the recorded edge damage from the Pecos survey. Over 94 percent of all flaked stone exhibited no edge damage. Edge damage in the form of microflaking was recorded for 3.7 percent of the items and constitutes the most abundant class. Microflaking with edge rounding, edge rounding, and battering are the next most common classes, each constituting less than 1 percent of the sample. Other edge damage classes each make up less than 0.04 percent of

the sample.

In our examination of the data, edge damage appeared to be more common on larger flaked lithic items. A statistical examination was carried out to evaluate the null hypothesis of no difference in size between flaked stone items exhibiting edge damage and those exhibiting none. Significantly different means for edge damaged and undamaged items were found using volume (length x width x thickness) as a measure of size (Table 9.12). Thus, large flakes and tools exhibit more evidence of use. The reasons for this are not clear, but in addition to the fact that edge damage is more likely to be identified on larger items, it seems probable that larger flaked stone items are easier both to hold and to haft.

Table 9.12. Student's T-comparison of item volume by edge damage.

Condition	n	mean	s.d.	T	d.f.	p>T
Undamaged	19,912	11,530	68,030			
				5.410	1185	.000
Edge damaged	1,176	52,584	259,700			

Note: Volume is expressed in cubic centimeters.

Technological Type

Each flaked lithic item recorded by the survey was assigned to one of 20 technological types. Technological types are conceived of as categories that are relatively free of functional interpretation (see functional type below). Technological types consist of six fundamental categories: angular debris, core, flake, unidirectional edge/uniface, bidirectional edge/biface, and tested cobble. Each of these categories is further subdivided into more specific classes based upon thickness or directionality. An "other" category is provided for items that do not match any of the above categories. Definitions for each of these technological types can be found in Appendix C.

Like other technological attributes such as platform or debitage type, the frequency of technological types provides a profile of flaked stone technology in the survey sample. The frequency of technological types within both the random sample and the combined random and judgmental samples is presented in Table 9.13. The following summary is based upon the random sample. Flakes and angular debris account for over 90 percent of the 19,970 items. Biface thinning flakes are relatively rare, accounting for just over 1 percent of the sample. Alternately, bifaces themselves are the fourth most common technological type, representing 1.61 percent. This difference in the frequencies of biface thinning flakes and bifaces is somewhat unexpected, considering that the manufacture of a single biface is expected to have produced a number of flakes. However, it is recognized that bifacial reduction may proceed by other means than thinning, such as the removal of relatively short and thick flakes from both sides of a core. Cores constitute 1.8 percent of the total assemblage. Of these, multidirectional cores are by far the most common. Unidirectional and bidirectional edged items, unifaces, and cobbles each account for less than 1 percent of the random sample.

Functional Type

In contrast to technological types, functional types are inferential categories that also carry information on artifact morphology. As with technological types, every item is assigned a functional type. These categories are based upon traditional interpretations of artifact use, which are drawn variously from ethnographic analogy, experiment, and assertion. These categories are listed, along with their frequencies within the random and total samples, in Table 9.14. The identification criteria for each of the functional types are listed in (Appendix C). The frequencies of individual functional types within the random sample provide a means of understanding the range of activities represented in the Pecos survey assemblage.

Approximately 6 percent of the recorded items in the random sample show evidence of use or modification into a shape suitable for use. The most abundant functional type is that of used flake (2.7 percent), defined as a flake that has not

been formally modified but shows evidence of use wear or damage. A preference for flakes over angular debris for use as expedient tools is evidenced by the relative rarity of used angular debris (0.28 percent). The most frequently recorded formed tools are projectile points, which constitute 0.8 percent of the random sample. Scrapers, when the four varieties are combined, make up 0.67 percent of the recorded items, and blanks and preforms make up 0.55 percent. Other functional types each constitute less than 0.5 percent of recorded items.

A total of 627 projectile points was recorded, constituting 2.97 percent of the total sample. All projectile points observed during survey were recorded. Functional codes were assigned to projectile points differently from other artifacts in order that information concerning size and morphology could be simultaneously collected (Appendix C). Projectile point classes and their frequencies are presented in Table 9.15. Based upon the largely Puebloan prehistoric occupation of Pecos National Historical Park, it is not surprising that the best represented categories are varieties of small notched points. Small triangular points are also well represented. Such projectile points have long been argued to be a component of bow and arrow technology (Bettinger and Eerkens 1999; Fenenga 1953) and likely relate to hunting and defense activities.

Table 9.13. Technological types.

Technological Type		Random Sample		Total Sample	
		f	%	f	%
Angular Debris	Total	2,340	11.72	2,344	11.12
Cores	Total	360	1.80	526	2.49
	Undifferentiated	52	0.26	64	0.3
	Unidirectional	69	0.35	107	0.51
	Bidirectional	27	0.14	49	0.23
	Multidirectional	212	1.06	306	1.45
Flakes	Total	16,571	82.98	16,641	78.91
	Undifferentiated	16,365	81.95	16,434	77.93
	Biface thinning	206	1.03	207	0.98
Unidirectional	Total	169	0.85	250	1.19
	Thin	96	0.48	134	0.64
	Thick	73	0.37	116	0.55
Uniface	Total	47	0.24	84	0.4
	Thin	32	0.16	54	0.26
	Thick	15	0.08	30	0.14
Bidirectional	Total	86	0.43	170	0.81
	Thin	55	0.28	110	0.52
	Thick	31	0.16	60	0.28
Biface	Total	321	1.61	964	4.57
	Thin	258	1.29	849	4.03
	Thick	63	0.32	115	0.55
Cobble	Total	65	0.33	92	0.44
	Tested	44	0.22	47	0.22
	Tool-undifferentiated	10	0.05	21	0.1
	Tool-unidirectional	4	0.02	11	0.05
	Tool-bidirectional	7	0.04	13	0.06

Other	Total	11	0.06	17	0.08
Total		19,970	100.00	21,088	100.00

Table 9.14. Functional types.

	Random Sample		Total Sample	
Functional Type	f	%	f	%
Not applicable	18,758	93.93	19,001	90.11
Used angular debris	56	0.28	56	0.27
Used core	23	0.12	38	0.18
Used flake	540	2.70	568	2.69
Spokeshave	5	0.03	5	0.02
Denticulate	2	0.01	3	0.01
Awl/borer/perforator	5	0.03	13	0.06
Graver	3	0.02	7	0.03
Scraper, undifferentiated	60	0.30	85	0.40
Scraper, end	18	0.09	34	0.16
Scraper, side	45	0.23	71	0.34
Scraper, thumbnail	4	0.02	12	0.06
Scraper, discoidal	5	0.03	6	0.03
Chopper	35	0.18	64	0.30
Hammer stone	6	0.03	14	0.07
Pecking stone	2	0.01	5	0.02
Flaked axe	1	0.01	2	0.01
Flaked hoe	4	0.02	13	0.06
Drill, undifferentiated	6	0.03	20	0.09
Drill, plain shafted	3	0.02	6	0.03
Drill, expanding base	4	0.02	10	0.05
Drill, lugged	1	0.01	2	0.01
Knife, undifferentiated	73	0.37	142	.67
Knife, beveled	1	0.01	5	0.02
Blank/preform	109	0.55	214	1.01
Other	42	0.21	65	0.31
Projectile point	159	0.80	627	2.97
Total	19,970	100.00	21,088	100.00

Table 9.15. Projectile point classes.

	Random Sample	Total Sample

Projectile Point Class	f	%	f	%
Indeterminate undifferentiated	14	8.81	43	6.86
Indeterminate stemmed	1	0.63	6	0.96
Indeterminate corner-notched	1	0.63	4	0.64
Indeterminate corner-notched/expanding base	-	-	1	0.16
Indeterminate side-notched	2	1.26	2	0.32
Indeterminate side-notched/expanding base	-	-	3	0.48
Indeterminate basal and side notched	-	-	1	0.16
Indeterminate triangular	2	1.26	2	0.32
Indeterminate lanceolate	-	-	-	-
Indeterminate other	-	-	-	-
Small undifferentiated	33	20.75	103	16.43
Small stemmed	8	5.03	24	3.83
Small corner-notched	20	12.58	81	12.92
Small corner-notched/expanding base	12	7.55	58	9.25
Small side-notched	11	6.92	65	10.37
Small side-notched/expanding base	11	6.92	59	9.41
Small basal and side notched	5	3.14	16	2.55
Small triangular	16	10.06	84	13.40
Small lanceolate	1	0.63	2	0.32
Small other	5	3.14	20	3.19
Large undifferentiated	4	2.52	8	1.28
Large stemmed	1	0.63	6	0.96
Large corner-notched	5	3.14	18	2.87
Large corner-notched/expanding base	3	1.89	11	1.75
Large side-notched	-	-	1	0.16
Large side-notched/expanding base	1	0.63	3	0.48
Large basal and side notched	2	1.26	2	0.32
Large triangular	-	-	1	0.16
Large lanceolate	-	-	-	-
Large other	1	0.63	3	0.48
Total	159	100.00	627	100.00

The patterns in the frequencies of functional types in the random sample indicate that the simplest of expedient tools (utilized flakes) are by far the most common class of tools. They are more than three times more abundant than the next largest functional class, indicating that many tasks requiring stone tools were carried out with minimal investment in tool manufacture and maintenance. Conversely, the next three most frequent functional classes are composed of relatively formal tools—projectile points, projectile point blanks and preforms, and scrapers. It thus appears that hunting was prominent among activities requiring stone tools and that greater technical investment was afforded hunting and game processing equipment. These ideas concerning technical investment and the importance of hunting are supported by more detailed investigations presented below.

Tool Classes for Analysis

The technological and functional type data classes for the Pecos Survey resulted in many different tool types. To further

examine changes in tool production and use in relation to raw materials and activities (presented in the following sections), the large number of types required some reduction. Tool classes are derived through a combination of technology and inferred functionality.

The majority of flaked lithic artifacts appear to be unspecialized forms suitable for expedient use. Specialized and unspecialized tool forms are characterized by differing energy investment requirements, and their production and maintenance are expected to have been organized differently. Tool classes for analysis are constructed with energy investment in mind. Changes in the treatment of tools belonging to these classes are specifically discussed later in this chapter.

Tool categories developed for the analyses include cores, expedient tools, low-energy tools, and high-energy tools. Cores are pieces of raw material that have smaller pieces detached from them but have no functional purpose other than as a source of flakes. This class includes the four different types of cores discussed above—unidirectional cores, multidirectional cores, bidirectional cores, and undifferentiated cores—with the exception of any that show evidence of use.

Expedient tools include all debitage and cores that have evidence of use and include such functional types as used flakes and used cores. Expedient tools do not exhibit any modification for a specific use. Low-energy tools exhibit shaping for specific tasks but do not represent a large expenditure of time or energy into production. This tool category includes, for example, unifacial end scrapers, cobble tool choppers, and bidirectional edged cutting tools. High-energy tools require a relatively greater amount of time, energy, and skill to produce. These include all bifaces regardless of function—examples include small, side-notched projectile points and bifacial drills and knives. Table 9.16 presents a breakdown of each of these tool classes.

Table 9.16. Tool classes derived from post-field analysis.

Tool Class	Count	Percent
High energy tool	894	35.1
Expedient tool	709	27.8
Core	473	18.6
Low energy tool	470	18.5
Total	2,546	100.0

The tool classes defined here are used in combination with the debitage classes defined under the debitage typology for the evaluation of the expectations that follow. All tool and debitage classes are mutually exclusive—an expedient tool cannot also be core reduction debris. While this presents problems, especially with regard to cores, exclusivity allowed for more control of the analyses presented in the following section. Single pieces would not be counted twice (for example once as cores and again as expedient tools). This enabled artifact class percentages to be used in the analyses that follow, broadening the range of appropriate statistical techniques.

The Organization of Flaked Stone Technology

The organization of lithic technology is driven by two fundamental constraints: the availability of raw material and, to a lesser degree, effective mobility (Andrefsky 1994). As each of the Puebloan periods in Pecos is characterized by a semi- to fully-sedentary mobility strategy, the focus here is upon changes in the availability of raw materials. Raw material availability is governed by geographic locations of sources and the social conditions that affect individual access to raw materials (social organization, mobility, trade relations, subsistence economy). Using our understanding of natural raw material distributions (presented in the beginning of this chapter) as a baseline provides a way in which to monitor changes in social conditions through changes in technology.

In the following sections we derive some expectations in regard to the research objectives for the Pecos survey. Using the data derived from survey and site recording in the park, we attempt to address the affects of population aggregation and trade upon the organization of lithic technology. The affects of these processes are particularly expected to be reflected in patterns of lithic raw material use and technological strategies. In the first section, a series of expectations are proposed and evaluated for technological organization and raw material use. In the following section, a series of expectations concerning technological organization and settlement patterns are proposed and evaluated. These expectations are based upon current knowledge of the prehistory of the Pecos area and our understanding of lithic technological organization and are evaluated using survey data from the random samples. Some expectations are amenable to statistical testing, while others are best examined subjectively.

Technological Organization and Raw Material

Under the simplest of conditions, the presence of specific raw materials in an archeological assemblage should be a function of distance to the source and should therefore be static through time. Deviations from this pattern are expected and require social or economic explanations. We examine the affects of changes in social organization upon raw material use in two basic ways. First, we examine the differential use of raw materials for the production of tool classes for the entire Pecos survey sample. These patterns are then monitored through time. Next, we examine changes in the use of a specific raw material category, obsidian, through time. The latter examination is facilitated by X-ray fluorescence analysis (Shackley and White 1998).

Tool Production and Raw Material

The idea that lithic raw material availability affects decisions about tool production and maintenance is fundamental to studies of technological organization (Nelson 1991). In the case of Pecos National Historical Park, many of the sites are Puebloan and semisedentary to fully sedentary. When comparing groups with a similar mobility pattern, it is the availability and quality of raw material that constrains or encourages wasteful or conservative reduction techniques (Andrefsky 1994). Earlier in this chapter raw materials were identified as being local, nonlocal, or exotic in reference to their availability. The quality and suitability of raw materials for lithic reduction were also discussed. These attributes provide a framework for the following investigations.

The relationship between raw material availability and quality in regard to conservation and tool production is modeled in Figure 9.5. Conservation for this model is defined as the employment of strategies that maximize utility through either prolonged tool use life (e.g., Cowan 1999; Kelly 1988), or intensive use of material (e.g., Parry and Kelly 1987). The latter results in minimizing the wasteful discard of usable items (e.g., flakes and large cores). This model further assumes that high-energy tools are designed for long-term use (Binford 1973, 1979) and are therefore conservative of material.

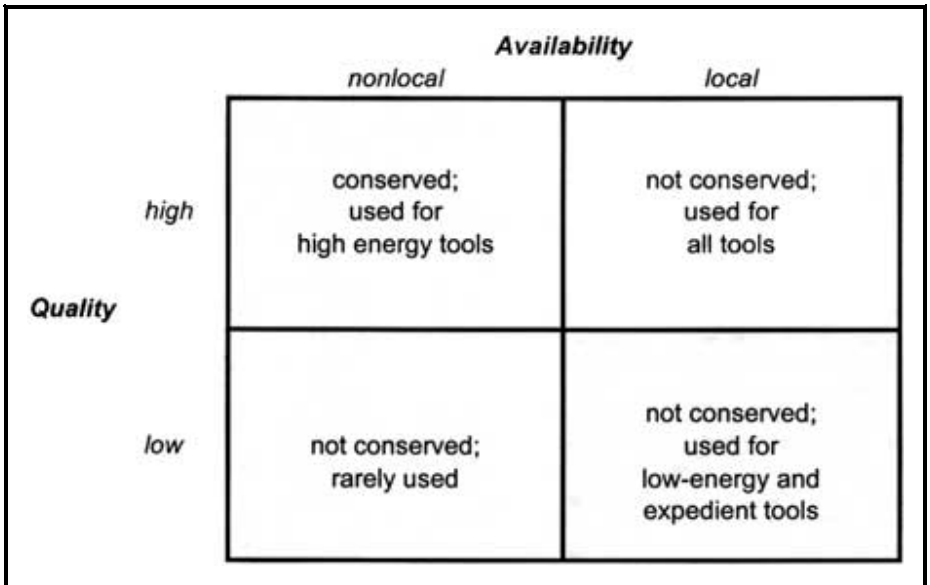


Figure 9.5. A model of conservation and tool production strategies in relation to raw material availability and quality.

According to the model, locally available raw materials are not expected to have been conserved to any great degree, and the tool classes for which they would be used are dependent upon their quality. Conversely, nonlocal materials of high quality, would be highly conserved and particularly favored for the production of high-energy tools. Nonlocal materials of low quality would not often be used, because their procurement cost probably outweighs their value for lithic reduction.

Following Andrefsky (1994:Figure 2), we derive expectations for tool classes and degree of conservation for particular raw material groups. In other words, depending on flaking quality and local availability, each raw material is expected to be used for particular types of tools. The expectations for each raw material group are as follows:

Obsidian — (nonlocal; high quality) conserved; used for high-energy tools such as projectile points. Obsidian debitage will also be used for expedient tools due to their sharp edges.

Nonlocal chert — (nonlocal; high quality) conserved; used primarily for high-energy tools.

Local chert — (local; variable quality) not conserved; used for a wide range of tools including cores, expedient tools, low-energy tools, and high-energy tools.

Local chalcedony — (local; high quality) conserved; used for high and low-energy tools. Due to higher quality compared to other local raw materials, chalcedony should be used more similarly to nonlocal chert.

Local siltstone and quartzite — (local; low quality) not conserved; used for large low-energy tools and expedient tools.

An additional set of expectations concerns changes in raw material use through time. Because local materials are always available, local material is expected to be used in similar quantities throughout the Puebloan sequence. Nonlocal materials, however, should increase during the time of greatest interaction with groups outside the Upper Pecos Valley. Ceramic, lithic, and faunal data indicate that trade relations with outside groups were the greatest during the middle to late 1400's (Kidder 1932; Spielmann 1982; Spielmann, ed. 1991). Therefore, Period 4 (A.D. 1450-1575) through the end of the Puebloan occupation of the park is expected to have visibly higher average volumes of obsidian and nonlocal cherts.

Evaluation of these expectations is based upon the comparison of relative percentages of each tool class with respect to raw materials. Figure 9.6 presents percentages of each tool type within the five main raw material groups—siltstone and quartzite, local chert, local chalcedony, obsidian, and nonlocal chert. The figure indicates that siltstone and quartzite were used for low-energy tools and cores, with roughly equal amounts of expedient and high-energy tools. As expected, local chert was used for roughly equal amounts of each tool type. The chalcedony is split between high-energy tools and expedient tools with very few low-energy tools or cores. Obsidian is highly skewed towards use in high-energy tools and very few cores but generally conforms to expectations. Nonlocal chert displays the largest departure from the expected use, with equal amounts used for expedient, low-energy, and high-energy tools.



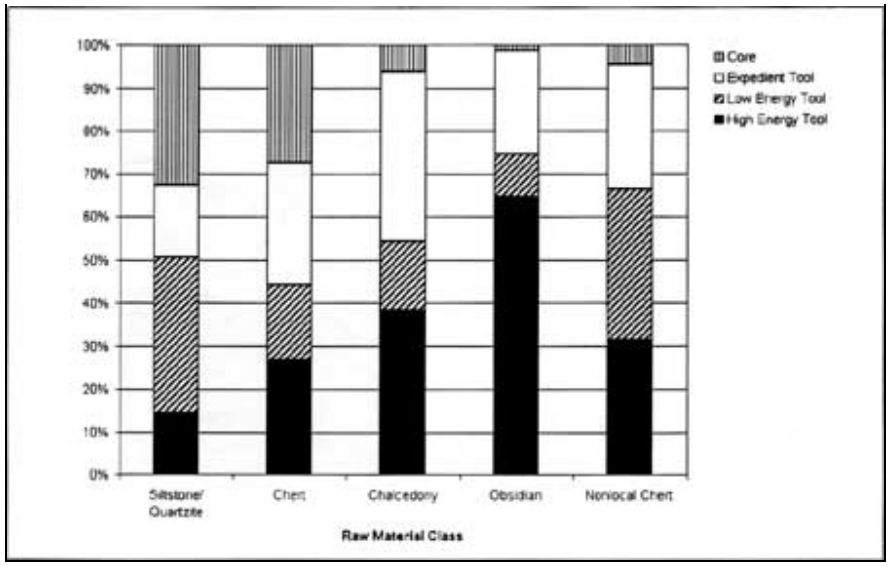


Figure 9.6. Tool types for major raw materials, all sites.

Figure 9.7 displays these same data in a different manner, showing the relative contribution of each raw material group in each tool class. Obsidian and local chert appear to have been preferred for high-energy tools. Low energy tools and cores display a pattern that includes more use of siltstone and quartzite than expected. Expedient tools have a higher percentage of obsidian than all other classes except high-energy tools. As indicated in the expectations, this is likely due to the extremely sharp edges on obsidian debitage.

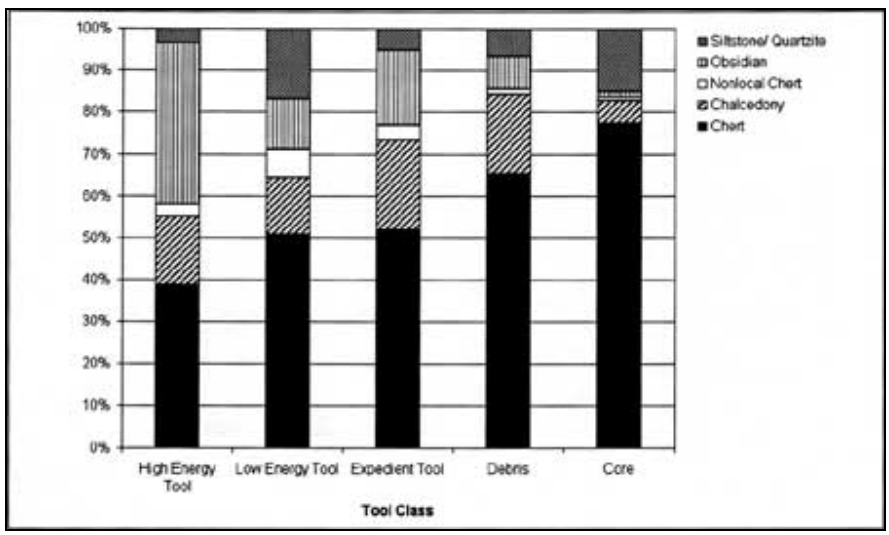


Figure 9.7. Raw materials for each tool type, all sites.

The level of concern with conserving raw material can be assessed using the actual amount of a given raw material, measured by weight or volume, recovered as a given tool class. Specimen weight was not recorded in the field; we therefore use volume (length x width x thickness) to compare raw material amounts. As an example of the relationship between raw material conservation and the volume of that raw material recovered archeologically, frequent abandonment or discard of relatively large cores of a specific raw material results in a large volume of material recovered archeologically for the core tool class and reflects a lack of concern for material conservation. At the other extreme, heavily conserved materials would only be discarded as tools and wasteful discard would be of minimal volume.

Changing patterns in raw material use and conservation through time can be examined by considering the volume of

each material type and tool class by time period. Note that in the following investigation, only undated sites (with no ceramics), and Periods 2 through 6 are discussed. The frequencies of Period 0 (pre A.D. 1075) and Period 1 (A.D. 1075-1200) sites resulting from the survey are so low (n=2 for both periods) that interpretations and comparisons based upon these sites would be suspect.

Figure 9.8 displays the average volume per site of siltstone and quartzite for assemblages through time. The undated sites have the greatest average use of siltstone/quartzite. There is a trend of increased average volumes through time until Period 5 (A.D. 1575-1700). There is also an increased use of siltstone/quartzite for low-energy tools throughout the Puebloan sequence. Cores account for a considerable portion of the siltstone and quartzite in each time period, while high-energy tools consistently account for a very small portion. This pattern indicates very little in the way of material conservation.

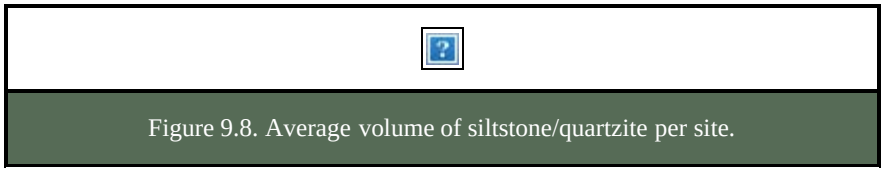


Figure 9.8. Average volume of siltstone/quartzite per site.

Figure 9.9 displays the relation of average local chert volume to tool type through time. The overall trend is similar to siltstone/quartzite—with an even greater volume of material recovered as cores. The pattern for local chert meets our expectations particularly well. The material is used for all tool types, does not appear to have been highly conserved, and its pattern of use is stable throughout all time periods.

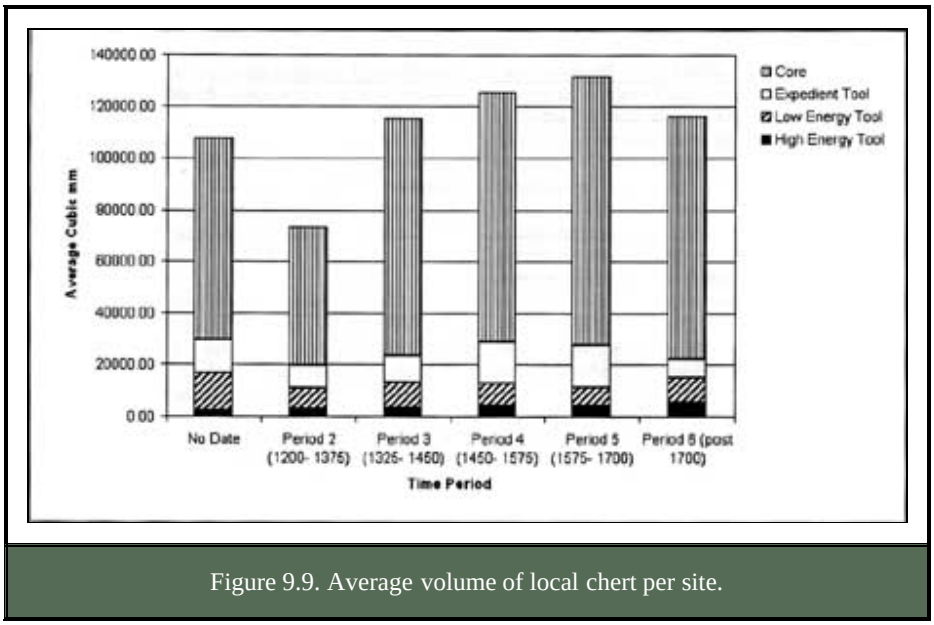


Figure 9.9. Average volume of local chert per site.

The temporal pattern is different for the local chalcedony, as shown in Figure 9.10. The volume of chalcedony rose through Period 4 (A.D. 1450-1575) and falls toward the end of the Puebloan sequence. Expedient tools account for much more volume than cores among items made of chalcedony. In addition, a higher proportion of the material is used for the production of high-energy tools. Both of these patterns indicate a higher degree of material conservation than is indicated for other locally available raw materials.



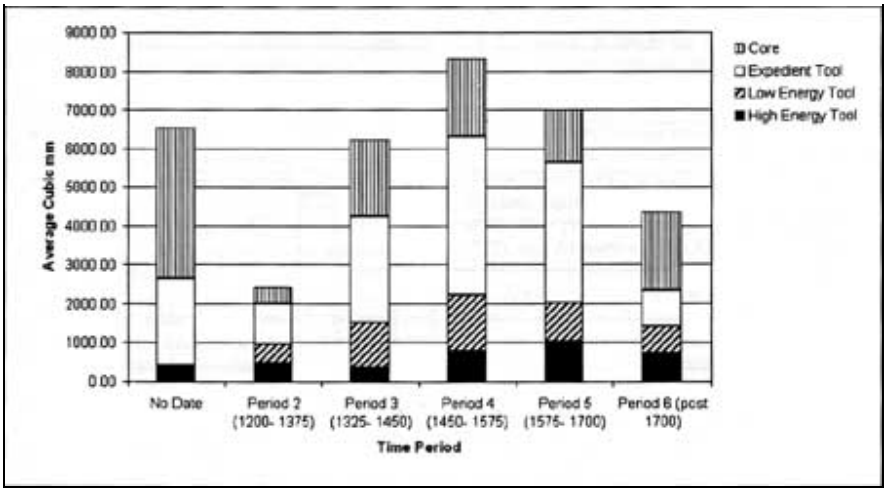


Figure 9.10. Average volume of chalcedony per site.

Raw material coming into the Pecos Valley from more distant sources increases in volume through time, at least until the end of Period 5 (A.D. 1575-1700). Figure 9.11 displays the average volumes for obsidian artifacts. Overall, there appears to be a fairly gradual increase in obsidian volume through time with a consistent emphasis upon use for high-energy and expedient tools. Between Period 3 (A.D. 1325-1450) and 5, however, there is a notable increase in average obsidian volume, along with a decrease in material conservation as indicated by the increasing proportion of tools other than high-energy tools. Cores do not represent a great portion of obsidian in any time period. A more detailed analysis of obsidian from the park is presented below.

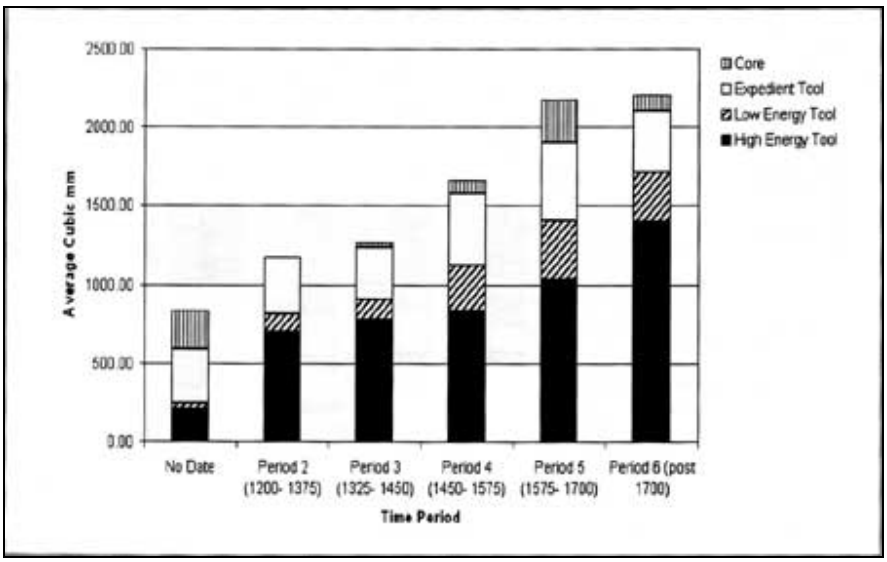


Figure 9.11. Average volume of obsidian per site.

Lastly, Figure 9.12 shows the pattern of volume for nonlocal cherts. Prior to Period 4 (A.D. 1450-1575) there are relatively few nonlocal chert materials. The undated sites also have very little nonlocal chert. In contrast, Periods 4 and 5 exhibit a considerable increase in the volume of nonlocal cherts, indicating either increased long-distance procurement, or more likely, increased interaction with other groups in the form of trade. Examination of the survey data revealed that raw materials from the Great Plains (particularly Alibates flint) were most abundant during these periods. Unlike obsidian, which is also presumed to have been a trade item, nonlocal cherts were not used or conserved in any unique way. Like local chert material, nonlocal chert was used for all tool types and consists of a high proportion of cores and expedient tools.

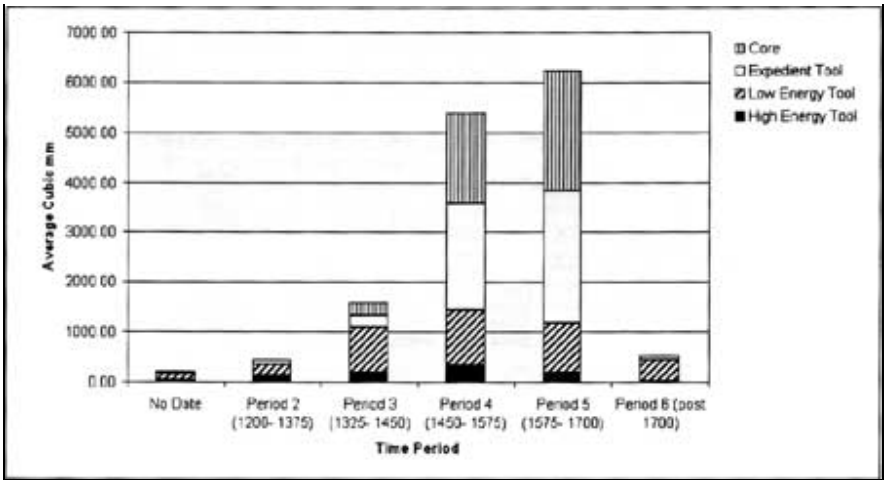


Figure 9.12. Average volume of nonlocal chert per site.

Several patterns resulting from this examination of raw material and technology warrant further discussion in relation to aggregation and trade. While trade for obsidian from the Jemez Mountain region appears to have gradually increased through time, a sharp increase in average nonlocal chert volume suggests that much of the interaction with groups from other areas began in Period 4 (A.D. 1450-1575) and continued through Period 5 (A.D. 1575-1700). As maximum population in the Upper Pecos Valley appears to have been reached during Period 3 (A.D. 1325-1450) (Chapter 7), a simple population threshold would not appear to account for the abrupt increase in trade. On the other hand, slightly lower overall populations more densely aggregated at one or two pueblos, which appears to be the case for Periods 4 and 5 (Chapter 7), do appear to correspond to the increased trade activity. Thus, it appears that only a centralized population was appropriately poised for substantial trade.

Judging from the presence of specific Great Plains sources, notably Alibates flint, the increased volume of nonlocal chert in Periods 4 and 5 appears to be related to some degree with increased interaction and trade with groups from the Great Plains. This same timing of interactions between the Plains and Pueblos is identified by numerous researchers (Baugh 1991; Habicht-Mauche 1991; Spielmann 1991). Correspondingly, obsidian from Jemez sources is most abundant in these Late Prehistoric period sites on the Southern High Plains (Baugh and Nelson 1987). Because there is little evidence of Plains/Pueblo interaction in the Jemez Mountain region for this time period, it seems probable that some of the obsidian on the Great Plains was being traded through the Pecos area.

Despite some of the nonlocal cherts from the park being of truly exotic origin, their use and degree of conservation does not appear to differ from that of local cherts. Thus it does not appear that they were any more desirable than the local material. This result runs counter to our expectation that high quality nonlocal raw materials should be used differently than other raw materials. A speculative explanation for this pattern is that exotic raw materials were little more than token gifts that accompanied the trade of more valuable items such as bison products and obsidian. As such, they would be of little more economic value than locally available raw materials of comparable quality.

Pueblo Period Obsidian Use

Earlier in this chapter we established that no obsidian is locally available in the vicinity of Pecos. Thus all obsidian raw material can be considered nonlocal (Jemez sources) or exotic (Mount Taylor sources) and can be used to better understand nonlocal and exotic raw material use through time. Specifically, by incorporating X-ray fluorescence studies carried out by the University of California at Berkeley (Shackley and White 1998), we can evaluate the differential use of specific obsidian sources for individual technological classes for the Pueblo period as a whole. Further, we can examine change in Pueblo period obsidian use through time by comparing Pecos Pueblo (PECO 228) with earlier pueblos—Forked Lightning (PECO 226), Dick's (PECO 434), Shin'po (PECO 307), Loma Lothrop (PECO 227), and Arrowhead (PECO 710).

X-ray fluorescence is a technique used to characterize the elemental composition of lithic material (Shackley 1998). It is possible to identify chemical differences between visually homogenous material through comparison of specific

elemental content measured in parts per-million. Individual artifacts can be traced to particular geologic sources by comparing the chemical signatures from artifacts with those from the geologic sources. A specific method of X-ray florescence, energy dispersive X-ray fluorescence (EDXRF), was used by the UC Berkeley lab (Shackley and White 1998) to characterize the obsidian from Pecos. EDXRF can be used to accomplish the same results as normal X-ray florescence without adversely affecting the artifact (Davis et al. 1998).

As discussed earlier in this chapter, the closest source area of obsidian to Pecos is in the Jemez Mountains (Baugh and Nelson 1987; Glascock et al. 1998). Other possible sources of obsidian to which the Pecos samples were compared include the Taos Plateau sources (Mt. San Antonio and No Agua Peaks), and Mt. Taylor (Grants Ridge and Horace Mesa), which are also discussed above, along with Red Hill, Gwynn Canyon, Mule Creek, Cow Canyon, and Antelope Wells (Peterson et al. 1994, 1997). The proximity of the Jemez Mountains to Pecos (see Figure 9.2) renders the use of each of these other sources less likely.

Within the Jemez Mountains, Baugh and Nelson (1987) identified seven locality complexes (Table 9.17). They sampled 16 localities within the locality complexes. The naming conventions for locality complex presented in Baugh and Nelson (1987) are used in this study. For example, rather than using "Polvadera obsidian" when reporting X-ray florescence sources, "El Rechuelos"—the name of the locality complex—will be used instead. One exception is the use of Bland Canyon as a separate complex from Cerro Toledo. This decision is based on the lab report from the UC Berkeley EDXRF lab (Shackley and White 1998). When presenting visually identified material, this analysis will use the naming conventions of the survey: Jemez Mountain obsidian, opaque Jemez Mountain obsidian, and Polvadera obsidian.

Table 9.17. Jemez Mountain obsidian sources.

Source System	Source Subsystem	Locality Complex	Collection Locality
Jemez Mountains	Tewa Group	Banco Bonito	
		Valle Grande	Cerro del Medio
			Cerro del Abrigo
			Cerros de los Posos
			Cerro Rubio
		Cerro Toledo	Obsidian Ridge
			Capulin & Alamo Canyons
			Paso del Norte
			Cochiti Canyon
			Bland Canyon
	Polvadera Group	El Rechuelos	Polvadera Peak
	Keres Group	Bearhead Rhyolite	Bearhead Peak
		Paliza Canyon Formation	Paliza Canyon
			Cañada de Cochiti
			Borrego Canyon
		Canovas Canyon Rhyolite	

Source: Baugh and Nelson 1987: Figure 4.

Table 9.18. Energy Dispersive X-ray Fluorescence sources for tool types.

Source	Small Point/Tool	Large Point/Tool	Debitage	Debitage w/cortex	Total
Bland Canyon	—	4	4	8	
Cerro Toledo	29	10	26	7	72
El Rechuelos	11	4	6	—	21
Grants Ridge	1	1	—	—	2
Paliza Canyon	1	—	—	1	
Valle Grande	25	7	12	2	46
Total	67	22	48	13	150

A sample of 150 obsidian artifacts was submitted for source identification. The sample included specimens from Pecos Pueblo, Loma Lothrop, Shin'po, Dick's Ruin, Forked Lightning Ruin, and Arrowhead Ruin (see Figure 1.3). Obsidian samples from each of these major pueblos in Pecos were derived mainly from collected artifacts, most of which were in the form of tools. In addition, a grab sample of 5-17 pieces of debitage from each of the above sites was collected. Some further samples were judgmentally included based upon their relevance to future research at Pecos National Historical Park or inability to be sourced based upon visual criteria. These artifacts were submitted to the EDXRF lab at UC-Berkeley. The EDXRF lab at UC-Berkeley has extensive source signatures for all known obsidian sources within the American Southwest (Shackley 1988, 1995).

Artifacts analyzed at the UC-Berkeley lab are categorized as small points/tools, large points/tools, debitage, and debitage with cortex. Small points and tools include such items as probable arrow points, drills, small scrapers, and knives but do not include used flakes. Debitage and debitage with cortex include all material removed from a tool or core that is not itself a tool, except for the case of used flakes. Most of the debitage with cortex only had a small amount of cortex on their dorsal faces.

A breakdown of tool types by EDXRF provenance is presented in Table 9.18. The Cerro Toledo (n=72), Valle Grande (n=46), and El Rechuelos (n=21) sources are the best represented in the sample. Bland Canyon (n=8), Paliza Canyon (n=1), and Grants Ridge (n=2) are present in smaller amounts. The relative abundance of each of the three major sources in the overall sample reflects their increasing distance from Pecos (Table 9.19). In other words, the geographically closest sources to the Upper Pecos Valley are the best represented in artifact assemblages, and the farthest are the least common. This represents the simplest of expected relationships—that abundance is a function of distance and indicates that differential social or economic conditions did not have a substantial effect upon the availability of one obsidian source relative to other sources of obsidian.

Table 9.19. Obsidian abundance and distance to source.

Source Area	Distance (km)[a]	Number of items
Cerro Toledo	81.7	72
Valle Grande	93.1	46
El Rechuelos	98.8	21
Bland Canyon	87.4	8

Grants Ridge	244.7	2
Paliza Canyon	96.5	1

[a]Distance from primary source or collection area to Pecos Pueblo.

The lack of cortex on any piece of El Rechuelos debitage, even when compared to other, less numerous, obsidian sources (such as Bland Canyon) suggests that El Rechuelos obsidian came into the Pecos region in a more reduced state than any others from the Jemez Mountains and is also likely related to the greater distance of the source. Another interesting observation is that El Rechuelos is relatively less exploited as a tool stone for larger points and tools. This implies that either the material available from El Rechuelos is unsuitable in quality, availability, or not of a sufficient size to produce large points or that the makers of the larger points and tools (most of these large points are dart points and match types for Archaic and Basketmaker II periods) did not use this source as extensively.

Change in obsidian use among the largest pueblos through time is expected to reflect variations in trade patterns. The small number of artifacts submitted for X-ray florescence analysis does not allow for rigorous statistical testing of the difference between the largest pueblos in Pecos National Historical Park. Figure 9.13 displays the percentage of specific obsidian sources identified from this study for each of the large pueblos.

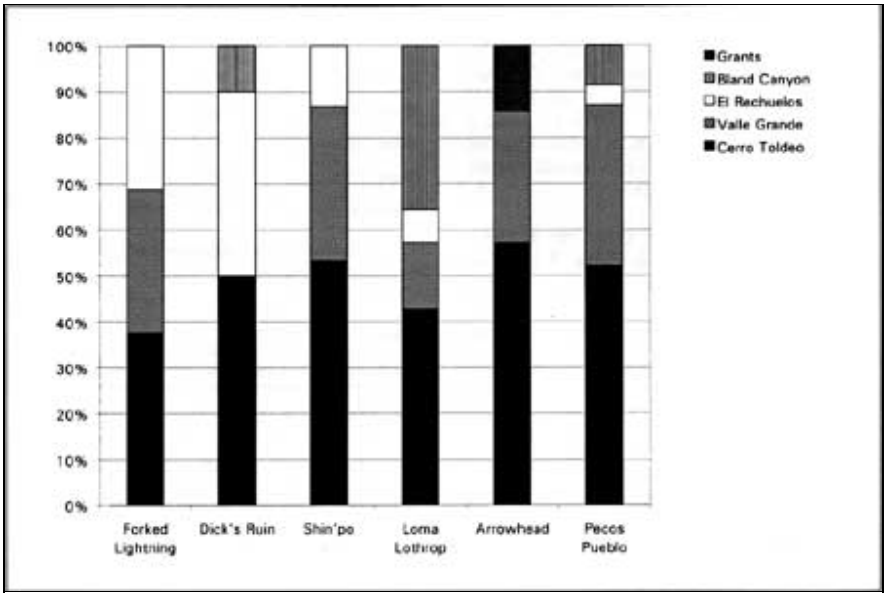


Figure 9.13. Obsidian sources determined by Energy Dispersive X-ray Fluorescence for pueblos.

The pueblos are arrayed along the base of the graph so as to correspond generally from earliest to latest, with considerable and unequal temporal overlap. It should be noted that there are possible later Plains components at Dick's Ruin, Loma Lothrop, and Shin'po (Head 1998) that may influence patterns in obsidian use. Early in the Puebloan sequence, at Forked Lightning Ruin (PECO 226), there are roughly equal amounts of Cerro Toledo, Valle Grande, and El Rechuelos sources. Dick's Ruin (PECO 434) has the highest percentage of El Rechuelos obsidian of all the sites (40 percent) with no Valle Grande and only a small amount of Bland Canyon. Shin'po exhibits smaller amounts of El Rechuelos and close to equal amounts of Cerro Toledo and Valle Grande. Toward the middle of the temporal sequence, Loma Lothrop (PECO 227) is distinguished by a relatively small proportion of El Rechuelos and a large percentage of material from Bland Canyon (all of the Bland Canyon sample is debitage and could have easily been detached from a single core). Arrowhead Ruin has no El Rechuelos and the only evidence of any long-distance obsidian, a drill identified as Grants Ridge obsidian. The only other piece of Grants Ridge material came from an Archaic/Developmental site. For the latter portion of the sequence, Pecos Pueblo has almost equal amounts of Cerro Toledo and Valle Grande as well as smaller amounts of El Rechuelos and Bland Canyon.

Figure 9.13 reveals several patterns in obsidian acquisition for the large pueblos. Obsidian from the Cerro Toledo

source was used extensively throughout the sequence. Valle Grande obsidian is a consistent contributor to the assemblages with the exception of Dick's Ruin, where none was identified. A reduction in utilization of El Rechuelos through the Puebloan sequence is indicated. Both Forked Lightning and Dick's Ruin have relatively high percentages from this source, while all the later pueblos have very little. Two sites stand out in relation to obsidian use. Dick's Ruin exhibits a noticeable lack of Valle Grande obsidian, which is present at all others. Arrowhead lacks El Rechuelos items but is the only Puebloan site in the sample that includes Grants Ridge obsidian. These latter observations, along with the abundance of Bland Canyon obsidian at Loma Lothrop, suggest that trade may have been oriented in a more southwesterly direction from the Upper Pecos Valley during the middle portion of the sequence. This suggestion is a possible avenue for future research when more comprehensive data become available. Because these results are based upon material gathered in a nonrandom fashion, making generalizations to the broader obsidian populations on each of these sites is tenuous at best. The results do indicate that the differential use of particular obsidian sources is primarily related to the distance of those sources from Pecos. It also appears that use of the El Rechuelos locality as a source of tool stone decreased through time compared with the Valle Grande and Cerro Toledo sources. Lastly, the results indicate that, as might be expected, trade for obsidian was focused almost exclusively on groups in the Jemez Mountain area.

Technological Organization and Settlement Patterns

We also anticipate that the effects of aggregation and trade on settlement organization (e.g., centralization of activities) led to differences in the distribution of tool and debitage classes among site types through time. This is evaluated through the statistical examination of percentages of each artifact class for site types from selected time periods.

The goal of this analysis is to identify differences or similarities between site types through time using the artifact classes presented earlier in this chapter. Specific expectations are proposed for both site types and time periods. Assemblages at the level of site component are used in the analyses that follow. For a single component (as defined in the field), the percentage of the assemblage for each of the following stone classes is used: high-energy tools, low-energy tools, expedient tools, cores, class 1 debitage, class 2 debitage, and class 3 debitage (see definitions above, Tables 9.8 and 9.16).

Because multiple variables (site type, artifact class, time period) are being simultaneously evaluated in the statistical tests, the Analysis of Variance (ANOVA) is used. ANOVA is a technique that is used to identify relationships between dependent and independent variables, whether the independent variables are quantitative or qualitative in nature (Kachigan 1991). ANOVA examines the difference in the mean values of a dependent variable that are associated with different values of the independent variable. The F distribution is used to assess whether this difference can be attributed to random variation in the sample means or to significant differences between the independent variables.

Most researchers outside archeology use ANOVA where the independent variables are controlled by the design of an experiment. In the case of most archeological applications—including this analysis—controlled experimental manipulation is impossible. Such nonexperiment uses of ANOVA require the analyst to settle for the problems associated with fixed effects, especially a lack of causal linkage between the dependent and the independent variable(s) (Kachigan 1991).

This investigation is also focused on the Puebloan occupation of Pecos. Small numbers of Archaic and Developmental sites prevented a statistical analysis of those time periods. Time period 1 (A.D. 1075-1200) was also removed from the second analysis (change through time) due to the small number of sites. The first statistical evaluation serves to examine the differences among site types for all Pueblo periods (see Chapter 5). A second statistical evaluation serves to examine differences among site types for individual time periods (see Chapter 4).

Artifact Classes and Site Types

Specific expectations for the abundance of particular artifact classes for different site types are based on site type definitions, which emphasize architectural features (Chapter 5). The activities corresponding to the definitions are assumed to have taken place at each site type. Special-use sites are primarily for resource extraction and should be characterized by simple and sparse artifact assemblages that reflect the use of expedient tools and some maintenance debris from low- and high-energy tools. Because seasonal sites represent short-term domiciles, artifact assemblages are expected to reflect more tool maintenance and relatively low investment in tool production. Habitation sites represent

the primary location of domestic activities, including tool production and maintenance, for most of the population, and are expected to be characterized by dense and diverse artifact scatters. Regardless of where particular tools were used, the tools themselves are expected to have most often been discarded in places where they were replaced through the production of new tools. For low- and high-energy tools these locations would most often be habitations, while at special-use sites primarily expedient tools were being produced and discarded. Thus, the following expectations for dominant artifact classes are derived for each site type:

Special-use sites — expedient tools and class 1 and class 2 debitage.

Seasonal sites — low-energy tools and class 1 and class 2 debitage.

Habitation sites — all artifact classes, with a relatively frequent occurrence of high-energy tools.

The null hypothesis to be tested is that there are no differences in artifact class frequencies for component assemblages from different site types. Rejection of the null hypothesis for any pair of site types indicates significant differences in artifact class frequencies.

The results of the ANOVA in all but one case are that the null hypothesis cannot be rejected. Thus, the analysis did not support most of the expectations for differences between site types. There were no significant differences between site types of all time periods with respect to percentages of low-energy tools, cores, class 1 debitage, class 2 debitage, and unknown/ambiguous debitage.

One expectation was supported by the analysis—more high-energy tools were found at habitation sites than at either seasonal or special-use sites (Table 9.20). Habitation sites recorded in the survey were composed of an average of 8.3 percent high-energy tools while both seasonal and special-use sites were composed of an average of 3.3 percent. This is not believed to necessarily reflect a greater frequency of activities requiring high-energy tools at habitation sites. As presented above, it more likely represents the discard of high-energy tools at a primary locus of tool replacement and maintenance.

Table 9.20. ANOVA comparison of average percentage of high energy tools from site types from all time periods.

Site Type	n	mean	d.f.	SS	F	p>F
Habitation	13	8.30				
Seasonal	192	3.31	2	314.641	5.52	.004
Special Use	382	3.33				

Site Types through Time

Identifying changes in artifact classes from site types through time would allow us to discern changes in the roles of particular site types in overall settlement organization. The differences within the Puebloan time span are not anticipated to be great since the Puebloan populations in the Upper Pecos Valley were primarily sedentary. Parry and Kelly (1987) suggest that such populations would not have significant differences in overall lithic technology. However, if one accepts Kidder's (1958) interpretation of the architecture at Pecos Pueblo as defensive, the latest time periods might be expected to have a greater frequency of high-energy tools (over 75 percent of which are projectile points and preforms) for defensive purposes. Although defensive technology was not necessarily limited to high-energy tools, two human vertebrae from Pecos Pueblo with imbedded projectile points (Kidder 1932) attest to their use in human conflicts. Kidder (1958:63) suggests that the quadrangle of Pecos Pueblo was built out of concern over such conflict. The building of the quadrangle at Pecos Pueblo corresponds roughly to the beginning of Period 4 (A.D. 1450-1575) in the Pecos chronology. If conflict in the region necessitated a greater defensive posture in the valley, implements of warfare such as projectile points would be expected to increase for habitations in Period 4 relative to Period 3 (A.D. 1325-1450). Thus, the expectations for changes through time are simple:

Periods 1-3, 6 — no differences in artifact classes for site types.

Periods 4-5 — greater frequencies of high-energy tools at habitation sites.

The first expectation mirrors the null hypotheses being tested—that there are no differences in artifact class frequencies for assemblage components from different site types. Rejection of the null hypotheses would indicate that significant differences do exist. Random samples are used in the ANOVA testing.

The results of the second series of ANOVAs are the frequent inability to reject the null hypothesis. Within each time period, there were few significant differences between site types. However, some differences are indicated to be significant for a few time periods. In Period 2 (A.D. 1200-1325), the analysis indicates that habitations have significantly higher percentages of high-energy tools than either special-use or seasonal sites (Table 9.21). The analysis did not identify any significant differences for other artifact classes.

The percentage of high-energy tools is significantly different for habitations from Period 3 (A.D. 1325-1450) as well (Table 9.22). There are no significant differences between artifact classes in Period 4 (A.D. 1450-1575).

Two artifact classes have significant differences for each of the site types in Period 5 (A.D. 1575-1700)—low-energy tools and class 2 debitage. Habitations dating to Period 5 have significantly greater amounts of low-energy tools in their assemblages compared to special-use or seasonal sites (Table 9.23). A greater amount of Class 2 debitage is marginally significant (p value between .05 and .10) for special-use and seasonal sites when compared to habitations (Table 9.24). This suggests that while low-energy tools were discarded in greater numbers at habitations, tool maintenance occurred at seasonal and special-use sites. As expected, there are no significant differences between site types for Period 6 (post-A.D. 1700).

Table 9.21. ANOVA comparison of average percentage of high energy tools from Period 2 site types.

Site Type	n	mean	d.f.	SS	F	p>F
Habitation	6	13.34				
Seasonal	39	3.48	2	530.701	11.84	.000
Special Use	56	3.79				

Table 9.22. ANOVA comparison of average percentage of high energy tools from Period 3 site types.

Site Type	n	mean	d.f.	SS	F	p>F
Habitation	10	10.67				
Seasonal	103	3.05	2	531.229	10.54	.000
Special Use	187	3.61				

Table 9.23. ANOVA comparison of average percentage of low energy tools from Period 5 site types.

Site Type	n	mean	d.f.	SS	F	p>F

Habitation	3	12.44				
Seasonal	67	2.61	2	277.564	5.76	.004
Special Use	99	3.04				

Table 9.24. ANOVA Comparison of average percentage of Class 2 debitage from Period 5 site types.

Site Type	n	mean	d.f.	SS	F	p>F
Habitation	3	9.15				
Seasonal	67	11.38	2	527.806	2.76	.067
Special Use	99	14.82				

The patterns indicate that reduction relating to high-energy tool technology is concentrated at long-term habitations. This does not necessarily mean that such high-energy tools were more often produced at habitations—there are no significant differences between the debitage classes for site types in most time periods. We suggest that habitations were places where high energy tools such as projectile points and bifaces were discarded.

Following Kidder's (1958) suggestion that the quadrangle at Pecos Pueblo was built for defense, it was expected that habitations from Periods 4 and 5 would show more evidence of these high-energy tools, primarily for defense purposes. The expected increase in high-energy tools for these periods was not supported by the data. The inverse is actually indicated. Habitations in Periods 2 and 3 have significantly more of these tools than other sites.

Why should habitations from these periods have more high-energy tools? Comparison of Pecos Pueblo with Rowe Pueblo and Arroyo Hondo, two other extensively excavated Pueblos in the northern Rio Grande area, suggests a potential answer to this question (Table 9.25). Rowe Pueblo is located in the Upper Pecos Valley about 7 km (4 mi) southeast of Pecos Pueblo and was occupied from the mid 1200s through at least the late 1300s (Cordell 1998:58). Arroyo Hondo is located about 13 km (8 mi) west/northwest of Pecos Pueblo along a tributary of the Santa Fe River of the same name. Arroyo Hondo was occupied from A.D. 1300-1425.

Table 9.25. Faunal and lithic comparison of Pecos Pueblo, Rowe Pueblo, and Arroyo Hondo.

Site	Mule Deer (%)	Hi Energy Tools (%)
Pecos Pueblo	50-75[a]	9.8
Pecos habitations	—	8.1
Rowe Pueblo	35.4	—
Arroyo Hondo	9.0	3.1

[a]Estimated (Kidder 1932).

The recent Rowe report identifies a larger than expected amount of large mammal bone found at the pueblo, 34.5 percent of which was from deer (Cordell 1998:63; Mick-O'Hara 1998). This compares well with Kidder's impression

that mule deer was the most abundant mammal represented in the Pecos Pueblo faunal assemblage. Kidder (1932:196) estimated that one-half to three-quarters of the mammal bone at Pecos Pueblo was mule deer. This may very well be an overestimation considering the incipient state of archeofaunal analysis in the 1930s, but nevertheless the observation indicates a conspicuous abundance of deer remains from Pecos Pueblo. In contrast to Rowe and Pecos Pueblo, only 9 percent of the identifiable sample was composed of mule deer at Arroyo Hondo (Lang and Harris 1984:46).

The pueblos also differ in regard to stone tool assemblages. The randomly sampled assemblages from all habitations recorded during this survey are composed of 8.1 percent high energy tools. The randomly sampled survey assemblage from Pecos Pueblo alone is composed of 9.8 percent high-energy tools. Roughly 3.3 percent of the total flaked stone assemblage from the pueblo of Arroyo Hondo reflects high-energy tools (derived from Phagan 1993, Table 21). Lithic assemblage data are not available for Rowe.

Taken together, the relative paucity of both mule deer remains and high-energy-stone tools recovered from Arroyo Hondo suggests that the hunting of large mammals was not a primary focus there. In contrast, the abundance of mule deer remains at Rowe Pueblo and Pecos Pueblo coupled with the higher percentage of high energy tools within Pecos National Historical Park seems to reflect a greater emphasis upon large mammal hunting. Thus, the patterns indicated for high-energy tools in the Pecos survey are more readily explained with regard to subsistence than to defense. It appears that more intensive large mammal hunting may have occurred during Periods 2 and 3 relative to Periods 4 and 5, with correspondingly greater investment in high-energy tools. If this is the case, then it would appear that the importance of large mammal hunting for the inhabitants of the Upper Pecos Valley decreased over this period of time. This proposition could be better evaluated with more detailed faunal analyses at sites within Pecos National Historical Park.

The Nonflaked Lithic Assemblage

Nonflaked lithic items are those stone artifacts that were not produced or maintained through reduction by flaking. This category includes ground, polished, and abraded stone items, as well as some that were used without intentional modification (e.g., manuports, anvils). Ground stone tools and technology are the subject of much of this section of the report due both to their abundance in the archeological record and their association with past food processing activities.

The recording system for nonflaked lithic items differed from that of flaked stone. Lithic analysts recorded all nonflaked lithic items that fell within a sample unit (Appendix C) and all others found on the site. Therefore, the ground stone database comprises all of the identifiable ground stone on the surface of sites within the park.

Material type, nonflaked lithic type, condition, and size (length, width, and thickness) were recorded for every item when possible. Length, width and thickness were recorded only for whole items or fragmentary items that fit together to make a whole. Size data were not recorded for incomplete items. For ground stone, nonflaked lithic type specified the ground stone form, cross-section shape, and number of grinding surfaces were also recorded. The recording manual (Appendix C) provides definitions for each of these attributes, including each of the ground stone types.

Nonflaked Lithic Assemblage Parameters

This section presents the summary results for the nonflaked lithic types recorded during the Pecos survey, regardless of time period or site type, with an emphasis on ground stone tools. These data serve as the baseline for the subsequent section in which specific expectations are evaluated. Summary results are presented by nonflaked lithic type—manos, metates, axes/mauls/hoes, and other nonflaked lithic materials.

Manos

Manos were assigned to several classes during field recording. Because mano morphology mirrors the morphology of the used surface on associated metates (Adams 1999), mano classes were defined in reference to probable association with certain metate types. Mano types include one-hand manos often associated with basin metates, two-hand manos associated with trough metates (with distinctive facets produced by incidental rubbing of the mano against the trough walls), and two-hand manos associated with slab metates, which are longer and narrower than trough manos and lack the distinct facets. If the type of two-hand mano could not be determined, manos were assigned two-hand mano, not further specified (nfs). If size could not be determined, the artifact was assigned to "mano, nfs." Survey crews identified

a total of 510 one-hand manos; 1 two-hand mano, trough; 16 two-hand mano, slab; 48 two-hand manos, nfs; and 167 manos, nfs.

Table 9.26 presents the breakdown of mano type by raw material. For the sake of brevity, the table displays manos used with trough and slab metates collapsed into the more general "two hand mano" category. Three major material types dominate the assemblage of manos—quartzite, sandstone, and silicified sandstone. These materials account for a total of 700 of the 742 manos, or nearly 95 percent. Quartzite and silicified sandstone are primarily found as cobbles in current and remnant alluvial deposits (such as gravel bars and terraces) that comprise much of the surface deposits of this portion of the Upper Pecos Valley. Sandstone is found as exposed bedrock or boulders, though some pieces are found in the alluvial deposits as well.

Cross-section data for manos provide information that can be used to infer grinding intensity and material conservation. Graphical representations of cross-section types are presented in Figure 9.14. Using ethnographic observations of Hopi women grinding corn as well as experimental observations (Adams 1993; Bartlett 1933; Cameron 1998), archeologists have identified specific cross sections that indicate intensity of mano use. The continued use of a two-hand mano results in a progression from subrectangular (Figure 9. 14g), through wedge (Figure 9. 14d), airfoil (Figure 9. 14f), and triangular (Figure 9. 14b) cross sections. This progression is not transferable to most one-hand manos, which most likely were used in a reciprocal and/or rotary motion (Wright 1993). Adams (1993, 1999) suggests that patterns of use from experimental grinding activities with one-hand manos produce different wear patterns depending upon the motion used. Rotary motion produces wear along the edges of the mano, while reciprocal motion wears the mano in the center. Rotary motion might result in biconvex cross sections while reciprocal motion with one-hand manos would probably produce a progression similar to that for two-hand manos. The degree of grinding intensity reflected in the cross-section morphology of discarded manos indicates the level of concern for material conservation. A low level of concern for conservation would be reflected in the discard of manos characterized by relatively low intensity of use; a high level of concern would be reflected in the discard of only intensively used manos.

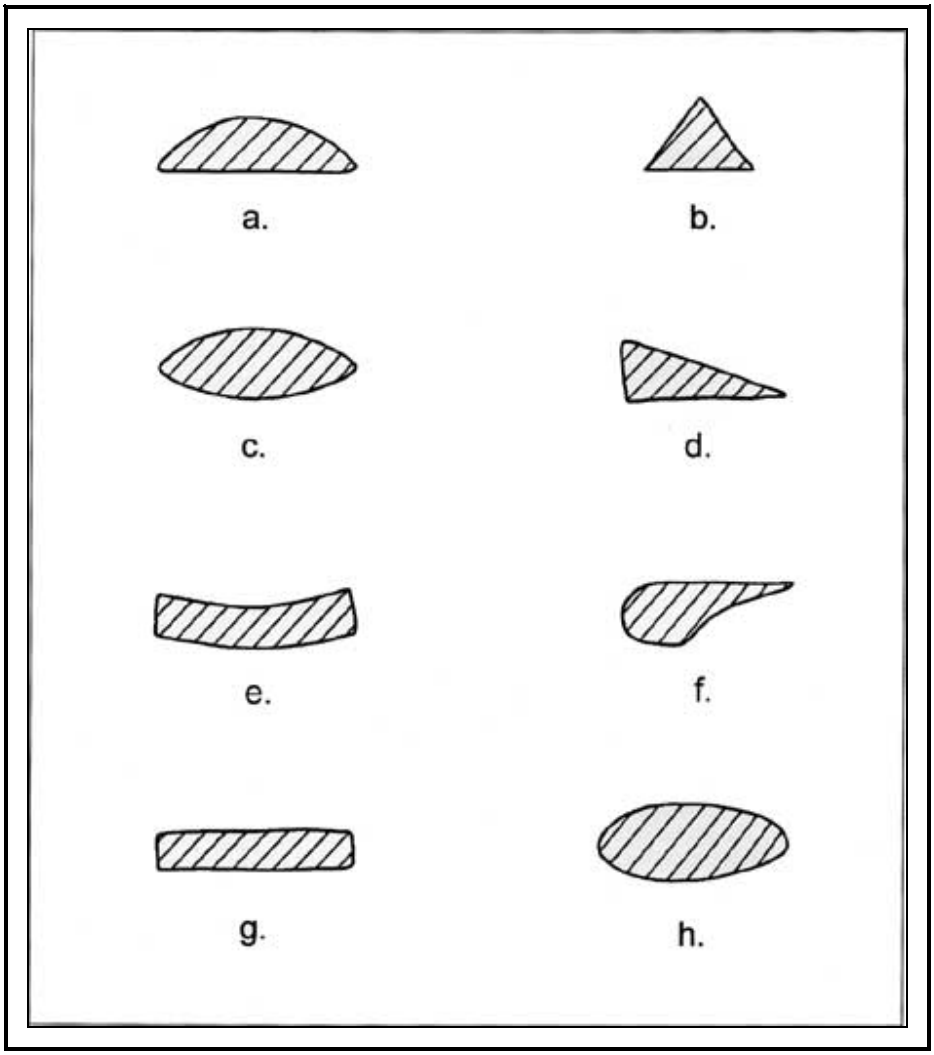


Figure 9.14. Cross-section classes for ground stone: a. plano-convex, b. triangular, c. biconvex, d. wedge, e. concave-convex, f. airfoil, g. subrectangular, and h. oval.

Table 9.26. Cross-tabulation of mano type by material type.

Material Type	Mano, nfs	Mano, one-hand	Mano, two-hand	Total
Igneous, nfs	1	2	-	3
Granite	3	1	-	4
Diorite	1	-	-	1
Basalt	1	-	-	1
Andesite	-	3	-	3
Metamorphic, nfs	3	5	-	8
Quartzite	39	93	16	148
Gneiss	-	1	-	1
Schist	4	4	-	8
Sedimentary, nfs	-	5	-	5
Siltstone	2	2	-	4
Sandstone	73	214	38	325
Silicified sandstone	38	178	11	227
Limestone	-	1	-	1
Conglomerate	-	1	-	1
Quartz	2	-	-	2
Total	167	510	65	742

Composite mano cross-section data from all sites within Pecos are presented in Table 9.27. Cross-section data were not recorded for a small number of manos (n=15). In decreasing frequency oval, subrectangular, and plano-convex account for 497 of 727 manos (68 percent). Oval cross sections are nearly twice as frequent as the next most frequent classes. One-hand manos tend to be oval, with plano-convex, biconvex, and subrectangular being frequent as well. On the other hand, most two-hand manos are subrectangular, with others being plano convex or oval in cross section. These patterns indicate a relatively low intensity of use prior to discard or abandonment for most manos. One hand manos in particular tend to be less intensively used.

Another way of estimating grinding intensity is to examine the number of ground surfaces on each mano. Table 9.28 presents these data for each general mano type. Examination of this table indicates that the majority of manos (n=461, or 62 percent) have only one ground surface, but a noticeable number have two or more ground surfaces (n=259, or 35 percent). Within each mano type specimens with one ground surface predominate; a roughly equal ratio of one-surface to-two surface manos occurs within the one- and two-hand manos (1.47:1 and 1.46:1, respectively) but "mano, nfs" has a much higher ratio (4:1) suggesting that these ambiguous manos were less intensively used.

Table 9.27. Cross-tabulation of mano type by cross section.

Cross Section	Mano, nfs	Mano, one-hand	Mano, two-hand	Total

Plano-convex	20	70	12	102
Biconvex	17	75	4	96
Subrectangular	35	77	25	137
Wedge	3	4	1	8
Airfoil	10	32	3	45
Triangular	4	3	1	8
Ovoid	42	203	13	258
Indeterminate	30	39	4	73
Total	161	503	63	727

Note: Fifteen records have no entry for cross section. This accounts for the difference in totals between Table 9.26 and Table 9.27.

Table 9.28. Number of ground surfaces by mano type.

Surfaces	Mano, nfs	Mano, one-hand	Mano, two-hand	Total
None	2	-	-	2
One	128	295	38	461
Two	32	198	26	256
Three +	3	-	-	3
Unknown	7	12	1	20
Total	167	510	65	742

Condition refers to the completeness of each mano as estimated by the lithic field analyst. Four condition options presented gross levels of artifact completeness and include: less than 50 percent, more than 50 percent but not complete, broken but complete (able to fit pieces together), and complete. Table 9.29 presents the totals for each of the mano types. Most of the "mano, nfs" class falls into the less than 50 percent condition (almost 80 percent). The majority of one-hand manos are complete (53 percent), while two-hand manos are evenly split between the three main classes (disregarding "broken, but complete," which has only one instance for all manos). The greater rate of breakage for two-hand manos is likely related to shape, because the greater ratios of length to thickness increase the probability of breakage under bending stress.

Table 9.29. ross-tabulation of mano type by condition.

Condition	Mano, nfs	Mano, one-hand	Mano, two-hand	Total
< 50%	132	90	20	242
> 50%	19	149	21	189
Broken, but complete	—	1	—	1
Complete	15	270	24	309
Total	167	510	65	742

Size measurements for each complete specimen were recorded as maximum length, width, and thickness. Table 9.30 displays the average measurements for each mano type. Comparison of the average sizes for one-hand and two-hand manos provides an opportunity to evaluate the reliability of the subjective classification. A t-test reveals that two-hand manos and one-hand manos are significantly different in length (Table 9.31) and width dimensions (Table 9.32) but not in thickness. On complete manos, total grinding area is larger for two-hand manos. Manos that could not be assigned as belonging to either the one- or two-hand variety fall between these two extremes. These results are not surprising since manos were classified as either one- or two-hand primarily based on size criteria, but they do serve to demonstrate the reliability of the field classification.

Table 9.30. Average sizes for complete manos by mano type.

Measurement (mm)	Mano, nfs	Mano, one-hand	Mano, two-hand
Average Length	127.26	113.76	185.67
Average Width	91.73	89.27	110.33
Average Thickness	51.28	49.47	48.00

Table 9.31. Student's T-comparison of mano type by length.

Mano Type	n	mean	s.d.	T	d.f.	p>T
One-hand	265	113.76	19.359			
				-6.948	17	.000
Two-hand	18	185.67	43.617			

Table 9.32. Student's T-comparison of mano type by width.

Mano Type	n	mean	s.d.	T	d.f.	p>T
One-hand	265	89.27	15.969			
				-3.996	18	.001
Two-hand	18	110.33	21.976			

Metates

The number of metates located and recorded within Pecos National Historical Park is rather low. Only 161 metates were identified for all Puebloan sites. Table 9.33 presents metates by material type for all Puebloan sites. A majority of these metates were made of sandstone (n=83, or 52 percent). Other frequently used materials are, in decreasing order, quartzite, orthoquartzite, and metamorphic, nfs. Other raw materials contributed less than 10 percent each. Of the metates that were complete enough to classify as to type, most were slab metates (n=46, or 29 percent). Only 29 (18 percent) were basin metates. Very few trough metates were identified (n=3, or less than 2 percent). The latter are included within the "metate, other" category in Table 9.33.

Table 9.33. Cross-tabulation of metate type by material type.

Material Type	Metate, nfs	Metate, basin	Metate, slab	Metate, other	Total
Igneous, nfs	—	—	1	1	2
Granite	4	2	1	—	7
Andesite	2	—	—	—	2
Metamorphic, nfs	4	—	6	—	10
Quartzite	14	—	7	—	21
Gneiss	—	3	1	—	4
Schist	4	4	—	—	8
Siltstone	2	1	—	—	3
Sandstone	41	17	23	2	83
Orthoquartzite	7	1	7	3	18
Limestone	1	1	—	—	2
Quartz	—	—	—	1	1
Total	79	29	46	7	161

Cross-section data are generally less informative concerning intensity of use for metates than for manos. Slab metate use intensity is particularly difficult to determine due to the relatively even surface wear expected and the inability to estimate original thickness. Metate cross sections (Figure 9.14) are a result of the size of the accompanying mano and the motion with which the mano was used (Adams 1999). Therefore, assuming that two-hand manos accompanied slab metates and one-hand manos accompanied basin metates, we would expect most slab metates to be subrectangular and basin metates to be convex-concave. Table 9.34 presents the cross-tabulation of metate type by cross section. Most basin metates fit the general expectation, but a surprising number (n=8 or 21 percent) of slab metates are also convex-concave. These might represent slab metates that were used relatively intensively with a one-hand mano or a comparatively short two-hand mano. The abundance of one-hand manos (n=510 or 69 percent), in comparison with the relative dearth (n=23 or 18 percent) of basin metates with which they are expected to have been used, might indicate that one-hand manos were in fact often used with slab metates.

Table 9.34. Cross-tabulation of metate type by cross section, all sites.

Cross section	Metate, nfs	Metate, basin	Metate, slab	Metate, other	Total
Plano-Convex	1	4	3	—	8
Biconvex	1	—	1	—	2
Convex-Concave	10	14	8	3	35
Subrectangular	30	3	21	—	54
Triangular	—	1	—	—	1
Wedge	—	—	1	—	1
Airfoil	2	—	—	—	2
Indeterminate	19	1	4	4	28
Total	63	23	38	7	131

Note: Thirty records have no entry for cross section. This accounts for the difference in totals between Tables 9.33 and 9.34.

Nonportable Grinding Features

In addition to portable nonflaked stone tools, 509 nonportable ground or pecked and ground features were recorded. Each of them occurs on a boulder or on exposed bedrock within a site or as an isolated occurrence (IO). The majority of these features are interpreted as processing features for subsistence items. These include 326 ground surfaces and 140 cupules and mortars. The ground surfaces vary from rectangular or square to round, oval, or indistinct in shape and may have been used as expedient metates. The cupules and mortars are round and deep relative to their circumference (typically 4-8 cm). These appear to have been created through a combination of grinding and pecking, and although their function is undemonstrated, they may represent mortars or "nutting stones," for the preparation of subsistence items or pigment. The remaining 44 features are relatively long narrow grooves traditionally interpreted as areas where ground tools (such as axes and mauls) were shaped or sharpened.

Four of the grinding features consist of grinding surfaces with smaller depressions at their bases, referred to here as complex grinding features (Figures 9.15 and 9.16). PECO 301 possesses two such features, both of which are surrounded by a wide groove that empties into the pecked and ground depression. IO 333 is analogous in form to those from PECO 301, consisting of a grinding surface surrounded by a groove leading to an underlying depression. Both the groove and the grinding surface are less well formed than those from PECO 301. IO 112 differs from these only in that no groove surrounds the grinding surface.

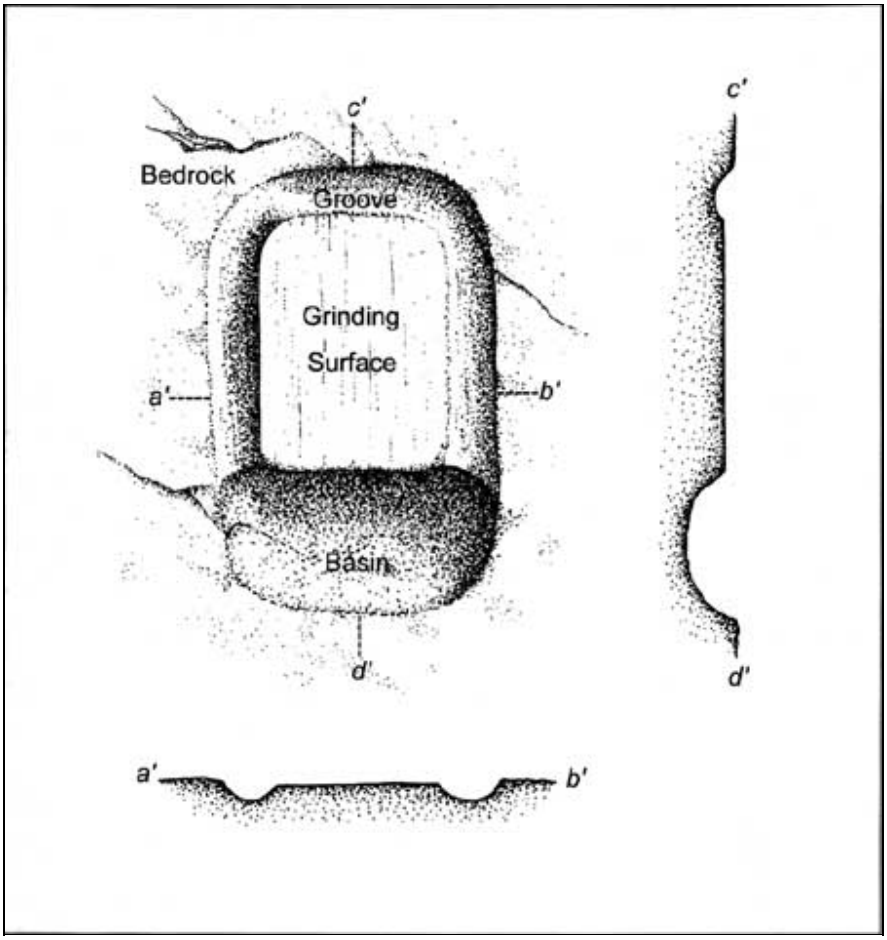


Figure 9.15. Idealized plan view and cross sections of a complex grinding feature.



Figure 9.16. Complex grinding feature at PECO 301 (LA 118875), feature 1-61-02, view N.

These arrangements may have served as grinding facilities analogous to a mealing bin containing a metate. Some support for this interpretation is found through a comparison of grinding surface size from these complex grinding features with those from complete metates recorded during the survey. Figure 9.17 illustrates that complex grinding feature surface sizes compare well with sizes for complete metates, falling mostly toward the larger end of the range. The size range compares especially well with that for slab metates, although statistical comparison is hindered by small sample sizes. Further support is provided by manos found near two of the features (those from PECO 301), one of which was noted to correspond in shape and size to the adjacent complex grinding surface.

Figure 9.17. Scatterplot comparing size of grinding area for complex grinding features with size of grinding area for complete metates.

Axes, Mauls, and Hoes

A relatively small number of these nonflaked stone tools were recorded. Eight ground stone axes (Figure 9.18a), 11 mauls (Figure 9.18b), and 16 hoes were identified on Puebloan sites. The only strong trend in raw material for these nonflaked lithic types is that hoes tend to be made of sandstone (n=10, or 63 percent), while mauls and axes were made from a greater variety of raw materials (Table 9.35). Kidder (1932:50) noted that fibrolite was a favorite material for what he defined as Type II axes (axes with specialized grooves) at Pecos Pueblo but that this material is not locally available. Montgomery (1963) proposed that the source for high quality fibrolite used in axes from around much of the Puebloan Southwest was the Truchas Peaks area (about 50 km [31 mi] north of Pecos Pueblo in the Sangre de Cristo Mountains). This led Montgomery, as well as Snow (1981:364), to propose that fibrolite axes were important exchange items among the northern Pueblos. Thus, it is somewhat surprising to note that a single axe of fibrolite, along with one maul, was recorded during this survey. It is difficult to ascertain the degree to which the sample is biased by previous collection in the monument, but reports of dozens of collected fibrolite axes (Kidder 1932; Montgomery 1963) suggest that such bias may be substantial and might explain the infrequency of fibrolite in the survey data.

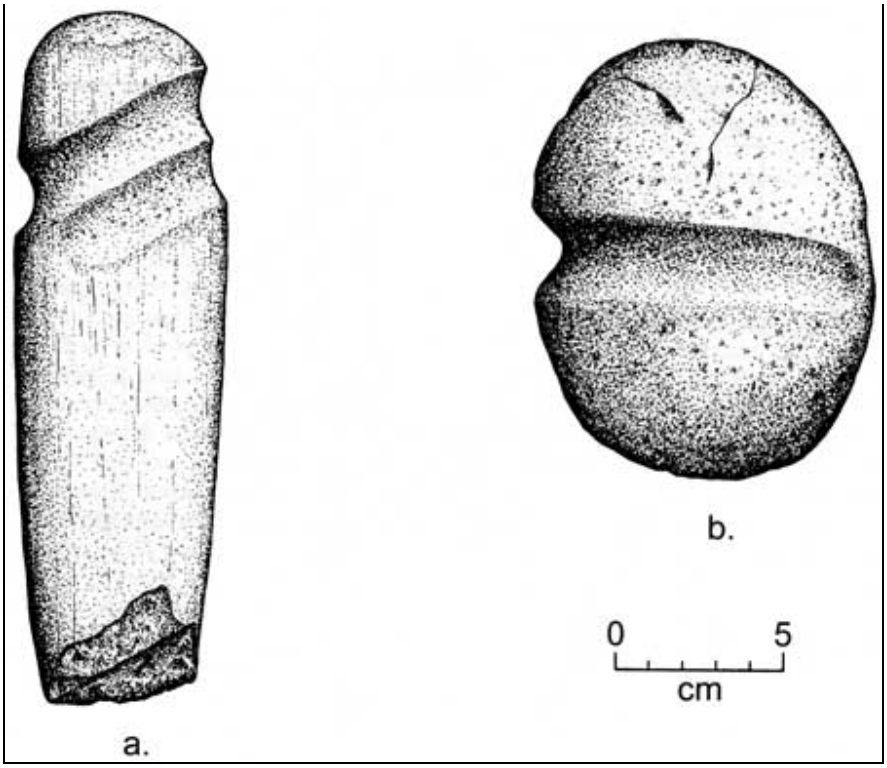


Figure 9.18. Ground stone tools: *a.* axe (Cat. No. 29180), *b.* maul (Cat. No. 29201).

Table 9.35. Cross-tabulation of nonflaked lithic type by material type.

Material Type	Hoe	Maul	Axe, ground	Total
Igneous, nfs	—	—	2	2
Metamorphic, nfs	—	—	2	2
Quartzite	2	3	1	6
Schist	4	1	1	6
Fibrolite	—	1	1	2
Sandstone	10	1	—	11
Orthoquartzite	—	5	—	5
Limestone	—	—	1	1
Total	16	11	8	35

Axes, mauls, and hoes appear to be distributed differently throughout the park. Figure 9.19 shows the geographic distribution of all axes, mauls, and hoes recorded within the park for Puebloan sites. All sites with axes are close to major drainages and tend towards the northern sections of the park. All but one are near either the Pecos River or Glorieta Creek and one of its major tributaries, suggesting their possible use for the procurement or processing of resources that occur in riparian environments.

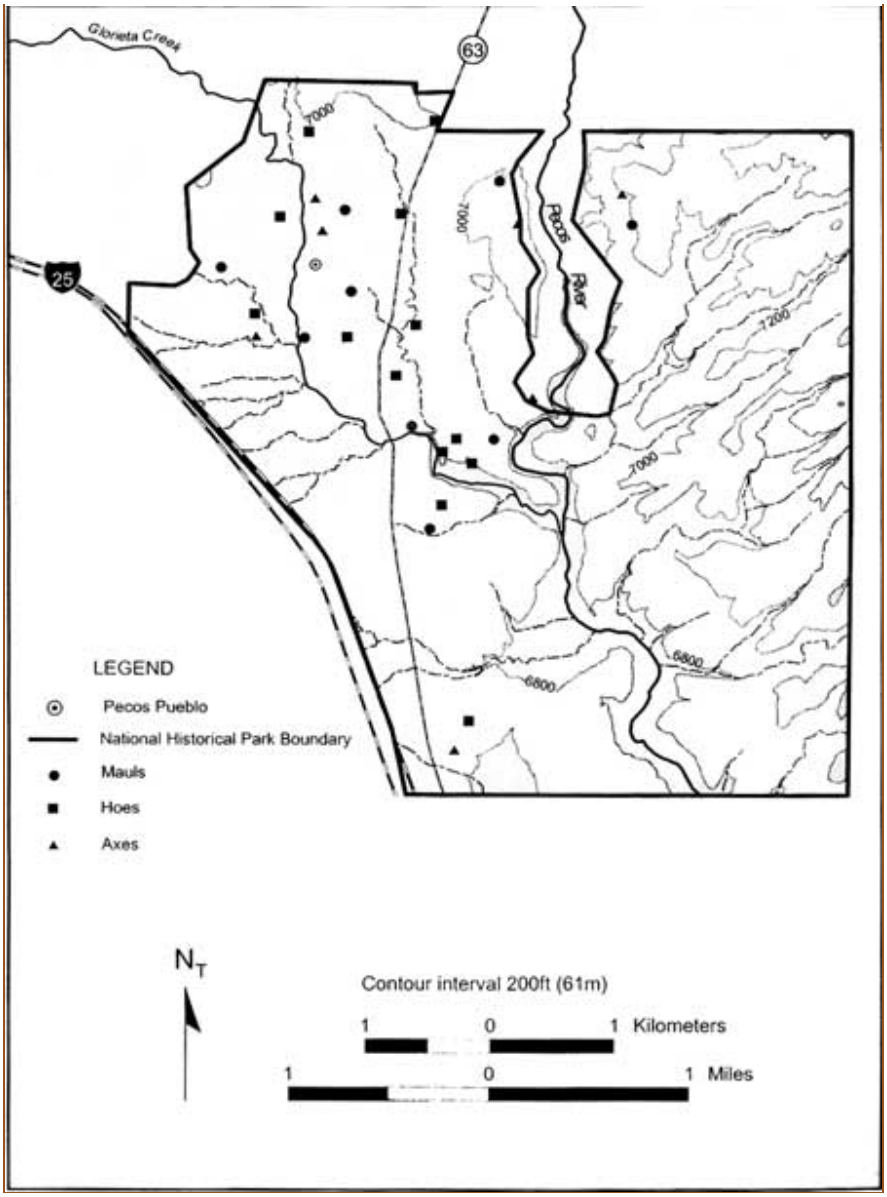


Figure 9.19. Hafted tools recorded by the survey. *(click on image for an enlargement in a new window)*

The locations of hoes presented in Figure 9.19 shows that most of these implements, traditionally assumed to be agricultural tools, are found along Glorieta Creek and one of its major tributaries. All but four appear to be very close to these drainages. These hoes are associated with a dense area of occupation within Pecos National Historical Park that may represent the greatest concentration of both population and agriculture.

The locations of mauls in the survey area reveal a contrasting pattern to both the hoes and axes. Further, mauls and hoes/axes do not co-occur on any sites (hoes and axes do co-occur on some sites). Mauls were more frequently found in upland areas between major drainages. Maul function has rarely been addressed in the archeological literature. It seems likely that they were used more for battering or crushing than for chopping, and perhaps functioned as quarrying implements for architectural stone, or as hammers for driving wedges to split wood. A lack of mauls in the excavations at Pecos Pueblo suggested to Kidder (1932) that these were more "archaic" implements, though he does report finding a number of examples at Forked Lightning Pueblo. They are not found to be particularly associated with early sites in the Pecos survey data.

Other Nonflaked Lithic Artifacts

A number of other nonflaked lithic items that do not fit into the categories described in the preceding sections were

recorded during the survey. Lithic analysts recorded 202 additional nonflaked lithic artifacts in 11 different nonflaked lithic classes. These were made from a wide range of material types (Table 9.36). Recorders used the "other" category most often (n=70) and added narrative descriptions that are difficult to summarize. Most of these tools were too fragmentary for assignment to a nonflaked lithic type, but some simply did not fit into available recording classes. The latter include items such as pecking stones, shaft-straighteners, and stone pipe fragments.

Table 9.36. All other nonflaked lithic artifacts.

Material Type	Manuport, cobble	Manuport, slab	Hammer stone	Anvil Stone	Pestle	Polishing Stone	Abrading Stone, slab	Abrading stone, grooved	Palette	Ornament	Other	Total
Igneous, nfs	—	—	1	—	—	—	—	—	—	—	7	8
Granite	—	—	—	—	—	—	—	—	—	—	2	2
Diorite	2	—	—	—	—	—	—	—	—	—	—	2
Basalt	—	—	—	—	—	—	—	1	—	—	1	2
Basalt, vesicular	2	—	—	—	—	—	—	—	—	—	—	2
Obsidian, Polvadera	2	—	—	—	—	—	—	—	—	—	—	2
Metamorphic, nfs	1	—	4	—	—	—	—	1	—	—	8	14
Quartzite	8	—	16	—	1	4	3	—	—	—	9	41
Schist	1	—	1	—	—	1	—	—	—	—	4	7
Fibrolite	—	—	2	—	—	—	—	—	—	—	1	3
Sedimentary, nfs	—	—	1	—	—	2	—	—	—	2	—	5
Siltstone	1	—	1	—	2	—	1	—	—	—	2	7
Sandstone	6	2	—	1	1	1	9	3	2	—	16	41
Orthoquartzite	4	—	1	—	—	—	5	2	—	—	6	18
Limestone	—	—	1	—	—	—	—	—	—	—	3	4
Chalcedony	1	—	2	—	—	—	—	—	—	—	—	3
Chert, nfs	5	—	12	—	—	1	—	—	—	—	2	20
Petrified Wood	2	—	—	—	—	—	—	—	—	—	—	2
Conglomerate	2	—	—	—	—	—	—	—	—	—	—	2
Quartz	1	—	—	—	—	1	—	—	—	—	6	8
Hematite	—	—	—	—	—	—	—	—	—	—	1	1
Turquoise	4	—	—	—	—	—	—	—	—	1	—	5
Other	1	—	—	—	—	—	—	—	—	—	1	2
Indeterminate	—	—	—	—	—	—	—	—	—	—	1	1
Total	43	2	42	1	4	10	18	7	2	3	70	202

Manuports comprise the next most frequently recorded nonflaked lithic class presented in Table 9.36, followed closely by hammer stones. Manuports were often cobbles of raw material that were probably intended to be used in making other tools—obsidian, chert, and chalcedony for chipped stone; basalt, sandstone, and silicified sandstone for ground

stone; and turquoise and petrified wood for personal adornment or some other purpose. Dense raw material was used for many hammer stones, with quartzite and chert being the most frequently encountered.

Population Aggregation and Grinding Intensity

The preceding section presents the overall patterns in the data for all nonflaked lithic materials. We can now use some of these data to address particular questions regarding the effects of population aggregation upon nonflaked lithic technology. In the research design (Chapter 1), it is hypothesized that an intensification of grinding activities, due to increased consumptive needs, occurred with the establishment of Pecos Pueblo as an aggregated population center. Based upon the relationship between grinding intensity and mano cross-section morphology presented above, the effects of aggregation should be identifiable in the Pecos survey ground stone assemblage. The prehistory of Pecos National Historical Park leads us to expect differences among both time periods and site types. After a brief review of patterning related to site types, we statistically evaluate changes in grinding intensity through time.

Grinding Intensity and Site Types

If mano cross-section morphology is related to intensity of use, the frequencies of particular cross sections should vary according to site type, which is an interpretation of the nature of site occupation based primarily upon architecture. Differences among site types are not statistically evaluated here but can be subjectively evaluated based upon graphical representations of cross-section distributions for different site types. Figure 9.20 presents a cumulative percentage graph of cross-section types from all time periods organized by site type. Subrectangular and oval cross sections are the most abundant types over all. Manos with oval cross sections constitute a greater proportion of the assemblages from seasonal and special-use sites relative to habitation sites. Those with biconvex cross sections are most common at habitations (but also common at special-use sites). These patterns probably reflect a more expedient use of available cobbles at sites that were occupied less often or for shorter periods of time. Wedge and triangular cross sections appear to be patterned according to occupational intensity, as well (although airfoil cross sections remain constant). Wedge and triangular cross sections are least common on special-use sites but increasingly common at seasonal sites and habitations. This pattern probably reflects greater reuse of ground stone tools at sites representing longer or more frequent occupation. Thus, with the assumption that our site types represent valid interpretations of occupational differences, it appears that there is a logical relationship between occupational intensity and intensity of ground stone tool use that is reflected in mano cross sections. This relationship provides a means by which we can examine change in intensity of ground stone use through time.

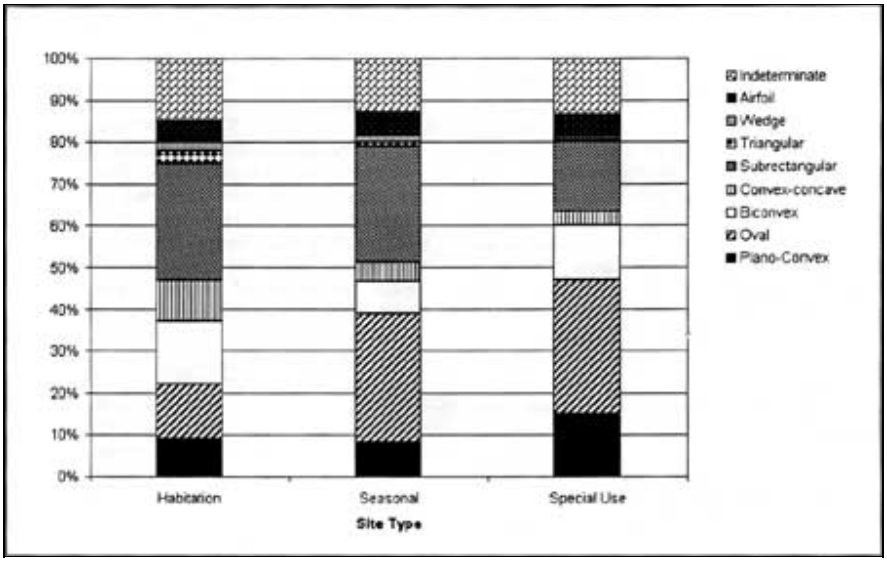


Figure 9.20. Cross sections of all manos by site type.

Grinding Intensity through Time

As presented above, intensification of grinding activities due to increased consumptive needs is hypothesized to have

accompanied aggregation. According to this hypothesis, the social unit (presumably a household) being served by an individual grinder had increased in size. One testable implication of this hypothesis is that frequencies of mano cross-section types that are associated with intensification of grinding activity rise during the periods of greatest population aggregation. As presented earlier, wedge, triangular, and airfoil cross sections are indicative of high grinding intensity for two-hand manos while these and biconvex cross sections are indicative of high grinding intensity for one-hand manos. Maximum population aggregation in the Upper Pecos Valley is estimated to have begun during Period 4 (A.D. 1450-1575) (Chapter 7, this volume). The expectation, therefore, is that the above cross-section types will be significantly more abundant for Period 4 and later periods than for the preceding periods. The null hypothesis that there is no difference in average frequencies of cross-section types is tested for Periods 3, 4, and 5 below. Rejection of the null hypothesis supports the expectations only if changes in the most frequent cross-section types are indicative of increased grinding intensity.

Despite having presumably recorded the total population of visible manos from sites within the survey area, this assemblage represents only surface artifacts from identified sites and remains a sample of a larger population. Resampling Statistics™ allow us to compare these subsamples derived from the mano data with a simulated distribution derived from the parameters of that same data, thus enabling us to evaluate differences within the assemblage. Resampling Statistics™ (also known as Monte Carlo simulation) require no assumptions beyond that of assuming the sample is representative of the population. Simply summarized, through resampling it is possible to construct simulated distributions based on the parameters of the original sample. These simulated distributions provide samples against which others can be compared to assess whether the two samples are likely to have been taken from the same statistical population. Significance levels were set at a two-tailed .05 probability, with p values less than .025 indicating a significantly lower frequency of individual cross-section classes and p values greater than .975 indicating a significantly greater frequency of those cross sections.

Distributions for mano cross-section types for each Puebloan time period were constructed in the following manner. A simulated distribution was constructed based upon the observed distributions from Period 2 (A.D. 1200-1325). Temporal trends were assessed using Period 2 as the baseline dataset since there are few Period 1 (A.D. 1075-1200) sites. The observed distribution for Period 3 was then compared to the simulated distribution for Period 2. By this procedure one can ascertain the probability that Period 3 manos come from the same population as Period 2 manos. This procedure is repeated for each period, with the observed percentages for the period of interest being compared to the simulated distributions based upon the preceding period.

The results of statistical tests are summarized in Table 9.37. The observed data is presented graphically in Figure 9.21. When we examine the probabilities of getting the distribution for Period 3 (A.D. 1325-1450) based on Period 2 (A.D. 1200-1325) (shown in Table 9.37), we find that there are a significantly higher number of plano-convex cross sections and a significantly lower number of subrectangular cross sections than expected for the Period 3 assemblages. The null hypothesis is therefore rejected in regard to Period 3. Significantly greater percentages of cross-section types that are not associated with intensive grinding activity are present. Whether this supports our expectations or not depends upon statistical results for Periods 4 and 5.



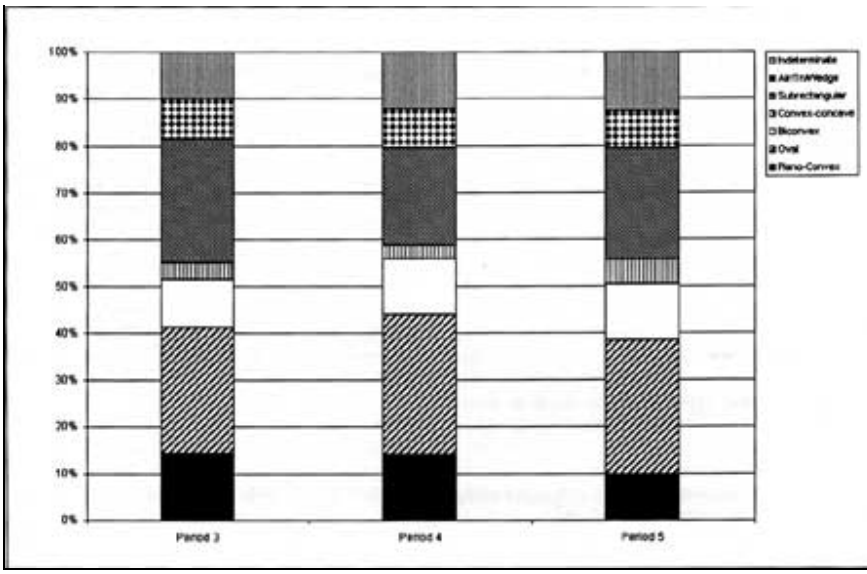


Figure 9.21. Cross sections of manos from all sites from Periods 3, 4, and 5 (observed distributions).

Table 9.37. Resampling comparison of mano cross section by time periods, observed distributions displayed.

	Period 2	Period 3		Period 4		Period 5	
Cross Section	n	n	p(2-3)	n	p(3-4)	n	p(4-5)
Plano-convex	19	67	**0.990**	54	0.386	37	**0.004**
Oval	41	125	0.967	116	0.906	110	0.255
Biconvex	18	48	0.479	46	0.808	46	0.461
Convex-concave	11	17	**0.003**	12	0.217	20	**0.977**
Subrectangular	60	124	**0.000**	80	**0.003**	91	0.918
Air/Tri/Wedge	11	40	0.965	32	0.345	30	0.341
Indeterminate	17	46	0.532	47	0.904	49	0.572

Note. Significant differences at 0.05 in bold.

The null hypothesis must also be rejected for Period 4 (A.D. 1450-1575). Subrectangular cross sections are significantly less frequent for Period 4 in comparison with Period 3. This indicates that manos were less frequently abandoned without intensive use in Period 4 in comparison with Period 3 but does not directly support our expectations. There do appear be to somewhat greater frequencies of wedge, triangular, and airfoil cross sections for Period 4, especially at habitation sites, but the increase is not statistically significant.

In the final test, the null hypothesis must again be rejected for Period 5 (A.D. 1575-1700). There are significantly lower percentages of plano-convex cross sections than in Period 4. Again, this pattern indicates less frequent abandonment of manos without intensive use, but expected increases in intensive ground stone use as indicated by wedge, triangular, and airfoil cross sections are not evident. Due to the low number of Period 5 habitation sites, these were not included in the tested sample, so they are not shown in Figure 9.21. The exclusion of these sites might be expected to render the expectation more difficult to support with regard to Period 5. Their exclusion, however, does not affect the results for Period 4.

We expected that, given a hypothesized increase in intensity of grinding activity due to the subsistence demands of an

aggregated population, mano cross-section types representing more intensive use would increase in relative abundance for sites from Period 4 and later. The statistical evaluations fail to provide any rigorous support for this expectation. Some weak support for the overall hypothesis is found in the fact that little-used manos were less frequently abandoned in Periods 4 and 5. The lack of support for the chosen implication of the hypothesis does not render the general hypothesis of population aggregation disproved. One explanation for the results might be found in the local abundance of cobbles of apparently preferred ground stone raw material. Given this situation, there would be little incentive to continue to use a particular mano once it became so worn as to impede grinding efficiency (or grinder comfort), because it could easily be replaced. Other possible explanations include a shift in disposal patterns for ground stone tools that might be expected with a change to specialized grinding facilities (however, only limited evidence for grinding facilities was found at Pecos Pueblo during excavation by Kidder [1932:71]) or that changes in grinding tool morphology do not accurately reflect aggregation so much as shifts in task specialization and the division of labor (Crown and Wills 1995:180-181).

The results from the analysis of ground stone from the Pecos survey indicate that people in Pecos did not invest a great deal of time or effort into implements for grinding. Unlike many other areas in the Southwest, Puebloan people in the Upper Pecos Valley area rarely created formally shaped grinding implements. Nor do raw materials for these tools appear to have been conserved by using the tools until their utility was exhausted. These characteristics may be a result of an available abundance of appropriate stone for grinding tools. Puebloan groups could afford to procure and abandon ground stone implements at their convenience. Subsequently, trade does not appear to have played a major role in providing material for nonflaked tools. The manos suggest that an expedient ground stone technology prevailed during the entire Puebloan occupation of the park area and that this was little changed during the time of greatest population aggregation.

Summary and Conclusions

The goals of this chapter were to summarize the flaked and nonflaked lithic data collected during the Pecos survey and to use these data to examine the affects of aggregation and trade upon lithic technological organization. Due to the low frequency of sites that could be confidently attributed to pre-Puebloan periods, the chapter focused upon Puebloan lithic technology. Taken as a whole the flaked stone data describe a very generalized lithic economy. The assemblage is dominated by local raw materials but has a specific and seemingly patterned array of nonlocal and exotic varieties. The investigation of platform and debitage types indicates that generalized core reduction debris is predominant in the overall assemblage. Further, technology was primarily expedient in nature, with low-energy and expedient tools being the most common functional types for flaked lithic artifacts.

Raw material use was mostly unspecialized, but patterns of differential use of individual raw material groups are apparent. We presented a simple model predicting the way in which strategies of use and conservation are driven by raw material quality and availability. The expectations derived from the model are mostly supported by the data for tools from the Pecos survey. Local cherts were used for all tool types and do not appear to have been conserved to any great degree. Obsidian, not available locally, was more often used for high-energy tools. Low volumes of unused material indicate that obsidian reduction strategies were designed with conservation in mind. The use of two raw material groups did not meet the predictions of the model. Local chalcedony was used conservatively and preferentially for high-energy tools. Contrary to expectations, nonlocal cherts were treated no differently than local cherts. They were made into the same array of tool classes and do not appear to have been conserved to any great degree.

Obsidian sourcing was carried out for selected artifacts using EDXRF. Examination of the results of the EDXRF analysis indicates the use of a variety of obsidian sources. The abundance in the sample of raw materials from particular obsidian sources is primarily a function of the distance of those sources from Pecos. It also appears that use of the El Rechuelos locality as a source of tool stone decreased through time compared with the Valle Grande and Cerro Toledo sources. As might be expected, obsidian procurement was focused almost exclusively on the Jemez Mountain area. Although direct procurement may have been possible, temporal patterns in the relative abundance of obsidian from individual sources suggest that trade may have played some role in access to obsidian.

Taken together, obsidian and nonlocal chert provide insight into the timing and nature of trade intensification at Pecos. More interaction with the Plains began in Period 4 (A.D. 1450-1575) based on the trends in the chipped stone raw material volumes. This is suggested by the large-scale increase in nonlocal chert during Periods 4 and 5 and the increase in average volume of obsidian in Period 4 that remains high through the end of the Pecos sequence. Because

maximum regional population is estimated to have been reached in Period 3 (A.D. 1325-1450), a simple population threshold would not account for the abrupt increase in trade. It appears that only a centralized population, such as that characteristic of Periods 4 and 5, was appropriately poised for substantial trade.

An examination of the tool classes associated with site types provided a way to evaluate the degree to which the habitation sites of later puebloan periods were poised for defense. Kidder (1958) proposed that Pecos Pueblo contained defensive architectural features that indicated an increased concern with warfare in what we are here referring to as Periods 4 (A.D. 1450-1575) and 5 (A.D. 1575-1700). Contrary to expectations, lower percentages of high-energy tools (such as projectile points) were found for these periods, which implies that there was little increased production of flaked lithic defensive weaponry. If there was increased concern with defense during these time periods, it was not manifested through an increase in high-energy tools. We propose that the relatively high frequency of high-energy tools for habitation sites in general is related to the importance of hunting. We further suggest that decreases in high-energy tool frequencies through time may correspond to decreasing emphasis on large mammal hunting. Greater abundance of large mammal remains in the Upper Pecos Valley habitation sites in comparison with that for Arroyo Hondo provides further support for this interpretation.

The parameters of the nonflaked lithic data also indicate a relatively simple and expediently organized technology. We particularly emphasized the examination of ground stone tools and found that little energy investment was made into shaping or maintaining their form. One hand manos were most common and typically did not exhibit substantial morphological change from use. Both slab and basin metates were found to be common, and these also showed little sign of intensive use. Changes in mano cross-section morphology were expected to indicate an intensification of grinding activity associated with population aggregation in Periods 4 and 5. The data for manos provided little support for this expectation. A probable explanation for this, as well as for the general expedience of ground stone technology from Pecos, can be found in the local abundance of stone of appropriate size and texture for use as ground stone tools. The manos suggest an expedient ground stone technology prevailed during the entire puebloan occupation of the park area and was little changed during the time of greatest population aggregation.

In conclusion, the affects of population aggregation upon the lithic technology of the Puebloan occupants of the Upper Pecos Valley are subtle. The social changes that surely accompanied this reorganization of human population had very little effect upon ground stone technology. The most visible effect of aggregation is an increase in trade resulting in greater frequencies of nonlocal and exotic raw materials for flaked stone. With the exception of obsidian, however, these materials do not appear to have played any unique role in the overall flaked stone economy and were probably not the commodity upon which trade was focused.

Notes

1. Evidence for Paleoindian and Archaic occupation of the survey area is based upon diagnostic projectile points. The Paleoindian period is represented by a single Folsom point (IO 96). This point was located at 2,173 m (7,130 ft) in elevation on a ridge top in the Tecolote Mountains.

Three sites appear to primarily reflect Archaic occupation. These sites occur in different environmental locations, but all are on ridge slopes. The first, PECO 300, has a basalt Armijo point, a basalt knife, and a high percentage of lithic material with evidence for use-wear. Most of the debitage appears to be from core reduction of locally available gray chert. PECO 397 has one orthoquartzite Bajada point and two one-hand manos. Much of the debitage shows evidence of tool manufacture or resharpening, and several utilized flakes and formalized knives suggest that this site may represent butchering activities. PECO 694 has two San Jose points and three Basketmaker II points, with three broken dart points that could not be typed. The debitage appears to represent a variety of reduction strategies. No other associated features were found, but 13 one-hand manos and a basin metate were also recorded.

Three more probable Basketmaker sites (in addition to PECO 694 above) were found. PECO 53 and PECO 207 are multicomponent (both have Spanish components) and each includes a pithouse feature dated in the early to mid-800s (see Appendix E). Their lithic assemblages are dominated by local cherts and chalcedony but also include obsidian and possibly Alibates chert. Both PECO 53 and PECO 207 were excavated before the current survey (Nordby 1990; Nordby and Creutz 1993a). PECO 61 is also multicomponent with a possible Basketmaker component present (based upon ceramics). The Basketmaker lithic assemblage from PECO 61 could not be differentiated from the overlying Pueblo assemblage.

2. The term "lithic raw materials," unless otherwise specified, is used here to refer to raw materials for use in reduction by flaking. Sources of ground stone materials are addressed in the nonflaked lithic section.

3. What is traditionally referred to as Pedernal chert is translucent and appears to be composed of quartz in a fibrous form; thus it appears to meet both traditional archeological and petrological criteria for chacedony.

4. What is traditionally referred to as Alibates flint consists of dolomite rock within which agate, a cryptocrystalline quartz, has precipitated resulting in the characteristic banded coloration.

5. This value of 3.3 percent is based on the reported proportion of projectile points and knives from Components I and II from Arroyo Hondo. Drills and gravers are lumped into a single category in the report and thus, unlike the Pecos survey assemblages, drills (which we consider to be high-energy tools) do not contribute to the high-energy tool percentage from Arroyo Hondo (we do not consider gravers to be high-energy tools). If the drills and gravers category is included for high-energy tools from Arroyo Hondo, the value increases to 3.8 percent.

<<< **Previous** <<< **Contents**>>> **Next** >>>

PECOS

From Folsom to Fogelson:
The Cultural Resources Inventory Survey of Pecos National Historical Park

CHAPTER 10:
EURO-AMERICAN SITES

Jeffrey L. Boyer, James L. Moore, Natasha Williamson, and Genevieve N. Head

Of the 629 archeological sites and 678 components recorded during the Pecos survey, 53 sites with 54 components are historic in date and Euro-American in origin. Euro-American artifacts are found on 50 of these sites. These historic sites reflect the significant presence and impact of Euro-American residents, short-term occupants, and users of the portion of the Upper Pecos Valley that now includes Pecos National Historical Park. The purpose of this chapter is to provide a summary of the Euro-American sites and artifacts recorded by the survey, to relate them to the temporal and thematic structure of the Cultural Landscape Overview, and to place them in social and economic context.[1]

The chapter is divided into four sections. The first section, written by Genevieve Head, gives a general description of the kind of Euro-American sites in the park and a brief summary of the seventeenth and eighteenth century Euro-American sites recorded by the survey. The second section of this chapter reports on temporal analyses of Euro-American artifacts from nineteenth and early twentieth century sites recorded during the survey. It was researched and written by staff of the Office of Archaeological Studies (Museum of New Mexico — OAS). Natasha Williamson performed data examination and manipulation of artifact data at the OAS. Williamson also recorded, in the field, additional artifact data from four sites, and re-recorded Euro-American artifacts collected during the survey for additional examination in the laboratory. Analyses of the data were performed by Jeffrey L. Boyer.

The third section of the chapter is a review of United States census records for San Miguel County for the years between 1860 and 1920. Natasha Williamson conducted the records review; Williamson also wrote all but the summary portion of this section. Although preliminary in scope, the census review shows the data potential of one group of documentary resources for illuminating population, social, and economic patterns within the Upper Pecos Valley and Pecos National Historical Park. It highlights the complex relations among the region's communities and between those communities and their regional, territorial/statewide, and national contexts. This review also illustrates the increasing integration of the Upper Pecos Valley into the region and the nation and subsequent changes in local community structure and economics.

The fourth portion of this chapter presents the results of an archeological examination of the Santa Fe Trail and trail segments within the Pecos Unit of Pecos National Historical Park. This study, which was directed by James L. Moore, was aimed at identifying remaining segments of the Santa Fe Trail that exist in the area. Other linear features were also examined to define their period of use and determine how they fit into the culture history of the Pecos area. Most linear features observed on aerial photographs were identified. Only two alignments were not identified from documentary sources and may represent trails associated with the occupation of Pecos Pueblo.

Description of Euro-American Components

Table 10.1 lists the Euro-American components recorded by the survey. This table differs from Table 5.1 presented in Chapter 5 in that it presents all recorded components attributed to Euro-Americans. Table 5.1 presents only those component types that are specifically Euro-American.

Table 10.1. Euro-American components recorded in the field.

Component Type	Count
Trash scatter	12
Euro-American structure	8
Homestead	5
Other — survey marker	4
Trash dump	3
Ranching feature	2
Trail (Santa Fe Trail ruts)	2
Inscription	2
Road	2
Unknown Rock Feature	2
Church	1
Military Button	1
Glass Scraper	1
Bridge	1
Lime Kilns	1
Mine	1
Excavation Fill	1
Dump/Shrine	1
Unknown Structure	1
Hearth	1
Petroglyph	1
Rock Shelter	1
Total Components	54

As in prehistoric contexts, trash features are the most numerous. Trash Scatters differ from Trash Dumps in that Trash Dumps appear to have been the result of a single disposal episode of materials gathered from somewhere else. Trash scatters generally appear to have been deposited over a relatively long period of time in their original location. Features recorded as Euro-American Structures range from lean-tos to the Forked Lightning Ranch house and also include the Estancia/Casas Reales; Kidder's archeological field camp and lab building at Forked Lightning Pueblo; a grist mill with holding pond, flume and acequia; corrals and out buildings from the dude ranch of the Tex Austin era; and Kozlowski's Trading Post. Five Hispanic homesteads can be considered special cases of Euro-American Structures. They are discussed in detail in the following section of this chapter.

Indicative of the historical continuity at Pecos is the fact that 29 (57 percent) of these historic components are secondary components, meaning they occur on sites dominated by earlier materials, usually Native American. Only two are on sites with earlier Euro-American components. Three of the sites discussed in this chapter have historic Puebloan ceramics in their assemblages. All three are Hispanic homestead sites.

Seventeeth and Eighteenth Century Euro-American Sites

Coronado's troops passed through Pecos in 1541, but Spanish presence at Pecos was not permanent until the very early part of the seventeenth century, probably around 1617 when the Lost Church was established (Ivey 1996; Kessell 1979; Stubbs et al. 1957). The majority of seventeenth and eighteenth century sites in the park appear to be Native American in origin and so are discussed in the previous chapters of this report that focus on the Native American occupation of the park. Of the 178 sites dated to Period 5 (A.D. 1575-1700) using the chronology based on Native American ceramics (see Chapter 4), only ten (5 percent) show evidence of European influence, all through ceramic vessel forms (see below). Of the 58 sites dated to Period 6 (post A. D. 1700) only the three homesteads mentioned above (5 percent) contained Euro-American as well as Puebloan materials. These facts highlight the dominance of Native American material culture in early historic assemblages, despite the profound effects of European contact on the lives of the Pecos people (Levine 1999:58).

Documentary evidence, previous work, and analogy were used to date the four seventeenth—eighteenth century Euro-American sites recorded by the survey and to give them Euro-American affiliation.[2] These methods were used because the sites had no or very, very few Euro-American artifacts on the surface. These sites are the Estancia/Casas Reales (PECO 64, LA 625) (Hayes 1974:53-58); Lost Church (PECO 213, LA 4444) (Stubbs et al. 1957); Square Ruin (PECO 35, LA 14114) (Nordby and Creutz 1993b); and the surface structure at Hoagland's Haven (PECO 53, LA 14154) (Nordby and Creutz 1993a). These sites are all in the vicinity of the Pecos Mission and are most likely related to mission activities (Figure 10.1). In addition, PECO 16 (LA 14091) is believed to be a construction of the Spanish Mission, though it has not been excavated. This feature has been called the "Ancient Walled Area," and is referred to by Bandelier (1881:89) as "huerto del pueblo [sic]," the fields of the pueblo inhabitants. It is probably one of the areas described by Dominguez as a kitchen garden or milpas in 1776 (Adams and Chavez 1956:213). Kidder (1958:118) refers to it as a reservoir, corral, or garden. The fact that the walls of this feature run counter to topographic contour, its size, and roughly square shape, as well as the fact that it appears to have been created using midden from the pueblo, suggest that it is probably a Spanish creation.



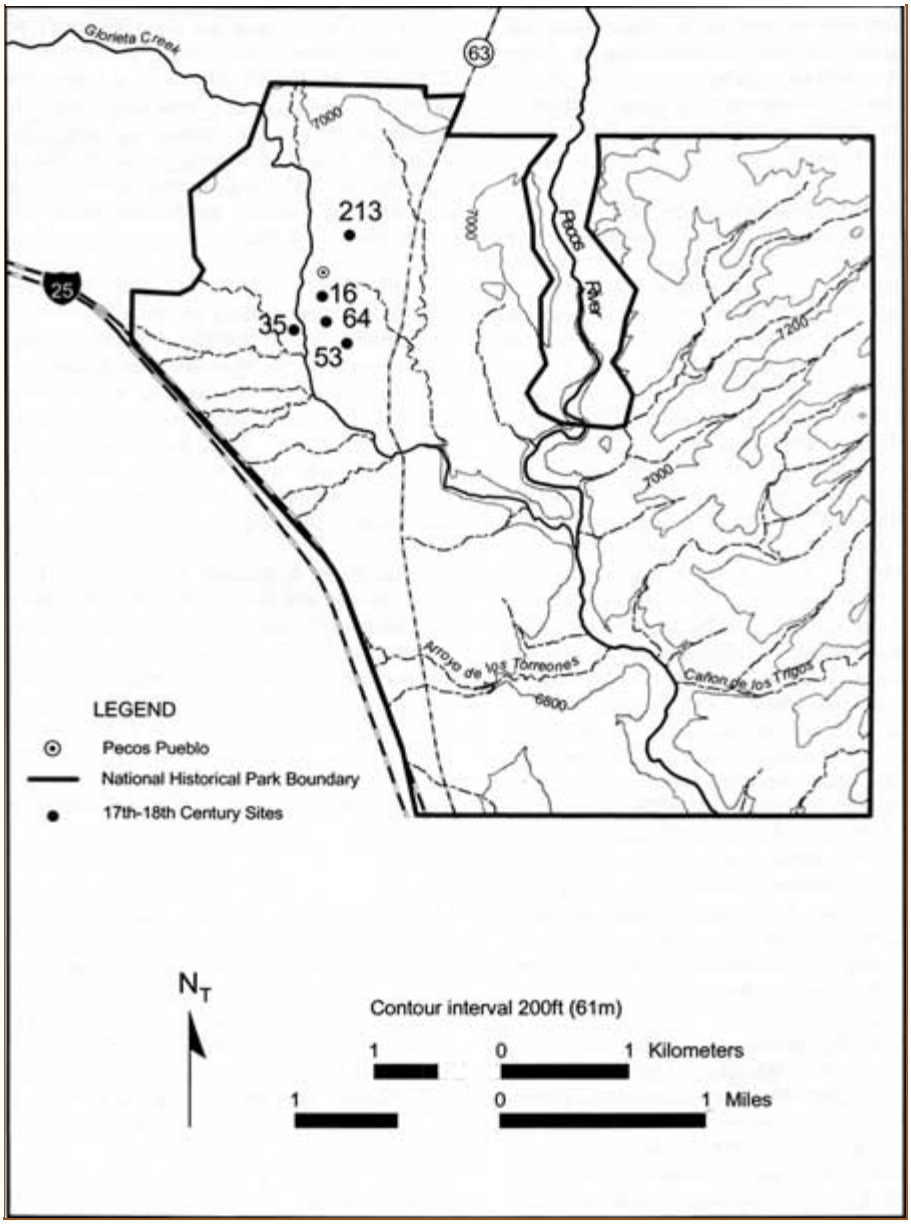


Figure 10.1. Seventeenth and eighteenth century sites recorded by the survey. *(click on image for an enlargement in a new window)*

The early Spanish at Pecos apparently adjusted to many aspects of Puebloan material culture, using the same kinds of tools and general purpose ceramic vessels. There were some ceramic forms, however, that the Spanish missionaries could not do without. Their needs were met by native craftspeople as can be seen in the presence of European ceramic forms executed in native materials. Such items were found on the surface of several sites. Table 10.2 shows the forms, ceramic types, and the kind of sites on which they were found (see also Chapter 8). Most of these forms are soup bowls. At the Estancia/Casas Reales (PECO 64) a fragment of a plain red candle holder was also found. It is unclear if the candle holder and other Euro-American materials directly relate to this site, however, because the field crew noted that back-dirt from the convento excavations in the 1960s had been dumped nearby.

Table 10.2. European vessel forms made with native ceramics.

PECO No.	Site Type	Ceramic Periods	Form	Ceramic Type	Count
12	Seasonal — small structure	2, 3, 5	Soup Bowl	Glaze V	1
16	Seasonal — multiple feature types	4, 5	Soup Bowl	Late Glaze V	1
64	Habitation — estancia	4, 5	Soup Bowl	Glaze VI — Kotyiti Glaze-on-Yellow	3
64	Habitation — estancia	4, 5	Candle Stick	Plain Red	1
228	Habitation — Pecos Pueblo	3, 4, 5	Cup	Undecorated Red	1
228	Habitation — Pecos Pueblo	3, 4, 5	Cup	Glaze V	1
228	Habitation — Pecos Pueblo	3, 4, 5	Soup Bowla	Plain Black	1
336	Seasonal — small structure	4, 5	Soup Bowl	Glaze V — Pecos Polychrome	1
366	Seasonal — multiple feature types	4, 5	Soup Bowl	Unknown Plain Polished	4
473	Seasonal — multiple feature types	3, 4	Soup Bowl	Glaze V	2
476	Special-use — single feature type	4, 5	Soup Bowl	Glaze V — Pecos Polychrome	1
640	Special-use — artifact scatter	5	Soup Bowl	Late Glaze V	11
658	Seasonal — small structure	4, 5	Soup Bowl	Undecorated Red	1
Total					26

[a]Field notes say, "Rim form somewhere between a bowl and a soup bowl.

The small number of sites with Euro-American artifacts dated to the seventeenth and eighteenth centuries and their limited geographic distribution indicate that the early Spanish presence in the valley was focused on the mission complex and Pecos Pueblo itself. It also suggests that the residents of the mission relied heavily on the pueblo for material goods and that few European imports left the confines of the church/convento complex.

The reader is directed to the recent Historic Structures Report (Ivey 1996) for more detailed and informative consideration of the seventeenth and eighteenth century structures in the park. That document also details construction of the mission church and convento, structures that were not recorded by this survey (see also White 1996).

Temporal Analyses of Euro-American Artifacts

Fifty-one historic artifact assemblages were recorded during the Pecos survey (Figure 10.2; Table 10.3). As part of the site recording process, in-field analyses of surface Euro-American artifacts were performed at each site. These artifact data were collected in the field during the survey and were provided to the OAS for analysis and write-up. This discussion presents the

results of in-field artifact analyses as they relate to site dating.

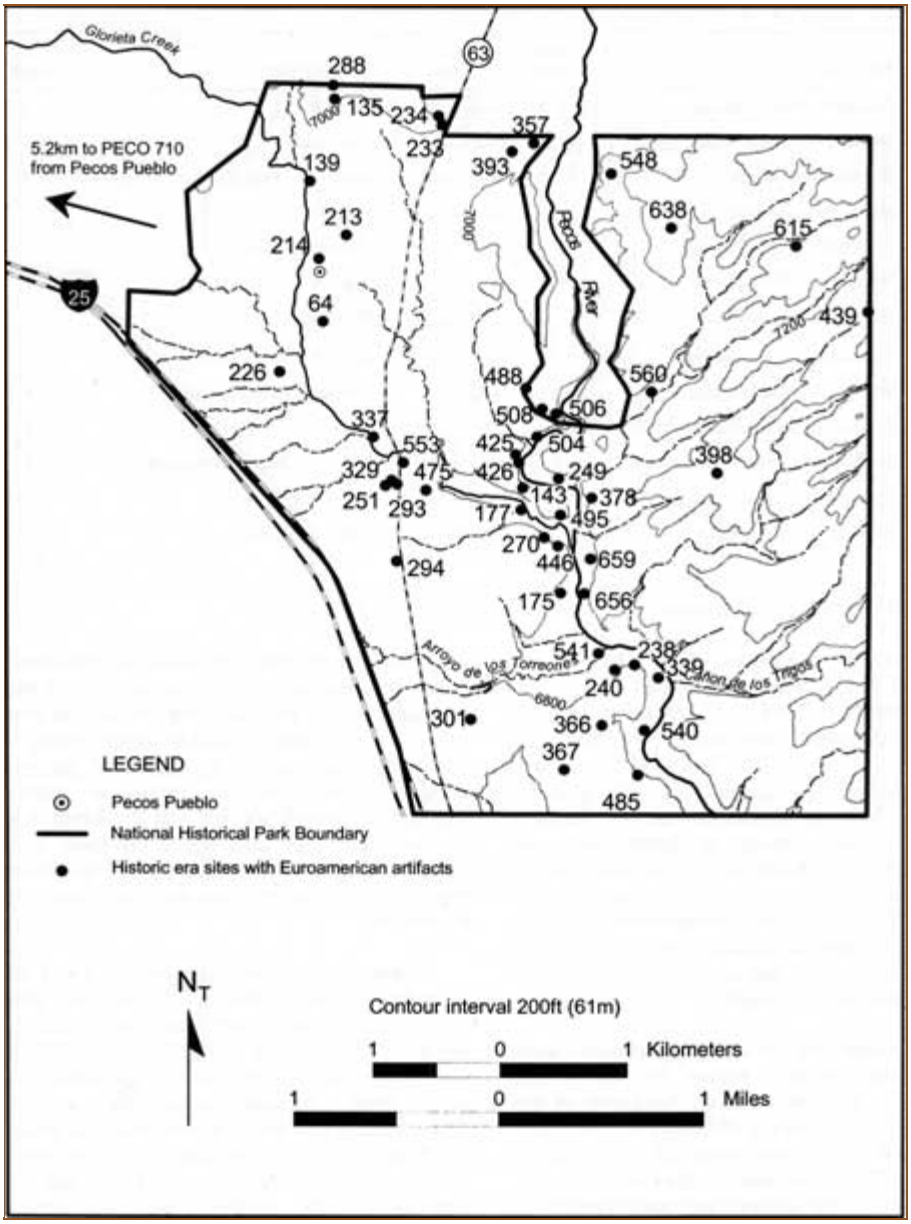


Figure 10.2. Sites with Euro-American artifact assemblages. *(click on image for an enlargement in a new window)*

Table 10.3. Site numbers and descriptions of historic era sites with Euro-American artifacts.

PECO No.	LA No.	Description
64	625	Estancia/Casas Reales
135 c2	118775	Trash scatter with rock piles
139 c2	118778	Trash scatter with rock piles
143 c2	69300	Five trash dump locations
175	118789	Homestead B — Rivera?

177	118791	Lime kilns
213 c2	4444	"Lost church"
214 c2	118810	Petroglyphs
226 c2	672	Kidder's camp at Forked Lightning Ruin
233 c2	118815	Trash scatter
234	118816	Trash scatter
238 c2	118820	Stock pen
240 c2	118822	Petroglyphs
249	110165	Grist mill, pond, acequia
251 c2	118831	Trash scatter, Santa Fe Trail?
270	118847	Homestead A — Quintana
288	118865	Trash scatter
293	85503	Unknown rock features
294 c2	85501	Trash scatter, Santa Fe Trail?
301 c3	118875	Trash scatter, wood cutting area?
329	38648	Trash scatter, Santa Fe Trail, Camp Lewis
337 c2	32391	Santa Fe Trail ruts
339	118907	Colonias Bridge road trash
357 c2	118925	Unknown structure with trash
366 c2	69282	Road trash, between Homesteads D and E?
367	118934	Homestead E — Ruiz
378 c2	69287	Rockshelter
393 c2	118958	Unknown rock feature
398 c2	118963	Civil War era military button
425 c2	69266	Trash scatter
426 c2	118988	Stock pen and trash scatter
439	119000	Surveyor's brass cap
446	119006	Trash dump, associated with PECO 270?
475	119032	Five trash dumps near Kozlowski's Trading Post
485 c2	119041	Rockshelter with petroglyph
488	119044	Surveyor's brass cap
495	119051	Forked Lightning Ranch house
504 c2	69301	Trash scatter
506 c2	119061	Surveyor's brass cap
508 c2	119063	Surveyor's brass cap
540	119093	Homestead D
541	119094	Homestead C — Rivera
541/10000	119094	Upper component
541	119094	Total assemblage
548	119101	Jose Baca Mine
553	86076	Kozlowski's Trading Post; ranch foreman's house
560 c2	119112	Lean-to with can scatter
615	119166	Lean-to with artifact scatter
638 c2	119187	Trash scatter at rockshelter

656 c2	119204 Trash scatter
659	119207 Trash dump
710 c2	251 Arrowhead Lodge features at Arrowhead Pueblo

Note: c# indicates that Euro-American materials are part of a second (or third) temporal component on the site.

Data Collection

When the Pecos survey was in the planning stages (1994), it was intended that historic artifacts would be analyzed using a hierarchical functional framework similar to that used by the OAS (Boyer et al. 1994; OAS 1994) and sampled following the same procedures as prehistoric artifacts (see Chapter 3). The functional framework groups artifacts by function rather than by material type, with the advantages that (1) artifacts can be related directly to human activities (Hannaford and Oakes 1983); (2) assemblages can be analyzed as a whole, on a single form, without having to be reconstituted from a plethora of material-specific forms; and (3) the problem of multimaterial items, so often found in historic contexts, is avoided.

This framework and sampling approach were used during the pilot survey for the project (Eininger et al. 1995) and the beginning of the first full year of survey (Eininger 1996). They were found to be cumbersome and time consuming in the field. The sheer number of artifacts in most historic contexts made the random sampling scheme inefficient and slow work. The in-field analysts spent considerable time recording large numbers of nondescript items. The functional recording system meant recording numerous null values for variables that did not apply to all artifact material groups. Also, few of the field crew were well equipped to quickly identify many of the details required for the functional analysis, slowing in-field analysis further as analysts referred to written sources and conferred with one another. The time spent on these tasks slowed survey coverage, outweighing the advantages of the random sampling and functional framework.

Consequently it was decided to focus the recording of Euro-American artifacts on items with time-diagnostic attributes that could be easily recognized. Analyzing "recognizable" artifacts in the field is best suited for gathering temporal data, because temporally sensitive characteristics of some items and material groups are often quickly identifiable. The recording framework was changed as well, to one that was material specific, rather than functionally oriented. Recording forms were created for individual material groups (cans/metal, glass, nails/miscellaneous—ceramics were recorded using the ceramic system used on all other sites). This paralleled the material specific recording methods used for prehistoric materials, which were separated into lithics, ceramics, and architecture.

These changes decreased the amount of time spent by National Park Service staff in the field, but in post-field data analysis the OAS staff found that these decisions seriously compromised the utility of the data for making generalizations about site function and for examining patterns of economy and production. The net effect of these decisions is that Euro-American artifact data obtained during the Pecos survey are not from representative samples. As such they are not appropriate for addressing questions requiring functional data, including distinguishing sites by on-site activities and looking for inter-site patterning of changing economic and land-use activities across space or through time. Therefore, issues of on-site activities and site functions and of economic and production patterns cannot be addressed in this chapter. Selected data on artifact types and functions and descriptive characteristics from the National Park Service database are presented in table form in Appendix F.

As a preliminary step toward mending the lack of functional information for the survey, OAS personnel used a hierarchical functional format to record surface artifacts on four sites during site visits on June 9, 1999. During these visits, readily recognizable artifacts were recorded. Recording focused on temporal data; artifacts selected were usually those whose characteristics had easily defined temporal parameters, although other functional and descriptive information were also recorded. The results of these analyses are presented in separate tables, one for each site, later in this discussion. These tables provide more reliable preliminary functional information for these sites, though artifact selection was not statistically random or systematic, and the results should not be taken as definitively representative of site assemblages.

The decisions to change the historic recording framework mentioned above also had some effect on temporal data. Use of artifact dates to derive accurate and precise dates for sites or intrasite proveniences or components requires "weighting" dates by frequency within material groups and artifact types, as well as within entire assemblages. This is not possible with the survey data, since they were not randomly selected and are not representative of the entire assemblage. However, the OAS examination of the temporal data collected during the survey revealed that the recorded artifact dates can be used to derive dates for some sites, if the following assumptions are made:

1. the recorded artifact dates are accurate or, if not, can be adjusted based on descriptive characteristics or analyst comments; and

2. the counts of artifacts with particular dates are accurate.

These assumptions appear to be warranted from the data. Though the data on Euro-American artifacts recorded by the survey cannot be used for considerations of site function, they can be used to provide dates for the sites. Site dating is a necessary foundation for defining site types and their distributions and for examining economic and production patterns. Combining temporal information with historical data and site descriptions allows these sites to be placed within the contexts of National Park Service-defined cultural periods.

Dating the Euro-American Sites

Pecos National Historical Park Cultural Periods

As part of the process of establishing a general management plan for the expanded Pecos National Historical Park, the National Park Service prepared a Cultural Landscape Overview of the Pecos Unit and Pigeon's Ranch Subunit of Pecos National Historical Park. The purposes of the Cultural Landscape Overview are stated as follows:

> This document looks at how people of different cultures have shaped and been shaped by the natural and cultural environments of the Upper Pecos Valley, and how remaining evidences of these relationships can be preserved into the future. (Cowley et al. 1998:13)

With these purposes in mind, the following objectives of the Cultural Landscape Overview are defined (Cowley et al. 1997:13):

1. Develop an understanding of the major changes over time that have created the cultural landscape of the majority of Pecos National Historical Park;

2. Apply this understanding to the development of a preliminary statement of significance;

3. Identify specific significant landscape characteristics and relationships;

4. Determine the extent to which these characteristics and relationships survive today, and the level of their integrity;

5. On the basis of this analysis, develop preliminary recommendations for planning and management, including a recommendation for overall landscape treatment; and

6. Recognizing the limitations of the project, identify future research and analysis needs.

As a result of pursuing these objectives, the National Park Service defined a series of "cultural periods" characterizing human occupation of the park and the surrounding portions of the Upper Pecos Valley (Cowley et al. 1997:23-125). Table 10.4 lists the cultural periods defined by the Cultural Landscape Overview (note that most sites recorded by the survey fall in the "Pre-Contact" cultural period, dated 10,000 B.C. to A.D. 1540, hence the temporal units devised for the Cultural Landscape Overview were not useful for organizing pre-historic materials. See also Chapter 1 for a review of the culture history of Euro-Americans in Pecos that makes use of these cultural periods).

Table 10.4. Cultural periods (Pecos unit only) from the Cultural Landscape Overview.

Cultural Period	Dates
Pre-Contact	10,000 B.C—A.D. 1540
Pecos Pueblo/Spanish Mission	A.D. 1540-1838
Spanish Colonial/Mexican/Hispanic Settlement, Santa Fe Trail, Civil War	A.D. 1812-1880
Railroad/Tourism	A.D. 1880-1941
Fogelson/Monument	A.D. 1941-1991
National Park Service	A.D. 1991—present

Source: Cowley et al. 1998.

Dating the Sites

Analysis of temporal data obtained from the historic sites had two goals: to derive site dates that are as accurate and precise as possible and to use those dates to place the sites within the contexts of the Pecos National Historical Park cultural periods.

In order to derive dates for each site, artifact dates from three of the material and functional categories used in the analysis format—glass, ceramics, and cans—were listed. Dates from nails and miscellaneous artifacts were not used due to the ambiguous identity of some artifacts in these groups.

Artifact dates are expressed as ranges with beginning and ending dates. In some cases, only the beginning or ending date could be recorded, usually due to a lack of sufficient datable characteristics to bracket the manufacturing periods of the artifacts. In those cases, date ranges were created by assigning an arbitrary length of 25 years for glass and cans and 50 years for ceramics.[3] Thus, artifacts with ending dates of 1930 are assumed to date between 1905 and 1930 if they are glass or cans and between 1880 and 1930 if they are ceramics. When the number of datable artifacts in a group or site is too small to obtain a meaningful

mean date, the simple date range of the artifacts is presented. In this situation, beginning and ending dates without actual ranges are presented as post- and pre-dates, respectively.

Mean artifact dates are determined for the different groups of artifacts by multiplying the midpoint of each date range by the number of artifacts with that date range. The resulting figures are added, and the sum is divided by the number of datable artifacts to obtain a mean date for the artifact group. This follows South's (1977) procedure for calculating mean ceramic dates. Adding and subtracting a single standard deviation figure from the mean date obtains a mean date range. Mean dates for the entire datable site assemblage are obtained in the same manner. However, by first obtaining dates for artifact groups, we can assess the impact of the different groups on the site date. This is important for determining the presence of different temporal components. Although there are exceptions, particularly the five homestead sites, mean dates for an artifact group were not calculated if there were fewer than 15 datable artifacts in the group. Mean dates for site assemblages were not usually calculated if dates were only obtained from one artifact group at the site.

In addition to mean artifact dates, dates were calculated for window glass fragments recorded during visits to four sites by OAS staff. These dates are determined according to thicknesses of window glass fragments, using formulas defined by Moir (1982) and Schoen (1990) (see also Roenke [1978] and White [1990]).

The results of artifact dating are presented in Table 10.5. Thirty-two of the 50 assemblages (64 percent) yielded artifact dates. Twenty assemblages (40 percent of assemblages, 63 percent of assemblages with datable artifacts) yielded enough artifact dates to obtain mean artifact dates. Twenty-seven assemblages (54 percent of assemblages) yielded glass artifact dates, five assemblages (10 percent of assemblages) yielded ceramic artifact dates, and 23 assemblages (46 percent of assemblages) yielded can dates. Although only one set of artifact dates was calculated for most sites, one site yielded three sets of dates. OAS in-field examination of PECO 541, identified as Homestead C and associated with Anicieto Rivera, suggested that an artifact concentration located on the terrace above the site's structural remains was not temporally or functionally associated with the structures. Consequently, artifacts in the concentration, which may represent a trash dump, were specifically analyzed in the field by OAS staff. The concentration was assigned the number PECO 10000, to distinguish it from the rest of the site. Artifact dates were calculated for the site assemblage as analyzed by National Park Service staff, for the PECO 10000 assemblage, and for the entire assemblage (Table 10.5).

Table 10.5. Assemblages with Euro-American artifact dates.

PECO No.	Artifact Dates			
	Glass	Ceramic	Cans	Assemblage
49	—	n=1 pre-1850	—	—
64	—	—	—	—
135	n=14 x=1933.5	—	n=17 x=1905.00	n=31 x=1920.63

	s=16.50 1917.00-1950.00		s=25.00 1880.00-1930.00	s=14.18 1906.45-1934.81
139	n=21 x=1936.23 s=9.72 1926.51-1945.93	—	—	n=21 x=1936.23 s=9.72 1926.51-1945.93
143	—	n=49 x=1934.43 s=19.88 1914.55-1954.3 1	n=205 x=1934.60 s=7.67 1926.93-1942.27	n=254 x=1934.57 s=11.12 1923.45-1945.69
175	n=69 x=1906.22 s=22.05 1884.17-1928.27	n=9 x=1902.76 s=27.51 1875.25-1930.27	n=4 x=1877.25 s=2.25 1875.00-1879.50	n=82 x=1900.38 s=27.23 1873.15-1927.61
177	—	—	—	—
213	—	—	—	—
214	—	—	—	—
226	n=2 x=1935.50 s=6.50 1929.00-1942.00	n=39 x=1937.46 s=3.61 1933.85-194 1.07	n=41 x=1937.37 s=3.82 1933.55-1941.19	
233	n=294 x=1937.32 s=13.90 1923.42-1951.22	—	n=57 1900-1960	n=351 x=1937.64 s=14.20 1923.44-195 1.84
234	n=4 post-1903	—	n=52 1912-1950	n=56 x=1930.79 s=0.77 1930.02-193 1.56
238	—	—	—	
240	—	—	—	
249	n=1 pre-1930	—	—	
251	—	—	n=12 1876-1930	—
270	n=32 x=1951.72 s=12.72 1939.00-1964.44	n=15 x=1846.00 s=32.21 1813.79-1878.21	—	n=47 x=1920.20 s=52.68 1867.52-1972.88
288	n=12 post-1904	—	n=100 1917-1934	n=112 x=1925.88 s=1.08 1924.80-1926.96

293	—	—	—	
294	n=6 pre-1930/1940	—	—	
301	n=30 1904-1929	—	—	—
329	n=44 x=1900.68 s=7.92 1892.76-1908.60	—	—	n=44 x=1900.68 s=7.92 1892.76-1908.60
337	—	—	—	
339	n=1 post-1904	—	n=60 1940-1955	—
357	n=12 x=1900.68 s=7.92 1892.76-1908.60	n=16 1859-1900	n=28 x=1889.82 s=12.03 1877.79-1901.85	
366	n=40 x=1905.38 s=14.15 1891.23-1919.53	—	n=3 post-1904	n=43 x=1905.74 s=14.34 1891.40-1920.08
367	n=221 x=1914.47 s=22.76 1891.71-1937.23	n=2 post-1885	n=82 post-1865	n=305 x=1914.29 s=24.18 1890.11-1938.47
378	—	—	—	
393	—	—	—	
398	—	—	—	
425	n=11 x=1926.18 s=11.68 1914.50-1937.86	—	n=92 post-1850	n=103 x=1880.47 s=16.26 1864.21-1896.73
426	—	—	—	—
439	n=1 post-1934	—	n=2 post-1897	—
446	—	—	n=42 1916-1948	—
475	n=45 x=1929.45 s=20.85 1908.60-1950.30	—	n=331 x=1948.22 s=6.97 1941.25-1955.19	n=376 x=1944.79 s=13.02 1931.77-1957.81
485	—	—	—	—
488	—	—	—	—

495	n=79 x=1945.21 s=17.56 1927.65-1962.77	—	n=883 x=1937.72 s=9.96 1927.76-1947.68	n=962 x=1938.31 s=10.95 1927.36-1949.26
504	—	—	n=7 1870-1880	—
506	—	—	—	—
508	—	—	—	—
540	n=8 x=1870.00 s=25.86 1844.14-1895.86	n=19 x=1887.42 s=26.07 1861.35-1913.49	n=2 post-1850	n=29 x=1883.83 s=26.87 1856.96-1910.70
541	n=29 x=1901.90 s=10.04 1891.86-1911.94	n=2 post-1880	—	n=31 x=1901.77 s=9.72 1892.05-1911.49
541/ 10000				n=13 x=1899.00 s=33.86 1865.14-1932.86
541				n=44 x=1901.29 s=16.67 1884.62-1917.96
548	n=4 x=1901.25 s=2.17 1899.08-1903.42	—	n=18 1920-1969	n=22 x=1936.64 s=16.71 1919.93-1953.35
553	—	—	—	—
560	—	—	n=3 post-1890	—
615	—	—	n=4 1910-1960	—
638	n=11 1886-1928	—	—	—
656	n=2 post-1930	—	—	—
659	n=3 x=1936.31 s=16.84 1919.47-1953.15	—	n=348 1933-1942	n=351 x=1937.45 s=3.54 1933.91-1940.99
710	—	—	—	—

Note: In the cells, 'n' is the number of datable artifacts in that artifact group, 'x' is the mean date for that group, and 's' is one standard deviation of the mean. If a cell has only a date or date range, all artifacts in that group have the same date.

Euro-American Sites and Cultural Periods

The 20 sites whose assemblages allowed determination of mean artifact dates fall into two periods, the Spanish Colonial/Mexican/Hispanic Settlement, Santa Fe Trail, Civil War period (A.D. 1812-1880; n=six sites, including the PECO 10000 portion of PECO 541) and the Railroad/Tourism period (A.D. 1880-1941; n=16 sites, including the rest of PECO 541). Table 10.6 presents these sites by defined cultural periods (see Table 10.4). Figure 10.3 shows the locations of sites dating to the Spanish Colonial/Mexican/Hispanic Settlement, Santa Fe Trail, Civil War period and Figure 10.4 shows the locations of sites dating to the Railroad/Tourism period.

Table 10.6. Euro-American sites confidently assigned to a cultural period, based on assemblage artifact dates.

PECO No.	Site Description	Assemblage Dates (A.D.)
Spanish Colonial/Mexican/Hispanic Settlement, Santa Fe Trail, Civil War Period, 1812-1880		
540	Homestead D	1857-1911
425 c2	Trash scatter	1864-1897
541/10000	Homestead C — Rivera, upper assemblage	1865-1933
270	Homestead A — Quintana	1868-1973
175	Homestead B — Rivera?	1873-1928
357 c2	Unknown structure with trash	1878-1902
Railroad/Tourism Period, 1880-1941		
541	Homestead C — Rivera, lower assemblage	1885-1918
367	Homestead E — Ruíz	1890-1938
366 c2	Road trash, between Homesteads D and E	1891-1920
541	Homestead C — Rivera, total assemblage	1892-1911
329	Trash scatter, Santa Fe Trail, Camp Lewis	1893-1909
135 c2	Trash scatter with rock piles	1906-1935
548	Jose Baca Mine	1920-1953
233 c2	Trash scatter	1923-1952
143 c2	Five trash dump locations	1923-1946
288	Trash scatter	1925-1927
139 c2	Trash scatter with rock piles	1927-1946
495	Forked Lightning Ranch House	1927-1949
234	Trash scatter	1930-1932
475	Five trash dumps near Kozlowski's	1932-1958

226 c2	Kidder's field camp at Forked Lightning Ruin	1934-1941
659	Trash dump	1934-1941

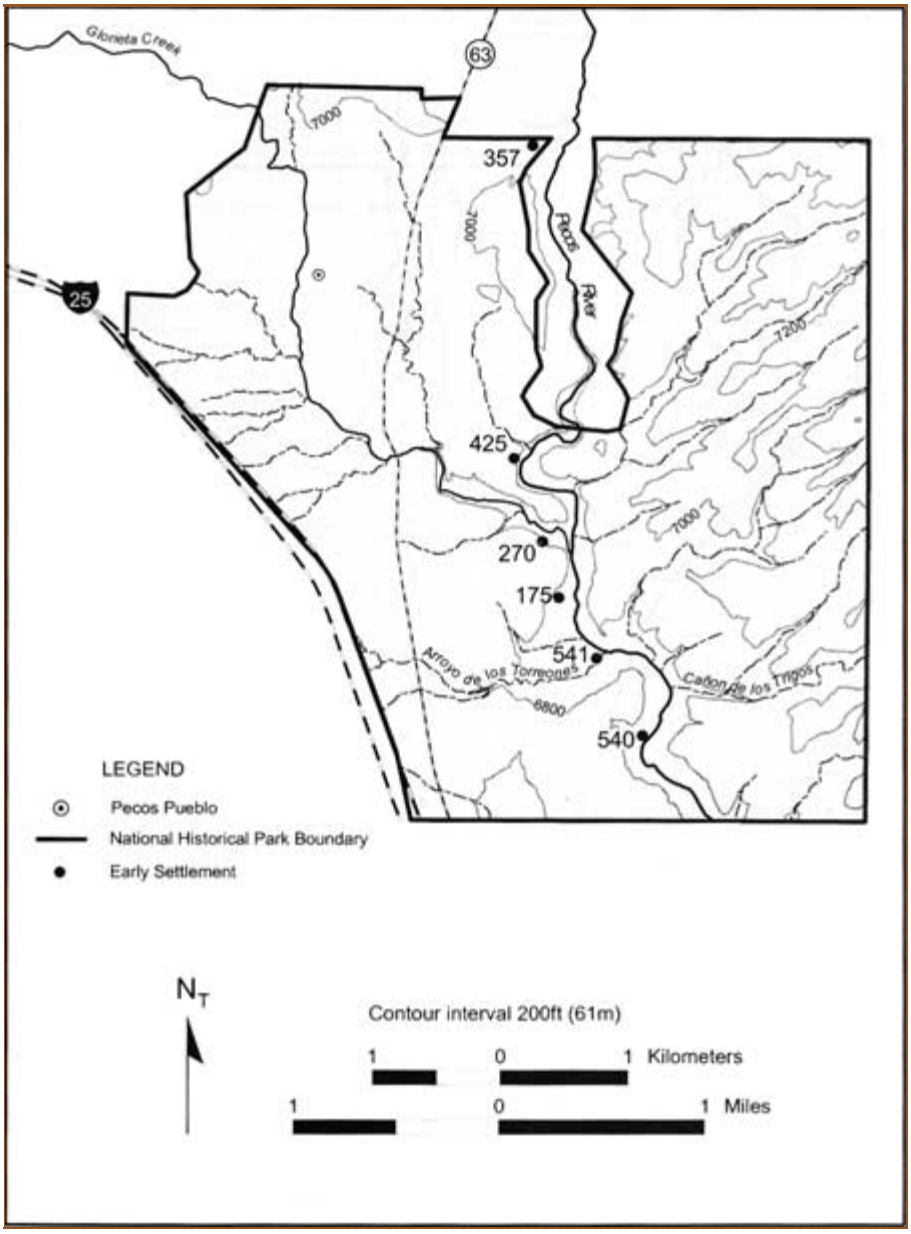


Figure 10.3. Sites dated to the Spanish Colonial/Mexican/Hispanic Settlement, Santa Fe Trail, Civil War Period using assemblage mean dates. *(click on image for an enlargement in a new window)*

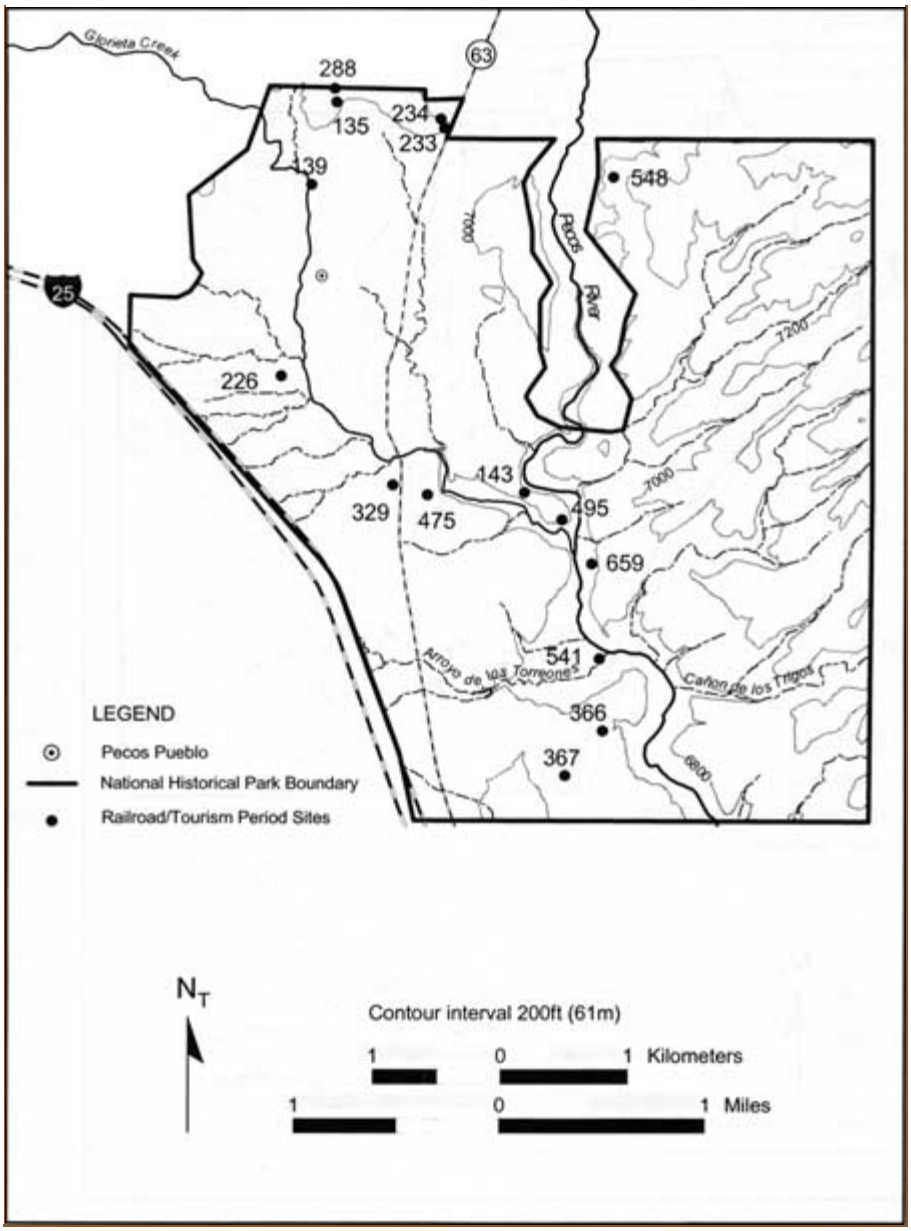


Figure 10.4. Sites dated to the Railroad/Tourism Period using assemblage mean dates. *(click on image for an enlargement in a new window)*

Twelve sites yielded dates from artifact groups but did not have sufficient dates for calculating an assemblage mean date and thus could not be securely assigned to a cultural period. Tentative period assignments were given to these sites based on the artifact group dates that were available. These sites are shown in Table 10.7. Eleven sites had no artifact dates but can be placed in a period based on documentary, association, or feature information. They are shown in Table 10.8. Seven sites could not be dated at all. They are shown in Table 10.9.

Table 10.7. Euro-American sites by cultural period, based on artifact group dates.

PECO No.	Site Description	Artifact Group	Artifact Group Dates (A.D.)
Probable Spanish Colonial/Mexican/Hispanic Settlement, Santa Fe Trail, Civil War Period,			

1812-1880.

504 c2	Trash scatter	Ceramics	1870-1880
Probable Railroad/Tourism Period, 1880-1941			
251 c2	Trash scatter	Cans	1876-1930
638 c2	Trash scatter w/rock shelter	Glass	1886-1928
560 c2	Lean-to with can scatter	Cans	post-1890
301 c3	Trash scatter/woodcutting area	Glass	1904-1929
615	Lean-to with artifact scatter	Cans	1910-1960
249	Grist mill	Glass	pre-1930
294	Trash scatter/Santa Fe Trail	Glass	pre-1930/1940
Probable Fogelson/Monument Period, 1941-1991			
439	Surveyor's brass cap	Glass	post-1934
		Cans	post-1897
339	Colonias Bridge and trash	Glass	post-1904
		Cans	1940-1955
446	Trash dump, near PECO 270 & 495	Cans	1916-1948
656	Trash scatter	Glass	post-1930

Table 10.8. Euro-American sites by cultural period, based on documentary, feature, or association dates.

PECO No.	Site Description
Probable Pecos Pueblo/Spanish Mission Period, 1540-1838	
64	Estancia/Casas Reales
213	"Lost Church"
Probable Spanish Colonial/Mexican/Hispanic Settlement, Santa Fe Trail, Civil War Period, 1812-1880	
240	Cross Petroglyphs
337	Santa Fe Trail Ruts
398	Military Coat Button
553	Kozlowski's Trading Post
Probable Railroad/Tourism Period, 1880-1941	

177	Lime Kilns for construction of ranch house
488	Surveyor's brass cap
506	Surveyor's brass cap
508	Surveyor's brass cap
710	Arrowhead Lodge Features (at Arrowhead Pueblo)

Table 10.9. Euro-American sites that could not be assigned to a cultural period.

PECO No.	Site Description
214	Petroglyphs
238	Stock pen
293	Unknown rock features
378	Rock shelter
393	Unknown rock feature
426	Stock pen and trash scatter
485	Rock shelter with petroglyph

Spanish Colonial/Mexican/Hispanic Settlement, Santa Fe Trail, Civil War Period (A.D. 1812-1880)

Of the sites that appear to fall within the Spanish Colonial/Mexican/Hispanic Settlement, Santa Fe Trail, Civil War period (A.D. 1812-1880) (Table 10.6; Figure 10.3), two are not securely dated to the period. The mean artifact dates for PECO 425 and PECO 357 are conditioned by the can dates, which are not very precise. Without the can dates, dating these two sites relies on their glass dates, which clearly fall in the Railroad/Tourism period (A.D. 1880-1941). These sites could be included in the Railroad/Tourism period, although that conclusion cannot be confirmed without systematic data recovery investigations.

The mean artifact dates for PECO 270 suggest that the site has two distinct components. One, seen in the ceramic dates, falls in the Spanish Colonial/Mexican/Hispanic Settlement, Santa Fe Trail, Civil War period (1812-1880), while the other, seen in the glass dates, falls in the Fogelson/Monument (1941-1991) period. Although it is common to find that ceramic dates are older than those of associated glass and metal artifacts, the difference in this case is about a century, which is too large to be accounted for by time lag or curation of ceramic items. It is reasonable to suggest, based on these data, that the older component is associated with the Benigno Quintana homestead at PECO 270 (Homestead A) and that the younger component is associated with the Fogelson (post-1941) occupation of PECO 495, the nearby Forked Lightning Ranch house and outbuildings. Reference to the survey site form for PECO 270 finds that the primary visible features of the site (cement structure pads) are remains of buildings constructed during the Tex Austin occupation (1925-1941) and dismantled during the Fogelson era (Gilbert Ortiz, former Forked Lightning Ranch foreman, personal communication 1995). Though this does not involve artifact dates, it would place use of PECO 270 during the Railroad/Tourism period (A.D. 1880-1941) as well.

As seen in Table 10.5, the PECO 10000 component of PECO 541 may have a slightly earlier

date than the rest of the site assemblage. Based on this date, the PECO 10000 component is assigned to this period, while the structural portion of the site is assigned to the Railroad/Tourism period (A.D. 1880-1941).

During survey, PECO 175 (Homestead B) was thought to have two components. One, presumed older, was associated with the site's structural remains, while the presumed younger one was seen as road trash found between the Pecos River bank and a road that runs through the site. Analysis of temporal artifact data does not support multiple components. Rather, the artifact dates are remarkably consistent in showing that only one component is evident at the site.

Field observations at PECO 540 (Homestead D) during the survey and during a subsequent site visit by OAS staff, strongly suggested that this site does have two components. One appeared to date before the United States occupation of New Mexico and the other appeared to date near the turn of the twentieth century. Datable Euro-American artifacts, recorded during survey and during a subsequent site visit, were fewer than needed to precisely date two components. The dates in Tables 10.5 and 10.6 are for the entire assemblage. If we sort out the datable artifacts from the apparently earlier structural area in the northern part of the site, however, we can calculate a mean artifact date of 1860.11, with a standard deviation of 25.56 years, and a mean date range of 1834.55 to 1885.67. Clearly, these dates are older than dates for the site as a whole. The remaining artifact dates are too few to provide a date for the southern component of the site. Of all the homestead sites recorded during the survey, PECO 540 had the largest assemblage of "native" ceramic types, including Ogapoge and Powhoge Polychrome, Kapo Black, and Ocate Micaceous, as well as Euro-American pearlware sherds. In contrast, no "native" ceramics were recorded in the southern part of the site and Euro-American whiteware sherds are dominant. These differences are suggestive of pre-railroad (1880) and post-railroad components at the site. Window glass thickness points to two, or perhaps three, building episodes. One piece from the northern structure, with a thickness of 0.045 inch, suggests that initial construction could have occurred as early as 1830 to 1845. As the total assemblage dates show, the other component probably dates to the late 1800s or early 1900s. One dated artifact observed on the southern part of the site is a clock gear with stamped patent dates of August 1902 and January 1903.

Railroad/Tourism Period (A.D. 1880-1941)

All of the sites assigned to this period seem to unambiguously fall within the period, including PECO 541 (without the PECO 10000 component). Several other sites warrant brief discussions. PECO 329 is an artifact scatter associated with the Santa Fe Trail and is in the location of Camp Lewis, the 1862 camp of Union soldiers involved in the battle of Glorieta Pass. Mean surface artifact dates point to use of PECO 329 at about 1900, however, indicating that these surface materials are not associated with Camp Lewis. This both contrasts with and resembles data obtained by Haecker's (1998) remote-sensing survey of the Camp Lewis area. Haecker's project used a variety of remote-sensing techniques to define the actual location and spatial extent of Camp Lewis. Artifacts were located using metal detectors. Haecker identified 14-31 percent of recorded artifacts with Camp Lewis, with most of the remaining artifacts being non-military items dating to the principal years of the Santa Fe Trail, ca. 1830-1880.

The surface survey did collect two artifacts from PECO 329 that can be associated with Camp Lewis, however. One is a U.S. Army General Issue uniform button with a recessed, lined shield. Wyckoff (1984) states that this button type was made by 1847, possibly as early as 1840, and that they were phased out in 1880. Still, uniforms with this button may have been issued for many years thereafter. However, Wyckoff also states that the federal government finally quit issuing old Civil War uniforms in 1880. Prior to 1851, uniform

buttons were silver, presumably over brass. (A U.S. Army General Issue uniform button was also found at PECO 398, an artifact scatter on the east side of the river. This button also has a recessed, lined shield, probably dating between 1847 [1840?] and 1880 and may be related to the Union army presence in the area, or to Hispanic use of the highlands.)

Another possible Camp Lewis artifact collected from PECO 329 is an extremely flattened lead bullet. It weighs 24.6 grams, or 380 grains (24.6x15.432 grains/gram). One groove is visible, but a second is not clearly present, and there is no indication of a third. These attributes suggest it was used in a rifled musket and places it in the Civil War era, roughly 1850-1870, but the flattening obscures other diagnostic information that would allow more precise dating (Charles Haecker, personal communication 2000).

The Jose Baca Mine site, PECO 548, consists of at least three adits and two shafts. Tailings piles and a thin scatter of artifacts sit outside the two openings to the mine. Local informants say the mine is the result of treasure and gold hunting (PECO 548 field notes, 1996) and is named for a prominent local judge and citizen of the area (see also Dobie 1931:233-237). It seems to have two temporal components, with glass artifacts pointing to site use at about 1900 and cans pointing to site use in the second and third quarters of the twentieth century. The length of the mean artifact date range reflects these two possible components. Without additional, systematic data collection, it is not possible to determine whether the dating disparity reflects temporal components, site and assemblage formation processes, or other factors.

Finally, the datable cans from PECO 495, the Forked Lightning Ranch house site, date to ca. 1925-1939, the Tex Austin era of the ranch. The ranch house was built in 1925 as the center of a dude ranch owned and operated by Tex Austin (born Clarence Van Nostrand), an early rodeo promoter and showman (Pecos National Historical Park interpretive materials, 1995). The building was designed by John Gaw Meem, a Santa Fe architect later credited as the originator of Pueblo Revival style architecture. Meem also designed the Laboratory of Anthropology in Santa Fe. Austin lost the ranch to creditors in 1933. It was purchased in 1939 by Colonel E. E. Fogelson, an oil man from Dallas, who married actress Greer Garson in 1941. The couple made the Forked Lightning Ranch their summer home.

Many of the glass artifacts recorded at the Forked Lightning Ranch House also date to the Tex Austin era, but the glass artifacts also have a longer mean date range. This may indicate that some glass dates push into the Fogelson era at the ranch (1939-1991), contemporaneous with the glass artifacts at PECO 270. It is rumored that the ranch house was built on the location of a razed Hispanic homestead. The artifact dates do not support this rumor, because the beginning dates of the glass and can artifacts coincide closely with the beginning of the Tex Austin occupation of the site. This does not preclude the possibility of an older Hispanic component, but that component, if present, is not visible in the datable Euro-American artifacts recorded during surface survey. In fact, survey crews intentionally did not sample the deep middens on the east/river edge of the site. Systematic data collection or excavation in this area could resolve these questions about the length and nature of occupation in this spot where the Glorieta Creek and Pecos River meet.

Sites Tentatively Associated with Periods or Unassignable to a Period

Twelve sites yielded too few artifact dates to calculate mean artifact dates. Although we cannot securely assign them to cultural periods, we can speculate as to the periods of some of these sites, based on the available dates for artifact groups (Figure 10.5, Table 10.7).



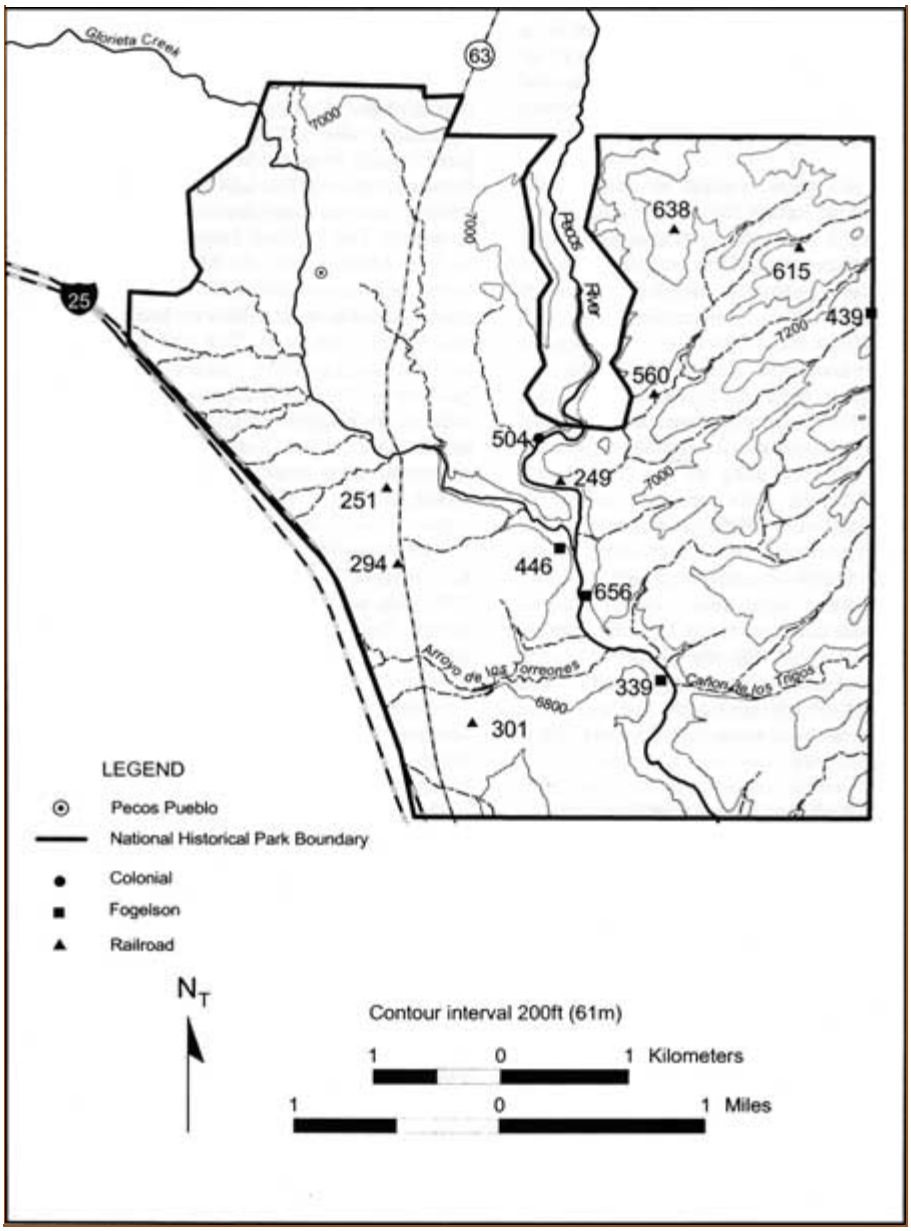


Figure 10.5. Sites assigned to a period using artifact group dates. *(click on image for an enlargement in a new window)*

Based on the artifact dates that could be obtained, one site, PECO 504, should probably be assigned to the Spanish Colonial/Mexican/Hispanic Settlement, Santa Fe Trail, Civil War period (A.D.1812-1881). Seven sites, PECO 249, 251, 294, 301, 560, 615, and 638, should probably be assigned to the Railroad/Tourism period (A.D. 1880-1941). PECO 249 is the site of the Cattanach grist mill. This mill was apparently constructed between 1905 and 1909 by Archibald D. Cattanach and operated by him until about 1918 (White and Porter 1996:2-4). It had a small capacity, only about 60 bushels per day (compared to 100-500 bushels for most merchant mills in New Mexico), but was probably the most modern and efficient grist mill between Santa Fe and Las Vegas at that time. As such it was an important element of the local economy. The railroad brought high grade flour to New Mexico from the Midwest, and by 1935 wheat was rarely grown in the state, and all the merchant mills in New Mexico had closed (White and Porter 1996:2-6). The mill was dismantled by Tex Austin in 1925, and the mill site probably flooded in 1929. Excavations in 1995 revealed little of the original structure, though a fragment of the bull wheel and two mill stones were recovered from the surface (White and Porter 1996).

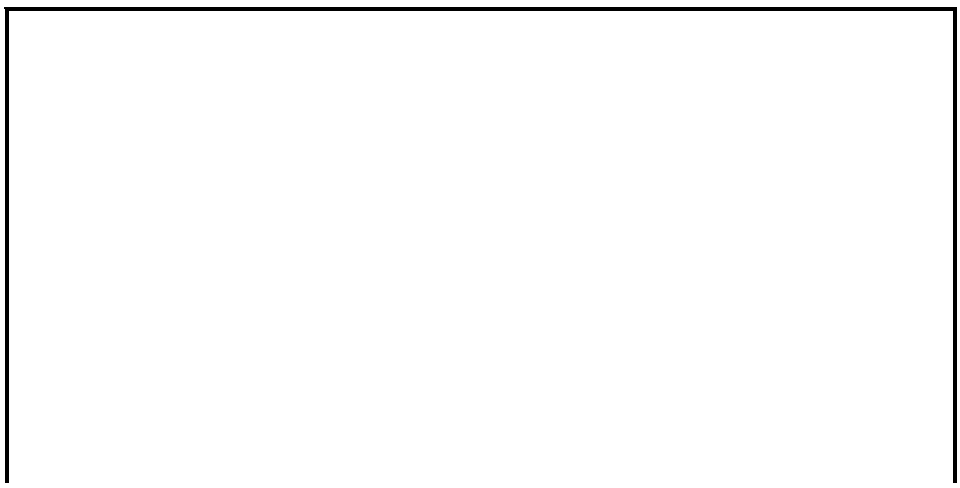
The four remaining sites dated through artifact groups, PECO 339 (the Colonias Bridge), 439, 446, and 656, should probably be assigned to the Fogelson/Monument period (A.D. 1941-1991)

Seventeen sites cannot be assigned to a cultural period using artifact dates. Eleven of these can be tentatively assigned to a period based on documentary, feature, or association evidence at the sites. They are listed in Table 10.8. Among these is Kozlowski's Trading Post (PECO 553). Martin Kozlowski was a Polish immigrant who fled his homeland after participating in the revolution against the Prussians (Kajencki 1990:52). He joined the U.S. Army shortly after his arrival in this country and fought the Apache in southern Arizona and New Mexico. After his honorable discharge in 1858, Kozlowski used his 160-acre government bounty land warrant to purchase 600 acres of ranch land located near a spring on Glorieta Creek (then known as the Arroyo de Pecos) (Kajencki 1990:56). The stage stop run by Kozlowski and his Irish-born wife Elena was a popular tavern for travelers along the Santa Fe Trail where weary stage passengers could dine on freshly caught trout and wash the dust from their faces (Kajencki 1990:56). For two months in 1862 the Kozlowski's tavern served as the hospital for the Union troops that fought in the Battle of Glorieta Pass, and Camp Lewis is immediately adjacent to the trading post. In 1878 Martin Kozlowski shot and killed a man who was arguing with his sons and spent the next two years in the Las Vegas jail. The coming of the railroad to the Upper Pecos Valley in 1880 brought the end of the stage stop. Kozlowski lived at his ranch until 1898, when he joined three of his sons and their families in Albuquerque. He died in Albuquerque in 1905 (Kajencki 1990:63-64). The buildings of his trading post were later used to house staff of the Forked Lightning Ranch during the Tex Austin and Fogelson eras.

The remaining seven sites cannot be assigned to a cultural period. These sites are shown in Table 10.9.

Comparing Homestead Artifact Dates with Documentary Dates

In the following discussion, the five Hispanic homestead sites recorded during the Pecos survey are discussed in order of their artifact dates, from earliest to latest (see Tables 10.5 and 10.6 for dates). Figure 10.6 shows their locations and the locations of private land tracts along the river as identified on a map drawn in 1913 by Vincent K. Jones during his survey of the Pecos Pueblo grant for Gross, Kelly, and Co. (Jones 1913a). His field notes from that survey provide details of the features and improvements he observed within each tract (Jones 1913b). For each site a brief history of land tenure is presented, followed by a comparison of dates derived from documentary sources and those derived from artifactual analyses. Based on the comparison, conclusions are presented regarding the dates of occupation and the identities of site occupants.



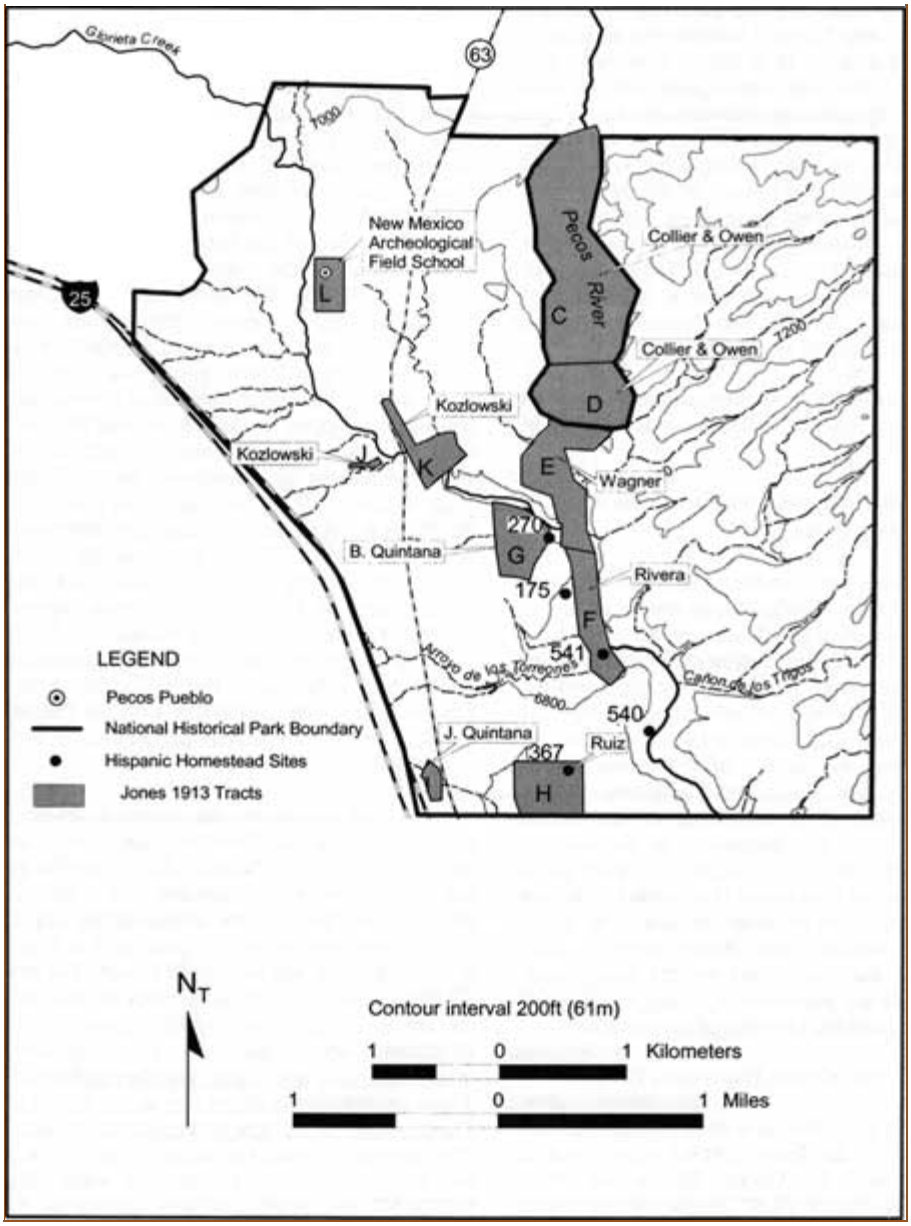


Figure 10.6. Hispanic Homesteads. *(click on image for an enlargement in a new window)*

PECO 540: Homestead D

PECO 540 is located in a tract of land that was unclaimed in the Jones (1913a) survey and is found between the Anicieto Rivera and Pedro Ruiz tracts (Figure 10.6). Figure 10.7 is a map of the site, Figure 10.8 is a photograph of the northern portion of the site. National Park Service survey records suggest that the early component at the site is associated with the Diego Padilla family. In 1813, Padilla, with two other petitioners, requested a grant to lands at Las Ruedas, located about four miles down the Pecos River from Pecos Pueblo (Kessell 1979:439). Their request was lost in bureaucracy, and in 1814, they applied for another grant, this time at Los Trigos, an ill-defined area along the Pecos River from near the eventual location of the Forked Lightning Ranch house south to the vicinity of Las Ruedas (Kessell 1979:443). This area extended well into the Pecos Pueblo grant. Their grant was approved the same year but was bounded on the north by the Pecos Pueblo grant. Hall (1984:20) states that Padilla "never established a permanent home at Los Trigos. He may have used the grant for a few years after receiving it in 1815. By the 1820s, he and his sons abandoned the Los Trigos

grant in favor of more promising land upriver, in the Pecos Pueblo grant." In fact, they had begun occupying jacales "in the bends of the river" (Hall 1984:26) by 1816 and had stock and gardens there by 1821. This description suggests that the Padillas lived in the vicinity of PECO 540 and is the apparent reason for associating PECO 540 with Diego Padilla in the survey records. Comanche raiding drove off the Padillas by 1826, and no new settlers moved back in until 1842 (Hall 1984:26).



Figure 10.7. PECO 540 (LA 119093), Homestead D. *(click on image for an enlargement in a new window)*



Figure 10.8 The northern portion of PECO 540, view SE, Pecos River in background.

The 1842 date corresponds closely to the mean glass dates for the site (Table 10.5) and is within the dates from the earlier, northern structural area of the site. Hall (1984:63; parentheses and emphases added) states, "In 1841, the *alcalde* of San Miguel del Vado had traveled upriver, found the Los Trigos grant uninhabited, and had installed twenty-five new families on the grant. Those families had no legal connection to the original, 1814 grantees (i.e., Padilla and others); but they were living there. When asked. they said that the boundary of their Los Trigos grant extended all the way to the Arroyo de Pecos, almost to the ruin of Pecos Pueblo itself." The "Arroyo de Pecos" probably refers to what is now known as Glorieta Creek. This would place PECO 540 well within the area claimed by the second occupants of the grant. If Hall's information is accurate, and PECO 540 is related to the post-1841 reoccupation of the flexible Los Trigos grant, which the artifact dates support, then PECO 540 was not associated with Diego Padilla or his family. Since we do not have the names of the post-1841 occupants of the Los Trigos grant, we cannot, at this point, speculate about the identity of the site occupants, but it seems clear that it was not Diego Padilla. Resolution of the issues of the dates of the two components and the identities of the site occupants will require systematic archeological data recovery investigations and intensive review of documentary materials.

Table 10.10 lists artifacts from PECO 540 by functional category, as recorded by OAS staff. The high frequency of "Domestic routine" artifacts, mostly sherds, is appropriate to a Hispanic homestead, particularly the dominance of "native" sherds in the older, northern part of the site. It points out the economic interaction between Native American and Hispanic residents of northern New Mexico, even after the abandonment of Pecos Pueblo.

Table 10.10. PECO 540: OAS artifact counts by functional categories and proveniences.

Provenience	Category	Count
540	Personal effects	1
540.1[a]	Unidentifiable	4

540.1	Foodstuffs	6
540.1	Indulgences	1
540.1	Domestic routine	23
540.1	Construction/maintenance	3
540.2[b]	Foodstuffs	1
540.2	Domestic routine	4
540.3[c]	Unidentifiable	4
540.3	Foodstuffs	1
540.3	Indulgences	1
540.3	Domestic routine	13
540.3	Furnishings	1

[a]540.1 is the large structure on the north side of the site.
[b]540.2 is a small outbuilding on the north side of the site.
[c]540.3 is the south side of the site.

PECO 270: Homestead A, Benigno Quintana

PECO 270 is located on the eastern edge of a tract, Tract G, identified by Jones (1913a) as belonging to Benigno Quintana (Figure 10.6). Figure 10.9 is a map of the site; Figure 10.10 is a photograph showing the location of the site. On August 6, 1909, Benigno Quintana filed a Declaration of Title, in which he states that his father, Cayetano Quintana, bought the land from Martin Kozlowski in 1853 and maintained possession until his death in 1898, when it passed to Benigno (San Miguel County Deed Record 67, pp. 206-207). Jones (1913b:12) states that Tract G, comprising 53.6 acres, with a house shown in the approximate location of PECO 270, "is claimed by Benigno Quintana, who has lived upon it, fenced it, and cultivated most of it for a great many years."

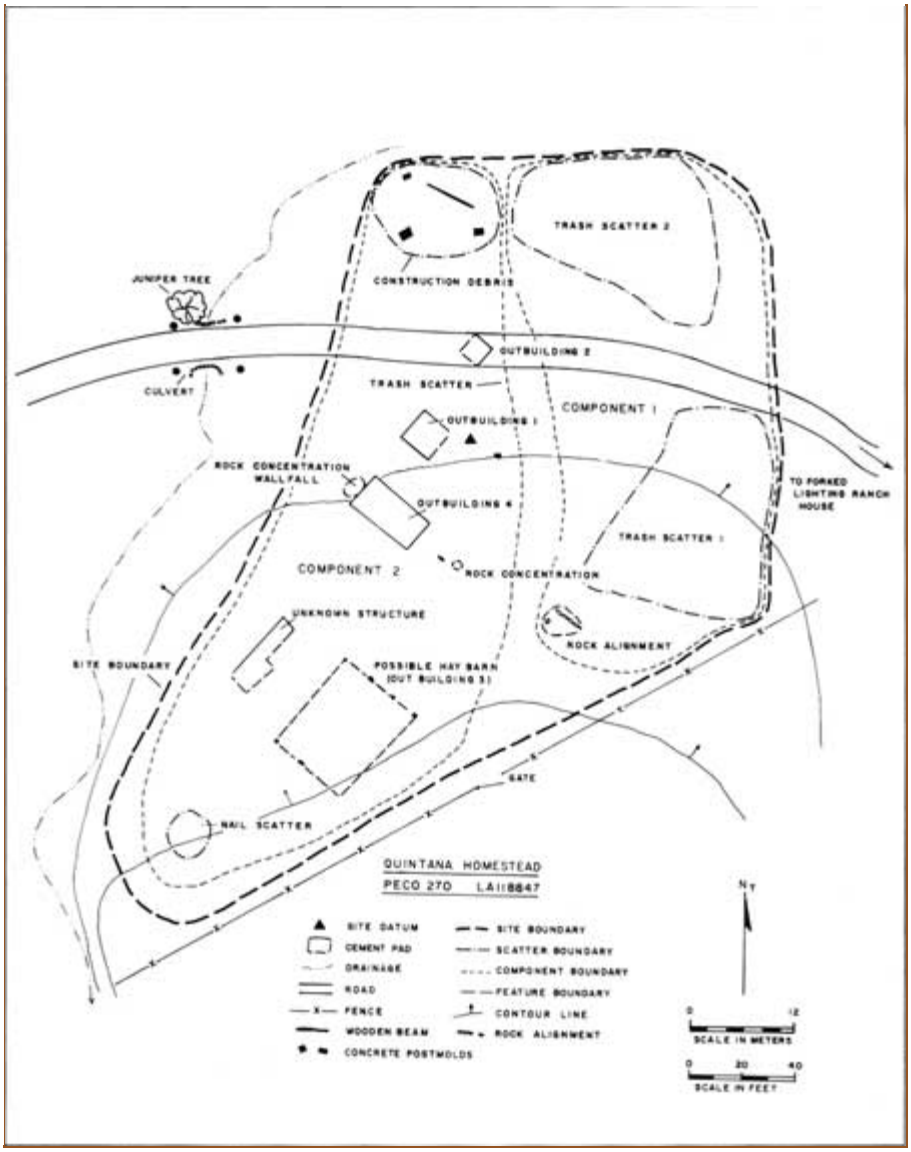


Figure 10.9. PECO 270 (LA 118847), Homestead A, Quintana. *(click on image for an enlargement in a new window)*



Figure 10.10 Overview of PECO 270 with the Forked Lightning Ranch house in background, view NE.

If Benigno Quintana was the person identified as Juan B. Quintana in a May 15, 1925 quit claim deed, then the land passed to Conferina Armijo de Quintana and Manual V. Quintana on that date (San Miguel County Deed Record 98, p. 177). On the same date, the land was sold to G. D. Hughes (San Miguel County Deed Record 98, p. 178), and then from Hughes to Tex Austin (San Miguel County Deed Record 98, p. 179).

Thus, the Quintana occupation of the land lasted from 1853 to 1925. Artifact dates suggest that occupation of PECO 270 began in the late 1870s or early 1880s, 20-30 years after Cayetano Quintana purportedly bought the land. This may indicate that PECO 270 was not the location of Cayetano's home and that the site was Benigno's home, beginning around 1880 (± five years). It is perhaps important in this regard that Benigno did not claim, in his 1909 title declaration, that Cayetano had lived on the tract, only that he maintained continuous possession of it. There is a remarkable correspondence between the 1925 date that ended Quintana ownership of the land and the end of the mean artifact date range (1928). It is also important to note that the beginning of the mean date range for artifacts recorded at the nearby Forked Lightning Ranch House site (PECO 495) is 1928.

Table 10.11 lists artifacts from PECO 270 by functional category, as recorded by OAS staff. The preponderance of "Foodstuffs" (bone) and "Domestic routine" items (mostly sherds) suggests that the portion of the site inspected was the location of a household midden.

Table 10.11. PECO 270: OAS artifact counts by functional category.

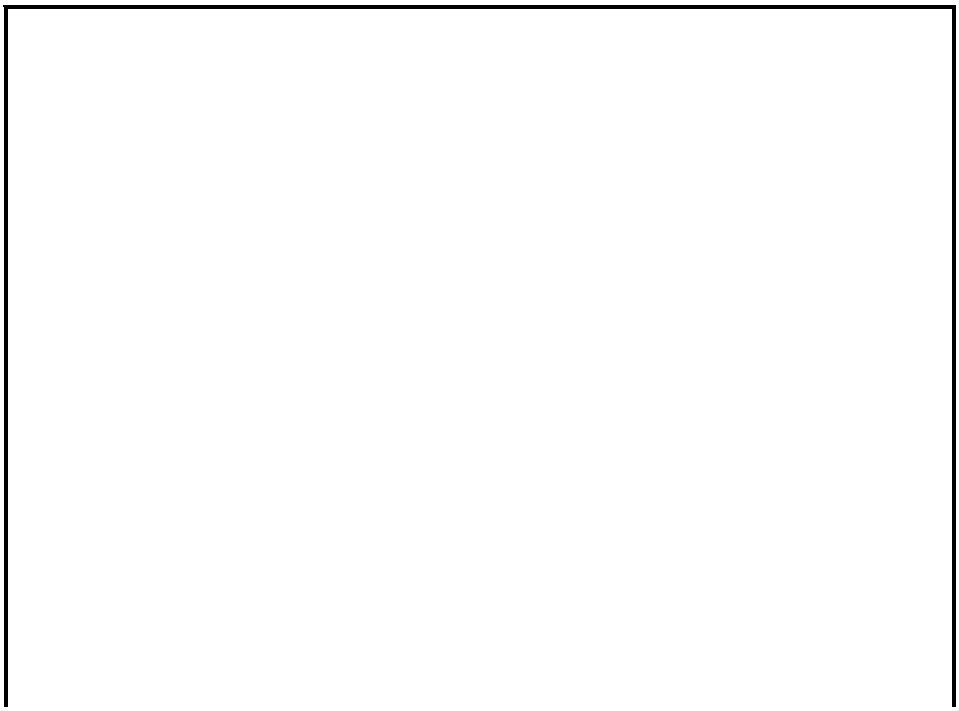
Category	Count
Unidentifiable	10
Foodstuffs	29
Domestic routine	33
Construction/maintenance	2

Several Euro-American artifacts were collected from PECO 270 during the survey. Three are stoneware sherds, one with a salt glaze over Albany slip; a stoneware bottle finish fragment with a glaze that is probably lead, since it exhibits an amber color, especially in the thicker sections; and a body sherd from a bottle of unknown function that was highly fired with a degree of vitrification that approaches a Chinese stoneware or heavy porcelain.

Other items collected from PECO 270 include a sponge-stamped whiteware saucer sherd with a repeated brown floral pattern,[4] a possible porcelain second or early whiteware,[5] a 1/4-inch thick fragment of flat glass that could be a piece of car windshield, shelving, mirror, or table top, and an unidentifiable rectangular copper plate, possibly cast, with holes in each corner.

PECO 175: Homestead B

PECO 175 is located immediately west of a tract, Tract F, identified by Jones (1913a) as belonging to Anaceto Rivera, probably the same person identified in other documents as Aniceto Rivera and Anicieto Rivera (Figure 10.6). Figure 10.11 is a map of PECO 175; Figure 10.12 is a photograph of one of the structures on the site. Based on the spellings in several other documents, Rivera's first name was probably spelled Anicieto. In reference to Tract F, Jones (1913b:12) states, "The only evidence of possession are an old deserted house and an old broken down fence near the road to Las Colonias by way of Los Trigos canon [sic]." Jones's map shows the Rivera house location, but it is farther south in the tract, approximately in the location of PECO 541. Thus, we have no documentary evidence of PECO 175 or an association with Anicieto Rivera. It seems reasonable to presume that if PECO 175 were occupied at the time of Jones's survey, an idea that can be supported with artifact dates, Jones would have known of it, particularly given the size and complexity of the site and its location along a road following the Pecos River south from Pecos, running through the Rivera tract. It seems reasonable to conclude that PECO 175 was not Anicieto Rivera's home and that it was already abandoned when Jones conducted his survey and well before the end of the mean artifact date range, 1927.61. Alternatively, the site, whose assemblage appears to represent domestic refuse, may have been occupied seasonally and, as such, was not recorded by Jones.



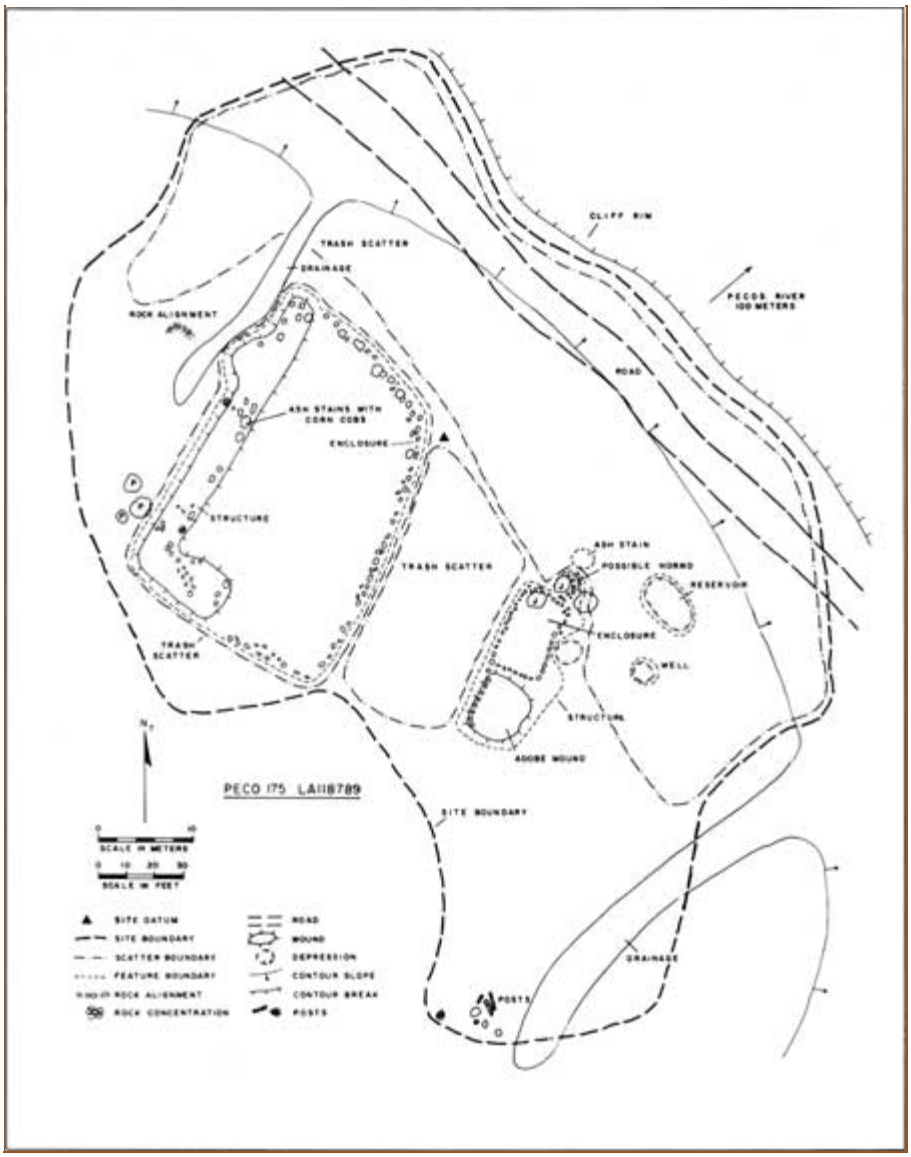


Figure 10.11. PECO 175 (LA 118789), Homestead B. *(click on image for an enlargement in a new window)*



Figure 10.12 PECO 175, southern structure, view SW.

It is important to point out that the mean can date ends in 1879, while ceramic and glass dates are consistent with each other in showing a longer time range (Table 10.5). This is a situation in which it is good to keep in mind that the mean artifact date ranges are statistical figures expressing periods of time within which most datable artifacts could fall and do not necessarily express the actual dates of site use. It is entirely possible that the site was occupied for a much shorter period of time than is reflected in the mean glass, ceramic, and artifact date ranges and that the site was abandoned before Jones's survey. Resolution of this issue, if possible, will require systematic archeological data recovery investigations and intensive review of documentary materials.

Table 10.12 lists artifacts from PECO 175 by functional category, as recorded by OAS staff in June of 1999. In the table, 175.1 is the area around the structures, while 175.2 is the midden area between the road and the edge of the Pecos River canyon. The high frequency of Domestic Routine artifacts, mostly sherds, is appropriate to a Hispanic homestead. The single Entertainment/Leisure artifact is a bisque porcelain doll leg, whose style dates between about 1860 and 1880 (Noel Hume 1970).

Table 10.12. PECO 175: OAS artifact counts by functional categories and proveniences.

Provenience	Category	Count
175.1[a]	Unidentifiable	4
175.1	Domestic routine	3
175.2[b]	Unidentifiable	5
175.2	Economy/Production	1
175.2	Foodstuffs	1
175.2	Domestic routine	12
175.2	Construction/Maintenance	4

175.2	Personal effects	1
175.2	Entertainment/Leisure	1
175.2	Transportation	2

[a]175.1 is the area around the structures.

[b]175.2 is the midden between the road and the bank of the Pecos River canyon.

PECO 367: Homestead E, Pedro Ruiz

PECO 367 is located near the eastern boundary of Tract H, identified by Jones (1913a) as belonging to Pedro Ruíz (Figure 10.6). Figure 10.13 is a map of PECO 367; Figure 10.14 is a photograph showing the location of the site. Tract H represented only the cultivated lands claimed by Ruíz, and Jones's map shows two houses in the approximate location of PECO 367. Apparently, Gregorio Calabaza sold the land to José Mariano Ruíz on May 26, 1839, a transaction that was recorded on August 2, 1867 (San Miguel County Deed Book 4, p. 35). According to the deed, Calabaza was a Pecos Indian who was acting on behalf of himself and all the remaining natives of Pecos Pueblo. Pedro Ruiz claimed possession of the land by inheritance from Mariano Ruíz, his father, and his title was quieted, along with the other claimants recorded by Jones, in San Miguel County case number 7613 in 1919. In 1926, Pedro and Hermenegildo Ruiz sold the land to Tex Austin.

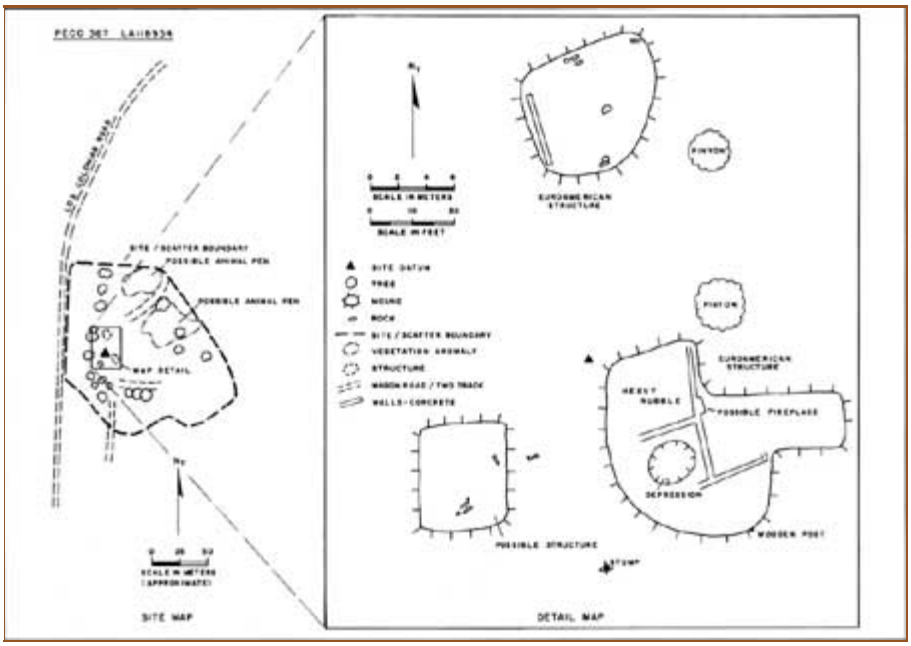


Figure 10.13. PECO 367 (LA 118934), Homestead E, Ruíz. *(click on image for an enlargement in a new window)*



Figure 10.14 View NW across PECO 367. Southern structure in higher vegetation.

Artifact dates from PECO 367 (Tables 10.5 and 10.6) fall near the later end of the dates of the Ruiz occupation of the land established by documentary sources, 1839 to 1926. They suggest that the site recorded as PECO 367 was occupied from about 1890 to the 1930s, from which we could infer that Pedro built the house at PECO 367 around 1890, some 50 years after his father acquired the land. Interestingly, this date corresponds to an 1891 tax receipt given to Mariano Ruíz for taxes due in 1889 (San Miguel County Tax Roll 1889, Precinct No. 12). Based on the documentary records, it is probably reasonable to place the end date in the mid-1920s. Alternatively, the archeological record may indicate that Ruíz lived at the site until the mid-1930s, a decade after the land was sold to Austin. Resolution of this issue, if possible, will require systematic archeological data recovery investigations.

OAS staff did not visit PECO 367, so no functional artifact data can be presented.

PECO 541: Homestead C, Anicieto Rivera

PECO 541 is located in Tract F, identified by Jones (1913a) as belonging to Anicieto Rivera (Figure 10.6). Figure 10.15 is a map of the site; Figure 10.16 is a photograph of the lower portion of the site. As noted earlier, Jones (1913b:12) states, "The only evidence of possession are an old deserted house and an old broken down fence near the road to Las Colonias by way of Los Trigos canon [sic]." Jones's map shows the house location, which is approximately the location of PECO 541, allowing preliminary identification of PECO 541 as the Anicieto Rivera home.

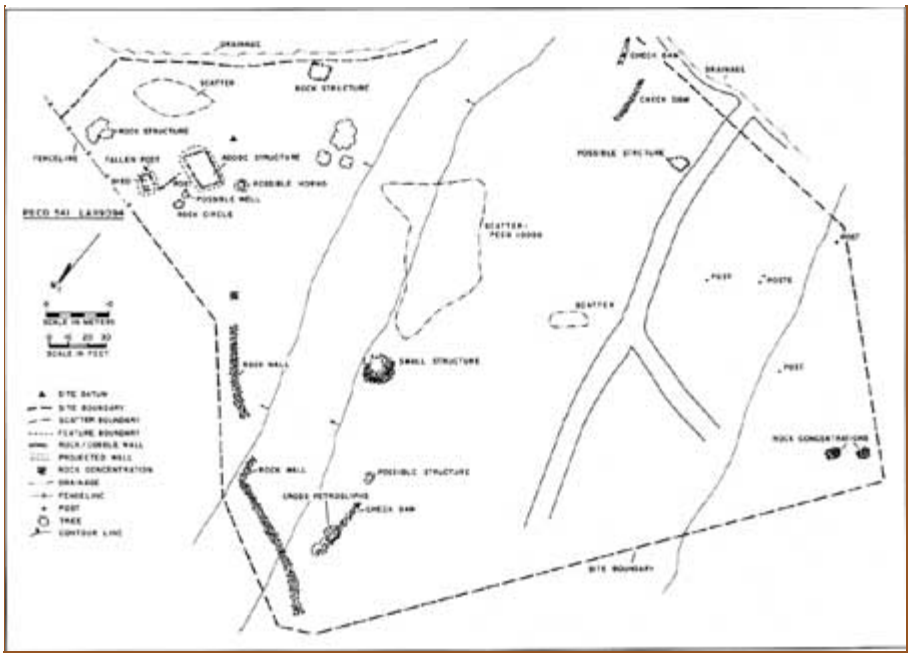


Figure 10.15. PECO 541 (LA 119094), Homestead C, Rivera. *(click on image for an enlargement in a new window)*

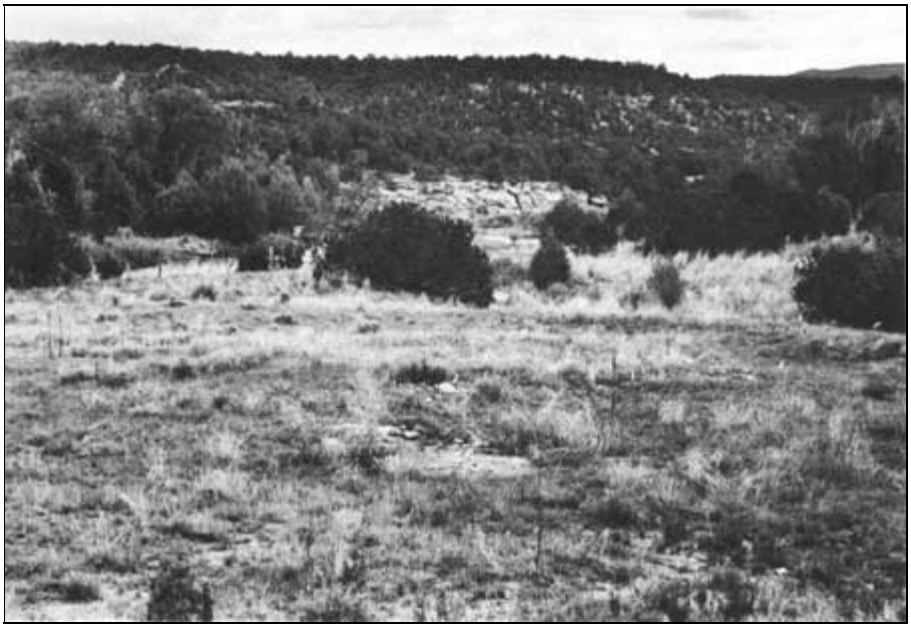


Figure 10.16 The lower portion of PECO 541, Pecos River in background, view E.

As discussed earlier, OAS in-field examination of PECO 541 suggested that an artifact concentration located on the terrace above the site's structural remains was not necessarily temporally or functionally associated with the structures. Artifacts in that concentration, which may represent a trash dump, were specifically analyzed by OAS staff in the field. The concentration was assigned the number PECO 10000, to distinguish it from the rest of the site. The PECO 10000 component of PECO 541 may have a slightly earlier date than the rest of the site assemblage. Based on this date, the PECO 10000 component is assigned to the Spanish Colonial/Mexican/Hispanic Settlement, Santa Fe Trail, Civil War period (A.D. 1812-1880), while the structural portion of the site is assigned to the Railroad/Tourism period

(A.D. 1880-1941).

Interestingly, the ends of the mean glass and artifact dates for PECO 541 fall before Jones's survey, supporting Jones's observation that the house was abandoned before he saw it. We cannot determine how much earlier with existing data, but the issue might be resolved following systematic archeological data recovery. It is also interesting to note that the mean artifact dates suggest that PECO 541 had a relatively short life, approximately 20 years, beginning in the early 1890s. This may help explain the small size and simple plan of the house remains, particularly in comparison with those of nearby PECO 175, which may have been occupied for 40-50 years, based on artifact dates (or somewhat less, based on our understanding of documentary evidence).

Table 10.13 lists artifacts from the PECO 10000 component of PECO 541 by functional category, as recorded by OAS staff. Comparison of these data with those in Table 10.14, which lists artifacts from the rest of PECO 541 by functional category, indicates very different sets of items, probably from very different contexts. In Table 10.13, the Foodstuffs items are oyster shell fragments. Most of the Domestic Routine artifacts are Euro-American whiteware dish sherds and pressed glass sherds (amethyst in color). The absence of "native" sherds suggests a non-Hispanic context. The Furnishings items are cast iron stove parts and steel hinges. The Construction/Maintenance category is represented by three cut nails, two wire nails, and single pane window glass fragments. Pane thicknesses of 0.078 and 0.085 inch indicate construction between about 1865 and 1885, with 1870 as a likely approximate date. The Personal Effects category is represented by a fragment of a milk glass cold cream jar. Most of the Unidentified artifacts are amethyst, aqua, and green glass, probably belonging in the Domestic Routine and Indulgences categories. One ceramic item is probably an heirloom creamware fragment. It is a handle in the shape of a human figure. Taken together, these data indicate a non-Hispanic household with access to a wide range of relatively expensive goods.

Table 10.13. PECO 541/10000: OAS artifact counts by functional categories.

Category	Count
Unidentifiable	16
Economy/Production	1
Foodstuffs	2
Indulgences	1
Domestic routine	16
Furnishings	5
Construction/Maintenance	11
Personal effects	1

In contrast, the artifacts observed in the PECO 541 component of the site suggest a different context. Most of the Unidentifiable artifacts in Table 10.14 are bottle sherds, many of which are suspected of being from beer or liquor bottles. The Indulgences artifacts are remains of a Poor Boy flask (liquor) and a tobacco tin. The single Personal Effects artifact is a "Tar Wine" bottle fragment. Tar Wine was a medicinal with a high alcohol content. The single Furnishing item is a kerosene lamp chimney fragment. Construction/Maintenance items are nails (five cut and one wire, indicating pre-1890 construction) and a single window glass

fragment, measuring 0.071 inch thick and probably dating between 1850 and 1870.

Table 10.14. PECO 541: OAS artifact counts by functional categories.

Category	Count
Unidentifiable	40
Indulgences	3
Domestic routine	17
Furnishings	1
Construction/Maintenance	7
Personal effects	1

Summary of Analyses of Euro-American Artifacts

Using artifact dates recorded at the Pecos National Historical Park Cultural Resources Inventory Survey (CRIS) historic sites, we have been able to assign or tentatively assign two-thirds of the sites to cultural periods defined by the Cultural Landscape Overview for the park. Seven sites, including all or parts of four of the five homestead sites (PECO 540, 270, and 175, and the PECO 10000 component of PECO 541) and three artifact scatter sites date or probably date to the Spanish Colonial/Mexican/Hispanic Settlement, Santa Fe Trail, Civil War period (A.D. 1812-1880) (Tables 10.6 and 10.7). Two of these homestead sites can be identified through documentary evidence with particular families. PECO 270 can be tied to the family of Benigno Quintana, and PECO 367 to that of Pedro Ruiz, PECO 540 may be associated with the second occupation of the Los Trigos Grant, while PECO 175 may be associated with Anicieto Rivera. These sites reflect the expansion of Hispanic settlement along the Pecos River, both from the south and from the Hispanic community of Pecos in the north.

Twenty-three sites date or probably date to the Railroad/Tourism period (A.D. 1880-1941) (Tables 10.6 and 10.7). They include PECO 367, the Pedro Ruiz homestead, and PECO 541, the house identified with Anicieto Rivera in the Jones survey (1913a, 1913b). They also include the Jose Baca Mine (PECO 548), the Forked Lightning Ranch House (PECO 495), and Kidder's camp at Forked Lightning Ruin (PECO 226), as well as the grist mill, pond, and acequia at PECO 249, and numerous artifact scatters. Some of these artifact scatters are associated with the different residences, others are probably associated with railroad-related wood-cutting activities. The sites in this period reflect the continuing expansion of Hispanic settlement and land use, as well as the aggregation of land tracts into the large Forked Lightning Ranch. They also reflect construction, use, and maintenance of the railroad through the Upper Pecos Valley and the beginning of archeological investigations at sites in the area.

Four sites may date to the post-1941 Fogelson/Monument period (A.D. 1941-1991) (Table 10.7). The remaining 18 sites cannot be assigned confidently to a cultural period on the basis of recorded artifact dates.

Together, the Euro-American sites recorded by the Pecos survey and dated in the above discussion provide spatial and temporal data that elaborate the park's cultural history and landscape. In particular, patterns of Hispanic settlement and land use and interaction between those patterns and changing land tenure with the formation and growth of the Forked

Lightning Ranch are evident in the survey records and data. Consequently, the survey data have helped to fulfill several objectives of the park's Cultural Landscape Overview:

- They have helped "develop an understanding of the major changes over time that have created the cultural landscape" of the park;
- They have helped "identify specific significant landscape characteristics and relationships;"
- They have helped "determine the extent to which these characteristics and relationships survive today, and their level of integrity." (Cultural Landscape Overview objectives 1, 3, and 4; Cowley et al. 1997:13)

As a result, the historic sites survey data can be used to develop planning and management recommendations and to identify research and analytical needs for Pecos National Historical Park (Cultural Landscape Overview objectives 5 and 6; Cowley et al. 1997:13), furthering the processes and goals of the park's management plans.

Review of Pecos Area Census Records

Census records are a primary source of information often overlooked by archeological researchers. The information contained in census records, while never the same from one census to the next, nevertheless allows broad social trends to be followed. It also allows the tracing of families and even individuals through time.

This discussion is a review of the United States census records for the Territory and State of New Mexico, San Miguel County, for the years 1860, 1870, 1880, 1900, 1910, and 1920, which are housed at the New Mexico State Records Center and Archives (NMSRCA) (there are no census records for 1890 at NMSRCA). The census records reviewed here certainly do not exhaust the possibilities of this line of research. Pecos was not found in the 1850 census, which is not to say it cannot be found. Time did not permit examination of the Territorial census of 1885. Spanish and Mexican census records for the Pecos Pueblo/Spanish Mission period were not examined in this study, but excellent reviews of Spanish Pecos area demographics can be found in Kessell (1979) and Levine (1999). Thus, the following review focuses on the Hispanic Settlement, Santa Fe Trail, Civil War period from about 1860 to the Railroad/Tourism period to 1920 (see Table 10.4), a time frame that is sufficient to document the change in the Pecos area from a local agrarian economy to one increasingly tied to the sweeping changes of the late nineteenth and early twentieth centuries. This review attempts to follow the Kozlowski (or Kozlowsky or Koslowsky) family, the Ruiz or Ruis family and the Quintana family. Benigno Quintana, the early occupant of PECO 270, was not found in the records, despite Jones's (1913b) assertion that he had been in the area many years. He may be the same person who is identified as J. B. Quintana in land records; this possibility was not checked in census records. Similarly, Anicieto Rivera was not found in the census records, although Riveras and Riberas are abundantly represented. He, too, may be referred to by a different name or a different spelling of his name.

In addition to these families, this review also attempted to follow Donaciano Vigil and Alejandro Valle, two important figures in Pecos—and New Mexico—history. In the 1840s, Vigil was secretary to the last Mexican governor, Manuel Armijo, then was named secretary of the new U.S. territory by General Kearney. As such he became the first registrar of documents related to land in New Mexico and was extremely influential in land dealings throughout the territory. Don Vigil moved to Pecos in 1854 and by the time of his death in 1877 his estate included the Los Trigos grant (south of the Pecos Pueblo grant) and almost all the irrigated land in the Pecos cienaga east of the Pecos River (Hall 1984:144,154). Born

Alexander Pigeon, Alejandro Valle adopted his new name after he came to the Pecos area from St. Louis in the 1840s, He obtained the grant which bears his name, immediately north of the Pecos Pueblo grant, in 1851—Don Vigil witnessed and registered the deed. Like Martin Kozlowski, Valle established a stage stop along the Santa Fe Trail, his at Pigeon's Ranch, near Glorieta Pass, just west of the Pecos Pueblo grant (Hall 1984:149).

The Pueblo of Pecos had stood empty, except for travelers, since 1838, so mention here of "Pecos" refers to the village, 2 mi (3.2 km) northeast of the pueblo.

1860: The Eighth Census of the Territory of New Mexico, San Miguel County

The 1860 census is especially valuable because it includes a census of livestock and agricultural products as well as people. The returns are for the whole county and time did not permit extracting more than a few known Pecosenos from the sample, but it does give an accurate picture of farming practices in the county. This review underscores the need for a thorough settlement history of the region, because many of the settlements listed in any given census never appear again. The 1860 census, for instance, lists "Settlements along the Pecos River from La Cuesta to El Pueblo." If El Pueblo were related to Upper Pueblo on the modern map, these settlements would be near Ribera, south of the park (Figure 10.17). Other useful information in the census, such as the morbidity tables, is compiled by church parish, information not available for this review. Pecos village did not have a resident priest in 1860.

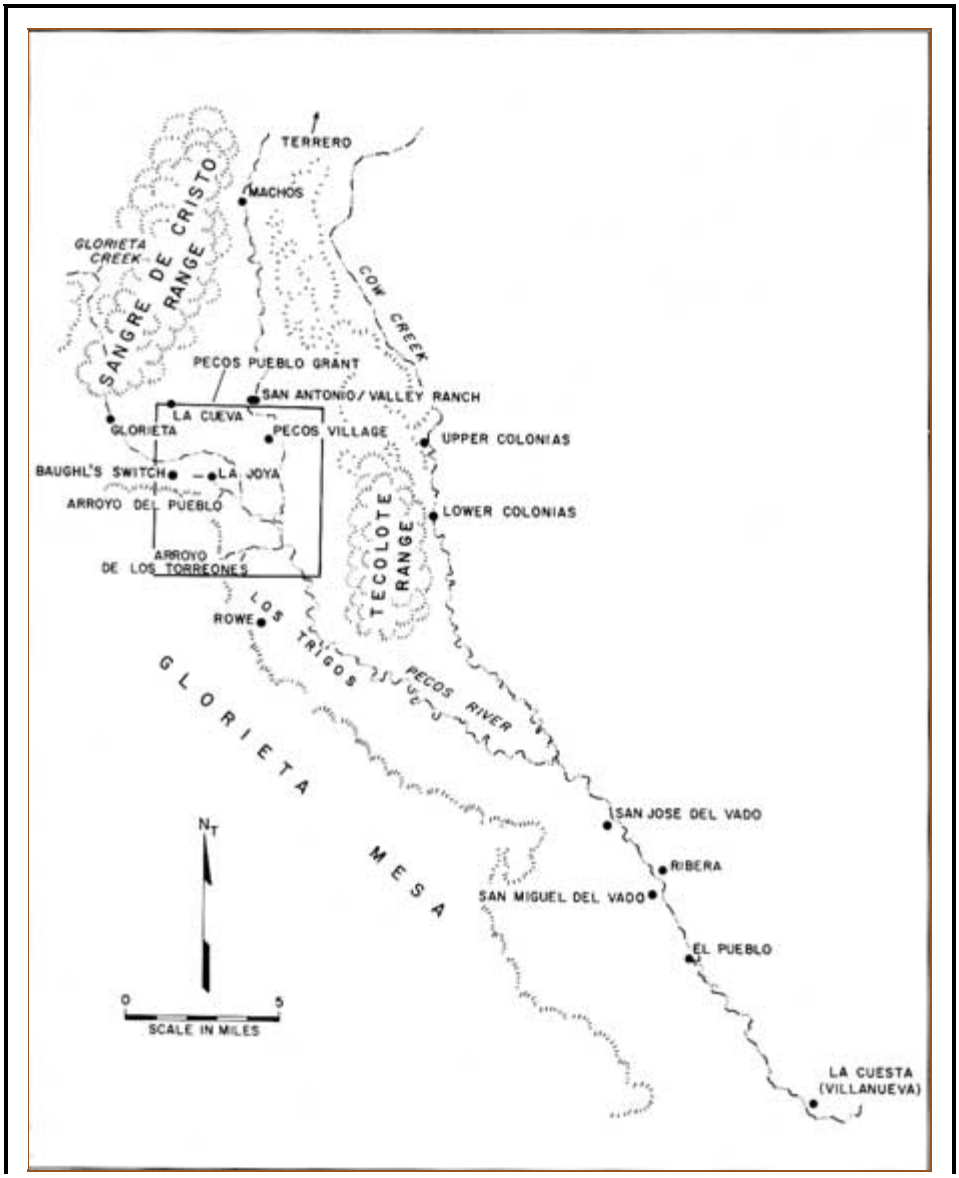


Figure 10.17. Locations mentioned in census review. *(click on image for an enlargement in a new window)*

"Anglo" money was already coming into the area. Most Hispanic farms were valued at between $100 and $3,000, while Anglo farms were valued from $1,000 to $18,000. In larger holdings, fewer acres were likely to be improved through clearing and possibly irrigation. Martin Kozlowski claimed 50 improved acres, a relatively high number, and two unimproved acres, on a farm valued at $1,500, with improvements and machinery valued at $200. Donaciano Vigil claimed only 12 improved acres at a value of $1,600, which suggests he had not yet begun accumulating the large landholdings mentioned in his 1877 will or that he reported most of this land as unimproved. Alejandro Valle claimed as much as 2,000 improved acres with a value of $6,000.

Most farmers kept some equine animals—a horse, mule, or ass. Many also kept working oxen, from 1 to 60. Many farmers also kept milch cows, with several farmers reporting herds of up to 100, although no butter or cheese production was reported in the census. It may be that all nonworking cattle were reported as milch cows. Most farmers kept a few pigs, usually only enough for on-site consumption. About half of the farmers kept sheep flocks, which varied widely in size from fewer than 10 to several thousand.

The census taker, Charles Emil Wesche, noted that crops were running only about 50 percent of expected yields and in some areas were total failures, from hail and locusts. A disease called "mal de lengua" by the locals caused high mortality among the mules. Frost wiped out almost all of the fruit. Only one farmer in the sample reported a fruit yield. The major crop was still corn. Almost all farmers reported corn crops of hundreds of bushels, with the range from 20 to 600. Some farms did even better. One Hispanic farmer reported 1,500 bushels from 25 improved acres, while an Anglo farmer reported 4,000 bushels from 250 improved acres. Wheat seems to have been grown in some sections of the county by most farmers and in other sections by virtually no one. In any case, wheat yields were in the tens to low hundreds of bushels. No one reported growing as much as 500 bushels of wheat. Surprisingly few farmers reported growing peas and beans, and no one in the sample grew even 20 bushels. Irish potatoes were also grown, but by even fewer farmers than grew beans, with never more than 15 bushels reported. It is interesting to note here that in the next year there would be comments in a Santa Fe newspaper lamenting the lack of potatoes and stating what a benefit it would be if someone in the territory were to grow some.

Among the industries listed were four mills, two of which were used to process both flour and lumber. One blacksmith did a large enough business to qualify as industry, processing about 6,000 pounds of iron. One carpenter also qualified, using 50,000 board feet. Evidently, none of these industries was near Pecos, although Donaciano Vigil is credited with setting up a molino in Pecos at some point in time (Hall 1984:146). The molino ground corn and survived into the 1940s (Cipriano Rougemont, personal communication 1999).

In the Pecos-Los Trigos area one blacksmith and one male domestic servant were recorded. All the rest of the men, out of a combined population of 488, were farmers, laborers, or farm laborers, a distinction that was apparently important at the time. The small scale and essential equality of the farming operations is shown in the fact that the farm laborers and farmers are nearly equal in number and many laborers also reported owning real estate. Many of the farm laborers were sons of the farmers. With one exception, shepherds were boys between the ages of 10 and 15, a practice that continued well into the twentieth century in Pecos (Sabino Varela, personal communication 1997).

Except for Juana Sena, a widow who described herself as a farmer, and one female servant,

no Pecos women reported an occupation other than housekeeping. Yet, Los Trigos had a washerwoman and a female servant, perhaps indicating harder times in Los Trigos.

At this time, the only information on Martin Kozlowski and his family is from the agricultural census. It seems odd that Kozlowski would appear in the agricultural census on the same page as Donaciano Vigil and Alejandro Valle but not be found in the personal census. However, according to the census, Kozlowski kept very little livestock, one horse, four oxen, and eight swine. He harvested only 80 bushels of corn from his 50 improved acres and grew no wheat, beans, or potatoes.

There were no Ruiz families in the Pecos-Los Trigos area or in El Macho or the two big ranches listed in the area, nor in the Torreones Creek area, as Arroyo de los Torreones was called in the census. Nor were there any farmers named Ruiz or Ruis in the county sample, which included most of the county. This may simply mean they were missed by the census, but if so, the family name was very rare in the area. Alejandro Valle, 53, was listed as having a twenty-nine-year-old wife named Carmen and two children. The Valles, the Kozlowskis, and a New Yorker named James Bugges with a large farm were the only non-Hispanics listed in Pecos.

The census taker noted there was not a single public school in all of San Miguel County. Wealthier families sent their children to Santa Fe College, while other children marked as being at school had attended a sort of relic "Dames School," run two or three hours a day in the winter by several women who taught their neighbor's children reading and writing.

1870: The Ninth Census of the Territory of New Mexico, San Miguel County

Several very distinct changes are immediately apparent upon analysis of the 1870 census. The population of the area seems to have dropped, but that may be a function of definition of the area by the census takers. However, only eight farm owners survive, employing 57 farm laborers. This fact, coupled with the 52 women who reported occupations, make it look like hard times had come to the Pecos Valley in the aftermath of the Civil War. Indeed, without quantifying, it appears that personal worth and real estate values had dropped considerably. For instance, Valle, now called Alexander rather than Alejandro, saw his worth drop from $14,000 to $3,971, which might explain why he spent years trying to get the Federal Government to reimburse him for the damage done to his stage stop by the Civil War battle of Glorieta Pass (Oakes and Swanson 1995:16). Only eight people report a personal worth over $1,000, including Donaciano Vigil at $1,500.

In 1870, Valle had three children, including a son, Justo, eight, born since the last census. Valle's daughter, Delfina, is one of 33 women and one man who described themselves as seamstresses. The number of women taking in washing had increased as well, from one to 13.

Ten people are listed as domestic servants. Children as young as eight and nine are listed as servants. Interestingly, the three youngest servants were Indians living with unrelated families. In fact, many children were living with families other than their birth family. One of the young Indian children was living with the Catholic priest and his parents, all of whom were from France. Of the six Indians living in Pecos, all were too young to have been Pecos Pueblo Indians, so presumably these were members of other tribes.

In spite, or because of hard times, more occupations are represented among men as well as women. There is a musician, a carpenter from South Carolina, a wagon boss, a lumber sawyer, a blacksmith (not the same man listed in 1860), and a gardener, who was the father of the priest. A resident priest also appears to have been a change for the village of Pecos.

From the 1870 census, we learn for the first time some personal information on Martin Kozlowski. Kozlowski, 43, was from "Polland" [sic] and his wife Ellene, 42, was from Ireland. Their oldest son, Joseph, 16, had been born in Missouri, while Thomas, the next oldest at 14, was born in New Mexico. Thus, the family came to New Mexico sometime between 1854 and 1856. The Kozlowskis had six children, two of whom, Juana, 12, and Carlos, 2, bore names reflective of their adopted homeland. The other children were William, 10, and John, 8. The family had a live-in washerwoman and a male domestic as well as a 16-year-old girl, Maria Antonia Quintana, for whom no occupation was listed but who undoubtedly functioned in the household as nursemaid or scullery maid. Mrs. Kozlowski was famous for her cooking at the stage stop on their property. The stage stop may have made the economic difference in their lives. Certainly in the 1870 census, they appear more prosperous than they did in the 1860 farm census, when they reported the farm and improvements as worth $1,700. In 1870, Kozlowski had real estate valued at $2,000 and a personal estate valued at $800. His was one of the few families reporting an increase in value during those 10 years.

The Ruiz family may have been in El Macho or Machos in 1870, since that is where they show up in 1880.

1880: The Tenth Census of the Territory of New Mexico, San Miguel County

The 1880 census taker included the names of the communities he was recording within the Precinct of Pecos. Thus, we have records for Glorieta, Pecos proper, Los Vallecitos, Los Trancos, Machos, La Cueva, Los Alamitos, La Joya, and Baughl's Switch (also called Bowll's Switch or Baughl's Siding) (Figure 10.17). The year 1880 marked the coming of the railroad through the area, but the economic benefits were scattered. Many areas, such as Los Vallecitos and Los Trancos were unaffected, whereas in Glorieta, half the able-bodied men were employed cutting timber or ties. The pace of life had quickened enough to require two blacksmiths in Glorieta, a male cook, and a "licor dealer." An influx of "foreigners" and easterners had taken most of the new jobs, leaving the Hispanic population in the farm laborer jobs. The census lists one immigrant from Canada, three from England, three from Ireland, five from France, and two from "Europe." Curiously, not a single person in Pecos Precinct was described as a farmer, perhaps reflecting the census taker's opinions or understandings. It may also represent the end result of the hard times of the 1870s, which also saw the "Great Panic" of 1873. Many farmers may have lost their land.

Machos seemed to have largely escaped the influx of foreigners, but the census recorded a small French community there. Carmen or Carmel Valle was now a widow, but her daughter and younger son were still living at home. Another French priest is resident in Machos, as well as a French laborer. Also living in Machos is the Ruis family, whose oldest son Pedro, at age 14, described himself as a musician.

Only one or two men in Pecos were actively cutting ties, but there are other clues that the coming of the railroad was impacting the community. For example, far fewer women had listed occupations, although one man was listed as a "washing man." Further, there was a small merchant class in Pecos, including a saloon keeper and a restaurant keeper. One man found employment clerking, probably for the saloon keeper, since he lived in that household. Another blacksmith plied his trade in Pecos, making three within five miles of each other.

The best evidence of changes precipitated by the railroad is the new community of Baughl's Switch, where the "Koslowskys" [sic] were living in 1880. Joseph, now married with two children, went by Jose. He had married a woman from "Mesure," which could be a phonetic spelling of Missouri. His brother William, still living at home, was known as Julian (probably Julian, a more common New Mexican Hispanic name for William than Guillermo,

the actual Spanish translation of William). Mrs. Kozlowski's name was spelled Helen instead of Ellene, Martin Kozlowski appears in the 1880 census as a resident of the jail in Las Vegas.

The most telling sign of the nature of Baughl's Switch, other than the name, is that the Kozlowski children and grandchildren were the only people listed as native New Mexicans, out of 80 residents living in the community. Two men gave their origin as Europe. Sixty-nine inhabitants, including Thomas Kozlowski, were making ties for the oncoming railroad, 10 others were contracting ties, and a den of six men gave their occupations as gamblers. Two contractors gave their names as August and Alexander Valles, of Ireland. Alexander would be of an age to be Alejandro Valle's eldest son, although the eldest son was listed as Rafael in earlier censuses. Thomas Kozlowski is listed as being from Colorado, yet we know from the 1870 census that he was born in New Mexico. The bustle of Baughl's Switch was short lived. In 1882, Adolph Bandelier traveled through the valley on the train and wrote in his journal that "the buildings at Baughl's have all disappeared" (Lange and Riley 1966:238).

1900: The Twelfth Census of the Territory of New Mexico, San Miguel County

Some 536 people were recorded in the Precinct of Pecos in 1900. The merchant class in Pecos had grown enough that specializations were listed, including whiskey salesman, jewelry salesman, grocery salesman, and others. Some of these men may not have had stores per se but were more likely peddling their wares out of the back of wagons around the area while making their homes in Pecos (George Adelo, personal communication 1995). Other specialties were freight-related occupations, including a teamster, a wagon driver, two express drivers, a simple freighter, and three freighters of railroad ties, showing that the region was still producing ties long after the railroad had come through, although only one man is listed as making ties, showing that the main production area was probably not in Pecos proper. The first miner and a miller made their appearance in the 1900 census in Pecos; the miller may have worked at Donaciano Vigil's molino. Farming had made a strong comeback, perhaps fueled by increasing access to a wider market as represented by the railroad and the teamsters. Twenty-four men reported that they were farmers, and 49 men were farm laborers, again many working on the family farm. Sixty-two men were day laborers. Women were not working as much as formerly. Only 16 laundresses were recorded and three milliners but no seamstresses. This may imply better economic times in Pecos.

There was also a school in Pecos by 1900, with three teachers, all locals. Two men, both Varelas, and a Rivera woman kept school, but evidently it was still a hit-or-miss proposition for most of the community's children. Virtually every child of eight and nine was in school, but only some five to seven year olds. Few teenagers attended, because by ages 10 to 12 many of them already had an occupation. It may well be that there was a subscription cost for schooling, because few families had all of their school-age children in attendance.

There were two priests in Pecos, both from France. Other sources indicate that most of the Kozlowskis had moved to Albuquerque and that Elena Kozlowski died there in 1895 (Kajencki 1990:63).

1910: The Thirteenth Census of the Territory of New Mexico, San Miguel County

In 1910, some 667 people were recorded as living on the Pecos Grant, and another 43 in the Precinct, which had changed its number from eight to nine. By this time, the railroad had become a major employer. Some 42 men described themselves as laborers or tie makers for the railroad, but even that is not the whole story. Several more described their place of occupation as the lumber camp, and one man described it as the tie camp, which makes it pretty clear that most of the loggers and saw mill employees were also working for the railroad, at least indirectly. In addition to the men who described themselves as working in

the lumber industry, no doubt the man listed as a "driver" and many of the odd job laborers were also similarly employed, at least on a casual basis. There was still a strong agricultural base, as evidenced by 97 men employed as farmers, farm laborers, and herders. For the first time herders on stock ranches replaced individual or family shepherds as livestock operators.

Jose Varela was still teaching school, but his daughter had joined him, as had the daughter of one of the town merchants, J. W. Harrison, who may have been the predecessor of the Adelos at the Town and Country Store. There was another French priest at St. Anthony's Church in Pecos.

Fourteen women described themselves as laundresses or servants. Only two or three were servants, and they were young girls. The laundresses describe their clients as either "regular customers" or "private family" and one woman declared herself the laundress at the hotel, but no hotelkeeper was found. It may be that the hotel was a boarding house farther up the canyon.

One miner, the miller, a carpenter, and an independent blacksmith were the trades representatives. The merchant class included Antonio Tanuz or Taniz, who was from Syria and who would, sometime in the next decade, stake Samuel Adelo (ne Abdullah) to a wagon of goods to get his start in Pecos. The merchant business had become complex enough that one man made his living as a bookkeeper. There were a few clerks as well.

For the first time, many people report having their own income. Judging by the age of most of these individuals, some sort of pension program may have gone into effect.

Unfortunately, none of the people we have been following appeared in the 1910 census. We know from Jones (1913b) that Tomas (Thomas) Kozlowski reappeared in the community in 1911 and had rebuilt a portion of the old trading post.

1920: The Fourteenth Census of the Territory of New Mexico, San Miguel County

This decade may be the high-water mark for Pecos. Only 549 people appear in the census, but at least another 200 were up the canyon, working at the mine. Many of these are "foreigners," but about half the work force were New Mexicans. The area was known as San Antonio or San Antonio/Valley Ranch (Figure 10.17). This is the heyday of the mine. Ten men in Pecos reported working as miners, with many more in San Antonio, as well as the usual complement of chemists, engineers, diamond drill operators, cooks, muckers, and others.

In the Pecos Precinct (No. 9), the number of agricultural workers had dropped again. Thirty nine farmers, 32 farm workers, and seven shepherds (no herders) were active, and the Rivera and Barela Stock Co. got a line in the census. But, for the first time, some of the farmers report a second cash job, freighting or, also for the first time, stock raising.

Nineteen men worked in transport, as either freighters or teamsters, but the express driver seems to be a thing of the past. Railroad workers numbered 24 and lumber workers, who were probably supplying both the mines and the railroad, numbered 39. The lumber mill was developing more specialties, such as lathe operator. The grist mill was still in operation, and carpenters, a bricklayer, a stonemason, and blacksmiths represented the trades.

New professions in town included a barber, several telegraph operators, and for the first time, a doctor and a lawyer. Another indicator of good economic times was that virtually no women were listed as working outside the home. Schooling was not recorded, however, so there is no way to determine if schooling was growing in acceptance. Jose Varela had retired from teaching and was farming, but one of his daughters continued the family tradition.

Again, unfortunately, none of the families we have been following appeared in the 1920 census. Time did not permit resolving the question of whether they had left the area or if a restructuring of precinct lines had put them in another district. This may also have been the problem in 1910, since Pecos had a new precinct number.

Summary

Although non-Hispanic residents of the region were increasing in number following the United States' occupation of New Mexico in 1846 and annexation in 1848, ethnic and economic patterns shown in the 1860 census reflect the Hispanic roots and nature of Pecos and the other San Miguel County communities. The economy of the Pecos area was almost entirely agrarian, including the few industrial trades in practice.

By 1870, census records suggest an economic recession in the region, seen in decreasing personal and estate values, in changing occupations, particularly in "service" occupations (laborers, servants, seamstresses, etc.), and, perhaps, in increased employment of women. At the same time, there seems to be an increased presence of non-Hispanic residents, as well as practitioners of trades less clearly tied strictly to farming and stock raising. These trends suggest changes in the nature and structure of communities in the region.

The 1880 census was taken in the same year that the railroad reached the region, and economic changes associated with the railroad were quickly felt, judging by the fact that they are already apparent in the census. The Upper Pecos Valley communities were becoming linked to regional and national industries and markets, encouraging rapid and significant changes from local, subsistence-based, agrarian patterns to wage- and contract-based employment. Also of importance was the formation of an actual railroad community, Baughl's Switch, and, as seen clearly in the census of that community, continual and increased immigration of non-Hispanics.

The continued impact of the railroad on regional communities is seen in the growing connections to regional, territorial, and national populations evident in the 1900 census. Particularly, we see the increased presence of merchants of various kinds and of freighters of various goods and materials, both of which show the movement of goods and materials into and out of the region and the move away from localized, subsistence-based economics. The presence of a mail carrier is an indication of the extent to which the Upper Pecos Valley was becoming integrated into the territory and the nation.

These trends are still evident in the 1910 census. Census records point to another important economic shift that began with the advent of the railroad and climaxed in the first three decades of the twentieth century—the growth of commercial pastoralism. This shift was created, in large measure, by the opening of eastern markets to ranchers and sheep pastoralists and resulted in the partidario (share-herding) system of herd management. It was prevalent across most of northern New Mexico before the Great Depression and impacted Native American, Hispanic, and Anglo herders and stockowners, changing their social and community structures and relations.

In the 1920 census, we see the continuing trend in which the Upper Pecos Valley is more strongly integrated into regional, statewide, and national industries, markets, and institutions. One very important aspect of this economic integration, beginning in the 1880s and continuing to the present, was the advent and growing dominance of a cash economy. Wage- and contract-labor appear to predominate occupations in 1920, as seen by the numbers of miners, freighters, teamsters, lumber workers, and railroad workers. The cash economy replaced the subsistence-based, agrarian economy that characterized the region before the railroad and before the rapid integration of Pecos into broader economic and social structures.

This review highlights, but does not exhaust, the data potential of one group of documentary resources, the census records, by examining briefly the information in those records concerning ethnicity and economy, as well as the lives of selected families. In combination with other documentary resources, particularly church records, a much more complete picture of the social and economic structure of the region can be revealed.

Ideally, the trends observed in this review are also visible in the archeological record of Pecos National Historical Park. Further, the archeological record can be expected to provide tangible data on the impacts of these trends on the residents of the Upper Pecos Valley.

An Examination of Trail and Road Segments near Pecos Pueblo

This study was aimed at identifying remaining segments of the Santa Fe Trail that exist in Pecos National Historical Park, but other potential roads and trails were also examined to define their period of use and determine how they fit into the culture history of the Pecos area. Aerial photographs were used to define linear features that might represent the remains of roads or trails near Pecos Pueblo. Most of these were located and examined in the field during May of 1999. Historic maps on file at the Public Room of the New Mexico Bureau of Land Management were used to identify road segments, as were historic accounts of the Pecos area. In this way, the functions of most of the linear features identified on aerial photographs and considered to be segments of roads or trails could be verified. Only two alignments were not identified from documentary sources and may represent trails associated with the occupation of Pecos Pueblo. No artifacts associated with the use of any of these trails in the nineteenth century were noted during the survey.

The Santa Fe Trail

The first trading expedition to use the general route of the Santa Fe Trail was that of William Becknell in 1821. The initial goal of Becknell's expedition was to trade with the Comanche, but they encountered some Mexican rangers and were persuaded to change their plans and trade in Santa Fe (Gregg 1954:13 [1844]). Because of their favorable report, others soon followed. While the trail was opened in 1821, the amount of commerce moving over it to New Mexico was limited for the first several years of its existence, and there were only eight to 10 expeditions between 1821 and 1824 (Connor and Skaggs 1977:34). By 1824 the main routes followed by the Santa Fe Trail had begun to emerge (Figure 10.18), and both the Mountain branch and the Cimarron branch were in use (Connor and Skaggs 1977). Trade began in earnest after 1825, when the United States completed a survey of the trail to mark its route and secure safe passage through Indian Territory (Connor and Skaggs 1977).



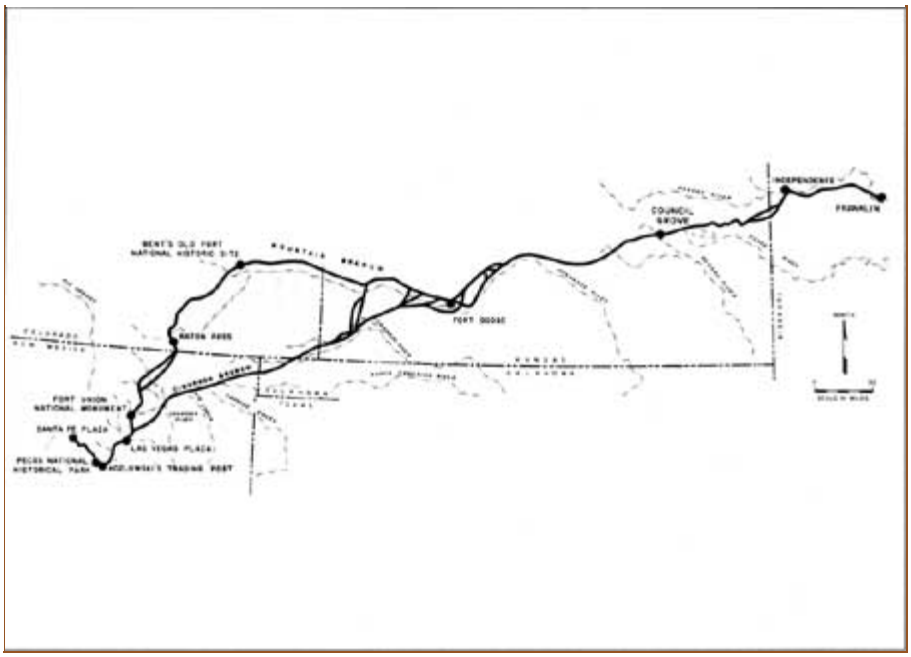


Figure 10.18. Santa Fe Trail route from Missouri to New Mexico. *(click on image for an enlargement in a new window)*

The eastern terminus of the Santa Fe Trail was at Franklin, Missouri until 1828. From that year on the trail began at the new town of Independence, Missouri (Connor and Skaggs 1977). Expeditions tended to leave in small groups and form up later at Council Grove in Kansas, where they would elect leaders and agree on the rules to be followed (Connor and Skaggs 1977; Gregg 1954 [1844]). Two main routes were used, the Mountain branch that followed the Arkansas River to Bent's Fort before turning south and the Cimarron branch that crossed the Arkansas River between the south bend and Fort Dodge, near present-day Dodge City, then headed southwest along the Cimarron river (Figure 10.18). The Cimarron branch was shorter than the Mountain branch, at 865 mi (1,392 km) from Franklin to Santa Fe versus 909 mi (1,463 km) for the latter (National Park Service 1990:14). After the move to Independence, the Cimarron branch was 753 mi (1,212 km) long, while the Mountain branch covered 797 mi (1,283 km) (National Park Service 1990:14). The Mountain branch was the more popular route during the early years of the trail because water was more readily available. It became less popular during the later years of the Santa Fe trade because of its length (Connor and Skaggs 1977).

The first ruts caused by traffic over the trail were seen after Becknell's second expedition to Santa Fe in 1822, in which goods were transported in three ox-drawn wagons (Connor and Skaggs 1977:33). Otherwise, most of the early expeditions carried goods on horse or mule back (Connor and Skaggs 1977:35). Most of the later expeditions transported goods in wagons drawn by mules or oxen, which could carry much heavier loads, often traveling four wagons abreast to avoid being strung out for miles in hostile territory (Duffus 1972:137; Gregg 1954:24 [1844]). The Santa Fe trade was disrupted in the three years preceding the Mexican War (1846-1848), because of a Mexican embargo against American goods (Connor and Skaggs 1977:203). Trade picked up again after the end of that conflict, only to decline once again during the Civil War. There was a resurgence of trade over the trail following the end of that war (Connor and Skaggs 1977:204). This resurgence of trade helped doom the Santa Fe Trail because it showed railroad promoters the economic possibilities of overland routes to the west, and they began to develop finances to take advantage of that potential. The railroad reached Santa Fe by 1880, effectively bringing trade over the Santa Fe Trail to an end, since it was more economical to ship goods by rail.

Pecos Pueblo and the Santa Fe Trail

Several accounts by travelers over the Santa Fe Trail mention the Pecos important area, providing information about that part of the route. Duffus (1972:156) notes:

> Along the fifty-eight miles between San Miguel and Santa Fe ran what might be called a highway. According to George Wilkins Kendall, the historian of the Texan Santa Fe expedition, which passed that way in 1841, it had been built "at the expense of the Santa Fe traders," and was at that time the only part of the trail upon which attention had been so lavished. It led the travelers past the ruins of Pecos Pueblo, lying in a lordly site, with far vistas of many mountains, through Glorieta Pass, then turned left at Cañoncito and went the final twelve miles northwest over the Glorieta range to Santa Fe.

San Miguel was the official port-of-entry until New Mexico was acquired by the United States in 1846 (Figure 10.17). This account indicates that the last section of trail between the port-of-entry and Santa Fe had seen some improvements during the Mexican period. While there is no mention of what those improvements were, this section of trail passed close by Pecos Pueblo.

The close proximity of the Santa Fe Trail to Pecos Pueblo is confirmed by Gregg (1954:190 [1844]), who states that in the 1830s travelers would often see residents of the pueblo standing on their roofs or leaning against a wall or fence. Pecos Pueblo was apparently commonly used as a campsite by travelers along the trail (National Park Service 1990:105). One of the most fascinating accounts of travel across the Santa Fe Trail is that of Susan Magoffin, who accompanied her husband Samuel just behind the detachment of American soldiers led by Stephen Kearney who took possession of New Mexico in 1846. Samuel Magoffin had been involved in the Santa Fe trade since 1828, when he joined his brother James who had been a Santa Fe trader since 1825 (Drumm 1982). In her journal, Susan Magoffin noted a visit to Pecos Pueblo on August 29, 1846, indicating that James Magoffin pointed out the room where he had occasionally stayed during some of his earlier trips when the village was still inhabited (Drumm 1982:101).

W. W. H. Davis came to New Mexico as the U.S. attorney for the territory in 1853 and provides a short description of Pecos Pueblo as seen during his journey over the Santa Fe Trail by mail coach (Davis 1982:54-55 [1857]). The expedition camped a short distance from the pueblo, which Davis examined while the mule team was being harnessed. He notes that the church was roofless at the time of his visit, an important observation because Magoffin's journal seems to indicate that it was still in place during her visit six years earlier (Drumm 1982:101). Both visitors note that the pueblo was in ruins.

Some years after these visits, Martin Kozlowski and his wife, Elena, built a hostel and stage stop near a spring that had previously served as a campsite for travelers along the Santa Fe Trail (Hall 1984:122; National Park Service 1990:105). According to information supplied to Adolph Bandelier by Elena Kozlowski, their ranch was established in 1858 (Lange and Riley 1966:80). It served as headquarters for Union troops during the Battle of Glorieta Pass in 1862, and troops were billeted there for two months following the battle (Hall 1984; Kajencki 1990; Swanson 1988).

The Deterioration of Pecos Pueblo

The deterioration of Pecos Pueblo is an important facet of this study, because at least two of the identified trail segments may relate to removal of wood from the pueblo and mission. In an 1884 journal entry, Bandelier (Lange and Riley 1970:336) notes that Don Ramon

Archuleta had come to Pecos in 1842 and that the buildings at the Pueblo were still intact at that time. Mariano Ruiz told him that the pueblo stood three stories high at the time of abandonment (Lange and Riley 1966:78). To follow up on this, Bandelier queried Elena Kozlowski about the condition of the ruins. She told him that she had:

> been here for twenty-two years and saw the houses still perfect. The church was with its roof and complete. Kozlowski tore parts of it down to build stables and houses. (Lange and Riley 1966:79)

Kozlowski used timbers from the mission and pueblo to build parts of his ranch (Lange and Riley 1966:412), though apparently not the main house. As Bandelier (1881:42) relates, Elena Kozlowski told him that the timbers from the mission were used to build outbuildings, apparently with the permission of the Archbishop of Santa Fe (Bandelier 1881:43).

Kidder (1924:87) indicates that local Hispanics were in the habit of removing timbers from the pueblo to use as firewood. He felt that the north building (Quadrangle) had retained its form for a few years following abandonment, since it was used as a temporary prison for a group of invading Texans captured by Governor Armijo in 1841 (Kidder 1924:87). Citing Emory's report concerning the conquest of New Mexico in 1846, Kidder (1924:87) notes that one of Emory's illustrations shows the kiva in the northwest part of the plaza, with the house walls behind it standing to a height of fifteen or twenty feet.

There are obviously some discrepancies between accounts. For instance, Elena Kozlowski told Bandelier (1881) that the mission's roof was intact when she and Martin arrived in 1858, yet Davis (1982 [1857]) indicates that the church was roofless in 1853. Perhaps Elena Kozlowski's twenty-two year old memory of the mission's condition was faulty. It is doubtful that the pueblo and mission were "in perfect condition" at the time of abandonment, since the population of Pecos had been dwindling for decades. Still, we might expect much of the pueblo to have remained fairly intact until the end. As Kidder (1924) notes, use of the Quadrangle as a temporary prison suggests that the main structure was still in good repair in 1841. However, Magoffin in 1846 and later Davis in 1853 both noted that the buildings were in ruins. Locals probably began salvaging timbers from the pueblo and mission soon after they were abandoned, and within less than 10 years they appear to have been in ruins.

Descriptions of the Segments Investigated

Thirteen linear road and trail segments were defined using aerial photographs, and most were examined in the field. Only two segments were not inspected on the ground, one because it was too faint to follow and a second because its relationship to another segment was not identified until historic maps of the area were consulted. A single long alignment was sometimes broken into several shorter segments for ease of description. The alignments were defined on 1:6,000 scale aerial photographs (on file at Pecos National Historic Park). Most were then ground checked and marked on USGS topographic quadrangles when confirmed. Figure 10.19 shows the locations of all segments in relation to Pecos Pueblo. Several roads that are marked on historic maps of the area have been added and are shown in Figure 10.20.



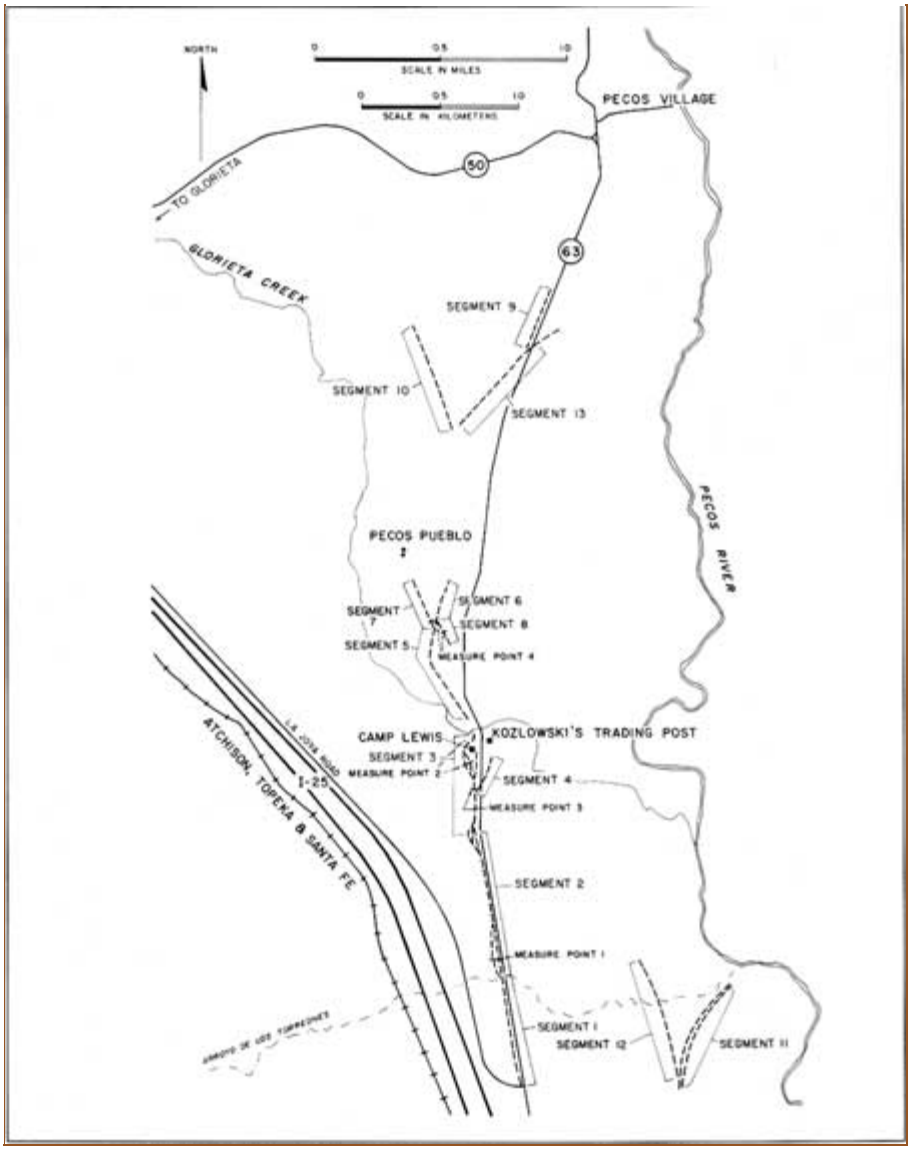


Figure 10.19. Road segments discussed in text. *(click on image for an enlargement in a new window)*

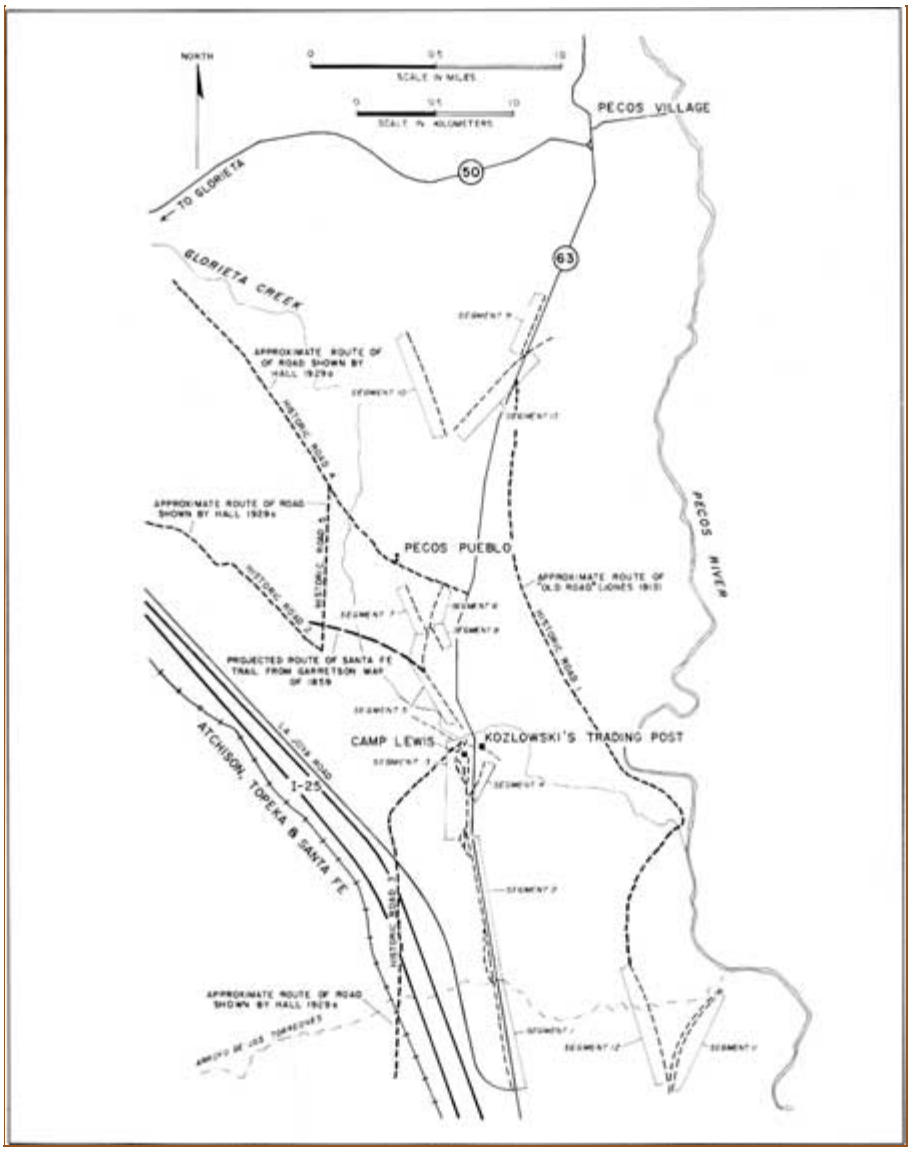


Figure 10.20. Historic roads derived from documentary sources. *(click on image for an enlargement in a new window)*

Other than linear alignments representing segments of trail, no surface artifacts or features that could be directly attributed to the Santa Fe Trail were located in this study (but see earlier discussion of PECO 329, 251, and Haecker 1998). In most places alignments appeared as shallow swales, but on slopes they usually became gullies that varied in depth according to the steepness of the gradient. Segments are described separately but are grouped by alignment. When possible, any correspondence with routes marked on historic maps of the area is discussed.

Santa Fe Trail

Seven segments appear to be related to the Santa Fe Trail, and occur on the west side of the NM 63 right-of-way south of Pecos Pueblo. Multiple parallel swales were visible along all of these segments, both on aerial photographs and on the ground. This is especially true where drainages are crossed, with the parallel swales probably reflecting alternate crossings used during wet weather or because of a washout. Elsewhere the parallel swales may indicate that caravans continued to move in multiple lines through this area, even though they should have been fairly safe from attack. Conversely, they could simply reflect the use of alternate routes when sections of trail became overly rutted.

Segment 1 begins where the La Joya de la Padre Road turns west from NM 63 and extends to the Arroyo de los Torreones, a distance of 750 m (2,461 ft). Two to three parallel swales were visible along this segment. No evidence of the linear alignment was noted south of this segment, either on aerial photographs or on the ground.

Segment 2 begins at the north end of Segment 1 and extends 950 m (3,117 ft) north to an unnamed drainage that flows into Glorieta Creek just west of Forked Lightning Ranch. Measurements were taken of the swales on this segment (Measure Point 1) at a place where three parallel swales are visible. The eastern swale is 4.2 m (13.8 ft) wide and 0.15 m (0.49 ft) deep, the central swale is 6.4 m (21 ft) wide and 0.28 m (0.92 ft) deep, and the western swale is 6.9 m (22.6 ft) wide and 0.25 m (0.82 ft) deep. Overall, the trail is 32.3 m (106 ft) wide at this point. Two to three swales were visible along this segment.

Segment 3 begins at the north end of Segment 2 and extends north for 650 m (2,133 ft), disappearing at the south edge of Glorieta Creek because of erosion. This segment leads to an arroyo crossing, swinging west around Civil War era Camp Lewis (PECO 329), and turning back to the east as it approaches the south edge of the arroyo to take advantage of a moderate slope down to the arroyo bottom. Where the swales descend the slope they have been deeply incised and now resemble wide gullies. Just before the trail turns east to descend into the Glorieta Creek bottom at least four separate swales can be seen on the aerial photographs. Unfortunately, only two swales could be distinguished in this area on the ground. Measurements along this segment (Measure Point 2) show that the eastern swale is 4.6 m (15.1 ft) wide and 0.24 m (0.78 ft) deep. The western swale, which may represent more than one set of ruts, is 9.7 m (31.8 ft) wide and 0.20 m (0.66 ft) deep. Separate measurements near Segment 4 (Measure Point 3) found that the swale is 17.6 m (57.7 ft) wide and 0.20 m (0.66 ft) deep and represents at least two separate swales that are visible on aerial photographs but cannot be distinguished on the ground. The number of swales visible along this segment varied from six at the southern drainage crossing, down to two in the central part of the segment, then up to four as the trail begins its descent to Glorieta Creek.

Segment 4 represents a turnoff from the main trail into Kozlowski's. The takeoff point is between 400 and 450 m (1,312 and 1,476 ft) southwest of the ranch building and is shaped like a V, with the northern branch providing access to traffic moving south on the main trail and the south branch to traffic moving north. Measurements taken in this area (Measure Point 3) show that the northern swale is 7.3 m (24 ft) wide and 0.25 m (0.82 ft) deep, and the southern swale is 8.0 m (26.2 ft) wide and 0.23 m (0.75 ft) deep. Just east of the point where the branches meet the trail enters the west edge of the NM 63 right-of-way and is obscured until the east edge of the right-of-way is reached. From that point the trail heads northeast toward Kozlowski's. As it descends the high terrace edge it turns into a fairly deep and wide gully. The entire traceable length of this segment is about 375 m (1,230 ft).

Segment 5 begins at the north edge of Glorieta Creek and extends northwest for 450 m (1,476 ft). At that point it turns back to the north for 225 m (738 ft) where it ends at a divide into two separate trails. Segment 6 begins at the divide and trends toward the north-northeast for 325 m (1,006 ft) before ending at the current entrance road to the park. Presumably, it would eventually encounter Segment 9 at the north end of the park, but the projected route crosses a badly eroded area where the trail is no longer visible. This section of trail is 6.3 m (20.7 ft) wide and 0.19 m (0.62 ft) deep (Measure Point 4). Segment 7 also begins at the divide and extends toward the north-northwest for 375 m (1,230 ft) before ending just short of the current park administration building. This section of trail is 7.5 m (24.6 ft) wide and 0.20 m (0.66 ft) deep (Measure Point 4). Three to four parallel swales were visible on the aerial photographs along the segment of trail along Glorieta Creek, but only two could be followed up the slope and on top of the terrace to the north.

Segment 9 is at the north end of the park and parallels the west edge of NM 63 for 450 m (1,476 ft). Two separate swales are visible through most of this area but have largely been converted to erosional channels so no accurate measurements were available. As discussed below, this segment probably ties in with other segments assigned to the Santa Fe Trail, but does not actually represent a segment of the trail.

Colonias Road

Segment 11 represents an abandoned section of the road to Lower Colonias, a small community in the Cow Creek drainage, east of the Pecos River. This portion of road consists of multiple parallel swales that cross a moderate slope on the north edge of a knoll that was used as a gravel quarry for the construction of Interstate 25. From the appearance of the swales, the road seems to have moved either upslope or downslope as erosion claimed each individual track. This is especially true at the northeast end of the segment, which contains numerous (eight+) channelized swales, some of which are incised up to 2 m (6.6 ft) deep. The swales are much shallower at the southwest end of the segment and are considerably less visible on the ground. No measurements were taken along this segment, and no attempt was made to document the actual number of swales present. This segment is about 800 m (2,625 ft) long and was used to access a ford on the Pecos River before the more recent bridge (PECO 339) was built.

Segment 12 is visible on aerial photographs but was not examined on the ground because its significance was not recognized during fieldwork. This segment, which is about 800 m (2,625 ft) long, is part of an unimproved dirt road on the west side of the Pecos River. Sections of this road are still in use, and its original route is shown as Historic Road 1 in Figure 10.20. It exited the Colonias Road near the south end of Segment 11 and, in a broad curve to the west, headed toward a crossing on Glorieta Creek near the current location of the Forked Lightning Ranch house. This segment is often referred to in survey field notes as "the South Boundary Road."

Miscellaneous Trail Segments

Three segments could not be assigned to specific historic trails, two of which may represent sections of trails associated with the occupation of Pecos Pueblo. Segment 8 runs northwest from the edge of the terrace top above the Glorieta Creek floodplain, intersecting Segment 6 about 50 m (164 ft) from where it separates from Segment 5. This trail could be followed for about 175 m (574 ft) and measures only 4.8 m (15.7 ft) wide by 0.15 m (0.49 ft) deep, much smaller than nearly all of the swales associated with historic roads. The southern end of this segment is near IO-68, originally described as a linear pile of cobbles. In addition to this feature, our study encountered two stone circles measuring 1.5 to 2 m (4.9 to 6.6 ft) in diameter at this location, built of variably sized cobbles and boulders in a single course. The function of the linear cobble pile could not be determined, but the cobble rings resemble a type of shrine used from prehistoric times to the present day by Pueblo Indians (Douglas 1917; Ellis 1969; Goldfrank 1927; Starr 1900). Thus, this segment may have carried traffic from Pecos Pueblo to a complex of shrines.

Segment 10 is visible as a long linear alignment on the aerial photographs, but only the northern third could be followed on the ground with any confidence. This swale is about 750 m (2,461 ft) long and begins near the north end of the Mesilla de Pecos, running toward the north-northwest. Though no measurements were obtained along this segment, it averages about 2-3 m (6.6-9.8 ft) wide and is very shallow. This configuration resembles Segment 8 in that it is narrower and shallower than swales associated with historic roads. Thus, it is likely that this segment also represents a section of trail used during the occupation of Pecos Pueblo.

Segment 13 is visible on aerial photographs as two to three faint parallel alignments running from near the southern end of Segment 10 to an intersection with the southern end of Segment 9. This feature is about 725 m (2,379 ft) long, and could not be followed on the ground.

Discussion of Trail Segments

Santa Fe Trail Segments

While we have thus far assumed that Segments 1, 2, 3, 5, 6, and 7 represent a section of the Santa Fe Trail that runs past Pecos Pueblo, there are problems with some of our identifications that should become clear as this discussion proceeds. One of the earliest federal surveys of the Pecos area was completed by John W. Garretson in 1859. His map (Garretson 1859) shows the Santa Fe Trail passing through this area and labels it as the road from Independence to Santa Fe. It travels north into the Pecos Pueblo Grant, curving broadly to the west to skirt the north edge of Glorieta Mesa. This map tends to confirm our definition of Segments 1, 2, and 3. As the road curves to the west, it passes near the southwest corner of Pecos Pueblo, confirming our identification of the south half of Segment 5. Using the configuration of the Pecos River on this map as a guide, the curve to the northwest probably began right after the crossing on Glorieta Creek near Kozlowskis, turning west about where Segment 5 now turns to the north. A projection of this section of the trail is shown in Figure 10.20.

This interpretation appears to be substantiated by a sketch map drawn by Adolph Bandelier during his study of Pecos Pueblo (Bandelier 1881:Plate I). This plan shows the "Military Road from Santa Fe" (Santa Fe Trail) crossing Glorieta Creek between 500 and 550 m (1,640 and 1,804 ft) southwest of the Pecos Mission. This is the approximate distance from the mission to the Glorieta Creek crossing on our projected segment of the trail in Figure 10.20. A second track labeled "Road to Rio Pecos" crosses the same approximate area but was not identified during our survey. Bandelier (1881:40) noted that the road from Baughl's Siding traveled to the east-southeast along Glorieta Creek but had to remain about a quarter of a mile west of the stream because of deep parallel drainages. The ford south of Pecos was apparently the first good location for crossing the stream. Thus, after crossing Glorieta Creek at Kozlowski's Ranch, the trail almost immediately crossed back over. These juxtaposed fords were apparently made necessary by the terrain; it was easier to cross the stream twice than it was to avoid it to the west.

The Garretson Map shows no spur of the trail running north to Pecos Pueblo, as represented by Segment 7. Whether this is because it was not a major thoroughfare and therefore not necessary for inclusion on his map or because it did not exist at the time is unknown. However, as discussed earlier, Pecos Pueblo was often used as a campsite by travelers along the Santa Fe Trail, probably both before and after it was abandoned in 1838. Thus, a spur of the trail to the pueblo might be expected. Conversely, the north half of Segment 5 and all of Segment 7 could represent a haul road used by Kozlowski when removing timbers from the pueblo.

Segment 6 is almost certainly not part of the Santa Fe Trail. Instead, it seems to be a section of the old Santa Fe to Las Vegas highway that existed before that route was paved. The map from Jones's 1913 survey shows the section of this road adjacent to Pecos Pueblo following the same approximate route as several segments of the Santa Fe Trail (Jones 1913a). It diverges from the Santa Fe Trail where Segment 5 turns to the northeast, and includes Segment 6. By bearing northeast soon after crossing Glorieta Creek at Kozlowski's Ranch, this track avoided the Mesilla de Pecos. A plat produced by Wendell V. Hall during a 1929 federal survey of the area (Hall 1929a) shows the pre-NM 63 route of this road, which his

field notes (Hall 1929b) indicate was paved when he did his survey. It appears to follow the basic course of the Santa Fe Trail, but sections of the earlier dirt track were apparently bypassed to the east when this road was built, including Segments 3, 5, and 6. Segment 6 appears to align with Segment 9 at the north end of the park, which probably represents another section of the same unimproved road.

Other than Pecos Pueblo, this section of the Santa Fe Trail passes two important associated sites within park boundaries. Kozlowski's has already been discussed in some detail; however, notes from the Jones survey provide important ancillary information. As he states, Tomas Koslowsky (Kozlowski) and his family had:

> rebuilt an old house and are at present living in it. This house was rebuilt during, July 1911 after having lain idle for a number of years. (Jones 1913b:14)

The rebuilt house was probably the main structure at Kozlowski's. This rebuilding of the house and Bandelier's (1881:42; Lange and Riley 1966:80) comments about Kozlowski using timbers from the Pecos Mission to construct outbuildings explain why tree-ring core samples taken from vigas in the main building at the ranch failed to provide dates consistent with the construction of the Pecos Mission (Appendix E). If timbers from the pueblo or mission were used in the main house, which is doubtful, they were probably removed prior to the rebuilding in 1911 or were replaced at that time.

The second important historic site associated with the Santa Fe Trail is Camp Lewis, which was used for a few days in March 1862 as a staging ground for the 1,350 Union soldiers that fought in the Battle of Glorieta Pass (Haecker 1998:1). A recent investigation of Camp Lewis by the National Park Service (Haecker 1998) showed that numerous artifacts related to that encampment exist adjacent to the Santa Fe Trail at the north end of Segment 3, where the trail swings to the west around a fairly level area before descending to Glorieta Creek. Several circular anomalies were defined by a proton magnetometer survey and infrared imagery and may represent positions where wagons were drawn into defensive circles. While Haecker (1998:49-50) notes that they could represent camps used by travelers along the Santa Fe Trail, he feels it is more likely that they were the locations of military supply wagons associated with the Battle of Glorieta Pass.

Turnoff to Kozlowski's Trading Post

Segment 4 (Figure 10.19) represents a turnoff from the Santa Fe Trail into Kozlowski's Trading Post. This segment is not documented on any of the maps of this area that were located. It may postdate the Garretson Map of 1859 and was most likely abandoned by 1913 when the Jones survey was conducted. Nevertheless, the location and configuration of this segment indicate that it functioned as the entrance into Kozlowski's Ranch and Trading Post from the Santa Fe Trail.

Section of the Colonias Road and Associated Tracks

Segments 11 and 12 represent an abandoned section of the Colonias Road and a related track. The more recent Colonias Road turns east at the point where these segments diverge. It passes to the south of the knoll that was once a gravel quarry, crossing the Pecos River at the bridge (PECO 339). Before the bridge was built, the road crossed the river at a ford north of the gravel pit, in the vicinity of PECO 541, and Segment 11 provided access to that crossing. There is also a ford south of the bridge, which may have been used as a contemporaneous crossing.

Garretson's (1859) map shows the Colonias Road leaving the Santa Fe Trail north of its modern exit from NM 63, running east and then curving north to cross the Pecos at the

approximate location of the northernmost ford. A nearly identical route is shown on Jones's (1913a) map, but the plat produced by Wendell V. Hall shows the road following its more recent path (Hall 1929a). This indicates that the bridge was installed sometime between 1913 and 1929, and Segment 11 was probably abandoned at about the same time.

Segment 12 forms the south end of a road that separates from the Colonias Road as it turns east to cross the Pecos River (Figure 10.20). Because this road seemed modern it was not ground checked. However, upon locating historic maps of the area, it was determined that this road was present as early as 1913, when it appears on Jones's (1913a) map. Its approximate route is shown in Figure 10.20, where it is labeled Historic Road 1. After leaving the Colonias Road, this track runs north and crosses the lower end of Glorieta Creek near Forked Lightning Ranch, though it predates that complex. It then trends northeast, ending at the old Santa Fe to Las Vegas Highway at the north end of the park.

Miscellaneous Segments

Two segments (8 and 10) do not appear on any of the maps that were consulted. These segments were distinct from sections of historic roads examined on the ground in that they are narrower than most road segments, and neither is as deeply incised. Only a single alignment is visible along these segments, both on aerial photographs of the area and on the ground. This contrasts with most road segments, which usually contain two or more parallel alignments. The presence of a probable ritual complex at the south end of Segment 8 suggests it was used to access that area. Segment 10 may begin near the north end of the Mesilla de Pecos, though no definite terminus was found. The configuration of this trail resembles that of Segment 8, except that no ritual features were found in association. Both segments are probably sections of trails used during the occupation of Pecos Pueblo.

A different function can be assigned to Segment 13. As noted earlier, this segment was too faint to be followed on the ground and was none too clear on aerial photographs of the area. A road is shown in this approximate location on Garretson's (1859) map and is labeled simply as "Old Road." This "Old Road" begins at the northeast corner of Pecos Pueblo and runs toward the northeast corner of the Pueblo Grant, crossing the Pecos River in the northeast quarter of Section 4 (T 15N, R 12E). Figure 10.19 shows the location of Segment 13, which has been projected a bit toward the east to show the approximate direction in which it heads. Basically, this road heads toward East Pecos, bringing to mind Kidder's (1924:87) comment about local Hispanics removing timbers from the pueblo for use as firewood. This faint track may be the remains of the road used for this purpose, and it may have fallen into disuse even before Garretson drew his map in 1859.

Four roads shown on Hall's (1929a) map are shown in Figure 10.20 because of their potential historic interest. Historic Road 2 begins southeast of Kozlowskis, runs along the south side of Glorieta Creek and continues northwest out of that valley, paralleling the AT&SF railroad line. No evidence of this road was noted during survey, but sections of it are visible on aerial photographs of the area, and some appear to have been in use until recently. Historic Road 3 leaves Historic Road 2 near the north end of Segment 3 and trends southwest then turns south. Most of this road was probably abandoned when I-25 was built through the canyon, but a short segment is still in use and parallels the north end of Segment 3, running around the edge of Camp Lewis.

Historic Road 4 left the Santa Fe to Las Vegas Highway at approximately the same point that the current entrance to Pecos National Historic Park exits NM 63, crossed the Mesilla de Pecos south of Pecos Pueblo, and continued to the northwest. It was joined to Historic Road 2 by a short segment of road (Historic Road 5) that paralleled the west side of Glorieta Creek. No evidence of Historic Road 4 was seen on aerial photographs, but part of Historic Road 5 is

visible.

Conclusions

By combining archeological survey, examinations of historic maps, and accounts of travelers and early archeologists in the Pecos area, we were able to define and identify several segments of historic roads. A section of the Santa Fe Trail remains within Pecos National Historic Park and runs up the west side of NM 63, crossing Glorieta Creek at Kozlowski's Trading Post. It then swings to the west to cross back over the stream, and at that point could no longer be followed.

While use of the Santa Fe Trail as a commercial route ended around 1880 when the railroad reached central New Mexico, some segments probably remained in use for many more years. This is true of the section examined by this survey, which continued in use as a route between Santa Fe and Las Vegas. Adolph Bandelier traveled from Santa Fe to Pecos Pueblo in 1880 and provides a detailed account of his trip (Bandelier 1881:40). The road he took followed the AT&SF railroad line past Glorieta to Baughl's Siding, which was about 2 km (1.2 mi) northwest of Pecos Pueblo (Julyan 1995). That road was very rough, but a good road led from Baughl's Siding to Pecos Pueblo and was probably a section of the Santa Fe Trail. This route is important, because it bypassed the village of Pecos completely, suggesting that the main road did not yet connect Glorieta and Pecos, as State Road 50 does today.

Extension of what had been the Santa Fe Trail north to the village of Pecos probably did not occur until after 1880 and was certainly accomplished by 1913 when the Jones Map was drawn. By then, of course, this section of road was no longer considered part of the Santa Fe Trail but was instead known as the Santa Fe to Las Vegas Highway (Jones 1913a). Unimproved sections of highway were identified and include the north part of Segment 5 and all of Segments 6 and 9. When NM 63 was paved, it was straightened and moved a bit to the east, preserving the segments identified by survey. Thus, this section of the Santa Fe Trail continued to function as a thoroughfare for 30-40 years after the railroad ended its use as a commercial route from the east. Indeed, parts of the Santa Fe Trail probably exist under NM 63 south of the La Joya de la Padre Road and under I-25 along Glorieta Mesa, so it still functions as an important transportation route.

Parts of other historic roads were also identified. Some are visible on aerial photographs as well as on the ground, while others were too faint to be followed on the ground. An interesting aspect of this study was the identification of two possible pueblo trails, which seem to differ from the historic roads. These trails consist of swales that are shallower and narrower than most of those along the historic roads. They also occur as single alignments, as opposed to the historic roads that generally contain multiple parallel alignments. These observations are potentially important and suggest that the configuration of foot paths varies enough from that of roads used by wagons and motorized vehicles that they can be distinguished from one another, even when abandoned for decades or longer.

Summary

Through a variety of approaches, this chapter has presented an introduction to some of the Euro-American archeological resources at Pecos National Historical Park. As with prehistoric studies, previous historical research, both documentary and archeological, has focused on Pecos Pueblo and the mission church and convento while the surrounding areas of the park and the Upper Pecos Valley have received less attention.

Consideration of the patterning of Spanish Colonial sites and artifacts indicates that most seventeenth and eighteenth century Euro-American settlement in the park centers on the

mission complex, and that despite the strong influence over pueblo life exerted by the Spanish church, Native American material culture dominates the record for this period.

Examination of the Euro-American artifact data suggest that it was not until the independence of Mexico from Spain, and even some time after, that Hispanic settlement began in the park. By using archeological data in conjunction with documentary sources, the identity of the occupants of two of the homestead sites has been confirmed and clues uncovered about daily life in early nineteenth century New Mexico. Census records augment these studies by providing insights into the economic and social status of the inhabitants of the local area and the extent to which the Pecos Valley became integrated with regional and national institutions. The Santa Fe Trail served as a conduit for many of the changes that occurred in the valley during the nineteenth century, and field research and examination of historic maps indicates that remnants of the trail still exist in the park. This combination of approaches also highlights trails that have a signature distinct from wagon roads, possibly the precursors of the historic trail that linked Missouri to Mexico and Pecos to the rest of the world.

Many questions remain to be asked of the Euro-American resources at Pecos National Historical Park. What effects did Mexican independence, the Santa Fe Trail, the Civil War, the two World Wars and the post-war years have on this high valley? Once the fulcrum of the frontier, does Pecos remain on the margins of broader systems? Future historical research in the Upper Pecos Valley would benefit greatly from combining documentary studies with those of material culture. Systematic archeological data recovery, including excavation and remote sensing, in tandem with the study of documents and oral histories, can provide great insight to the changes in land use, settlement, culture, and economy that have shaped the lives of people now living in the Pecos Valley and the American Southwest and will continue to influence our lives in the future.

Notes

1. In addition to the work presented here, the OAS also provided three additional products: (1) a list of primary historical documentary resources related to nineteenth and early twentieth century land use and occupation within Pecos National Historical Park and adjacent portions of the Pecos Pueblo grant and the Upper Pecos Valley (This list was compiled by Boyer from Hall's [1984] footnote references), (2) additional information from Williamson on the Euro-American artifacts collected during the survey, and (3) a discussion of sites included in the component landscapes defined in the Cultural Landscape Overview, based on artifact dates. These materials are on file at Pecos National Historical Park and at the National Park Service, Santa Fe.

2. The survey did not record the Mission Church and Convento. For details on these structures, please see the Historic Structures Report (Ivey 1996)

3. Ceramic manufacturing characteristics, such as decoration styles and techniques tend to change more slowly than do similar characteristics of most other artifact groups. Consequently, the associated temporal ranges are longer for historic ceramics than those for cans and glass.

4. Price (1979) shows an identical brown stamped vessel from a site in the eastern Ozarks occupied between 1815 and 1870 but suggests the ceramic type dates after the late 1840s, The Ozark piece also included the rim with a green band and leaves. Ketchum (1983) shows a bowl with the same floral motif in blue with brown and yellow. He first calls it transfer ware, which it is not, but then describes it as "cut sponge." He dates the type between 1870 and 1920.

5. The paste of this sherd is a highly vitrified whiteware or perhaps a soft porcelain. In addition, the glaze has enough cobalt to puddle blue at the interior rim. The exterior glaze is very poor, exhibiting runs and streaks that seem to be original to the piece, and is noticeably blue. In addition, the glaze is very pinholed and the painted design colors bubbled through the glaze. Noel Hume (1970) mentions the blue puddling effect on porcelains produced at Leeds, England, suggesting that blue puddling is not a reliable distinction between pearl-ware and whiteware. The glaze quality suggests that the vessel was "second" quality. It may have been a Leeds porcelain or an early whiteware.

<<< Previous <<< Contents>>> Next >>>

peco/cris/chap10.htm
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PECOS

From Folsom to Fogelson:
The Cultural Resources Inventory Survey of Pecos National Historical Park

CHAPTER 11:
SUMMARY AND CONCLUSTIONS

Janet D. Orcutt and Genevieve N. Head

Community development and exchange are the two central themes addressed in the Pecos survey report, focusing on the prehistoric Puebloan occupation of Pecos National Historical Park. In addition, the chapters also summarize ceramic, lithic, and architectural data recorded by the survey, and this is the first time that lithics in the Pecos area have received significant attention. Community development and exchange take place in several spheres, and we are able to examine those through changes in population size and aggregation and the differentiation of activities at the major site types.

In tracing the changes associated with the development of Pecos Pueblo, we examined several key variables from different points of view. Population growth rates and measures of aggregation indicated that people moved into the Pecos area and that aggregates persisted even as population declined. Nearest-neighbor analyses and ceramic compositional studies demonstrated that interpueblo relationships within the Upper Pecos Valley were characterized by cooperation, not competition. Examining the productivity of small catchment areas around site types highlighted the importance of resource productivity for decisions about site location. Ceramic vessel sizes and measures of grinding intensity provided indirect information on agricultural intensification, which we expected to accompany aggregation. The abundance and distribution of nonlocal ceramic types and lithic raw materials gauged change in the direction and intensity of exchange with groups outside the Upper Pecos Valley.

Most analyses of Puebloan materials are organized by time and site type. Powell (Chapter 4) developed a seven-period chronology based on the decorated ceramics recorded at sites. Sites were assigned to periods using probability dating, in which the probability distribution for each ceramic type was based on the median and standard deviation in the known production span for that type. The probability distributions were "averaged" for each site to reflect the statistical probability that a site was occupied in a particular period. If a site's probability of membership in a period was .20 or higher, the site was assigned to that period. Most ceramics are post-1200, covering Periods 2 (A.D. 1200-1325) through 6 (A.D. 1700+).

Head's typology (Chapter 5) assigned sites to functional types that collapse the survey's descriptive types into fewer, more meaningful groups. Three major types—habitation, seasonal, and special use—were defined based on the presence and nature of nonportable features and structures, reflecting duration of occupation and variety of activities. One advantage of using these types is their widespread acceptance among archeologists for categorizing Puebloan systems.

After defining the functional types, Head compared the number of artifact types, the density of artifacts, and the nature of feature groups across the site types and found statistically significant differences between them. Habitation sites include pueblos and communal

pueblos. All habitations have features, and they have more artifact types and higher artifact densities than seasonal or special-use sites. Seasonal sites were occupied for short periods of time over several (agricultural) seasons. Shelters at seasonal sites were not substantial and may not have been preserved. Compared to habitations, seasonal site assemblages are less diverse and artifact densities are lower. Special-use sites are situated to exploit a specific resource for a short time. Although they may be used repeatedly, they have few features and artifact assemblages are less complex than at habitations or seasonal sites.

The following discussion summarizes the results of the survey analyses within the temporal framework developed by Powell in Chapter 4. Some ceramic and settlement analyses did not make use of Powell's chronology, and those are discussed separately.

Period 0 (pre A.D. 1075) and Period 1 (A.D. 1075-1200)

The survey recorded five sites dating to Periods 0 or 1. The survey also recorded an isolated, broken Folsom point in the Tecolote Range, indicating temporary or intermittent use of the area by Paleoindian hunters. Three Archaic sites were recorded, all located on ridge slopes and without any features. The two Period 1 sites comprise one seasonal and one special-use site.

Period 2 (A.D. 1200-1325)

There are six habitations, 39 seasonal sites, and 56 special-use sites in Period 2. Because Period 2 is the first period with a significant number of sites, it serves as the baseline against which to compare subsequent periods. The early Puebloan occupation is substantial, and already aggregates are as large as 360 people. The survey did not record any pre A.D. 1200 habitations, so we do not know whether there was a permanent population in situ from which the Period 2 population developed or whether a portion of the people came from elsewhere. The extent of the occupation before 1200 is unknown. A small pithouse village, dating around A.D. 850-900, had been deeply buried and was discovered in the 1970s during NPS-related construction (Nordby and Creutz 1993a). While there probably are more buried habitations dating to the same time, it is impossible to estimate the magnitude of the pithouse occupation. In addition, adobe structures beneath the main occupations at Rowe and Forked Lightning probably date to the eleventh and twelfth centuries. Based on this sparse sample, there were people living in the Pecos area before 1200, but it is not possible to estimate the population.

The population in Period 2 was close to 800 people. We expected conflict or competition over resources to accompany population growth, which would be reflected by a median nearest-neighbor statistic (mNND) indicating even spacing among sites, especially habitations. The mNND, however, reveals clustered distributions between and within all site types. Habitations are clustered, indicating a lack of competition over resources. Special-use sites cluster among themselves and with seasonal sites, probably because wild resources and agricultural land are in similar areas. Seasonal and special-use sites cluster with habitations, which indicates the use of resources close to home.

Because Period 2 had the lowest population and smallest aggregates, we expected less dependence on agriculture than in periods with more people or larger aggregates. Therefore, we expected less evidence for the consumption and storage of corn during Period 2 than in subsequent periods. Undecorated jar sherds dominate the Period 2 ceramic assemblage, comprising almost 60 percent of the sherds. The prevalence of cooking jars indicates that cooking was a dominant activity. The sizes of ceramic vessels were expected to increase through time as aggregation and agricultural intensification increased. Cooking jars generally are smaller in Period 2, but none of the differences in vessel size through time are significant.

Storage (decorated) jars are slightly larger than in Periods 3 and 4, but they make up a small percentage of the Period 2 ceramic assemblage. Serving (decorated) bowls are smaller than in subsequent periods, and they comprise a smaller percentage of the assemblage than in later periods except Period 5.

Flaked lithics add to our insight regarding subsistence during the early Puebloan occupation of the Pecos area. High-energy tools are significantly more abundant at the earlier pueblos. The tools were not manufactured at the habitations, based on the amount of debitage but were discarded there more often. The large amount of mule deer bones at Rowe (Cordell 1998) and Pecos Pueblo (Kidder 1932) indicate that hunting contributed more to the diet in the Upper Pecos Valley than at other northern Rio Grande pueblos (Cordell 1998). The abundance of high-energy tools, therefore, probably reflects a higher dependence on hunting.

Ceramics and lithics both indicate trade between the Pecos area and other parts of the northern Rio Grande Valley during Period 2. Forked Lightning, the earliest pueblo in the Pecos survey area, is one of only two pueblos with nonlocally tempered utility ware. Forked Lightning is the only pueblo in which the nonlocal temper is sanidine, which probably originated on the Pajarito Plateau. In addition, a small percentage of utility ware at Period 2 habitations have nonlocal micaceous pastes. Approximately 20 percent of the white ware at Forked Lightning has either nonlocal temper or paste. The percentage increases to 50 percent if sherd-tempered (grog) white ware was imported. Much of the sherd temper contains nonlocal volcanics; thus, these wares were either traded into the area or Pecos potters selectively ground volcanic-tempered imports to use for temper. Dick's Ruin, which was occupied slightly later in Period 2 than Forked Lightning, has a smaller percentage of grog-tempered white ware but a higher percentage of nonlocal tempers or pastes than Forked Lightning.

Obsidian from the Jemez Mountains sources—Cerro Toledo, Valle Grande, and El Rechuelos—is present at Forked Lightning Pueblo. At Dick's Ruin, Cerro Toledo and El Rechuelos obsidian are the most common, but there is no Valle Grande obsidian, and the amount from Bland Canyon is small.

Despite differences in the specific sources, the presence of nonlocal materials in the ceramic and lithic assemblages at Forked Lightning and Dick's Ruin indicate that Pecos had exchange ties to the Rio Grande Valley. The origins of the raw materials suggest that the focus of trade during Period 2 was with the Rio Grande pueblos in the vicinity of the Pajarito Plateau and Jemez Mountains.

Period 3 (A.D. 1325-1450)

The number of sites increased in Period 3. There are 10 habitations, 104 seasonal sites, and 188 special-use sites. The human population in the valley is estimated at over 2,000 people, more than double the Period 2 (A.D. 1200-1325) population. Period 3 marks the peak of the pre-historic population, and the 0.8 percent growth rate from Period 2 to Period 3 is higher than that expected through natural growth (Hassan 1981). There are 564 people at the largest aggregate in Period 3, an increase of approximately 200 people over Period 2.

It appears that the Upper Pecos Valley attracted people from other areas, which could be related to climate and agricultural productivity. The dryness index devised by Orcutt and Benedict (Chapter 6) for the Palmer Drought Severity Index (PDSI) indicates that potential agricultural productivity improved in Period 3. Period 2 (A.D. 1200-1325) was drier and the yearly PDSI values indicate high variability between 1270 and 1298. Moisture availability in Period 3 was much less variable, and a lower percentage of years were very dry. The improved climate possibly led to increased agricultural productivity and predictability, and

may have helped attract people to the valley.

We expected competition over resources to arise in Period 3 because of the large population increase. The mNND, however, indicates that sites, including habitations, remain clustered. We assume there was no animosity between communities and that resource exploitation continued to focus on nearby resources. If competition or conflict over resources was a factor in site locations, habitations in particular would be evenly spaced, or possibly randomly spaced, but not clustered.

Greater locational diversity accompanies the increase in people and sites in Period 3. Landform is the most useful environmental variable recorded by the survey, and the number of occupied landforms increases.

Greater social stress is a consequence of aggregation because the chances for interpersonal conflict increase with larger groups. We expected to find evidence for integration of larger numbers of people through community rituals. Because rituals usually involved kivas, we expected larger kivas to accompany aggregation as communities incorporated more people into their ceremonies. The number of kivas peaks in Period 3, and the kivas are slightly larger than in Period 2. Population growth, therefore, did lead to more kivas, and increased aggregation led to a small increase in the average kiva size. Seven is the maximum number of kivas at one site in Periods 2 and 3, and the ratio of habitation rooms to kivas doubles in Period 3.

Undecorated utility ware, consisting of plain, corrugated, and unknown types, continues to dominate the ceramic assemblage. Undecorated (cooking) jars are more common than decorated (serving) bowls or decorated (storage) jars, although they represent a smaller percentage of the Period 3 ceramic assemblage than they did in Period 2. In Period 3, decorated (serving) bowls and decorated (storage) jars become a larger part of the ceramic assemblage. Increased serving and storage, and probably cooking, could be the result of a higher population, however, given the proportional composition of the assemblages, it would appear that agricultural intensification may have been a factor.

Vessel sizes suggest that agriculture was intensified in Period 3. Cooking jars and serving bowls are slightly larger, indicating either greater consumption of agricultural products or increased household size accompanying population aggregation. Storage jars decrease slightly in size, which does not contradict our expectations for greater storage resulting from agricultural intensification because decorated jars comprise a larger percentage of the ceramic assemblage than in Period 2 (A.D. 1200-1325).

High-energy lithic tools continue to occur more frequently at habitations, as they did in Period 2. Thus, hunting appears to maintain its importance in the diet, even with the increase in agriculture. We also expected grinding intensity to increase with agricultural intensification and aggregation. Compared to Period 2, which provides the baseline data for grinding intensity, the opposite occurs. Mano profiles show a decrease in grinding intensity in Period 3, which means that a mano was used for a short time, then discarded. A possible explanation lies in the local abundance of suitable cobbles for manos, making it easier to discard a worn mano than to invest energy in maintenance.

We expected an increase in agricultural features with the formation of Pecos Pueblo and greater dependence on agriculture. The survey recorded 38 agricultural features, so they are not very common. The number of features doubles in Period 3, and there are a greater number of agricultural feature types. In addition, there are more complex features such as a reservoir, systems of terraces or field borders, and grid gardens. Generally, this helps confirm the increased importance of agriculture in Period 3.

Ceramic petrography indicates that trade ware constitutes up to 50 percent of the white ware at Period 3 sites if sherd-tempered (grog) white ware is considered nonlocal. The percentage of grog-tempered white ware declines within Period 3 sites when Dick's Ruin, Loma Lothrop, and Pecos Pueblo are ordered temporally. As grog temper declines, the percentage of sherds with definitively nonlocal paste or temper increases. Approximately half of the white ware sherds from Pecos Pueblo have nonlocal temper or paste, although the sample of white ware is small (n=10). There is no evidence that any single pueblo controlled ceramic trade, suggesting this was a cooperative enterprise.

Period 3 marks the appearance of glaze ware in the Pecos area and the Rio Grande in general. Shepard's work (Kidder and Shepard 1936) indicates that while most Glaze I sherds are nonlocal, poorer quality, locally-tempered ceramics appear, and by late in Glaze I, Pecos potters are making their own glaze ware.

We expected standardization or specialization in ceramic production to accompany aggregation and agricultural intensification at Pecos Pueblo, and the petrographic data suggest this did occur. There is less variability in utility and white ware tempers and pastes at Pecos Pueblo than at contemporaneous but slightly earlier pueblos. There are seven to nine utility ware paste groups at the earlier pueblos and only four at Pecos Pueblo. There are five to six utility ware temper groups at the earlier pueblos and only three at Pecos Pueblo. The trend is not as clear in white ware, probably because there is more trade in white ware. Four to eight white ware paste groups are represented at earlier pueblos, but Pecos Pueblo has three groups. Six to eight white ware temper groups are found at earlier pueblos, and there are six at Pecos Pueblo.

The volume of obsidian increases slightly in Period 3 assemblages, indicating that trade for some lithic raw materials remained oriented towards the Jemez Mountains. There are shifts in the specific sources—at Loma Lothrop, El Rechuelos declines and Bland Canyon is high. Although the volume of nonlocal chert triples in Period 3, it is low compared to Periods 4 and 5. The increase in nonlocal chert signals the beginning of the shift in trade networks towards the Plains. The patterns of use and conservation of obsidian and nonlocal chert are different. Most of the obsidian in Period 3 was used for high-energy tools while most of the nonlocal chert was used for low-energy tools. There may have been less concern with maximizing the use of "rare" materials, possibly because the nonlocal chert came into the area as a subsidiary to other more important Plains trade items such as bison products.

Period 4 (A.D. 1450-1575)

The number of sites declined sharply in Period 4. There are three Puebloan habitations, 90 seasonal sites, and 142 special-use sites. Pecos Pueblo is the primary residence, and the other habitation probably represents seasonal use of Long House, which was a habitation in Period 3 (A.D. 1325-1450). Population declines in the Pecos area as a whole, but the aggregate at Pecos Pueblo increases to almost 900 people according to the survey data.

The PDSI dryness index indicates high potential agricultural productivity so the population decline may not be related to moisture or agricultural productivity. One possibility is that people reorganized to cope with environmental degradation resulting from over 200 years of land use. Another is that increased interaction with Plains tribes, and the potential conflict accompanying that relationship, encouraged aggregation in a central and defendable location. There also may have been conflict with other Rio Grande pueblos. The North Pueblo Quadrangle, with its encircling wall, obviously is a defensive structure, and it dates to Period 4.

Because people were concentrated in one major habitation, we expected to see changes in the

nearest-neighbor relationships among site types. The nearest-neighbor analysis used a database with three habitation sites—Pecos Pueblo, one small Puebloan habitation, and one Euro-American site. The habitations are randomly distributed, which probably reflects a desire to locate away from the large aggregate at Pecos Pueblo to find locations with sufficient local resources. If the other habitations, especially the Puebloan one, are actually seasonal sites, this also could account for the randomness among the three sites.

Nearest-neighbor distances among and between nonhabitation site types indicate clustering, so there is no change from previous periods. Habitation and special-use sites continue to cluster in Period 4. Seasonal sites no longer cluster with habitations, possibly reflecting a need to find arable land farther from the aggregate, either because nearby fields had gone out of production or there was greater use of irrigable fields northeast of Pecos Pueblo outside the boundaries of the park.

Despite fewer sites, seasonal and special-use sites continue to occupy a diversity of landforms. Ridge slopes comprise a higher percentage of the locations than in Periods 2 or 3, which could be related to resource availability or might reflect a need to view the surrounding landscape.

We expected the size of the basal social unit to increase and the number of social units to decrease to relieve the stress caused by a larger community. Specifically, integrative mechanisms such as larger kivas that accommodated more people should appear in Period 4.

There are fewer kivas in Period 4, and the number of rooms per kiva declines. The maximum number of kivas at one site more than doubles from seven in Period 3 to 15 in Period 4. More kivas suggests an increase in the number of basal social units instead of a decrease. Average kiva size, however, doubles in Period 4, indicating that larger groups were integrated as aggregation increased. A large integrative structure, Kiva 12, was built at Pecos Pueblo that is four times the size of the next largest kiva. Kidder (1958:218) felt the kiva was not completed and never was used because it was unroofed and seemed to have filled rapidly. Integrative structures without roofs are now known across the Southwest, however. The appearance of such a large kiva at the peak of aggregation suggests the development of community-level rituals that were not present earlier.

Period 4 is the only one in which undecorated utility ware jars do not dominate the ceramic assemblage. As seen elsewhere in the northern Rio Grande at this time, decorated wares increase to half of the ceramic assemblage at sites. As the percentage of decorated jars increased, the percentages of undecorated cooking jars and decorated bowls decreased. The decline in undecorated cooking jars is larger than the decrease in serving bowls. The increase in storage jars lends some support to our contention that storage should increase as larger aggregates intensify agriculture.

The patterns in vessel size through time are interesting, but they are not statistically significant. In general, although vessels are smaller in Period 4, the difference is slight, and it appears that the assemblages in Periods 3 and 4 are very similar. We expected larger households or commensal units, and possibly communal feasting, as aggregation increased, all of which should be reflected in larger cooking and serving vessels. It does not appear that increased aggregation led to a change in the size of the group cooked for or served during this period. When decorated bowls are sized by ceramic type, however, Biscuit A and B bowls, which date to late Period 3 through most of Period 4, are larger than contemporaneous glaze ware bowls. If communal feasting took place, it appears that Biscuit ware bowls were used. Later in Period 4, as Biscuit ware declines, Glaze V bowls take over the communal feasting role.

We expected increased grinding intensity in Period 4 to go along with aggregation and agricultural intensification. It does appear that manos were used longer before being discarded; however, the level of intensity is not high. As stated before, there is an abundant. supply of natural cobbles in the area so there may not have been much incentive to refurbish worn manos.

Based on Kidder's (1958) assertion that the Quadrangle was built for defense, we expected more high-energy tools in Period 4 if increased numbers of projectile points were used during confrontations. This is not the case, and the significant occurrence of high-energy tools in previous periods is attributed to the importance of hunting. It is likely that projectile points were not manufactured specifically for defense. Certainly, they could have been used when needed for that purpose without causing an increase in their frequency.

As an outgrowth of agricultural intensification, we expected more agricultural features and more complex agricultural features that were built and maintained at the community level. We expected this to occur in Period 3, when population peaked and Pecos Pueblo was formed, and it did. We expected the number and complexity of features to remain high in Period 4; however, that is not the case. It is likely that if agriculture was further intensified, it was done so northeast of the pueblo, outside the boundaries of Pecos National Historical Park, where irrigation was possible.

Ceramics and lithics indicate the importance of trade in Period 4. Approximately 20 percent of the striated utility ware at Pecos Pueblo has nonlocal igneous temper. Obsidian continues to increase slowly through time in lithic assemblages. Most of the obsidian in Period 4 is from the Cerro Toledo and Valle Grande sources. Nonlocal chert, such as Alibates flint, increases sharply in Period 4, indicating that trade and interaction with Plains groups intensified. The change in the direction of trade coincides with high aggregation rather than the peak in population size. Most of the exotic chert is in the form of cores, expedient tools, and low-energy tools, indicating that these rare materials were not conserved in the same way as obsidian. It is possible that the chert was a secondary byproduct of trade for more desirable Plains resources. The amount of obsidian at sites in the southern High Plains increases during the late prehistoric, and it is likely that Pecos Pueblo was the conduit for much of that obsidian. Obsidian may have had a higher "value" because of its importance as an export.

Period 5 (A.D. 1575-1700)

Many changes occurred in the Puebloan system in Period 5 as a result of Spanish colonization, the establishment of missions, the Pueblo Revolt (1680), and the Reconquest (1692). The number of Puebloan sites continued to decline in Period 5. Pecos Pueblo is the only Native American habitation, and there are 67 seasonal sites and 107 special-use sites. According to the survey data for Pecos Pueblo, population declined slightly, to around 750 people; however, figures based on Kidder's excavation data place the population between 800 and 1,100 people. Whatever the actual size, Pecos Pueblo is the only aggregate in the Upper Pecos Valley.

The PDSI dryness index indicates that Period 5 is similar to Periods 3 and 4. Drier spikes in the yearly PDSI values are not as sharp as previous periods, and variability is low until approximately 1680-1700, which coincides with the Pueblo Revolt and Reconquest. Climatic factors, therefore, are not expected to be important in subsistence or settlement shifts. Of greater impact should be the Euro-American settlers in the area who needed land for agriculture and grazing.

Nearest-neighbor distances suggest some reorganization in settlement relations. Non-habitation sites remain clustered within and between the two site types. Habitations and

special-use sites are randomly located with respect to each other, possibly reflecting resource depletion near Pecos Pueblo that forced people to go farther for suitable resources. The sites used in the nearest neighbor analysis included Euro-American habitations in addition to Pecos Pueblo. These other habitations are randomly located with respect to Pecos Pueblo because they are part of a different social and economic system. Seasonal sites and habitations are randomly distributed with respect to each other, a trend that began in Period 4, which may reflect depletion of fields around Pecos Pueblo or the use of irrigable fields outside the park boundaries. Because of Spanish settlement, it is not possible to interpret Puebloan social and economic systems the same way we did for earlier periods.

Declining site numbers did not affect the diversity of site locations. Seasonal and special-use sites are in a variety of settings. A higher percentage of sites are on ridge slopes than in the earlier periods, continuing a pattern that began in Period 3.

Integrative mechanisms persist at Pecos Pueblo. Although the number of kivas declines, the number of rooms per kiva is more than double what it was in Period 4, indicating that the ritual system integrated more people. Average kiva size declines in Period 5, but one large kiva may have been a community integrative structure.

Undecorated cooking jars once again dominate the ceramic assemblage, after their decline in Period 4. The number of cooking jars increases, and they comprise nearly 50 percent of the assemblage. The quantity and percentage of decorated storage jars also increase, the only vessel form to do so from Periods 2 through 5. The number of decorated serving bowls decreases in Period 5, however, which is puzzling given the apparent increase in cooking.

Decorated serving bowls and undecorated cooking jars are not much larger in Period 5; however, decorated storage jars did increase in size. The increases in the number and size of storage jars suggests that larger quantities of food were stored in jars than before. Glaze V bowls, which are significantly larger than bowls of other ceramic types, may have been used for communal feasting as in Period 4.

The percentage of low-energy tools at habitations in Period 5 is significantly higher, as is the percentage of Class 2 debitage at seasonal and special-use sites. Thus, it appears that tool maintenance occurred at nonhabitations, but tools were discarded at habitations. Grinding was slightly more intensive than in Period 4. Grinders tended to use manos a little longer before abandoning them; however, mano profiles indicate less intensive use than expected. The total number of agricultural features declines and so do the more complex agricultural features. As in Period 4, we suspect that primary fields were northeast of Pecos Pueblo outside the park where irrigation was feasible. Therefore, we probably are not measuring the full extent of agricultural investment.

One indication of Pecos's status as a major trade center is the presence of Pecos Glaze V at other sites in the northern Rio Grande in the 1500s and 1600s. However, Shepard's petrographic analyses of glaze ware indicate that although Glaze V was produced at Pecos Pueblo, Glaze VI, which appears ca. 1625, was nonlocal.

Obsidian and nonlocal chert increased in Period 5. While trade with groups near the Jemez Mountains remained consistent, Plains trade increased in Periods 4 and 5. As in Period 4, obsidian was conserved more than nonlocal chert, indicating that the chert was a less important element of trade than bison or obsidian.

Period 6 (post A.D. 1700)

The number of sites in the Pecos area continued to decline. Pecos Pueblo is the only

Puebloan habitation, and there are 20 seasonal and 34 special-use sites relating to the Native American occupation. The Puebloan population declines, and the aggregate at Pecos Pueblo shrinks to 455 people based on the survey data. According to Kessell (1987:490), 800-1,000 people lived at Pecos Pueblo in the late 1690s and early 1700s, and that number steadily dropped to 449 people in 1750. In 1838, the 18 people in residence left the pueblo.

We did not examine the PDSI for Period 6 because climate was only one small factor with which the Puebloans had to cope. At the least, conflict with Apachean and Comanche groups, tense relationships with settlers and traders, the rise of the economic importance of Hispanic villages, and European diseases accelerated the population decline at Pecos Pueblo.

Sites are located on a diversity of landforms. The distribution of special-use sites differs from previous periods in that several landforms each make up more than 10 percent of those occupied. The nearest-neighbor distances also indicate changes in settlement configuration. For the first time, special-use sites are randomly distributed rather than clustered with each other. Special-use and habitation sites are randomly associated, as in Period 5. Habitations are randomly distributed relative to each other, but only one is Native American. Seasonal sites continue to be randomly distributed relative to habitations. It is possible that the random distributions among site types are the result of many fewer sites; however, it most likely reflects social factors that constrained Puebloan movement and land use across the landscape.

Kivas were used at Pecos Pueblo in Period 6, although they may not have been the only form of social integration. The mission complex probably assumed an integrative role through a combination of voluntary and involuntary participation in Christian ceremonies. There are fewer kivas in Period 6, which would be expected with population decline, and fewer rooms per kiva, indicating decreased integration through the rituals associated with kivas. The average Period 6 kiva is only slightly smaller than in Period 5.

The number of decorated bowls, decorated jars, and undecorated jars each decrease in Period 6, which corresponds to the population decline. The proportional composition of the ceramic assemblage indicates slight decreases in decorated (storage) jars and undecorated (cooking) jars. The percentage of decorated (serving) bowls increased, however. Cooking jars are smaller. Serving bowls are slightly smaller, but very close in size to Periods 3, 4, and 5. Storage jars are larger, although they make up a slightly smaller percentage of the ceramic assemblage. In general, it appears that traditional domestic activities continued at Pecos Pueblo in Period 6. Glaze VI bowls are significantly smaller than Glaze V bowls, suggesting that commensal group size declined or communal feasting disappeared.

Flaked lithics did not change significantly in Period 6, and grinding intensity was not measured. Glaze ware was not made after 1700, possibly because the Spanish controlled the lead-ore sources in the Cerrillos Hills. Glaze ware was replaced by a variety of matte-paint ware. While some of the historic matte-paint wares probably were made locally, many were imports from other pueblos in the northern Rio Grande. Euro-American settlers used Puebloan ceramics, and new shapes and designs were developed to meet their needs.

The amount of obsidian at Period 6 sites, mostly as high-energy tools, is equal to Period 5. The disruption of Plains-oriented trade, however, is obvious from the drastic decline in nonlocal chert to Period 2 levels.

Site Types

Some ceramic and settlement analyses were structured by functional site type without temporal divisions. These analyses provide insight into aspects of subsistence, site function, and household organization.

Ceramics across Site Types

The survey recorded 30,709 sherds, representing a minimum of nearly 7,500 vessels. Utility ware, Rio Grande Glaze Ware, and Pajarito White Ware are the most common ones recorded, in that order. We expected ceramic assemblages to differ among the site types based on the differences in site function.

Habitations are long-term residences at which a wide variety of activities occurred. As a result, we expected a range of ceramic wares and vessel forms, and we expected larger vessels for storing, preparing, and serving food to the entire household (at a minimum). We also expected more trade wares at habitations than nonhabitations.

Seasonal sites are short-term, part-time residences usually associated with tending crops. There are fewer people and activities at seasonal sites so there should be less variety in ceramic assemblages, and vessels should be smaller because food is prepared and served to a smaller group. Trade wares should be rare at seasonal sites.

Special-use sites represent short-term procurement or processing episodes. We expected a limited variety of ceramic types, small vessels, and no trade wares at special-use sites.

There is a variety of wares at habitation sites, as expected; however, variety also is high at seasonal and special-use sites, contrary to expectations. White Mountain Red Ware, which is nonlocal, is most common at seasonal sites and occurs in equal percentages at habitations and special-use sites. Glazes and historic polychromes occur in higher percentages at nonhabitations than habitations, which also is contrary to our expectations. There appears to be more variety in the domestic activities at nonhabitations than we predicted, and trade wares are not limited to habitation sites.

Vessel forms confirm that a range of domestic activities occurred at nonhabitations. Undecorated (cooking) jars are most common at habitations, as expected. The percentages of decorated (serving) bowls and decorated (storage) jars, however, are higher at nonhabitations. Only 18 percent of the storage jars are at habitations. Several factors could account for the vessel form discrepancies. Vessels probably are taken from the household assemblage at the habitation for use at short-term activity sites. Vessel form functions may become blurred at nonhabitations because some pots could assume multiple functions. Breakage may have been higher at nonhabitations if vessels were used for multiple functions. It also is possible that vessels were used to store nonfood items left at the nonhabitations from season to season. In general, these findings are consonant with evidence from other studies demonstrating that sites occupied fewer than 10 years can differ greatly in ceramic functional classes despite having the same site function (Mills 1989).

Vessel sizes follow expectations slightly better than wares or vessel forms. We expected larger vessels at habitations, and smaller ones at seasonal and special-use sites, respectively. Although the results are not statistically significant, the trends generally are as predicted. Decorated (storage) jars are larger at habitations than at seasonal or special-use sites (in that order). Undecorated (cooking) jars are the same size, however, at habitations and seasonal sites. Decorated (serving) bowls are larger at seasonal sites, followed by habitations and special-use sites. Vessels always are smaller at special-use sites, which fits our expectations. Again, it is possible that vessel form functions are less specific at seasonal sites. Perhaps vessels are taken from the household assemblage with multiple functions in mind, which might lead to selection for larger vessels.

Site Types and Plant Productivity

A recent soil survey at Pecos National Historical Park provided information on the relative

productivity of plant types for different soil types. Using a 100-m buffer to characterize the immediate environment around each site type, we examined the selection of site locations according to the potential productivity of soils for three classes of food resources—grains and seeds, grasses, and herbaceous plants—and two classes of fuel resources—coniferous species and shrubs. To assess the significance of the immediate site environment, the resources within the 100-m buffers were compared to everything outside the buffers.

Relatively low food and high coniferous potentials characterize habitation locations. The choice of locations with abundant coniferous resources places residences close to fuel and building materials.

Slightly higher potential food productivity characterizes seasonal site locations, but the associations are lower than expected for the highest level of productivity. The analysis identified two sets of site locations for seasonal sites. One group is in areas of potentially high coniferous productivity, and the other set is in locations with low coniferous productivity. Locations with low conifer productivity may have been easier to clear for fields, while those associated with higher conifer productivity may have lent themselves to exploiting fuel or construction materials. It is likely that functions overlapped, and the areas cleared of timber were used for fields.

Special-use sites are associated with intermediate potentials for all food resources, which may indicate the exploitation of a variety of wild foods. One set of sites is associated with high conifer and shrub potentials while another set is in areas of low conifer and shrub potentials. The sites in areas with high wood potentials probably were there to facilitate gathering fuel or arboreal food resources. Those in areas with low conifer and shrub potentials may have been situated to exploit food resources that do not coexist with coniferous species.

The settlement analyses by site type confirm the general functional differences among the site types. Site locations differ among the site types, and significant associations indicate complex relationships between soil productivity and site types.

Euro-American Sites

Fifty-three sites, consisting of 54 components, are historic Euro-American. The construction of the Lost Church in the early 1600s marks the beginning of the material Spanish presence in the Pecos area. In addition to the Lost Church, three other sites, all in the vicinity of the mission complex, are attributed to the Spanish. Very few Euro-American artifacts are associated with these early sites. Instead, Euro-American occupants depended on Puebloan potters to supply European vessel forms, such as soup plates and candlesticks, made from native materials using traditional techniques.

Most of the datable historic artifact assemblages fall into two of the periods outlined in the Cultural Landscape Overview for Pecos National Historical Park (Cowley et al. 1998). Six sites belong in the Spanish Colonial/Mexican/Hispanic Settlement, Santa Fe Trail, Civil War Period (A.D. 1812-1880) and 15 date to the Railroad/Tourism Period (A.D. 1880-1941).

Three of the five Hispanic homesteads can be tied to specific families through historic records and maps. Occupation spans were estimated using historic artifacts and comparisons with historic documents.

Until the 1820s, the focus of trade was on Mexican goods. The Santa Fe Trail, which provided the first major connection to the United States, introduced the Pecos and Santa Fe areas to goods from the east. Several segments of the Santa Fe Trail are visible within Pecos

National Historical Park. The success of trade over the Santa Fe Trail attracted railroad promoters, and in 1880 a railroad line to Santa Fe, passing through the Pecos area, was completed. The efficiency of shipping goods by rail opened up a variety of economic opportunities to Pecos area residents and brought more people to the area.

Census records between 1860 and 1920 document the economic and social changes in the Pecos area. From a subsistence-based economy focused on farming and domestic stock, the primarily Hispanic communities were later joined by non-Hispanics and tradesmen who were not directly tied to agrarian activities. Change accelerated in 1880 with the completion of the railroad. Wage and contract labor became more prevalent, and by 1900 merchants in the Village of Pecos were bringing a variety of goods into the region. By 1910, the railroad made transport easier, which encouraged the development of commercial pastoralism as markets in the east opened up to western ranchers. These trends continued into the 1920s.

The occupation of Pecos Pueblo declined steadily with the spread of Euro-American settlement. After the pueblo was abandoned, roof beams were scavenged for construction and firewood, and the Quadrangle was used to house prisoners in 1841.

Conclusions

> *A place is nothing in itself. It has no meaning, it can hardly be said to exist, except in terms of human perception, use, and response.*
>
> Wallace Stegner, *This Is Dinosaur*

The preceding chapters serve as the final report on the cultural resources inventory survey of Pecos National Historical Park. Because Puebloan materials are the most prevalent in the park, this volume focuses on the development of the Pecos community during the Puebloan occupation of the Upper Pecos Valley. Our purpose was not to explain village formation at Pecos. Our goal was to help "unpack" the concept of aggregation (Kohler 1989) by examining its affect on social integration, agricultural intensification, settlement behavior, and exchange.

Increased social integration accompanied the growth in aggregate size in the Pecos area. Kivas became larger, and there are two very large kivas at Pecos Pueblo, one in Period 4 (A.D. 1450-1575) and one in Period 5 (A.D. 1575-1700), that probably served as community kivas. In addition, large Biscuit ware and Glaze V bowls may indicate communal feasting in Periods 4 and 5. Evidence for social integration disappears in Period 6 (A.D. 1700+) with the number of kivas and size of serving bowls declining as population decreases.

The prevalence of cooking jars in all periods indicates the importance of agriculture throughout the Puebloan occupation. Hunting was important in Periods 2 (A.D. 1200-1325) and 3 (A.D. 1325-1450) based on the abundance of high-energy lithic tools. The measures of agricultural intensification through time are mixed. Ceramic vessel forms and size suggest that storage in jars and serving in bowls may have increased, possibly indicating that agriculture increased in importance. The number and complexity of agricultural features peak in Period 3, then both decline in subsequent periods. Most likely, the best land for intensification was outside Pecos National Historical Park near the present town of Pecos where irrigation was possible. Grinding intensity, measured through mano shape as another potential indication of agricultural intensification, decreased in Period 3, and although it increased in Periods 4 (A.D. 1450-1575) and 5 (A.D. 1575-1700), grinding intensity was less than expected. Abundant raw materials for manos probably render this measurement less useful because new manos were readily available to replace slightly worn ones.

Aspects of settlement changed with aggregation. Based on our assumption that Pecos Pueblo outcompeted the other aggregates in the valley, it is interesting that the pueblos in Periods 2 (A.D. 1200-1325) and 3 (A.D. 1325-1450) are clustered, indicating a lack of competition among "competing" aggregates. Possibly, the competition was not over local resources, which is why it is not reflected in the nearest-neighbor distributions, but was related to competition and exchange with groups outside the Upper Pecos Valley. This reinforces a picture of the people of the Upper Pecos Valley living as a single community, though in different residences. The Pecos mesilla may have been the best highly visible and defendable location for a centralized trade center and from which to monitor movement through the valley. The transition to a single large aggregate there may have been accomplished with little internal conflict.

Trade relations were present throughout the Puebloan occupation of the valley. Nonlocal temper in utility and white ware in Periods 2 (A.D. 1200-1325) and 3 (A.D. 1325-1450) indicate trade primarily was with groups to the west. In Period 3, approximately half of the white ware was nonlocal, and most of the Glaze I ceramics were traded in to the valley. Later in Period 3, Pecos potters began making their own glazes, which they continued to do until they began importing Glaze VI in Period 5 (A.D. 1575-1700). Pecos Glaze V is found in small quantities at other Rio Grande sites. Obsidian was the primary nonlocal lithic raw material in Periods 2 and 3, although nonlocal chert increased slightly in Period 3. It was not until Period 4 (A.D. 1450-1575) that nonlocal chert from the Plains became common, indicating a switch in trade focus to the east. The shift in the direction of trade coincided with aggregation at Pecos Pueblo. The quantity of obsidian also increased in Periods 4 and 5, and it probably was one of the resources traded eastward for bison products. In Period 6 (A.D. 1700+), significant trade with the Plains ended, but obsidian and historic matte-paint ceramics indicate that trade with the west continued. Despite its strong economic ties to the Plains and the increasing presence of Europeans in the valley, Pecos was firmly rooted in the Pueblo world.

From the beginning of the permanent Euro-American presence in the early 1600s, the social and economic focus in the valley changed. Pecos Pueblo's residents attempted to maintain their traditional social, economic, and religious cycles under the close scrutiny of a new religious body. Population declined rapidly at Pecos Pueblo and the last few occupants left in 1838. They turned to Jemez Pueblo, where the Pecos roots are still strong and where the Pecos people maintain their identity over a century later.

In contrast to the decline at Pecos Pueblo, the Euro-American population in the valley grew quickly, especially in the 1800s after the Santa Fe Trail opened the area to a wider exchange network. The success of trade over the Santa Fe Trail led to the coming of the railroad, which encouraged more people to establish businesses in the Upper Pecos Valley. Economic booms in other parts of the country enabled Tex Austin, E. E. Fogelson, and others to create large ranches in the valley, a trend that continues to this day.

The Upper Pecos Valley is a relatively small place, only about eight miles long from where the river emerges on the flats just north of the village of Pecos, to the southern end of the valley just south of the railroad town of Rowe; and only two to four miles wide from the base of Glorieta Mesa to the toes of the Tecolote Mountains. Yet the expanse of human history at Pecos is vast. We hope the results reported in this volume contribute to the continued creation and recreation of Pecos through research and interpretation. We also hope they will assist those entrusted with the care of Pecos National Historical Park in making wise management and preservation decisions.

<<< Previous <<< Contents>>> Next >>>

peco/cris/chap11.htm
Last Updated: 13-Feb-2006

PECOS

From Folsom to Fogelson:
The Cultural Resources Inventory Survey of Pecos National Historical Park

APPENDIX A:
Pecos Archeological Survey 1997 Site Data Form, Manual, and Glossary

PECOS ARCHEOLOGICAL SURVEY 1997 SITE DATA FORM MANUAL

CHECKLISTS

Site stake, map location, aerial photo, site map, photos, survey form, artifact density form: Enter a "check" in front of the tasks that have been completed, and "-" for those that don't apply.

Lithic form, ceramic form, glass form, metal form, miscellaneous historic form: Enter a number indicating how many of each form type were completed or "-" for those that don't apply.

Collections: Enter a number indicating how many items were collected or "-" for those that don't apply.

Start/Finish Time (no data entry): This will be used to determine total recording time (to be entered by lab person in "Total Time" under Registration Data below). Enter start and finish time for recording the site using military time (1200/1430). Start time reflects when you arrive on the site; finish time when all recording tasks (including pinflag retrieval) are done and you are ready to move on. If recording spans more than one day, show both recording episodes. Subtract lunchtime/downtime from finish time so that the lab person doesn't have to wonder about it (if you were on the site from 900 to 1315 with a 30 minutes off for lunch—show start/finish as 900/1245).

Shaded areas: indicate information that will be completed in the lab.

REGISTRATION DATA:

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* needed for NMCRIS form

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* PECO # (4 char): Enter number (following the prefix PECO) as assigned by the crew chief. This number will serve as the permanent park number; it will be marked on the site stake and serve as the reference number for all park records. The PECO field number should be written on the top of all recording form pages and used for labelling all associated documentation (topo maps, planviews, photo logs etc.). When rerecording sites—if a PECO # has been previously assigned, that number should be maintained. In instances where several previously recorded PECO sites are rerecorded as a single site, the newly recorded site should be assigned only one of the previous PECO #s, however, all the PECO #s should be listed under "Previous site numbers/names" in the "Previous Investigation" section so that those site

records can be cross referenced. If the site was previously recorded using another temporary/field numbering system and/or LA number, it will still require a PECO number.

* LA # (7 char): This refers to the Laboratory of Anthropology site number. For newly recorded sites, LA # will be assigned at a later date and should be left blank. For previously recorded sites with existing LA #s, the previously assigned LA # should be entered here. If two or more previously recorded LA sites are being rerecorded as one site, only one of the LA #s should be maintained, however, all LA #s should be listed under "Previous site numbers/names" in the "Previous Investigation" section so that those site records can be cross referenced.

* Site name (30 char): If the site has been named (e.g., Dick's Ruin, North Pueblo) enter the information here. If more than one name exists, show the most prominent here; list others in "Previous Investigations" section.

Park unit (2 char):

FL Forked Lightning Ranch
CM Core Monument
PR Pigeon Ranch
JR Johnson's Ranch

Survey area # (2 char): preassigned number used to identify the survey area (get # off of project area map).

Management unit: Leave blank for now; to be established by PNHP.

* Recorders (15 char): Enter three initials for each crew member, list crew chief first (TVZ/JMV/GLH/MIS).

* Date (7 date): Recording date by day, first 3 letters of month, last two digits of year (10JUN93).

Total Time (5 num): Total time in minutes. Lab person will do.

LOCATIONAL DATA:

* State (2 char): NM has been filled in for you

* County (10 char): San Miguel has been filled in for you

* Quad (13 char): Pecos 1961 has been filled in for you

* Aerial photo (5 char): Enter the flight line and frame number (e.g., 4-6, 3-11). Try to use the aerial photo that will put the site as close to the center of the photo as possible. Outline the site boundary on the aerial and place an "x" on the site stake location. If a roomblock is present, show the outline of the structure with a dashed line. Label site using the PECO # (just the number, you don't have to precede with "PECO").

* UTM (2/7/8 char): The zone is 13, which is filled in for you. The easting and northing should be left blank to be filled in later. Do not enter information from the GPS unit—this location is inaccurate until it can be corrected in the lab.

* GPS (1 char): indicate Y or N to indicate if UTM is GPS generated.

* Meridian (4 char): This is filled in for you—NMPM

* Township. Range Section. 1/4, 1/4, 1/4 (2 char ea): T15N, R12E applies to all the Forked Lightning Ranchlands and has been filled in; the 1/4 sections will be filled in later by lab person.

* Location (500 char): Provide a brief description of the site's location using named landmarks whenever possible (e.g., located along a piñon-juniper covered terrace 150m south of the mouth of Glorieta Creek and 20m west of the Pecos River. The eastern edge of the site coincides with the bedrock terrace rim; an old two-track road intersects the western edge of the site). Even if there are no prominent landmarks close by to tie into, describe the site location in reference to the closest landmark (e.g., The site lies on the north edge of an unnamed east-west arroyo within an open bulldozed area. The Ranch House lies roughly 1 km north; Shin'po, 1.5 km southwest, is visible from the site). Be consistent in your use of place names. To help with consistency between crews try to use the following terminology:

NM63 — refers to the state road bisecting the park

The Trading Post — Kozlowski's place, now the Resource Management etc. offices

The Ranch House — the big pink house above the river we now call "home"

Forked Lightning Ranch Road — the road that begins at the Trading Post and goes to the ranch house.

South Boundary Road — the dirt road that branches south from the Forked Lightning Ranch Road and continues to the south boundary fence

SITE DESCRIPTION:

* C#/Component # (1 char — already filled in: 1, 2, 3, 4): For the purposes of this recording system, "component" will be used to indicate the cultural/temporal affiliation(s) of the site remains. A site component is comprised of culturally and/or temporally associated features and refuse scatters. A site will be either single or multi-component. At a single component site, all the structures, features, and refuse scatters comprising the site are associated with the same culture group and time period (e.g., two small structures, a checkdam, and a lithic and ceramic scatter with Glaze I sherds would be recorded as one component dating 1315-1425). A multi-component site would contain spatially associated features of different cultural and/or temporal associations (e.g., Component 1 — a small structure with Glaze I sherd scatter, dated 1315-1425; Component 2 — a firehearth in association with a nondiagnostic lithic scatter, date unknown; and Component 3 — historic wood debris and trash including sanitary seal cans, dating post-1900). In instances where an occupational hiatus is evident across a site, only one component need be identified, however two sets of dates should be entered in the subsequent "Dates" field.

Component numbers must always be entered on the top of the "Feature" and "Refuse Scatter" pages (and any continuation pages associated with them) and whenever referencing/labelling a feature or refuse scatter in other sections of the form, in comments, on the site map, photo log, and/or on artifact labels (e.g., 1-01-01, 2-23-01).

* Culture/Cultural Affiliation (21 char): List the cultural affiliation of each component recorded; the possibilities are as follows:

Paleoindian
Archaic

Basketmaker
Puebloan
Plains
Apache
Native American — specific culture group and/or temporal association is unknown.
Euroamerican
Spanish
Anglo
Unknown
Other — use for any cultural affiliation not listed above (write in)

* Date (4 char fields — 5 char ea): Estimate beginning and end dates based upon diagnostic indicators. If a hiatus in occupation is indicated at a single feature or group of features, show two sets of dates (see component discussion above).

Confidence (1 char): Confidence in date assignment

1 Low
2 Moderate
3 High

* Component Type (26 char): Choose one — if you feel compelled to list more than one, be aware that only the first one will be entered into the database, so write the most significant type first.

Communal Pueblo	Fire/roasting feature(s)	Ranching feature(s)
Pueblo	Unknown rock feature(s)	Euroamerican trash scatter
Small structure(s)	Agricultural feature(s)	Trash dump(s)
Possible structure	Bedrock feature(s)	Trail(s)
Unknown structure	Lithic and ceramic scatter	Road(s)
Tipi ring(s)	Ceramic scatter	Other (describe)
Kiva	Lithic scatter	
Shrine	Quarry	
Rockshelter	Rock art/inscriptions	
Storage	Homestead Campsite	
Architectural feature	Euroamerican structure(s)	
Hearth	Church	

* Site Summary (500 char): Brief narrative summary describing the site. Be succinct and clear. Basically it is to give anyone perusing the form an idea of what's there without reading the whole form (e.g., "The rubble remains of a two-room structure with associated sparse lithic and ceramic scatter and rock alignment of unknown function; these lie within a large dispersed lithic scatter. An old jeep trail runs through the east end of the site with a post-1900 trash scatter along the west edge of the road. The site has been heavily impacted by road construction and vegetation removal"). Use words, not codes.

* Maximum Site Dimensions (2 num fields — 4 num ea): **Maximum** length x width, paced to nearest meter (no decimals).

* Area (5 num): Square meters, most representative area - in most cases this will be length x width as entered above; however if you aren't using maximum length x width as entered above to figure area, describe how the area was calculated in "Comments". If site is triangular, use 1/2 L x W and note in "Comments"

* Criteria (3 char): Rationale for assigning site size, can have 2 entries (e.g., 1/2)

1 Extent of archeological features and artifacts
2 Topographic features (based on limits of topographic features, e.g., mesa rim, erosional features)
3 Disturbance (based on modern activities, development, disturbance)
4 Other (specify)

* Subsurface Potential (1 char): Maximum subsurface potential.

0 There are no subsurface materials, site is surficial
1 Subsurface materials are likely/present, but shallow (<10cm)
2 Subsurface materials are likely/present to moderate depths (<50 cm)
3 Subsurface materials are likely/present to substantial depths (>50cm)
4 Subsurface materials are likely/present, but extent of depth is unknown
5 Other (specify)

This estimate is based on observations of site soil deposition and topographic location or feature depth unless otherwise noted in comments (other possible indicators include cutbank profiles, burrowing, excavation, roadcuts). If subsurface potential is measurable (i.e., using mound height, the profile of an arroyo cut) enter measurable extent in comments).

Comments (350 char) Use this space to comment on dimensions, site area, site depth, and criteria

FEATURES:

Features (structures, minor features, refuse scatters) should be described and grouped by component — therefore, if you have a multicomponent site, you will need to fill out a separate Structure/Minor feature page and Refuse Scatter page for each component (if applicable). Make sure the appropriate component number — 1, 2, etc. — is filled in at the top of each page.

* Type (2 char): see Glossary for definitions/usage.

Structures

01 Communal pueblo (100+ rooms)
02 Pueblo (6-99 rooms)
03 Small structure (1-5 rooms)
04 Tipi ring/stone circle
05 Rockshelter (w/architecture or modification)
06 Pitstructure
07 Kiva
08 Shrine
09 Euroamerican structure
10 Outbuilding, not further specified
11 Unknown depression
12 Unknown structure
13 Possible structure (rubble/debris/mound)

Agricultural/Water Control/Ranching Features

50 Terrace
51 Checkdam
52 Grid garden
53 Ditch/acequia
54 Reservoir/catchment
55 Corral
56 Pen
57 Fence
58 Other agricultural/water control/ranching feature (specify — e.g., well, orchard, trough)

Bedrock features

14 Other structure (specify — e.g., torreon, mill, outhouse, dugout/rootcellar, church)

Architectural Features

20 Wall
21 Stone circle (unknown function)
22 Storage unit/cist
23 Windbreak
24 Other architectural feature (specify — e.g., tent anchors, gameblind, plaza)

Fire-related features

30 Firepit/hearth
31 Ash and/or charcoal deposit/stain
32 Firecracked rock concentration
33 Firecracked rock, burned adobe
34 Other fire feature (specify — e.g., horno, kiln, roasting pit)

Unknown/Other Rock Features

40 Rock alignment (nonagricultural)
41 Rock concentration/scatter
42 Vertical/upright slab(s)
43 Cairn
45 Quarry (building material)
46 Quarry (clay)
47 Other rock feature (specify)
60 Natural shelter (unmodified)
61 Grinding area
62 Sharpening area
63 Petroglyphs/Pictographs — rock art
64 Inscriptions
65 Other bedrock feature (specify — e.g., bedrock mortar, beam socket, post hole, bedrock pit)

Trails. Roads

70 Hand/toeholds
71 Trail
72 Steps/stairs
73 Road
74 Two track/wagon track
75 trail/road feature (specify — bridge, RR)

Other

78 Other feature (specify)
79 Unknown feature (specify)

If you use any of the "other" categories, be sure to describe in comments and label next to number entered in "Type" box (i.e, 58 - well).

No./Number (2 char): 01 to Each feature will be numbered, this number serving as its "official" designation, e.g., if you have two tipi rings and one hearth within one component, the tipi rings (04) would be numbered 01 and 02 respectively, and the hearth (30) would be numbered 01. All subsequent reference to each feature (maps, photos, etc.) will use this type-number designator (04-01, 04-02, 30-01) as its identifier. Rock art and inscriptions should be recorded and numbered by panel and total # of elements should be estimated in "Comments". Steps and hand and toeholds should be numbered and described in sets and the total number of steps or hand/toeholds should also be indicated in "Comments".

(Note: we are assuming that all structures will be single story - indicate in "Comments" if otherwise)

Feature Size (2 num fields with 4 num w/1 decimal ea. — 000.0 x 000.0): Length x width of constructed features in **meters to nearest tenth** — measured with tape. If the feature is circular, enter the diameter and be sure that the shape is entered as "03" (circular). Only measure if boundaries/outer walls are distinct/definable and represent the size of the entire constructed feature, otherwise enter dimensions under the next field "Feature Extent". Feature size might include dimensions of a visible roomblock, standing wall, corral, cairn, or firepit

or dimensions of modified bedrock features such as a petroglyph panel or grinding surface. If the feature has deteriorated to the point where its actual dimensions are not measurable, do not enter any size here.

Feature Extent (2 num fields with 4 num w/1 decimal ea. — 000.0 x 000.0) Length x width in **meters to nearest tenth** of the entire area a feature encompasses — measured with tape (e.g., the extent of a fire-cracked rock concentration, rubble scatter, or area of scattered posts). Complete this field even if the feature size is measurable. For example, if you have a well defined feature such as a one room structure indicated by intact walls with a surrounding rubble scatter, you would enter the roomblock size based on the wall alignments under "Feature Size" above, then measure the entire extent of the feature, encompassing intact walls and scattered rubble, and enter that value here. We are hoping that by collecting both measurements whenever possible, we may be able to obtain enough data to extrapolate feature size in some instances where only feature extent is apparent. In instances where the feature size is the same as feature extent, enter the dimensions in both fields, even if redundant. Feature Extent should always have a value!

Shape (2 char):This for constructed shape, use indeterminate if can't tell

01 Rectangular	05 D-shaped	09 Arcuate
02 Square	06 U-shaped	10 Irregular
03 Circular	07 L-shaped	99 Indeterminate/Unknown
04 Oval	08 Linear	

Wall Ht (4 num): Maximum wall height in **centimeters**; measured with tape. Measure only standing wall remains. For rockshelter structures, measure constructed wall height if available and include bedrock walls/ceiling height in "Comments" section.

CRS/Number of Courses (2 num): Number of courses measured for the maximum wall height. If you have entered data ≥1, there should also be an entry in "Wall Height".

Mound Ht (3 num): Height above pgs — measure to the best of your ability in **centimeters**.

Depth (3 num): in **centimeters**; depth below present ground surface (do not include mound height). Would use in instances where there is a depression or cultural materials exposed by previous excavation or disturbance. **Do not leave blank** — enter 999 if depth is unknown, 000 if the feature is surficial.

Rooms visible (3 num): In reference to structures, indicate the number of visible rooms. A visible room is identified by two or more standing walls or wall alignments. Enter 0 if none.

Rooms estimated (3 num): In reference to structures, the total number of rooms estimated for a given structure including those that are visible and those that are inferred from the size and form of rubble area and any visible alignments. For example, if one room is visible but the rubble area is too large to be a single room, estimate as best you can how many rooms are there, recognizing that the estimate lacks the same degree of confidence that visible rooms have. Can use 999 if there is absolutely no way to estimate room count. Both "Rooms visible" and "Rooms estimated" should be filled in.

Construction (8 char): Can list up to three types if applicable, list dominant type first (e.g., 01/06/13). This data should reflect original feature construction, not present condition. If you are not dealing with a constructed feature, enter n/a (i.e., ash stain, FCR scatter, trail).

01 Coursed masonry
02 Uncoursed/piled masonry
03 Masonry, indeterminate construction
04 Single course
05 Vertical slab(s)
06 Jacal
07 Adobe
08 Probably adobe
09 Excavated
10 Natural shelter
11 Ground
12 Pecked
13 Painted (pictographs, inscriptions)
14 Incised
15 Log construction
16 Frame construction
17 Upright posts
18 Other — (specify)
99 Unknown/indeterminate (describe in "Comments")

Fabric (8 char): Can list 3 types if applicable, list dominant type first. Definitions of sandstone types are presented below.

01 Shaped sandstone, not further specified
02 Shaped limestone
03 Shaped mixed stone
04 Shaped other stone (specify)

11 Unshaped sandstone, not further specified
12 Unshaped limestone
13 Unshaped mixed stone
14 Cobbles
15 Unshaped other (specify)

16 Boulders, sandstone
17 Boulders, limestone
18 Boulders, other (specify)

21 Bedrock — sandstone, not further specified
22 Bedrock — limestone
23 Bedrock — other (specify)

27 Firecracked rock
28 Earth/soil
29 Mortar/adobe

30 Vegetal material
31 Wood (natural)
32 Milled lumber
33 Concrete
34 Metal
35 Other (describe in comments)

99 Unknown

Note: There are several types of sandstone available within the Pecos Valley. The following descriptions have been compiled for Pecos Pueblo and may match what you are seeing. If so, note the type in the structure/feature comments along with estimates of the nearest outcrop of that type. If none of these types match, don't use them.

Type 1 — dark reddish-gray micaceous siltstone
Type 2 — pink arkosic sandstone with large soft sandstone and light gray feldspar pebble inclusions.
Type 3 — coarse reddish brown micaceous sandstone
Type 4 — pink micaceous medium to very coarse sandstone
Type 5 — pink-white nonmicaceous medium grained sandstone

Association (11 char): Type and number of refuse scatter this feature is functionally/spatially associated with; can enter two scatters. If the feature is not associated with a particular scatter, enter 00-00 as the association.

Stability (7 char): Use three digits to describe feature stability, integrity, and threat.

The first digit will be a 1 (stable) or a 2 (unstable)

The second digit will be 0 (no threat), 1 (minimal threat), 2 (moderate threat) or 3 (significant threat).

The third digit will be a 0 (little remains), 1 (mound, rubble, and/or subsurface remains), 2 (wall remnants/alignments, or 3 (standing/intact remains).

Possible combinations are listed below:

Stable — no active threat

100 Stable — no threat, very little remains, just not much left (of surface or subsurface feature)
101 Stable — no threat to mound, rubble, and/or subsurface remains
102 Stable — no threat to wall remnants/alignments
103 Stable — no threat to standing/intact feature

Stable — minimal threat

110 Stable — minimal threat — very little remains, just not much left (of surface or subsurface feature)
111 Stable — minimal threat — mound, rubble, and/or subsurface remains
112 Stable — minimal threat — wall remnants/alignments
113 Stable — minimal threat — standing/intact feature

Unstable — minimal threat

210 Unstable — minimal threat — very little remains (of surface or subsurface feature)
211 Unstable — minimal threat — mound, rubble, and/or subsurface remains
212 Unstable — minimal threat — wall remnants/alignments
213 Unstable — minimal threat — standing/intact feature

Unstable moderate threat

220 Unstable — moderate threat — very little remains (of surface or subsurface feature)
221 Unstable — moderate threat — mound, rubble, and/or subsurface remains
222 Unstable — moderate threat — wall remnants/alignments
223 Unstable — moderate threat — standing/intact feature

Unstable — significant threat

230 Unstable — significant threat — very little remains (of surface or subsurface structure)
231 Unstable — significant threat — mound, rubble, and/or subsurface remains.
232 Unstable — significant threat — wall remnants/alignments
233 Unstable — significant threat — standing/intact structure

✔ (1 char): Check if additional info is presented in "Comments".

Room size (2 num fields, 4 num w/1 decimal ea — 000.0 x 000.0): measurements of interior floor area of each visible room, to a **tenth of a meter.** Rooms should only be measured if walls/floor limits are discernible — if the room is too poorly preserved to define or project (with confidence) all four walls, don't measure! Number the measured rooms consecutively on the site map and use those numbers when indicating room size. **Make sure you write**

down the number of the feature whose rooms you are measuring (i.e., 03-02: Room 1: 1.2 x 3.3, Room 2: 2.0 x 2.2).

Agricultural Feature/Field size/Slope/Aspect (4 fields — 5 char/5 num/2 num/3 num) for each agricultural feature recorded, indicate the potential agricultural area defined (in m^2), the slope of that area (degrees, use clinometer), and the aspect (i.e., SE, NNW, 5, etc.). There may be instances where the extent of the field area is unknown despite the presence of a well defined feature. For example you might have two terraces: the lower one, 50-01, defines an area 25m across, 5m wide (width=the space between the lower and upper terrace); therefore the area is $125m^2$. The upper terrace (50-02) is 30m across; the width of the area is unknown, but extends at least 15m back; the area would be 450+. In instances where the field area is totally unknown — enter 999. An example of a completed entry would be: 50-01/125/10/SE. **Please be sure to fill this out if you have an agricultural feature**, its easy to overlook since you get used to passing over this section.

Comments (250 char): Use this area for any supporting descriptions or explanations of the features. Make sure that you have entered a ✔ in the last column of the table — this is to alert future researchers to the fact that additional information pertaining to that feature is provided. When entering information in the "Comments", section, be sure to cross reference any narrative by prefacing the comment with the feature type and number (e.g., 01-01: despite the very sparse rubble, the NE corner was visible above the low mound).

REFUSE SCATTERS:

*Type (2 num):

80 Mixed scatter — lithics and ceramics; both lithics and ceramics are well represented, neither form an overly dominant part of the artifact assemblage; 20%-80% lithics and 20%-80% ceramics. Determination of the percentage of ceramics:lithics within the scatter will be an estimate based on site observations as well as the results of the grid count and sampling procedures when applicable.
81 Ceramic dominant lithic and ceramic scatter — at least 80% of the artifacts are ceramics (<20% are lithic). Even if you only have a few lithics on an otherwise extensive ceramic scatter, you would use this scatter type (i.e., if you have both ceramics and lithics in your analytical sample, you must record the scatter as lithic and ceramic).
82 Lithic dominant lithic and ceramic scatter — at least 80% of the artifacts are lithics (<20% are ceramic ceramic). Even if you only have a few ceramics on an otherwise extensive lithic scatter, you would use this scatter type (i.e., if you have both lithics and ceramics in your analytical sample, you must record the scatter as lithic and ceramic).
83 Ceramic scatter
84 Lithic scatter
85 Pot drop
86 Lithic quarry
87 Euroamerican trash scatter — Euroamerican (i.e., glass, cans, metal, and/or wood)
88 Trash dump (Euroamerican)
89 Isolated occurrence — when isolated artifact type occurs within site boundary (i.e., diagnostic projectile point within an historic site). Make sure you show location on site map.
90 Other (i.e., midden, trash mound)

No./Number (2 num): 01 to Each refuse scatter will be numbered sequentially according to

type — e.g., if there are 2 pot drops, they would be 85-01 and 85-02; one ceramic scatter would be numbered 83-01. The type and number will then serve as the various scatters' official designation, all subsequent reference to these scatters (maps, comments, etc.) will use this type-number designator as the identifier (85-01, 85-02, 83-01).

Dimensions (2 num fields — 4 num ea): Maximum length x width to nearest meter (no decimals) — can be paced.

Depth (3 num): Maximum suspected depth in centimeters; if depth is suspected but extent is unknown enter 999, if scatter is surficial enter 0 (not n/a)

Stability (1 num): Use the following:

1 Stable — no active erosion	3 Unstable — minimal erosion
2 Stable — minimal erosion	4 Unstable — moderate erosion
	5 Unstable — significant erosion

✔ (1 char): Check if additional info is presented in comments on site form. Note: there is space provided on the individual artifact field inventory sheets (ceramic, lithic, historic artifacts) for specific assemblage remarks.

Comments (250 char): Use this area for any supporting descriptions or explanations of the scatters. Make sure that you have entered a ✔ in the last column of the table — this is to alert future researchers to the fact that additional information pertaining to that scatter is provided. When entering information in the "Comments", section, be sure to cross reference any narrative by prefacing the comment with the scatter type and number (e.g., 80-01 and 80-02 were defined as separate scatters based on the presence of NM63 cutting through the center of the site).

SAMPLING:

This section refers to sampling for the purpose of conducting on-site artifact analysis. The specifics of the on-site artifact analyses are discussed in the individual artifact analysis manuals (ceramics, lithics, historic artifacts). The sampling information recorded below should coincide with the information provided on the individual artifact inventory records. (This section will be used to described artifact analysis sampling; density data will be entered on a separate "Density Grid" page that will be added to the site record).

Feature Sampled (5 char): Enter the type and number of the feature being sampled (e.g. 81-01). You do not need to use the component number here since it is already at the top of the page.

Sample No. (2 num): The number of the sample area. The sample areas will be numbered sequentially per feature (e.g., 81-01 might have two samples — 01 and 02; and 81-02 might have one sample — 01).

Sample Type (1 num):

1 Lithic and ceramic	4 Mixed trash (Euro-american)	7 Other (specify)
2 Lithic only	5 Glass only	
3 Ceramic only	6 Metal only	

Representation of Scatter (1 num):

1 Sample of scatter within gridded transect
2 Sample of scatter outside of gridded transect
3
4 Entire scatter — use if the entire scatter is picked up for analysis as one sample
5 Judgmental sample
NA Use for items of interest outside of samples

Dimensions (num): dimensions of sampled area, length x width to tenth of a meter. If several individual grid squares (i.e., 5) are included in one sample can indicate as (5)2 x 2. If a circular area (dogleash method), provide dimension as radius. (Note: dogleash area with a radius of 5.65m ~100m^2).

Area (3 num): area of sample unit in square meters.

✔ (1 char): Check if additional info is presented in "Comments".

Sampling Comments (750 char): If necessary, use to describe observations/decisions that directed your sampling approach (e.g., 80-01: Two separate sample areas were defined in order to analyze the artifacts in the immediate vicinity of the structure, separate from those in the surrounding scatter. Since there was no clear drop off or distinct density change boundary, an arbitrary distance of 5m from the structure limits was used to define Sample 1). You don't need to describe methods if you followed "standard operating procedures".

DENSITY GRIDS (insert density page after scatter page of form)

Density Grid data will be entered on a separate page to be inserted into the site form (when applicable). Guidelines for when and how to implement the density counts are discussed in the lithic and ceramic manuals.

Feature (5 char): Enter the type and number of scatter being counted (you do not need to show the component number as it has been entered at the top of the page)

Density datum location (2 num fields, 3 num ea): Distance in meters and bearing from the site datum.

Grid Size (2 num fields, 2 num ea.): Size of grid square (L x W) or **radius** of dog leash (indicate radius measurement with an "R"). Note: a 5.65 m radius produces a 100 m^2 area

Grid Square # (2 num): List each of the randomly selected grid square numbers in this column; one unit per line.

Sample # (2 num): If the density grid square unit was also used for an analytical sample, enter the corresponding sample number here.

Counts (3 num): Enter the artifact counts per grid square.

Comments (250 char): Use this space to denote aspects of the unit that might affect artifact counts (i.e., ground cover, if only part of the unit falls within the scatter boundary, etc.) Also use this space to note if any collected artifacts were from this unit.

Schematic drawing/sketch map: This drawing will be used to record the density grid layout and hopefully will help you in implementing the various associated field activities. It is meant to be a sketch map, you don't need to be overly concerned with scale or precision, but make sure you've correctly entered the random bearing information and grid size at the top of the

page.

RESOURCE MANAGEMENT DATA:

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^needed for ASMIS

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^ Site condition (1 num): Overall condition of the site based on the cumulative effect of all on-site impacts.

0 No damage
1 Low — minimal damage/displacement/loss
2 Moderate — significant damage/displacement/loss
3 High — severe damage/displacement/loss
4 Total loss/completely destroyed

^ Threat to site (1 num): Evaluate the severify of the overall threat to the site

0 None
1 Low - minimal, not yet resulting in significant damage to the site
2 Moderate - presently or will soon cause significant site damage
3 High - presently or will soon cause major site damage
4 Total loss or collapse imminent

* % of Site Intact (num): Estimate percent of site intact; from 0 (totally destroyed) to 100% (totally intact)

* % Surface Visibility (num): Amount of site surface visible through vegetative or other kinds of cover (intrusive fill, pavement)

Soil erosion

Soil pedestal height (2 num): maximum height in cm.

Channel/Gully depth (3 num): maximum depth in cm

% Sheet wash (3 num): percent of site area susceptible to sheet wash

* Site impacts: For each type of impact (see list provided on form) that has occurred/is occurring at the site, show the extent of site affected by the impact/ the degree of damage/ and the future threat (i.e., 3/2/1). You only need to fill in those impacts that apply, leaving the rest blank.

Extent (1 field, 7 char): Use this field to indicate the per cent site area(s) that have been/are being affected. Use the following codes:

0	0%, none affected	3	50-74% affected
1	1-24% affected	4	75-99% affected
2	25-49% affected	5	100% affected

^ Damage (1 char): severity of the damage/loss of integrity that has taken place

0 No damage

1 Low (minimal) damage/displacement/loss
2 Moderate damage/displacement/loss
3 High (severe) damage/displacement/loss
4 Total loss/completely destroyed

^ Threat (1 char): Seriousness of continued threat from the impact

0 Not active - no longer/not a threat
1 Low - minimal, not yet resulting in significant damage to the site (>10 yrs)
2 Moderate - presently or will soon cause significant site damage (3 to 10 yrs)
3 High - presently or will soon cause major site damage (<3 yrs)
4 Total loss or collapse expected (<1 yr)

For example if the entire site has been heavily impacted by historic grazing, enter 5/3/0 alongside livestock; if only one of the four features/scatters is being actively impacted by channel erosion, you would enter 2/2/2 alongside channel erosion.

Note: "Veg removal" refers to the bulldozing/clearing of vegetation as seen across large areas of the ranch.

"Artifact collection" - this refers to unauthorized and authorized collection (i.e. if the site has been previously recorded and sampled). "Other" write ins might include: woodcutting, soil creep, trail. List and evaluate each "other" write in separately.

SITE EVALUATION:

This section is for recording a site's eligibility for the National Register and its potential to yield further information for research and interpretation.

* National Register (1 num): eligibility recommendations

1 Not eligible
2 Eligible
3 Unknown/need data

* Criteria (7 char): Enter all applicable criteria

1 Associated w/events that have made a significant contribution to broad patterns of our history
2 Associated with the lives of persons significant to our past
3 Embodies the distinctive characteristics of a type, period, or method of construction; or represents the work of a master, or possesses high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction.
4 Have yielded or may be likely to yield information important in prehistory or history

* Basis (2 char): This field was devised to meet NMCRIS requests for: 1) why the site was found to meet the eligibility criteria; or 2) why the site was recommended as ineligible; or 3) why the site was evaluated as unknown and what additional information is needed.

If you recommended the site as Eligible - Choose the relevant areas of significance:

01 Agriculture	10 Ethnic Heritage - Hispanic
02 Architecture	11 Ethnic Heritage - Native American
03 Archeology-prehistoric	12 Ethnic Heritage - European
04 Archeology-historic-aboriginal	13 Exploration/Settlement

05 Archeology-historic-nonaboriginal
06 Commerce
07 Community Planning
08 Conservation
09 Economics
14 Military
15 Religion
16 Transportation
17 Other*†

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†Other possibilities are: Art, Communications, Education, Engineering, Entertainment/Recreation, Health/Medicine, Industry, Invention, Landscape Architecture, Law, Literature, Performing Arts, Philosophy, Politics/Government, Science, Social History.

If you recommended the site as Ineligible:

20 Little to no site integrity
21 Little to no information value
22 Other (specify)

If you recommended the site as Unknown:

30 Need to determine presence of subsurface materials
31 Need additional information (records search, check previous collections)
32 Other (specify)

Significance (1 num): Can the site be considered significant based upon its individual potential to contribute to the archeological record, or only when viewed in the context of a district or collective of sites.

1 Individual 2 Collective

Research Potential (1 char): Assessment of research potential - consider database size, preservation, uniqueness, and dating potential in making this evaluation.

0 None 2 Moderate
1 Low 3 High

* Dating (1 char): The dating potential of the individual dating methods presented.

0 None 2 Likely/good possibility
1 Possible but doubtful 3 Certain

Interpretive potential (1 char): Assessment of interpretive potential - consider information value, uniqueness, and visual integrity of the site.

0 None 2 Moderate
1 Low 3 High

Site visibility: (1 char ea): Site visibility, as it pertains to visitors, from within the site boundaries and offsite 30m

0 None 2 Moderate
1 Low 3 High

Site access (1 num): enter the distances to paved road, dirt road, river (other is optional). When indicating distance to the closest paved road (NM63 or La Joya), be sure to circle which one you are measuring to. For other, don't forget to write in what you are using (i.e., north park boundary, interpretive trail, admin, ranch house, trading post, - 25, Santa Fe Trail)

1 0-20m 3 101-300m 5 501-1000m
2 21-100m 4 301-500m 6 >1000m

MANAGEMENT RECOMMENDATIONS:

Recommendations: Check (✔) all applicable recommendations, enter "E" if its an emergency situation (needs attention within 6 months).

No further work - the site does not require any further work or management consideration under present conditions.

Records search - Conduct background research (primarily pertaining to historic sites); e.g., literature search, oral history, ethnographic research, review of early plats and maps

Collection analysis - analyze/evaluate previous collections for additional artifact data

Collect/test/excavate to mitigate - for actively eroding/threatened sites - mitigate loss via data recovery

Test for i.d. - for features/sites of questionable cultural origins, test to verify that it is, in fact, a feature/site

Consider for additional research - site is worthy of consideration for additional research

Monitor condition - periodic inspections to track changes in condition due to natural and human causes (ideally all sites are recommended for monitoring, however check this recommendation if the site is higher priority or of greater concern than the "norm").

Stabilize/backfill - for sites that are actively eroding/threatened, mitigate loss via in situ preservation actions (e.g., structural stabilization, reburial)

Erosion control - actions need to be taken to minimize/control soil and water erosion within the site area

Other - specify

Management Comments: (240 char) Any comments concerning any of the above management issues as necessary.

ENVIRONMENTAL DATA:

Physiographic zone (2 num):

1 Pecos Valley 3 Tecolote Range 5 Apache Canyon
2 Pecos River 4 Glorieta Corridor

* Landform (2 char):

01 Ridgetop	10 Alluvial Fan
02 Ridge slope	11 Arroyo/Drainage
03 Saddle	12 Riverbottom/floodplain
04 Knoll	13 Terrace
05 Low rise	14 Mesilla top (Mesilla to be used specifically
06 Flat-gentle slope/plain	15 Mesilla slope for Pecos Pueblo vicinity)
07 Talus	16 Other (specify)
08 Bench	
09 Cliff face	

* Elevation (4 num): Enter the elevation in feet (nearest 20 foot interval) using the USGS topo quad.

Aspect (3 char): Enter the predominant slope direction of the landform upon which the site is located, use directional abbreviations (N, NNE, NE, etc.). Use 0 (for open) if there is no aspect, e.g., for an area with level topography - a flat mesa top or plain.

Slope° (3 num): Enter the slope of the landform upon which the site is located to the nearest degree. Use the clinometer to measure the slope degrees (the clinometer measures slope in both percentages and degrees, so make sure you are reading the correct side of the dial).

* Soil (4 num): based on general field observations - refer to soil handout for breakdown of soil types. Can enter two if gravel is one of them (e.g., 01/12)

01 Silt loam	05 Sandy silt loam	09 Sandy clay loam	13 Silt
02 Silty clay loam	06 Sand	10 Sandy clay	14 Bedrock
03 Silty clay	07 Loamy sand	11 Clay	
04 Clay loam	08 Sandy loam	12 Gravel	

* Deposition (5 char): indicate significant depositional or erosional processes that have contributed to the formation of archeological deposits on the site; can enter two (e.g., 01/04)

1 Alluvial	3 Aeolian	5 No deposits - bare bedrock
2 Colluvial	4 Residual	6 Other (specify)

* Vegetation Zone (2 char):

10 Grasslands (<2% tree cover)	30 Ponderosa pine/Douglas Fir
13 Grass/Chamisa/Juniper (<10% tree cover)	31 Ponderosa pine
14 Floodplain meadow	40 Riparian (mix)
15+ Grass/Juniper (<10% tree cover)	41 Juniper dominant riparian area
	42 Deciduous dominant riparian area
16+ Grass/Piñon/Juniper(<40% tree cover)	43 Grass/forb dominant riparian
17+ Grass/Piñon/Juniper(>40% tree cover)	60 Rocky outcrop/bare rocks
	90 *Other (specify - could include wetland, denuded mudflats
20 Piñon/Juniper (% tree cover unknown)	

+ added in 1996

21 Piñon/Juniper(<40% tree cover)
22 Piñon/Juniper (>40% tree cover)
23 Piñon/Juniper/Ponderosa/Fir (>40%)
24+ Piñon/Juniper/Ponderosa (<40%)
25+ Piñon/Juniper/Ponderosa (>40%)
26+ Piñon/Juniper/Mt. shrub
27+ Piñon/Juniper/Mt. Shrub/Ponderosa

* Nearest Water

Type (2 char): List closest water source using the following codes....

Permanent/Perennial - year round	Ephemeral (precip/runoff dependent)
01 River	09 Wash/arroyo
02 Creek/Stream (e.g., Glorieta)	10 Natural catchment
03 Spring (flowing)	
04 Seep (doesn't flow)	Other
Intermittent - seasonal (blue line/on topo)	11 Reservoir/constructed catchment
	12 Well
05 Creek/Stream	13 Cistern
06 Spring	14 Acequia/Ditch
07 Seep	
08 Natural catchment	

Direction (3 char): Use letter abbreviations - N, NNE, NE, ENE, E, etc.

Distance (4 num): Straight line distance, in meters

* Permanent water - (if the same as nearest water will need to repeat information)

Name (36 char): Write out (e.g., Pecos River, Glorieta Creek, Galisteo Creek. There are also six known springs: Trading Post Spring, Poison Spring, Mud Seep, Cottonwood Spring, Middle Pasture Spring, unnamed spring north of North Pueblo, and other springs may be located as a result of the survey). Crew chiefs will have maps of spring locations

Direction (3 char): Use letter abbreviations - N, NNE, NE, ENE, E, etc.

Distance (4 num): Straight line distance in meters

PREVIOUS INVESTIGATIONS:

* Other site numbers/names (40 char): Enter any other site names or numbers assigned during previous recording or research efforts, including the present LA number. If combining two or more previously recorded sites, make sure all site numbers are shown

* Project name/date/type (250 char): If the site was previously recorded indicate when and by whom - the name of the project (if there is one), and the reference, if known. Some possible

entries are:

1976 Forked Lightning Ranch Survey
1976 Core Monument Survey, rerecorded 1989...1992
1980 Rowe Pueblo Reconnaissance Survey
1984 Rowe Project Site Survey
1969 (or 1970) Univ of Nebraska Survey
1991 (or 1993) State Road 63 Survey
1994 State Road 63 Testing

* Site marker (75 char): Describe the type and location of any previously placed site markers; show location on site map (make sure you differentiate between old site marker and newly placed site stakes in map key).

* Collections (250 char): Indicate if site was previously collected and how; where the collection is, if known. If collections were taken, remember to consider "Artifact Collection" in the "Impacts" section and to consider "Collection analysis" in the "Management Recommendations".

Comments (500 char): Additional comments as necessary - note and explain differences between the original recording of the site and the present recording.

PHOTOGRAPHS: This record is in addition to the Photo Record sheet.

* Roll No. (9 char): enter the film roll number. The film will be numbered for you (check film canister and film casing). The number will be prefaced by "PECO", which has been filled in for you on the form; then a B (for black and white) or C (for color) followed by sequential numbers; i.e., B1, B2, B3, or Cl, C2, C3, etc. Each crew will carry one B/W camera every day in the field; a color slide camera will be rotated among crews.

* Exposure number (2 char): Shot number as indicated by the photo log (1-36), not the counter on the camera. Always write down photos even if they are mistakes...

ICRC# (5? char): To be assigned later

View (3 char): Direction of photo shot - N, NNE, NE, E etc.

Subject (100 char): A **brief description** of what was photographed; doesn't need to be detailed since the photo log will serve as the main reference for this information (i.e., do not include descriptive info like "north arrow in right foreground" or "LJK sitting under tree to left" - this should go in the photo log). Also, unlike the photo log which should include both the feature name and number, you only need to use the feature name in this description (i.e.. small structure) unless you need to distinguish between two features of the same type, in which case. include the number as well (i.e., small structure 03-02). This information will be used by people unfamiliar to our coding system.

COLLECTIONS:

FS# (4 num): assigned in lab

Artifact Code (3 char) - use same code as artifact inventory form:

For lithics put function and tech type (use 243 for mineral specimen)
For ceramics type and form
For historic class and function

Component # (1 char): 1, 2, 3 etc.

Feature (5 char): The type and number of the feature that the artifact was collected from (e.g., 80-01)

Sample # (2 char): If collected from within a sample area enter the sample area number (e.g., 01).

Description (30 char): Use standardized terminology, the **artifact description should be general to specific**. Include any labelling or numbering system you might have utilized in the field or on the site map. Always describe from general to specific being consistent in your terminology. Use the terminology presented below when applicable:

sherd, Santa Fe B/W, bowl body,
sherd, Glaze, jar rim
projectile point, corner notched, chert, pp1
drill, expanding base, obsidian-Jemez

Don't forget to analyze the collected artifacts and enter the data on the analysis forms. Be sure to note the collections on the site map and on the applicable artifact form. If there are multiple artifacts of the same type, make sure they are numbered consistently here, on the artifact tag, on the site map, and on the analysis form.

ASSEMBLAGE CHECKLIST

Assemblage Data: This information is needed for the NMCRIS form. Place an entry by each category noting the presence - "✔" or absence - of each artifact type at the site.

Assemblage size: Enter one of the following for each category. If less than 100, include count (in parenthesis).

0	None	3	101-1000
1	1-10	4	1001-10,000
2	11-100	5	>10,000

PECOS

From Folsom to Fogelson:

The Cultural Resources Inventory Survey of Pecos National Historical Park

APPENDIX B:
Sampling Guidelines

Sampling Guidelines

The sampling strategy outlined below has two separate, but complementary goals: (1) estimating the artifact density of a scatter, and (2) estimating the artifact attribute population parameters. Refuse scatters will be sampled only when it is not feasible to analyze all artifacts; for lithics this is more than 100 items, for ceramics, 200. The goal of sampling is to obtain a reasonable estimate of the scatter population parameters, which requires a representative sample. More often than not, simple random sampling does not result in a representative sample. A more representative sample may be obtained by stratifying the scatter into quadrants, gridding the scatter within each quad, then randomly selecting a given number of grid units within each quad. A third concern in the sampling and analysis process is to maintain the original character of the site by returning artifacts as close as possible to the locations they came from.

ARTIFACT DENSITY ESTIMATES (use only for refuse scatters associated w/structures)

1. Define Scatter, Determine Scatter Area, Identify Quadrants.

If a scatter is to be sampled, define the scatter boundaries, measure the scatter (length, width), determine scatter area, and divide the scatter into four roughly equal quarters.

2. Determine Size and Number of Sample Units.

The size and number of sample units will be determined by the total scatter area. The total area sampled should equal 10 to 15% of the total area of the scatter. Size of units should range from 2x2m to 10x10m. All sample units for a single scatter must be the same size. Keep in mind that a large number of sample units is analytically preferable, but may be impractical. Select the size and number of these units weighing the costs and benefits of both these concerns. For example if you have a scatter that is 4500 m^2 you will want to sample 450-675m, aiming for 2 sample units per quadrant, you could lay out eight 5m radius dogleash units (628m^2) or eight 8 x 8 grid units (512m^2).

3. Select Sample Units.

Use the bottom of the density grid sheet or a separate sheet of graph paper to outline the scatter boundaries and superimpose the grid and quads. Number all grid units that appear to have at least half their area within the scatter. Select sample units from each quad using a random numbers table until you have chosen units equalling 10-15% of the surface area of the entire scatter. The number of units selected should at a minimum include 4 units (1 per quad); at a maximum, 20 units (5 per quad) for the entire scatter. As noted, the number of

sample units should be divided equally among the quads. Write down the numbers of the units from each quad in order of random selection on the density grid form.

4. Locate Sample Units and Record Artifact Counts.

Sample units can be located in two ways:

1) establish a density datum (on the ground and on your map); using your map, establish the distance and azimuth to your grid unit (pick a corner) from the datum; or if using dogleash units, establish the distance and azimuth to the center; then using those coordinates, locate that point on the ground by shooting the bearing and measuring the distance from the datum.

OR

2) using the grid system you have created on your map, figure the X, Y coordinates of your selected sample units; then using the metric tapes and pinflags, project the Y axis on the ground and at the appropriate intervals shoot a 90 bearing and measure out to each calculated X coordinate.

Once you have located the corner or center point, lay out and label your unit, and pick up and count all artifacts in it. Label the bag with the sample unit number. Record counts on the density grid page. (If the number of items in your sample units is highly variable, and you have a relatively small number of units, you will probably want to select additional units. Additional sample units will help to decrease the population variance, and thereby allow a more precise estimate).

5. Return Artifacts to Sample Units.

After all analyses are completed, return all collected artifacts to the sample unit from which they came. This is essential to preserve site integrity.

SAMPLING FOR ARTIFACT ATTRIBUTE ANALYSIS (use only for refuse scatters associated w/structures)

Sampling for artifact analysis will be carried out within the framework created by the artifact density sampling. Our experience last year showed that ceramics rarely required sampling, but lithics were frequently sampled. The following discussion applies primarily to lithics, but the same principles can be used for ceramics when necessary.

The goal in lithic artifact analysis sampling is to analyze 30-40 out of 100 artifacts picked up from the four quads of the scatter. The procedure by which the 100 artifacts are selected is outlined below.

1. The sample units to be included in artifact analysis are selected randomly, in a "round-robin" manner from all four quads (these units will in most cases be the same as those established for the density grids). One sample unit is selected (using random numbers) from each quad until approximately 100 items have been picked up. After the first round (one sample unit from each quad), the number of items included is counted. If more than 75 items are selected, then no additional samples need be selected. If fewer than 75 are picked up in the first round, then you will need to select 4 more sample units - one from each quad - until at least 75 artifacts have been picked up (although we are aiming for 100 lithics, having to pick up 4 units at a time may result in picking up more than a 100 lithics - this is okay, but the sample should be designed to stay below 200 lithics, see "sampling strategy for very dense scatters" below). No more than 300 items (total of 3 samples) are to be included regardless of scatter artifact count.

2. For scatters where the number of items picked up is less than 200, select one simple random sample of 30 items for analysis using the random numbers board and table, doubling up artifacts on the board if necessary. Analyze artifacts as outlined in lithic and ceramic manuals.

3. If the estimated number of items exceeds 20,000, then 15 items from each quad must be analyzed (total of 60 items analyzed). The maximum number of items to be analyzed is not to exceed 90. This would only occur if the total estimated was 30,000 or greater. On scatters of this artifact density, an equal number of items from each quad should be analyzed in order to ensure that the analysis sample includes items from all quads of the scatter. This will also divide the sample into units that are of more manageable size to be laid out on the random numbers board.

Sampling strategy for very dense scatter

If after laying out the density grid as described in the sampling directions it appears that you may pick up more than 200 items in each density grid unit, then the density grid unit should be subdivided into a smaller grid unit for artifact analysis sampling. The goal is to keep the size of the sample unit consistent among quads and avoid picking up more than 600 items. It does not matter if the grid size for artifact analysis is not the same as the grid size for artifact density estimation. For example, if you have a very dense scatter (i.e., 2 items/m^2) that covers 10,000 square meters and you have chosen ten 10x10 units for the density grid count, if you were to use these units for your analysis sample, it is likely that in the first round of pick up, you could get 800 items. To avoid having to mess with this many items on a random number board, subdivide the 10 x 10m unit into smaller units (i.e., 5x5, 2x2 etc.) and pick up only the southwesternmost subunit. The important thing is to keep the sample units the same size and anticipate having to collect 4 units at a time (one from each quad). Analyze up to 3 sets of 100 (1 set for every 10,000 items estimated, but no more than 3 sets).

SAMPLING FOR ARTIFACT ATTRIBUTE ANALYSIS (use for refuse scatters not associated w/structures)

As with the sampling strategy outlined above you are aiming for approximately 100 flaked stone items, or 1% if estimated artifact count is greater than 10,000 items with no more than 300 items (3 samples) included regardless of scatter artifact count. Unlike the refuse scatters associated with structures, we will not be establishing a grid for the nonstructural scatters since we are not doing density estimates at these scatters. Because of this, the artifact analysis units can be placed judgmentally. We still want multiple samples to insure a representative sample of all parts of the scatter (i.e., four 5x5), however these sample units can be placed judgmentally - in areas that would best and most efficiently provide a representative sample of the scatter.

ARTIFACT PICK UP FOR SMALL SCATTER

When doing the artifact analysis at scatters that do not require sampling (fewer than 100 flaked lithics and 200 ceramics) a major concern is to maintain the integrity of the artifact scatter.

Artifacts must be put back in their original position. This can be easily accomplished by marking artifacts with numbered flags (one set of numbers for lithics, one set for ceramics). For lithics, use the random numbers board to select the 30 items to be analyzed, find the corresponding numbered flags then record those lithics right at their location. All groundstone in a scatter needs to be recorded and this is most easily accomplished by moving from item to item. For ceramics, we found it was easiest to lightly write the number of the

flag on each artifact (use pencil), bring all the sherds together for analysis, then return each to the appropriate flag.

<<< Previous <<< Contents>>> Next >>>

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peco/cris/appb.htm
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PECOS

From Folsom to Fogelson:
The Cultural Resources Inventory Survey of Pecos National Historical Park

APPENDIX C:
Pecos Archeological Survey 1997 Lithic Manual/Coding Guide and Form

PECOS ARCHEOLOGICAL SURVEY
1997 LITHIC MANUAL/CODING GUIDE

PECO# (3 num): The PECO number as assigned by your crew chief

Component # (1 num): Use component number as assigned on the main site form.

Recorder (3 char): Enter initials of person doing the analysis

Date (7 - date): Recording date by day, first 3 letters of month, last two digits of year (10JUN93).

Time (2 fields 2 num ea): Total time it took for lithic analysis, enter hours:minutes (2:30). This is analysis only. **NOTE:** During the initial stages of the survey, we will want to know how much time we take to set up and collect the grids and/or samples - write this time down in parentheses next to total time (only one analyst needs to do this).

Feature sampled (5 char): The type and number of the refuse scatter that was sampled (as assigned on the main site form, i.e., Mixed ceramic and lithic scatter 1-80-01).

Sample# (2 num): The number of the sample area. Sample areas will be numbered sequentially per refuse scatter (i.e., 80-01 might have two samples: 01 and 02; and 83-01 might have one sample: 01). Use 00 for "Items of Interest" outside sample areas

Sample type (1 num):

1 Lithic and ceramic
2 Lithic
7 Other (explain)
NA For "Items of Interest" outside sample areas

****

NOTE: Items of interest (i.e., projectile points) and all groundstone not associated with any sample collection area but that are worthy of analysis should be analyzed and recorded on a separate Lithic Inventory Form. In filling out this form (for these general site/nonsample artifacts), the Sample # should be entered as "00", Type will be "n/a", and Dimensions will be entered the same as the refuse scatter dimensions minus the other sample areas.
****

Dimensions (2 num fields - 4 digits w/1 decimal ea. - 000.0 x 000.0): dimensions of the sampled area, length x width to the nearest tenth of a meter. If sample consists of multiple grid units show number of units in parenthesis followed by the dimensions of the individual units; e.g., (5) 2 x 2m.

Pickup (3 num): Total number of artifacts picked up in the sample collection.

Analyzed (3 num): Total number of artifacts analyzed from sample (aim for 30). This number should not include any artifacts that were analyzed from outside sample area (i.e., groundstone, diagnostics, etc).

Sample NFL/Nonflaked lithic (2 num): Total number of nonflaked lithic (NFL) analyzed from within the sample area

Other FL/Flaked lithic (2 num): Number of flaked items from the sample pickup that were not selected as part of the random sample analysis but were analyzed because they were unusual or of interest. These flaked items should be recorded **after** the sample artifacts - skip a few spaces and **clearly mark as "not in random sample"** (can add a separate page if appropriate). Artifact numbers for these in-pickup-but-not-in-random-sample artifacts items do not need to be contiguous with the sample artifact numbers.

*Assemblage Summary (200 char): Summarize lithic assemblage - briefly discuss material and functional types, reduction stages, diagnostics, spatial distribution, general observations. Since **we only need one assemblage summary per scatter,** for scatters with multiple samples, provide the assemblage summary on the first lithic form only and leave blank on subsequent forms.

FLAKED STONE

Artifact # (2 num):

This provides an item number for each artifact analyzed within the sample. Comments concerning any of the artifacts should be cross-referenced using this number. As mentioned above, flaked artifacts of interest that were in the sample pickup but not chosen in the random sample should be listed after the sample artifacts and clearly separated and labelled as "not from the random sample".

Material type (3 num):

Igneous
100 Igneous, undifferentiated
110 Granite
120 Diorite
130 Basalt
131 Vesicular Basalt
140 Andesite
141 Rhyolite
150 Obsidian, undifferentiated
151 Obsidian, Polvadera
152 Obsidian, Jemez
153 Obsidian, Jemez opaque

Sedimentary
300 Sedimentary, undifferentiated
310 Siltstone, undifferentiated

Metamorphic
200 Metamorphic, undifferentiated
210 Quartzite
220 Gneiss
230 Schist
240 Diabase
250 Fibrolite

311 Siltstone - Stone Type 1: dark reddish gray micaceous siltstone.
320 Sandstone, undifferentiated
321 Silicified sandstone/Orthoquartzite
322 Sandstone - Stone Type 2: pink arkosic sandstone, coarse with large soft sandstone pebble and light gray feldspar pebble inclusions.
323 Sandstone - Stone Type 3: coarse reddish brown micaceous sandstone.
324 Sandstone - Stone Type 4: pink micaceous sandstone, medium to very coarse.
325 Sandstone - Stone Type 5: medium grained, red or white, nonmicaceous
330 Limestone
331 Dolomite
350 Shale
360 Chalcedony - use for translucent cherts
370 Chert, undifferentiated
371 Pedernal chert - white/gray with red, black, yellow dendritic inclusions
372 Alibates Flint
373 Petrified wood
374 Chert, nonlocal
380 Conglomerates

Other
400 Other (specify)
410 Quartz
420 Hematite
430 Turquoise
999 Indeterminate

Color (2 num): Give the color of the raw material. This is especially important for cherts.

01 Black	11 Pink
02 Brown	12 Purple
03 Buff/Beige	13 Red
04 Clear	14 Red w/white
05 Gold	15 Red w/grey
06 Green	16 White
07 Grey	17 White w/grey
08 Grey w/white	18 White w/pink
09 Dark Grey	19 Orange/rust
10 Light Grey	20 Other (describe in comments)

Cortex % (3 char): The percentage of total artifact surface that is cortex (i.e., if all of dorsal face of flake is cortex, percent would be 50%).

0 0 (None) 2 25-50% 4 90 - 100% (All)
1 1-25% 3 50-90%

Platform type (3 char): can list two, i.e., 2/3 (see attached figure)

0 Not applicable/absent
1 Single faceted/flat
2 Multifaceted

3 Abraded
4 Cortical
5 Retouched
6 Crushed
7 Collapsed
8 Lipped
9 Unknown

Condition (1 num)
For tools, indicate if the artifact is intact or how much is missing:

1 Less than 50% there 3 Broken but all there (pieces fit together)
2 More than 50% there 4 Complete

For debitage, indicate the debitage category (use hierarchy shown below [Sullivan & Rozen 1985]):

5 Complete Flake 7 Flake Fragment
6 Broken Flake 8 Debris

Artifact Type	Debitage
Single Interior Face	Discernible Not Discernible
Point of Applied Force	Present Absent
Margins	Intact Not Intact
Debitage Category	Complete Flake (5) Broken Flake (6) Flake Fragment (7) Debris (8)

!!!! DO NOT USE TOOL CONDITIONS FOR FLAKES OR DEBITAGE CATEGORIES FOR TOOLS !!!!
HT/Heat Alteration(7char): some of definitions based on Museum of NM 1990
1 Crazing - minute surface cracks, often crosshatched, caused by rapid heating/cooling or by processing specimen that doesn't heat or cool evenly (too thick). Care should be taken in using this code since some stream rolled cherts can develop microcracks under the cortex that are difficult to distinguish from crazing.
2 Potlidding - concave flake scars caused by the removal of piano-convex flakes; resulting from rapid heating causing moisture within the material to vaporize and explode outward
3 Luster - change in luster resulting from thermal alteration; difficult to detect due to natural luster variability and should be used conservatively and only when luster differences between facets are visible.
4 Discoloration - Color change resulting from heathing; use conservatively since natural coloration can be varied.

Use-wear (3 char): Record the dominant uses visible. Use hand lens if necessary. The category can accept up to 3 characters for two types of use, separated by a slash (see Glossary for definitions)

1 Microflaking
2 Edge Rounding
3 Ridge/edge frosting
4 Polish
5 Striations - perpendicular to edge
6 Striations - parallel to edge

7 Striations - oblique to edge
8 Battering
9 Other

Technological type (2 char): see Glossary for definitions

01 Angular debris/shatter	BIFACE THINNING FLAKE - need 7 of 10 attributes for complete flakes, 5 of 7 for broken flakes:
10 Core, undifferentiated	COMPLETE FLAKES
11 Core, unidirectional	1. Platform more than one facet and/or is modified by retouch and/or abrasion.
12 Core, bidirectional	2. Platform is lipped
13 Core, multidirectional	3. Platform angle is less than 45 degrees
	4. Dorsal scar orientation is parallel, multidirectional, or opposing
	5. Dorsal topography is irregular
20 Flake	6. Edge outline is even
21 Flake, biface thinning	7. Flake is less than 5mm thick
	8. Flake has relatively even thickness from proximal to distal end.
31 Unidirectional edge, thin (w:th 3:1)	9. Bulb of percussion is weak (diffuse)
	10. Pronounced ventral curvature.
32 Unidirectional edge, thick (w:th<3:1)	BROKEN OR COLLAPSED PLATFORM FLAKES
33 Uniface, thin	1. Dorsal scar orientation is parallel, multidirectional or opposing
34 Uniface, thick	2. Dorsal topography is regular
41 Bidirectional edge, thin	3. Edge outline is even
	4. Flake is less than 5mm thick
	5. Flake has a relatively even thickness from proximal to distal end.
42 Bidirectional edge, thick	6. Bulb of percussion is weak
43 Biface, thin	7. There is a pronounced ventral curve
44 Biface, thick	
50 Tested cobble	
51 Cobble tool, undifferentiated	
52 Cobble tool, unidirectional	
53 Cobble tool, bidirectional	
60 Other	

Functional type (3 char) (see Glossary for definitions).

00 Not applicable	20 Chopper
01 Used Angular Debris	21 Hammerstone
02 Used Core	22 Pecking stone
03 Used Flake	23 Flaked axe
04 Spokeshave	24 Flaked hoe
05 Denticulate	30 Drill, undifferentiated

06 Awl/borer/perforator	31 Drill, plain shafted
07 Graver	32 Drill, expanding base
10 Scraper, undifferentiated	33 Drill, lugged
11 Scraper, end	34 Knife, undifferentiated
12 Scraper, side	35 Knife, bevelled
13 Scraper, thumbnail	36 Blank/Preform
14 Scraper, discoidal	60 Other (describe in comments)

Projectile Points will be assigned functional codes in a different way from other artifact types in order to get more information from the single code. Projectile point codes will be 3 digits long.

The first digit will always be "4". This will help alert the analyst that the item is a projectile point.

The second digit will be used to denote size and can be:

1 indeterminate
2 small
3 large

Use indeterminate when there is not enough of the item to put it into one of the other size categories. There are no actual thresholds for the large and small categories at this time, determinations can be subjective and can be cross-checked with dimensions.

The third digit will be used to denote general form. The values are as follows

0 undifferentiated	5 side-notched, expanding base
1 stemmed	6 basal and side notched
2 corner-notched, nfs	7 triangular
3 corner-notched, expanding base	8 lanceolate
4 side-notched, nfs	9 other (describe in comments)

A large side-notched point will be coded 434, a small stemmed point will be 421, a large lanceolate point will be 438, and a fragment of an undifferentiated point of unknown size will be 410.

Size (mm): Measure the total size of all artifacts with calipers to the nearest millimeter (large items such as metates can be measured with a tape.). Measure length and width as if you were placing the artifact in a box that exactly fit its maximum dimensions and measure that box. Thickness should be measured at the widest point perpendicular to the box.

Length (4 num)
Width (4 num)
Thickness (4 num)

Comments: Use this space to comment on any unusual features of the item and to explain any uses of "other".

NONFLAKED LITHIC/GROUNDSTONE
Artifact # (2 num): Provides item number for each artifact analyzed. Comments concerning

any of the artifacts should be cross-referenced using this number. Any nonflaked stone artifacts analyzed from outside the sample area should be entered on a completely separate form (labelled Sample 00).

Material type (3 char): See materials for flaked stone above

NFL/Nonflaked lithic type (3 char): see Glossary for definitions

01 Manuport, cobble	40 Hafted item, undifferentiated
02 Manuport, slab	41 Hoe
	42 Maul
10 Hammer stone	43 Axe (ground, not flaked bit)
11 Anvil Stone	
12 Mortar	50 Polishing stone
13 Pestle	51 Abrading stone - slab
	52 Abrading stone - grooved
20 Mano, undifferentiated	
21 One-hand mano	60 Shaped stone, undifferentiated
22 Two-hand mano, undiff.	61 Palette
23 Two-hand mano, trough	62 Jar cover
24 Two-hand mano, slab	63 Cooking slab
25 Mano, other, comment	64 Architectural slab (door cover, deflector)
	65 Ornament
30 Metate, undifferentiated	
31 Basin metate 80	80 Other (specify)
32 Trough metate 99	
33 Slab metate	99 Unknown groundstone
34 Metate, other (specify)	

Condition (1 char) Indicate if the artifact is intact or how much is missing.

1 Less than 50% there	3 Broken but all there (pieces fit together)
2 More than 50% there	4 Complete

Size: Measure length, width, thickness of complete artifacts only (mm) -

Length (4 num)
Width (4 num)
Thickness (4 num)

Cross section (2 char): for manos and metates

1 Plano-convex	5 Triangular
2 Biconvex	6 Wedge shape
3 Convex-concave	7 Airfoil
4 Subrectangular	9 Indeterminate
	10 Oval

of Grinding Surfaces (1 num): Indicate # of grinding/use surfaces, 0-4. Enter "9" if indeterminate

Comments (50 char): Use this space to identify any unusual features of the item and to

explain uses of "other"

General Comments (250 char): Use this space to comment on any interesting features of the entire lithic assemblage. If discussing an individual artifact, be sure to refer to its Artifact #.

<<< **Previous** <<< **Contents**>>> **Next** >>>

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peco/cris/appc.htm
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PECOS

From Folsom to Fogelson:
The Cultural Resources Inventory Survey of Pecos National Historical Park

APPENDIX D:
CERAMIC RECORDING

PECOS ARCHEOLOGICAL SURVEY
1997 CERAMIC INVENTORY FORM MANUAL/CODING GUIDE

PECO # (3 num): The PECO number as assigned by your crew chief
Component# (1 num): Use component number as assigned on the main site form.

Recorder (3 char): Enter initials of person(s) doing the ceramic analysis

Date (7 - date): Recording date by day, first 3 letters of month, last two digits of year (10JUN93).

Total Time (2 fields 2 num ea): Total time it took for ceramic analysis, enter hours:minutes (2:30). This is analysis only. **NOTE:** During the initial stages of the survey, we will want to know how much time we take to set up and collect the grids and/or samples - write this time down in parenthesis next to total time (only one analyst needs to do this).

Cer. Dates (4 fields 5 char ea): Ceramic dates determined as a result of the analysis (can enter two sets if applicable).

Confidence (1 char): Confidence in the date indicated by the ceramic analysis.

1 Low
2 Medium
3 High

Feature sampled (5 char): The type and number of the refuse scatter that was sampled (e.g. 83-01).

Sample# (2 num): The number of the sample area. The sample areas will be numbered sequentially per refuse scatter (i.e., 83-01 might have two samples: 01 and 02; and 80-03 might have one sample: 01).

Sample Type (1 num)

1 Lithic and ceramic
3 Ceramic only
7 Other

Dimensions (2 num fields - 4 digits w/1 decimal ea. - 000.0 x 000.0): dimensions of the sampled area, length x width to the nearest tenth of a meter. If sample consists of multiple grid units show number of units in parenthesis followed by the dimensions of the individual

units; e.g., (5) 2 x 2m.

Pickup (3 num): Total number of artifacts picked up in the sample collection.

Analyzed (3 num): Total number of artifacts analyzed from sample. Do not include diagnostics or other sherds of interest that might have been looked at outside the sample area.

Assemblage Summary (200 char): Briefly summarize ceramic assemblage - consider discussing types, date determination, diagnostics, spatial distribution, general observations.

TYPE INVENTORY

Group# (2 num): This is filled in for you - the number serves as an identifier for all subsequent analysis.

Types (Char - 3): Ceramic typology

UTILITY WARES
100 Unidentifed grayware
101 Lino Gray
102 Kana'a Gray
103 Plain gray
104 Corrugated
105 Blind Corrugated
106 Indented Corrugated
107 Indented Blind Corrugated - not further specified
108 Indented Blind Corrugated - weak
109 Indented Blind Corrugated - strong
110 Clapboard Corrugated
111 Micaceous Plain
112 Micaceous Corrugated
113 Micaceous Blind Corrugated
114 Micaceous Indented Corrugated
115 Micaceous Indented Blind Corrugated - nfs
116 Micaceous Indented Blind Corrugated - weak
117 Micaceous Indented Blind Corrugated - strong
118 Micaceous Clapboard Corrugated
119 Cundiyo Micaceous Smeared Indented
120 Cordova Micaceous Ribbed
121 Pecos Striated - not further specified
122 Pecos Faint Striated
123 Pecos Heavy Striated

BICHROMES
200 Unidentified Whiteware
201 San Marcial B/W
202 Kwahe'e B/W Slipped
203 Kwahe'e B/W Unslipped
204 Socorro B/W
205 Chupadero B/W
206 Santa Fe B/W Slipped
207 Santa Fe B/W Unslipped
208 Mesa Verde B/W
209 Pindi B/W

POLYCHROMES APACHE
400 Unidentified Polychrome
401 Sakona Polychrome
402 Tewa Polychrome
403 Tewa Black-on-red
404 Late Tewa Polychrome
405 Pojoaque Polychrome
406 Puname Polychrome
407 Ashiwi Polychrome
408 Gobernador Polychrome
409 Ogapoge Polychrome
410 San Pablo Polychrome
411 Powhoge Polychrome

PLAIN WARES
500 Los Lunas Smudged
501 Potsuwi'i
502 Undecorated red
503 High polish undecorated red
504 Plain Red
505 Plain Black
506 Kapo/Tewa Black
507 Unknown plain polished

GLAZES
600 Unidentified Glazeware
601 Unidentifed G/r
602 Unidentifed G/y
603 Unidentified G/p
604 Los Padillas G/p
610 Glaze I/A- undifferentiated
611 Agua Fria
612 Cieneguilla GI/y
613 Cieneguilla G/p
614 Sanchez G/r
615 Sanchez G/y
616 Sanchez G/p

210 Galisteo B/W
211 Rowe B/W
212 Jemez B/W
213 Wiyo B/W
214 Biscuit A
215 Biscuit B
216 Sankawi'i B/C
217 Tabira B/W
218 Tabira Plainware
219 Biscuit Unknown

RED WARE
300 Unidentified redware
301 Puerco Black-on-red
302 Wingate Black-on-red
303 Wingate Polychrome
304 St Johns Black-on-red
305 St Johns Polychrome
306 Heshotauthla Poly

617 San Clemente G/p
620 Glaze II/B - undifferentiated
621 Largo G/y
622 Largo G/r
623 Largo G/p
624 Medio Polychrome
630 Glaze III/B/Espinosa G/p
631 Glaze III Red
632 Glaze III Yellow
640 Glaze IV/D/San Lazaro G/p
650 Glaze V/E - undifferentiated
651 Pecos G/p
652 Puaray G/p
653 Escondido G/p
654 Glaze V - Late
660 Glaze VI/F - undifferentiated
661 Kotyiti G/r
662 Kotyiti G/y
663 Kotyiti G/p

710 Ocate Micaceous
711 Cimarron Micaceous
712 Perdido Plain
713 Dismal River

UNKNOWN
999 Just Unknown

Form (Char - 2): Vessel shapes/form

01 Jar	06 Seed jar	11 Pipe
02 Bowl	07 Soup bowl	12 Miniature
03 Shouldered Bowl	08 Square bowl	13 Other
04 Special Closed	09 Ladle	99 Unknown
05 Canteen	10 Handle	

Count (4 num): Number of sherds in the group

Weight (4 num): Weight of the group to nearest tenth of a gram

Rims (4 num): Record the number of rim sherds in the group (also fill out the 'Rim Sherd Inventory").

Vessel (2 num): Vessel count - in the course of the inventory, individual vessels may be distinguishable (mostly in the case of decorated wares). Follow number entry with "A" (for actual) if you know, or can project with confidence, the number of vessels represented. Use "M" if you can only provide an estimate of the number of vessels. When the time constraints and the number and nature of the sherds in the sample prevent you from coming up with an actual vessel count without additional work use "M".

Comments (Chars - 200): Note any interesting features/characteristics of the sherd group, presence of worked sherds. Can use to show diagnostics and associated dates that led to your ceramic date assignment.

RIM SHERD INVENTORY

The rim sherd inventory is designed to gather information that can be used to project vessel size and function. Document only those sherds that can provide a confident measure of vessel rim diameter (see "Diameter" discussion below)

Group # (2 char): Enter the Group # under which this rim sherd was counted on page 1. Record each measurable rim sherd individually unless you are certain they are from the same vessel.

Diameter (2 num): Project interior diameter of vessel rim in cm using the handy dandy measuring chart - match the arc of the rim sherd with the arcs illustrated on the rim chart (if a rim diameter falls between two illustrated rim sizes, you can enter the intermediary value; e.g., if the rim sherd falls between 44cm and 48cm as shown on the chart, you can "round" your entry to 46). **Only enter rim diameter if the rim sherd(s) allows you to project vessel size with confidence** - if the arc of the rim fits with one, or at most two, of the possible diameters shown on the chart. **Do not inventory rims that can be made to fit more than two possible diameters.**

of sherds (2 num): This will be 1 unless you have grouped multiple rim sherds from the same rim (again, only group them if you are certain they are from the same vessel).

% of rim (3 num): Estimate percent of rim represented by the sherd(s) using the handy dandy measuring chart. If you have grouped rims from the same vessel together, make sure the percentage entered reflects their total representation of the rim

Comments (200 char): as necessary.

Page of

Pecos Archeological Survey 1997 Ceramic Inventory Form

PECO#_____ Comp#_____ Recorder_____ Date_____

Cer. Dates _____ Confidence ___ Total Time_____

Feature sampled	Sample #	Type	Dimensions	Pickup	Analyzed

*Assemblage Summary_____

_____

_____

TYPE INVENTORY							
Group#	Type	Form	Count	Wt	Rims	Vessel	Comments
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							

Comments_____

_____

_____

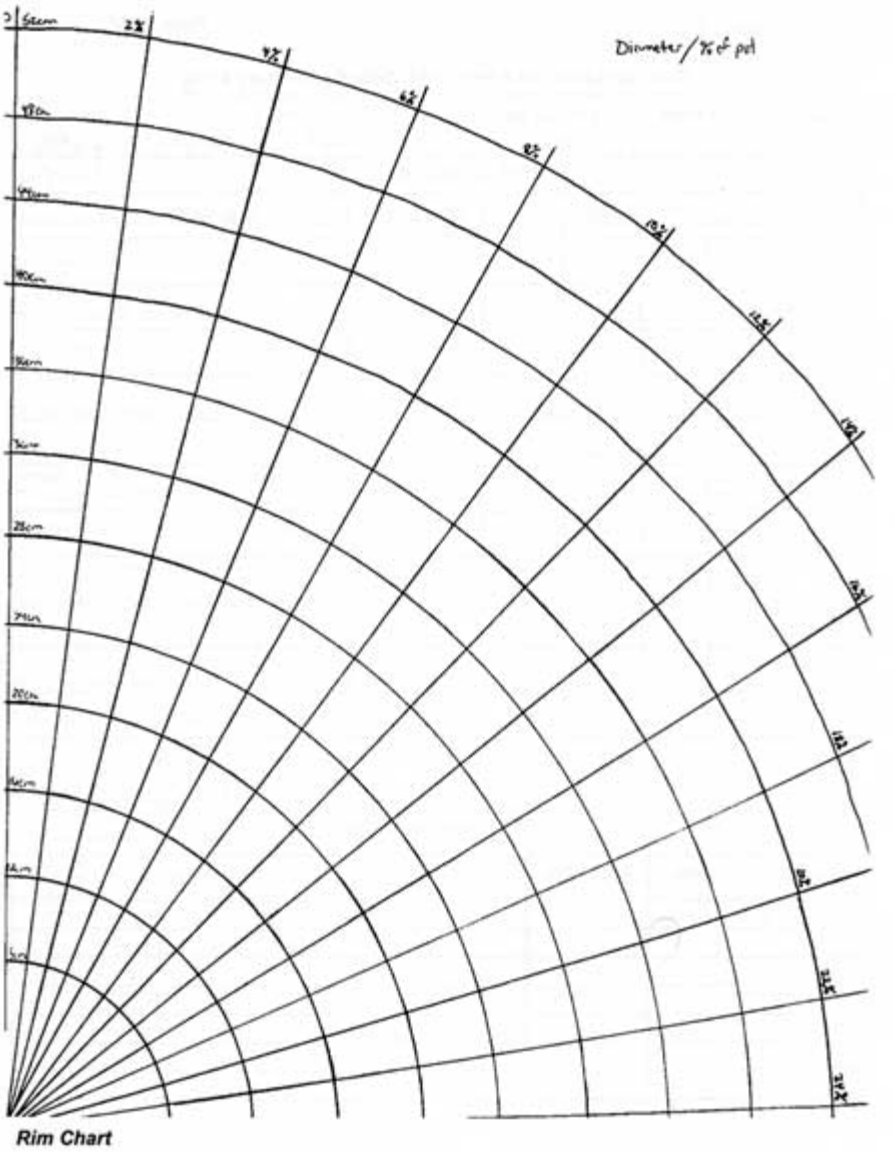
Page ___ of ___

Pecos Archeological Survey 1997 Ceramic Inventory Form

PECO#_____ Comp#___ Feature Sampled_____ Sample #___

TYPE INVENTORY Cont'd							
Group#	Type	Form	Count	Wt	Rims	Vessel	Comments
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							

RIM SHERD ANALYSIS				
Group #	Diameter	# of sherds	% rim	Comments



(click on images for an enlargement in a new window)

<<< Previous <<< Contents >>> Next >>>

PECOS

From Folsom to Fogelson:

The Cultural Resources Inventory Survey of Pecos National Historical Park

APPENDIX E:

1,100 YEARS OF CONSTRUCTION WOOD USE IN THE UPPER PECOS VALLEY

Thomas C. Windes

Contents

Sampling Strategy

The Early Puebloan Sample
- Early Park Pithouses
- Arrowhead Pueblo
- Forked Lightning Ruin
- Rowe Pueblo

Pecos Pueblo
- The Sample
- Structure Dating
  - North Pueblo (Figure E.3)
    - West Roomblock
    - Plaza
    - East Roomblock
    - Kivas
  - South Pueblo (Figure E.5)

Pecos Mission Church
- History of Construction
- Reuse of Mission Beams in Pecos Pueblo
- Wood Implications of the Pueblo Revolt
- Church Deterioration and Reuse of Beams
- Stabilization
- The Mission Sample
- Previous Sample Proveniences
- Interpreting the Sample Results
- The Convento

Early Hispanic Settlement along the Upper Pecos River
- The Sample
- San Miguel del Vado
  - The Church
  - The Plaza Structures
- Park Homesteads
  - Village of Pecos

Las Colonias
Terrero Rivera Homestead
Kozlowski's Stagecoach Stop and Trading Post
The Sample
Structure Dating
Main Building (Structure 20; Figure E.30)

CONCLUSIONS
Tree-Ring Dating Success
Harvest Timing
Labor Investments

Acknowledgments

References Cited

List of Tables

E.1. List of tree-ring symbols and abbreviations

E.2. Tree-ring samples from the park pithouses, Arrowhead Pueblo, Forked Lightning Pueblo, and Rowe Pueblo (PDF Format)
E.3. Wood elements sampled from Pecos Pueblo prior to 1970 (PDF Format)
E.4. Wood specimens inventoried at Pecos Pueblo in 1998 (PDF Format)
E.5. Wood elements sampled from the Pecos Mission Churches and Convento (PDF Format)
E.6. Wood structural elements sampled from San Miguel del Vado (PDF Format)
E.7. Wood elements sampled from the Hispanic homesteads along the Pecos River (PDF Format)
E.8. Wood structural elements sampled from the Village of Pecos, Las Colonias, and Terrero (PDF Format)
E.9. Wood specimens collected from Kozlowski's Trading Post and Stagecoach Stop (PDF Format)
E.10. Use of tree species through time in the Upper Pecos River Valley (PDF Format)

List of Figures

E.1. Early pithouses excavated at Pecos National Historical Park
E.2. Layout of Pecos Pueblo and the associated Spanish structures
E.3. Plan of the Pecos North Pueblo and the adjacent earlier structures to the north and west
E.4. The North Pueblo and the location of visible posts
E.5. Plans of the South and West Pueblos and the location of visible posts
E.6. Section of a Pecos Mission beam collected by Col. Luddington in 1869 while chief quartermaster for the New Mexico Military District
E.7. Pecos Mission Church and Convento
E.8. Pecos Mission Church, looking east through the nave to the sanctuary and apse
E.9. Elevation view of the interior south wall of the apse, sanctuary, and nave, Pecos Mission Church
E.10. Elevation view of the interior north wall of the nave, sanctuary, and apse, Pecos Mission Church
E.11. Elevation view of the interior south and east walls of the northeast sacristy (Room 58), Pecos Mission Church
E.12. Elevation view of the interior west wall of the southeast sacristy (Room 57), Pecos Mission Church

E.13. Elevation view of the interior north wall of the main sacristy, Pecos Mission Church
E.14. Elevation view of the interior east walls of the sanctuary and apse, Pecos Mission Church
E.15. Plan view of the San Miguel del Vado plaza area
E.16. San Miguel del Vado church. View looking west from near the crossing of the Pecos River along the Santa Fe Trail
E.17. San Miguel del Vado church
E.18. The San Miguel del Vado church sanctuary
E.19. San Miguel del Vado church
E.20. Plan of sampled structures at San Miguel del Vado
E.21. Plan of the Territorial House in San Miguel del Vado bordering the Santa Fe Trail
E.22. Plan view of the PECO-540 homestead
E.23. Plan view of the Village of Pecos
E.24. House behind Harrison's (now Adelos Town and Country Store and the Shell gas station) similar to the Pablo Martinez House sampled next to the St. Anthony's Parish in the Village of Pecos
E.25. Plan of Martinez House on the grounds of the Pecos Catholic Parish
E.26. Decorative designs carved on corbels in the Las Colonias church, which were probably taken from the Pecos Mission Church
E.27. Sketch plan of the Rivera homestead buildings near Terrero in 1994
E.28. The initial cabin and barn at the Rivera homestead near Terrero
E.29. Plan of the structures at the Kozlowski Stagecoach Stop and Trading Post except for the main building
E.30. Plan of the main building (Structure 20) at the Kozlowski Stagecoach Stop and Trading Post
E.31. Plan of the outlying buildings at the Kozlowski Stagecoach Stop and Trading Post

Appendix E: 1,100 Years of Construction Wood Use in the Upper Pecos Valley Thomas C. Windes

When the Spanish passed north through the Galisteo Basin in A.D. 1580 (all dates herein are A.D.) and entered the Pecos country, they encountered "a forest with many pine trees which appeared to be the largest that had been discovered in New Spain" (Hammond and Rey 1966:94). Thus, the Spanish had encountered the southern reaches of the Sangre de Cristo Mountains, a heavily forested region spiked with numerous peaks over 11,000 feet (3,353 m), including the highest in New Mexico, Mt. Wheeler, at 13,161 feet (4,011 m). Numerous valleys are incised into the range, including the Pecos Valley, through which flows one of the few permanent streams in the state. The Pecos River, with headwaters near the 13,102 foot-high (3,993 m) Truchas Peak, 46 km north of Pecos Pueblo, extends far south across the length of the state and into Texas. The area around Pecos Pueblo and the national park, at an elevation of 6,900 feet (2,103 m), experiences a growing season of only 127 days, although precipitation is a bountiful 15.6 inches (396 mm) annually (Levine 1999:3; Nordby and Creutz 1993:1-7).

The Pecos Valley is covered in piñon and juniper *(Juniperus monosperma, J. scopulorum,* and hybrids) that have always provided much of the wood resources for inhabitants. In addition, cottonwoods, elms, and willows grow along the Pecos River, while economically important ponderosa pine, Douglas fir, aspen, spruce, and true fir grow nearby on the mesas and in the higher elevations of the surrounding mountains. These trees provide a variety of woods suitable for construction purposes and fuels.

The primary goal of this work was to systematically document all the dendrochronological wood sampled within the study areas and to bring new chronometric results to the individual structure construction episodes. This study provides data, much of it new, on 1,025 tree-ring samples. A broader goal, however, is to examine the use of woods found in a variety of

construction settings within Pecos National Historical Park and the Upper Pecos Valley, and to determine their chronometric relationships to cultural events. Potential structural wood for dating is found in only a few areas of the park, mostly associated with Pecos Pueblo, the mission church, and a few historic structures inventoried during the survey. As part of an historic structures' report, the Kozlowski stage coach stop and trading post and outlying buildings were sampled. Samples taken during earlier research are discussed here as well. The present work incorporates the materials sampled from two earlier pithouses in Pecos National Historical Park excavated in the 1970s (Nordby and Creutz 1993). It also encompasses the dendrochronological study begun in 1974 by National Park Service archaeologist Gary Matlock on the earliest historic buildings in the villages of Pecos and San Miguel del Vado. Matlock's samples are reported on here as are samples from these villages taken by the author in 2000 and 2001. This report also includes a historic homestead sampled by the author in the Upper Pecos canyon near Terrero in 1994.

Sampling Strategy

A number of different sampling strategies were utilized for this study. The primary emphasis for the recent wood survey was to establish a chronological framework for the Hispanic homesteads inventoried along the Pecos River. At the same time, historic structure and cultural landscape reports were prepared by Jake Ivey and Katherine Colby (1998) for the newly acquired Kozlowski's stagecoach stop and trading post and outbuildings, with dendrochronology used to assist the interpretation of construction and use. Coevally, Jake Ivey (1996) has prepared a detailed report on the mission architecture, construction, and stabilization of the Pecos Mission buildings. Chronometric assessments of these activities would help confirm or alter the historic record. Finally, along with new maps being prepared for the North and South pueblos at Pecos by Shawn Penman, numerous post remains were inventoried and sampled to tighten chronology of the protohistoric occupation.

Each of these tasks provided different challenges for study. The homesteads revealed numerous badly weathered juniper specimens, which were sampled exclusively by cutting to provide the greatest chance at dating success. The fresh-cut ends left in-situ were stamped with the field specimen number with a steel die set. Time, funds, and the numerous large-diameter pine vigas, reached primarily by ladder, made an extensive sampling of Kozlowski's difficult. A small volunteer crew and the expected high success of the pine specimens resulted in sampling about every other viga or post. After the initial results were received, the front offices were re-sampled to identify any remaining nineteenth-century vigas. Additional samples were also taken from the outbuildings and other features. Samples were extracted with a 5/8-inch diameter hollow drill and plugged with maple dowels stamped by die set with the field specimen (FS) number.

At the mission church, all architectural elements were sampled by drilling, with the resultant holes plugged with 5/8-inch stamped dowels. Finally, the badly weathered visible architectural posts in the pueblos were drilled with 5/8-inch or 7/8-inch diameter drills and plugged with stamped dowels. Badly weathered, split, or rotted wood was sometimes cut because drill cores often fragmented. A few v-shaped cut samples were removed, with the remaining element stamped for identification. In all cases, the stamped field numbers were blackened by permanent markers and sealed with a lacquer coat, but direct solar exposure has eradicated the ink and lacquer on most samples two years later. All of the samples were analyzed by the Laboratory of Tree-Ring Research, Tucson, Arizona. Symbols and abbreviations used in the present study for the tree-ring results are listed in Table E.1.

As with most historic samples, the church beams had been altered on the exterior by bark shaving. Thus, effort was made to sample these elements in locations deemed closest to the original exterior surface. Sometimes, spots of bark were left after the debarking process and

these spots provided the most secure results reflective of the actual tree death date. Because it is difficult to tell the actual or near actual outer ring from a core sample in the laboratory, field observations listed here help provide determination of this critical attribute.

The Early Puebloan Sample

Early Park Pithouses

Preparations for the 1977 Pecos Conference resulted in the discovery of a pithouse site near the park administrative offices, while a second was discovered during testing of a Euro-American structure following an archaeological survey of the park (Nordby and Creutz 1993). Both structures were cleared and revealed burned roofing on the floor and in the floor fill (Table E.2). These yielded a number of specimens submitted to the tree-ring laboratory for dating. In addition, both were sampled for archaeomagnetic dating. Hoagland's Haven (PECO-53; LA 14154) was a circular pithouse 65 cm deep and about 10 m across (79 m^2) (Figure E.1). It burned near the end of its use, perhaps at abandonment, producing 29 roofing tree-ring samples, 19 (66%) of which dated. An archaeomagnetic sample of nine cubes (Earth Sciences Observatory #1561) from the central hearth, later remodeled, failed to produce datable results. At least two tree-cutting episodes were evident from the roof remains: at A.D. 832 (4 cutting dates) and 841 (2 cutting dates). It was not possible from the small sample to determine if 832 was the initial harvesting event for the pithouse with remodeling in 841 or if the structure was built during or shortly after 841 using some reused beams. The latest date is 841. Two non-cutting dates postdate 832, which suggest that at least four samples could be from the 841 harvest.

The sample is dominated by piñon, sprinkled with a few juniper and ponderosa pine—the three species most likely to have been represented in immediate proximity to the site, as they are now. It is possible that the piñon was locally abundant and preferred over juniper for construction purposes. Ponderosa pine provides more desirable construction elements, but suitable young trees probably were widely scattered, as they are at present. Analyses of soil samples by Paul Minnis, however, revealed that charcoal, presumably from firepit use, was dominated by juniper and piñon, with occasional oak and grape *(Vitis)* present (Nordby and Creutz 1993:4-41, 4-46).

The Sewer Line Site (PECO-207; LA 118808) consisted of two superimposed large (77 m^2), subrectangular pithouses, about 9 m across and one meter deep (Figure E.1) with a mere eight carbonized floor samples. Although samples came from four of the five main roof supports, none of these dated. Only one of the measured samples (Table E.2), however, seemed large enough to have been a roof support post. All samples were piñon, producing three dates (38%). The single cutting date at 801r, followed by two non-cutting dates at 777vv and 785vv, tentatively suggest construction around 801. An archaeomagnetic sample of 10 cubes (Earth Sciences Observatory #1560) from the burned adobe remains yielded a date by Robert DuBois of 920 ±38, which seems late given the single tree-ring date and the probable short-use life of pithouses. However, it does postdate the construction timbers, as it should, and the temporal spread, while large, is not unreasonable. Two surface rooms, which attracted the initial testing, were interpreted from ceramic evidence as occupied at about 1550.

Arrowhead Pueblo

This Coalition/Classic pueblo (Figure 5.15; Holden 1955) consists of five roomblocks, of about 100 rooms arranged around two quadrangles, on top of a mesa overlooking Glorieta Arroyo and the Civil War Glorieta Battlefield. Between 1933 and 1948, one block of 79 rooms and at least one kiva were investigated by William Holden of the Texas Technological

College (Holden 1955). Later tests in 1-2 unburned rooms (Rooms 80-81?) near the north trailhead were conducted in 1966 by the author under the auspices of the Methodist Church Conference. Holden's samples (Table E.2) came mostly from the excavated corner kiva along with a few room specimens excavated in 1933 and 1935 from the southern roomblock adjacent to the kiva.

The site sample indicates reliance upon small, young ponderosa pine trees for roof construction, suggesting the relative local abundance of pine. Age diversity is evident among the samples suggestive of a relatively pristine forest stand unimpacted by previous harvesting until the pueblo was built. Today, moderate- and large-sized ponderosa pines and juniper cover the mesa. Either the occupants selected small, young trees in a more diverse setting or young pine trees were common nearby, perhaps covering the mesa until it was cleared for occupation. The majority of the sample derives from burned roofing, mostly from the corner kiva (65 of 101 samples; 64 percent) and several rooms excavated by Holden. Although Holden (1955:104) describes the room roofs as being constructed of primary beams covered by small poles, the measured sample yielded almost all small poles. If large-diameter primaries had been common, surely pieces of them would have been well represented and the more likely choices for tree-ring collection.

Samples from the kiva clearly mark construction in 1390 or shortly afterwards, which may have replaced an earlier plaza kiva found under the roomblock (Holden 1955:107). Twenty-six dates at 1390, all with incomplete outer rings except one, and a smaller batch of cutting dates in 1389 with incomplete and complete outer growth rings suggest that the wood harvests occurred in at least two events: the late summer/early fall of 1389 and the summer/fall of 1390. The latest date of 1391 +vv may indicate the final harvest for a needed beam or two or a later replacement beam.

The earliest rooms are in the southeastern section, but only a mere seven rooms yielded dates. Unfortunately, the room numbers published in Holden (1955:Figure 1) do not match those assigned to the samples (n=23). A mix of cutting dates in 1370 and 1390 suggest either the original harvesting for the pueblo started in 1370 and, after a hiatus, was completed in 1390, or that construction was initiated at about 1370, with some remodeling or repairs in 1390. Given that the corner kiva was either later remodeled or built in 1390, the areal extent of the sample suggests major construction or refurbishing at the pueblo—perhaps heralding the arrival of a new immigrant group.

Forked Lightning Ruin

Located on the Glorieta Wash about one kilometer below Pecos Pueblo, this large Coalition-period site, with about 140 ground-floor rooms, probably was abandoned by 1300 as proposed by Kidder (1958:42-43) and Stubbs. These inhabitants probably comprised one of the new groups that later moved to Pecos Pueblo. Despite considerable excavation, only charcoal was recovered, which yielded non-cutting dates in the 900s, 1000s, and 1100s (Table E.2). All but one of the 26 samples were of piñon, a species commonly used for firewood. All the pieces were small and fragmented, suggestive of fuel rather than architectural remains. In contrast, both Arrowhead and Rowe pueblos yielded whole or partially intact cross-sections of burned roofing. None of the Forked Lightning sample were given provenience data, although Stubbs (in Kidder 1958:43) thought the samples may have derived from reused beams—probably emphasizing the earlier-than-expected dates rather than their potential use for firepit fuel based on species and size. There is some confusion over the reference to the unsuccessful search for datable material from Kidder's burned rooms, implying that the sample came from rooms other than the burned ones. Thus, the dates probably do little other than indicate some activity at the site in the 1000s and 1100s.

Rowe Pueblo

A third Coalition pueblo, with roomblocks enclosing three plazas, was first tested by Carl Guthe in 1917 at Rowe, New Mexico. W. S. Stallings collected one datable sample from Guthe's test trench in 1931. Excavations between 1977 and 1980 by Walter Wait (Wait and Cordell 1980) of the National Park Service yielded piñon (3) and ponderosa pine (2) samples from Room W-1, but none dated because of short (<20) ring series and apparently these were discarded. In 1980, 1983, and 1984, Cordell (1998) also excavated at the site, recovering the remaining tree-ring samples (Table E.2). Rowe Pueblo yielded 35 pieces of wood, mostly pine, with dates in the 1300s. Cordell (personal communication 2000) believes that all the samples, except perhaps Guthe's, came from roofing. Measurements of these samples confirm probable use as roofing elements, mostly from small, secondary poles. Only a single specimen, from Room 22, was large enough to suggest a primary roof beam or roof support post. Wood charcoal identified at Rowe Ruin from flotation samples revealed the use of juniper, piñon, oak, and willow for fuel (Cordell 1998:61; Toll 1998). Corn analyzed by Toll (1998:160) at Rowe indicates crops grown under marginal conditions, as might be expected for the area.

The majority of samples came from rooms in the middle quadrangle, with wood preservation best in the eastern roomblock. Samples from Rooms 21 and 22 came from subfloor tests that encountered the underlying roof material of Rooms 23 and 24, respectively. The sample from multistory Room 30 derived from fill above the roof layer and cannot be associated with the curved-wall kiva construction (Cordell 1998:19). Roofing material from Room 112, in the north roomblock, failed to date, although radiocarbon dates of 898 and 1286 were obtained (Cordell 1998:53). The sample from Test Pit 307 came from the south of the south roomblock in an earlier adobe-walled pueblo. A more varied set of dates was obtained from radiocarbon analysis (Cordell 1998:54-57); three archaeomagnetic dates were also obtained. Overall, the small tree-ring sample represents only a small part of the overall construction activities that must have taken place at this large pueblo.

Pecos Pueblo

The Pecos River Valley experienced a lengthy occupation by Puebloan peoples, but between A.D. 1425 and 1450 inhabitants had coalesced into a single, large building, the North Pueblo (Figures E.2-E.3). Massive excavations were conducted by Kidder (1924, 1958) at Pecos Pueblo between 1915 and 1929. Dendrochronology was in its infancy during these years, but material collected by Kidder produced numerous tree-ring dates from collapsed structural elements (e.g., Robinson et al. 1973:26-29). Given the prolific finds of architectural wood recovered, however, only a small sample of poorly provenienced wood was ultimately kept and analyzed (Table E.3). Unfortunately, specific proveniences were often unreported because such information was deemed useful to only a few (Kidder 1932:12). In 1998, volunteers and the National Park Service staff reexamined the South and North Pueblos to document and sample the numerous upright posts observed scattered throughout the site. Although the ground was covered in thick grasses, 105 pieces of wood from the North Pueblo, all upright portico posts for ground- and upper-floor roofs and roof support posts, were inventoried and 104 sampled (Figure E.4; Table E.4). In addition, fourteen wall support posts still evident within and adjacent to the exteriors of rooms excavated at the north end of the South Pueblo and in the West Pueblo were also recorded and sampled (Figure E.5; Table E.4). Finally, the nine ventilator tunnel lintels in Kiva 16, presumably prehistoric because of their burned condition, were sampled (Table E.4). This kiva was rebuilt and now serves as a tourist attraction along the North Pueblo trail.

The Sample

Tree-ring samples were extracted from the North and South Pueblos by a number of investigators. At the Laboratory of Tree-Ring Research, notes, letters, photographs, and maps, some of them conflicting, help identify the function and proveniences for many of the early samples. The majority of the North Pueblo samples were collected by Kidder during his work in the 1920s. One hundred and four came from the North Pueblo, concentrated in and adjacent to the main interior plaza. These came from rooms primarily in the middle of the West Roomblock, where much excavation took place, and from the burned E-series rooms near the southern end of the East Roomblock (Figure E.3; Kidder 1958:99-103). Few came from kivas, while many samples were obtained from poorly identified interior plaza contexts in the northern, eastern, and southwestern areas. Another 118 specimens from upright posts protruding above the present mounds and nine more from the Kiva 16 ventilator were sampled by the author and helpers in 1998.

Material (84 samples) from the South Pueblo is better documented (Figure E.5; Tables E.3-E.4). Kidder first excavated several rooms there in 1920 that were designated the "K-100" series rooms. He returned in 1924 and dug a six-room unit (Rooms C-C 39, 62[63], 66, 67, 79, and 82), which yielded almost no tree-ring material. Samples labeled "DL" were also obtained by Kidder, from the "mid-ruin," while others later were obtained by Stallings ("RG" samples). This was followed by massive clearing of rooms in the north half of the pueblo in 1939 by the Civil Conservation Corps, led by J. W. Hendron, John Corbett, and Marjorie Tichy-Lambert (Ivey 1996:Chapter 4:9-10; Kidder 1958:106), for display during the 1940 Coronado Cuarto Centennial Celebration. This work yielded samples for the Gila Pueblo, Arizona, tree-ring laboratory: GP 1380-1384 from Corbett and the School of American Research (SAR; in Santa Fe) in November 1939; GP 2389-2410 from the SAR in March 1940; and GP 2645-2646 from William Witkind in September 1940. Two PEC samples (#3-4) samples were also assigned from Hendron's work in 1940.

Finally, to help resolve dating problems for Kidder, ten tests (#1-10) were cut across several dispersed rooms in the southern half of the South Pueblo by Stubbs, Smiley, Wendorf, and Ellis in 1956 to secure new specimens. While many were simply narrow east-west trenches, two areas, which became Rooms 5 and 7, were apparently expanded to secure suitable material. These duplicate room numbers at the north end of the pueblo. George Carr and John Corbett mapped the South Pueblo in 1940; their room numbers are used here along with the prefix designation C-C. In 1972, Gary Matlock tested for wall foundations below floors in Rooms 1-3, 5, and 9-10, followed in 1976 by Larry Nordby, but neither project produced tree-ring specimens because most of the materials had been cleared out decades before. Finally, in 1998, thirteen samples were taken by the author from posts, primarily in the excavated rooms.

As a group, dates from the North Pueblo span A.D. 1299 to 1678, with some clustering in the 1430s and early 1500s. These came primarily from eleven or so rooms that dated. The South Pueblo, where about 26 rooms dated, revealed considerable clustering of dates from the northern rooms between 1420 and 1448. Dates at the southern end (two rooms) were later and scattered between 1427 and 1613, with some clustering in the 1480s. The latter came from charcoal and roof fragments but were not cutting dates.

Although dates are numerous from the two pueblos, caution in their interpretation is necessary given the longevity of occupation on the mesa, from at least the A.D. 1200s, and the movement of peoples joining together from other valley pueblos. Two large sites occupied just prior to Pecos Pueblo seemed to have been stripped of construction timbers. Forked Lighting Ruin yielded no intact roofing material (Kidder 1958:24-25), nor did Rowe Ruin (Cordell 1998). Given the arduous task of procuring timbers, it is likely that much of the former material was hauled to Pecos and reused. Once at the site, considerable movement of roof beams occurred (see Ivey 1996:Chapter 4). Yet, there is a surprising lack of early

dates in the sample. The poor quality of the construction at Pecos as time passed (Kidder 1958:59, 68, 71, 79) would also have impacted the architectural integrity of the structures as the use of support props for walls and roofs increased. Unfortunately, many of the samples were assigned no structural context. There may also have been indiscriminate use of the term "viga" in the lab notes to identify both roof primaries and secondaries. Finally, a few pieces designated as "lata" in the records were assigned to secondary beam (latilla) status for this report.

Remarks by Kidder (1958:108), the recent sampling of visible posts, and culling of the lab notes, indicate that tree species is highly indicative of structural element function. The vast numbers of posts were usually of tough, resilient juniper (98 percent of 124 posts), a species seldom used for other structural elements, except perhaps for kiva ventilator lintels and roof closing material. Three vigas were also noted as juniper. Conversely, the tall, straight conifers (ponderosa pine, Douglas fir, spruces and true firs) were commonly used for roofing beams. Of those assigned functions, 91 percent (of 76 elements) were used for roofing, with occasional use for lintels (4), posts (2), and a corral door or gate jamb (1).

Structure Dating

North Pueblo (Figure E.3)

West Roomblock

The most extensive excavation was done in the West Roomblock. There, a series of east-west aligned rooms were excavated. The best sampled was Connie's room in the middle of the West Roomblock, possibly either Room 18, 39, or 50a according to a sketch map at the tree-ring laboratory. This room yielded six dates, with two cutting dates of 1513. Another five dates, all cutting dates between 1510 and 1514 came from "north of Connie's room." Subsequent inspection of the laboratory notes suggests that "Connie's room" was later appended to the original record label of "Plaza length N of," thus, suggesting additional samples from Connie's Room or one adjacent to it. Two other samples came from north of Connie's, but on the eastern side of the quadrangle, possibly near or in Room 46, yielding one cutting date of 1513. Another room in the East Roomblock, south of the East Entrance, also had cutting dates at 1512 and 1513. Only one room on the map south of the entrance reveals four walls, indicative of excavation: Room 42, the most likely origin of the latter dates.

The remaining best-dated batch came from Rooms 26 and 30. For most samples, notes indicate "Room 26 or Room 30," although it might mean beams were common to both rooms like those in Rooms 106-107 in the South Pueblo. Kidder (1958:Figure 31b), however, shows Room 26 stacked with beams from four stories, a sampler's delight. At least 17 specimens are visible in the Kidder room photograph, but only six samples were obtained. Both rooms are part of the same east-west series of rooms and next to one another, with a cluster of four cutting dates at 1434, probably from reused beams. However, a fifth date is much later, at 1589vv, suggesting a late replacement beam. Two undated samples came from Rooms 20 and 21 but clearly one of the two Room 20s on the map (Figure E.3) is a misprint.

Finally, a group of wall or portico juniper posts aligned east-west across Rooms 71 and 79, near Guardhouse Kiva H, yielded a surprising group of dates, given the extreme paucity of dated juniper specimens from the site. Despite the weathered and split post exteriors, all four clustered between 1448 and 1467, suggesting a late 1400s harvest date for the group. These dates are similar to others in the north part of the West Roomblock.

Plaza

Numerous samples were obtained from the interior plaza, but without specific provenience. These dates span four centuries. Our two earliest dates from the mesa, A.D. 1299, came from here (perhaps representing the same tree), with two others at 1348—all cutting dates. Another pair of cutting dates at 1434 came from the western side, matching those from Rooms 26 and 30. The west and north sides yielded 1501vv and 1558v dates, respectively. Finally, the seventeenth century was represented by 1612v, 1669vv, and 1678vv dates, all in the north area. These do little for interpretation except to broaden the span for some eras of pueblo construction or remodeling.

East Roomblock

Excavations centered upon two areas in the East Roomblock: adjacent to the east passage through the roomblock center and two tiers of six-room units in the southern area designated as the E series rooms. Room 42, adjacent to the passage, is discussed above. The E-series, however, was heavily burned (Kidder 1958:99-100). Samples were obtained primarily from a single room, E-11 (undoubtedly E-II or, less likely, E-XI), the most thoroughly sampled room at the site with 18 samples collected in 1929 from the roof. Unfortunately, Kidder does not refer specifically in his published accounts to the wood in this former multistory room. Beams comprise roughly two diameters of about 10 and 18 cm. Fourteen were in the small category and probably were latillas (secondaries) despite their designation as "vigas" in the lab archives; the others must be primaries. Overall, the numbers suggest all or nearly all beams were sampled from the single roof present in the Kidder (1958:Figure 35) illustration. One small beam (KL-29/11) appeared squarish, although a second massive pine beam 10 by 29 cm in cross section is a more likely candidate for a former mission church viga. Unfortunately, it did not date. Seven cutting dates at 1501 came from Room E-II, followed by the latest date of 1515c, a cutting date. Four of eight others predated 1501 by a mere 5-16 years, suggesting tree harvest for the room in 1501 followed by a single replacement beam in 1515. A single cutting date of 1496 from deadwood in probable adjacent Room E-10 (E-X; Figure E.3) suggests that it was part of the same wood harvest. The E-series rooms were occupied until "well into the historic period," perhaps into the 1800s (Kidder 1958:99).

Kivas

When Castaño de Sosa arrived at the pueblo in 1591, he noted 16 kivas and 5 plazas (Hammond and Rey 1966:277-278). Kidder (1958:143-226) later recorded 23 kivas and excavated 17 of them, along with four late above-ground "guardhouse" kivas (H, I, J, and K) that may have protected access along the passageways leading into the main quadrangle. Kessell (1979:381) feels that the latter are part of the fortifications mentioned in a letter by Governor Vélez Cachupín in 1750. Certainly, the passageways needed protection against the Comanche assaults at the gates, especially during the worst period of strife between 1739 and 1786 (Levine 1999:67), when formidable attacks by as many as 500 warriors occurred (Kessell 1979:395-396). Cordell (2001), however, does not believe that these kivas served a defensive role.

Because many excavated kivas failed to yield surface clues of their existence, many more must exist. All kivas investigated had their roofing materials removed, although upright posts to support the roof timbers and the mouth of the ventilator tunnel were commonly encountered during excavations. At Hopi, the kiva roofs were deemed too valuable to abandon. Thus all roofs were routinely removed for reuse after the kiva was no longer used (Montgomery et al. 1949:66). Also common at Pecos was the use of upright juniper slats for lining, or embedded within the kivas walls, and juniper and pine ventilator tunnel roof slats. Despite the problems with warfare and the burning of kivas by the Spanish, surprisingly only Kiva 7 had burned, early in its use.

Unfortunately, despite a wealth of potential dendrochronological material, few samples were collected from the kivas. True, much material was rotted and, in the early days of tree-ring analyses, juniper was considered unworthy of collection; the unsavory reputation of juniper, notwithstanding, a fair amount of it was collected anyway. Still, many beams were discarded unsampled that would have proved insightful today. Only a mere 11 pieces were sampled, yielding five dates. Most of the specimens were not given specific provenience information, but Kidder's published notes (1958:143-226), records at the tree-ring laboratory, and sizes help identify probable proveniences (Table E.3; those marked with a question mark are provenienced by this author).

Kidder (1958) excavated three kivas (5, 6, and 10) constructed during the earliest occupation, when black-and-white pottery was made, but used much later until apparently filled in during later suppressive measures (Kidder 1958:238-239). However, it is unlikely that they survived over three centuries of use only to be part of the four destroyed and filled in by the Spanish in 1714 (Kessell 1979:314). One undated specimen (DL-7) labeled "old kiva" certainly represents one of these three kivas. In addition, wood was recovered from Kiva 5 in 1920; the size and species approximate that given by Kidder (1958:155, Figure 42) for the kiva ventilator tunnel roof slats. Unfortunately, no date was obtained.

The remaining specimens were obtained from Glaze IV through VI period (a.d. 1475-1700) kivas in the North Pueblo. Sample RG 107 came from the "SW corner kiva," which must be Kiva 14. The large size of the specimen matches the south roof support post (see Kidder 1958:214) obtained from the mission after its 1680's destruction. The northern rectangular support was too rotted for dating. Kidder (1958:215, 264) considered this one of the last kivas built, postdating the construction of adjacent great Kiva 12. The rectangular post dated at 1634vv, but the amount of sapwood loss (i.e., Nash 1997) indicates a date of about 1682 for the specimen. This specimen came from the same tree as a viga found in nearby Room 37-0. Presumably, the same group scavenged the mission beam and then cut it for construction reuse in structures built and used in common sometime after the Pueblo Revolt.

Kiva 12 yielded one juniper post sample that failed to date. Kidder (1958:186, 264) found a monstrous 686 cm long and 66 cm diameter beam lying across Kiva 7, a structure which incorporated yellow adobes from the Lost Church construction of 1620. The kiva's second floor may have been placed by the time of the Revolt in 1680. Two fragmentary samples from this burned kiva evidently came from rotted elements—Kidder (1958:186) states that the monstrous beam was "too rotted to tree-ring date," which means either that it was not sampled because of its poor condition or, more likely, that its condition precluded dating. Only one (DL-34) of the two fragmentary laboratory specimens could now be measured, at about 21 cm diameter, suggesting that it was from the specimen described by Kidder. Two rotted squarish roof support posts were found in Kiva 7 during excavation (Kidder 1958:182, 195, Figure 52). Sample RG-2571 is described as from a kiva in the north quadrangle, but only Kiva 7 was excavated in that location. The 21 by 28 cm rectangular cross section nearly matches the Kiva 7 roof support posts described by Kidder as 9 by 12 inches (23 by 30 cm) and, thus, this sample is interpreted as a Kiva 7 specimen; RG-2571 dated at 1587+ +vv, but exhibited no sapwood. The estimated date for this sample, therefore, is after 1722, marking a late use of the kiva.

A large pine specimen (KL-25/3) supposedly from Guardhouse Kiva H is probably mislabeled because Kiva H contained only a juniper-slat liner along its walls (Kidder 1958:223). More likely, the rectangular 14 by 21 cm specimen came from one of the rectangular roof support posts in Kiva I noted by Kidder (1958:221) as 6 by 8.5 inches (15 by 22 cm) in size. Based on the amount of sapwood left in the 1552vv specimen (i.e., Nash 1997), its estimated cutting date was 1694. Mold-made adobe bricks used in construction also confirm the late construction of Kiva I. Two other "guard house" specimens undoubtedly

came from one of the four excavated guardhouse kivas but the size, species, and dates of the two timbers, at 1354vv and 1358c, indicate only that reused vigas from the earlier black-and-white pottery period were utilized. Kivas J and K yielded no wood, leaving H and I as the only possible candidates. But the latter yielded no other wood than that mentioned above, leaving the two samples' provenience in a quandary. Perhaps the field notation meant a provenience *associated* with a guardhouse kiva. Kidder (1958:225) noted "well-preserved remains of a first- and second-story roof" adjacent to Kiva K, presumably Room 7 (Figure E.3), where samples might have been taken. The only other samples dated to the 1300s came from the western side of the quadrangle.

Finally, Kiva 16, excavated by Charles Amsden in 1929, is located about 23 m north of the South Pueblo and was abandoned probably by the late 1600s (Kidder 1958:202). It yielded an unsampled roof support post and an intact ventilator in "excellent condition" with nine "cedar" pole lintels (five intact) and a pair of posts supporting a larger lintel at the ventilator mouth (Kidder 1958:202, Figure 46). Nothing is mentioned of burning by Kidder but when the author sampled the nine roofing splints, they were heavily sooted and burned. Although the kiva was reconstructed in 1939 by J. W. Hendron, presumably the ventilator tunnel would have needed only partial refurbishing. It seems unlikely that stabilized elements would have been burned to induce an older appearance, especially considering that the kiva was not documented as burned. The mortar around the splints also appeared original and heavily sooted. Four of the nine lintels must have been replaced, but it a mystery why the entire tunnel roof appears as a burned, sooted original unit. No dates were provided from the sampling, so the origins of the lintels remain in doubt. Two pine "ventilator" samples (PEC-3, -4) were obtained by Hendron and sent to the tree-ring laboratory in 1940. Their diameters are much too large for ventilator lintels (which are usually juniper splints) and they are the wrong species. Nevertheless, they only could have come from Kiva 16, stabilized by Hendron in 1939. Their ventilator designation, size, and species suggest these were the two posts in front of the ventilator tunnel first discovered by Amsden. Unfortunately, neither dated, leaving all the wood from Kiva 16 with uncertain origins.

South Pueblo (Figure E.5)

The best date clusters come from the South Pueblo (Table E.3), a house with a complicated construction history meticulously discussed by Ivey (1996:Chapter 4). Kidder's work revealed an initial Coalition pueblo of 40 rooms built at about 1300—one of several on the mesilla top. It was abandoned in the early- to mid-1400s and possibly much of the structural wood robbed for construction in the North Pueblo (Ivey 1996:4-24 to 4-26). Ivey (1996:4-7) is uncertain about events in the South Pueblo but believes that parts were constructed between 1425 and 1490, then rebuilt in the Spanish period using scavenged beams, and then remodeled between 1714 and 1718, referring specifically to the K-100-series rooms excavated by Kidder in 1920. According to Ivey (1996:Chapter 4:26; 1998:128), the Franciscans came to some agreement with the Pecoseños, abandoning the "Lost" Church just as it was nearing completion in 1620 in favor of a more protected location on the mesilla top. The Franciscans moved into the northern end of South Pueblo, rebuilding their quarters with salvaged Puebloan beams in the northern 3-4 rows of rooms—a pattern also noted for Las Humanas (Hayes 1981:28-32). Within 2-3 years, the Franciscans built a new convento at the south end of the South Pueblo, probably using beams from the Lost Church.

South Pueblo was shortly thereafter greatly expanded into its present size by Christian Pecoseños, presumably abandoning their rooms in the North Pueblo, bringing their house beams with them, and using many of the yellow adobe bricks taken from the Lost Church (Ivey 1996:4-26 to 4-27). The abandonment by a large segment of the North Pueblo inhabitants under the banner of a new faith probably was a source of friction to the remaining North Pueblo inhabitants that later helped flame the seeds of rebellion in 1680. With the

Reconquest in the 1690s, pro-Spanish Pecoseños then took control. The center of power at Pecos in the 1600s apparently rested within South Pueblo (Ivey 1996:4:28). The last occupied rooms at Pecos before abandonment in 1838 were in the seven rows of rooms south of the old Franciscan-occupied rooms at the north end of the South Pueblo, attesting to the shift in residency from the North Pueblo to the South Pueblo.

Tree-ring dates do little to corroborate the above history, although a more thorough sampling, particularly of smaller elements employed for secondaries, splints, lintels, jambs, etc., might have marked many of the above constructions and remodelings. Kidder (1958:106) excavated the K-series rooms in 1920 in the South Pueblo and then a single east-west suite (Rooms 39, 62(63), 66, 67, 79, and 82) in 1924. Although, Kidder indicates Room 62 as part of this suite (some tree-ring samples also were labeled such), the Carr-Corbett map indicates that it should have been labeled Room 63. Adding to the numbering problem, however, is that the map has no Room 62 (nor, conversely, if Room 62 is correct, Room 63 is thus absent). For this report, Room 62 is discarded in favor of Room 63.

While many tree-ring samples from South Pueblo are not given a specific room provenience, samples obtained from 12 identified rooms yielded dates; 35 of the overall 37 dates were between 1420 and 1448 and all were cutting dates, mostly from roof vigas. The earliest date, obtained from deadwood, was only slightly earlier, 1415+ +v. The tight clustering of dates normally would indicate that construction of the northern rooms was mostly between 1433 and 1444—a period Kidder (1958:107) thought was too late for the ceramic evidence. In addition, three samples listed as "north of K-106" must be from Room C-C8. None of these dated, although two were juniper and suggest samples taken from the roof support posts still evident. These may be from the same juniper post group sampled in Room 8 by the author (FS 205-207; Table E.4). The only beams discovered during excavation that spanned two rooms came from Rooms K-106 and 107 (Kidder 1958:Figure 34); these rooms yielded the best set of dates from the South Pueblo and were found in extremely good condition when excavated. Unfortunately, they were left open for a future tourist exhibit, which never materialized, and fell to ruin (Ivey 1996:4-6).

Room C-C52 yielded the latest date of the group, 1673vv, which correlates temporally with the Spanish-era cultural material associated with the rooms around the period of the 1680 Revolt. Another late specimen occurred in Room C-C92, where a juniper post yielded a non-cutting date of 1525vv. It is indisputable that a major occupation of the South Pueblo occurred during the Spanish era. As Kidder (1958:107) observed, the tight clustering and preservation of the 1400s beams seem to allay suspicions that the beams were reused from the North Pueblo. Only a few like dates came from the North Pueblo—all apparently clustered in a few rooms on the west side of the quadrangle, but mixed with dates centuries later. While it is conceivable that entire roofs could have been moved *en masse* to the South Pueblo, we would expect that some upgrading of deteriorated timbers would have occurred and that stain, soot, and latilla- and wall-crush patterns from previous use would have alerted excavators to their reused condition. Unfortunately, the poor excavation records from 1939 and 1940 leave us with little to ponder.

At the south end of South Pueblo, a different pattern emerges. A number of tests for new dates to cross-verify those from the north end were conducted in 1957. All but one of the samples obtained from testing yielded dates later than those in the north end of South Pueblo. However, the majority were fragments or charcoal, which may not be roofing material. Besides a single non-cutting date at 1427, the remaining six non-cutting dates ranged between 1468 and 1488. Two dates from under the fallen floor in south-end Room 7 suggest structural wood cut at about 1488. Three other pieces from the room were piñon charcoal and probably represent firepit fuel. One dated at 1613, indicative of either late room use or later refuse deposited in the room.

The fine-tuning of events at Pecos Pueblo, however, is not possible given the present tree-ring sample. If smaller elements had been provenienced and sampled, then much more about remodelings and shifts in construction would have been known, resulting in more thorough insights into the corresponding cultural events.

Pecos Mission Church

History of Construction

The most prominent architecture in the valley is the massive mesilla-top ruin of the colonial Spanish mission church at the south end of the Pecos Pueblo mesilla (Figure E.2). Oral history and historical records provide a background in which to assess and correlate the tree-ring dates for the many constructions and repairs of the churches. There have been four churches near Pecos Pueblo, with the first, the Lost Church, built in about 1619/1620 below the north end of the mesilla by Fray Pedro Ortiz (Hayes 1974:19; Hewett 1943:142-143; Ivey 1996:3-9; Stubbs et al. 1957). Shortly afterwards, the church was relocated to the south end of the mesilla and a massive new church was constructed between 1622 and 1625/1629 (Hayes 1974:3-5; Ivey 1996:11-8; Levine 1999:19). This imposing structure, built in cruciform by Fray Pedro Ortega and Fray Andrés Juárez, was the largest mission in the Southwest until it was destroyed during the 1680 Pueblo Revolt. Excavations revealed that much of the convento had burned, along with the church roof, choir loft, door and window lintels, and the interior furnishings and woodwork (Ivey 1996:11-27).

Kessell (1980:223) graphically describes the mission destruction:

> The destruction of the mammoth church at Pecos in the Pueblo Revolt of 1680 must have been a grand show. The Pecos Indians later blamed the Tewas. Whoever threw it down, they did so with a vengeance. As a start they probably heaped piñon and juniper branches and dry brush inside the cavernous structure. Then they set it afire. When the roof caught and began burning furiously, a strong draft was created through the tunnel of the nave from the clearstory window over the chancel thereby blowing ashes out the door. It was like a giant furnace. When it died down, the blackened walls of the gutted monster still stood. To bring it low Indians bent on demolition clambered all over it, like the Lilliputians over Gulliver, laboriously but jubilantly throwing down adobes, tens of thousands of them. Unsupported by the side walls, the front wall toppled forward facade down, covering the layer of ashes blown out the door.

It is uncertain, nevertheless, if the church and mission were completely burned at this time (Vetancurt in Hayes 1974:22-23, 32; Kubler 1972:85), before some architectural wood had been salvaged. It would have been difficult to fire the high roof, covered in thick adobe, without some dismantling before the fires described by Kessell could have taken place. During the Reconquest, a more modest temporary chapel was erected on the grounds between 1692 and 1696 along the south side of the destroyed church. Finally, the fourth and final church, the one now standing, was constructed by Fray Zeino between about 1705 and 1706 over the ruined foundations of the 1620's church. A century of strife and hard times followed (Kessell 1979; Levine 1999). A final remodeling occurred after 1776, probably between 1794 and 1798, when the sacristy and apse roofs were replaced (Ivey 1996:12-18 to 12-19) during a brief period of prosperity following peace with the Comanche in 1786. The last inhabitants of the mesilla left in 1838 for Jemez Pueblo leaving the pueblos and church to their fate.

Reuse of Mission Beams in Pecos Pueblo

Kidder encountered several squared timbers in his work in Pecos Pueblo, often in association

with mold-made adobes (Kidder 1958:113) that may have been procured after the razing of the mission church during the 1680 Pueblo Revolt. At least nine or ten squared timbers are reported by Kidder (1958:112, 221, 264, Figures 31b, 32b, and 62) or were observed at the tree-ring lab from the North Pueblo (Table E.3). Six were found as kiva roof support posts in the interior plaza and in the West Roomblock: Guardhouse Kivas H and I beside the north and southwest passages, Kiva 7, Kiva 14, and an unknown north plaza kiva. Room 26 also contained a pair supporting the walls (Kidder 1958:112). Because of the provenience confusion between Rooms 26 and 30, it is suspected that the squared timber (KL-9) observed at the tree-ring lab from Room 30 (Table E.3) actually came from Room 26. If they were taken from the church/convento, then room construction or remodeling must have occurred after 1680 despite the four viga cutting dates for Rooms 26 and 30 at 1434. Given the 42-foot span of the 1620s church vigas, these must have been cut into shorter lengths for use in the pueblo. The other specimens also dictate some construction or remodeling after 1680 along the western side of the pueblo. Kidder (1958:219) believes that all the guardhouse kivas were probably built after 1600 and perhaps at least two (with squared beams) after 1680. No squared timbers came from the South Pueblo. According to Stubbs et al. (1957:84), squared vigas from the first and second churches were salvaged for use in the pueblo in Kiva 7 and used to repair sections of the west wing of the North Pueblo—these may also have been reused a third time in the post-Revolt church constructions.

Wood Implications of the Pueblo Revolt

The widespread fame and skill of the Pecos Pueblo carpenters (Chavez 1971; Kessell 1979:292) undoubtedly provided them with opportunities to obtain or to fashion their own squared vigas. Kidder (1958) failed to note the presence or absence of any decorative carvings on the squared timbers that would help confirm their mission origins. Little note has been made of squared timbers used in the convento except for steps (i.e., Ivey 1996:Appendix I-18, Appendix III-7). On the other hand, the rising discontent of the pueblo inhabitants with Spanish rule and the dichotomy between their respective religions may have discouraged use of squared timbers in the pueblo as markers of oppression until the church had been destroyed. The five squared beams from the pueblo observed at the tree-ring laboratory (a sixth was small and uncertain) had dimensions comparable to those from the mission church and are much larger than almost any other structural elements measured for the pueblos. Thus, a strong case can be made that these were all probably salvaged from the mission buildings.

The inevitable factionalism inherent in puebloan society would have smoldered with the Christianization and relocation of many North Pueblo inhabitants into the South Pueblo as suggested by Ivey (1996). Subsequent friction over the Franciscan presence probably allowed the North Pueblo inhabitants to gain brief control during the Pueblo Revolt. The South Pueblo exhibited no kivas, as might be expected for an occupation by Christianized Pecoseños, considering the Franciscans aversion to kiva ritual and ceremony. With the Pueblo Revolt in 1680, a spate of new kiva building took place throughout the Spanish province (Kidder 1958:238). This may have manifested itself in architectural symbols—squared timbers and black adobe bricks—taken from the mission after its destruction and reused in kivas in the North Pueblo. The apparent absence of these material goods in the South Pueblo remodelings may suggest tacit resistance by the Christianized Pecoseños to the anti-Spanish faction during destruction of the mission. Thus, the finding of mission beams primarily in the North Pueblo kivas suggest that such timbers symbolize Puebloan triumph over Catholicism and, perhaps, the center of anti-Spanish resistance. Although the tree-ring sample is poor, the absence of squared timbers in the South Pueblo might signal passive participation by the Christian faction during the Revolt and non-participation in the mission's destruction.

This interpretation might be strengthened if there were also an absence of salvaged black adobes used for remodeling in the South Pueblo. The interpretation, however, is weakened by the estimated dates (see Nash 1997) from three of the four squared timbers found in the North Pueblo that place cutting after the 1680 Pueblo Revolt. These three yielded estimated dates of 1682, 1694+, and 1722+, which places their harvest period at around 1700. The late dates, then, suggest timbers used for the 1705 or 1706 or later church constructions unless native carpenters uncharacteristically fashioned their own huge squared beams for use in the pueblo. The fourth timber, however, is estimated to have been cut at about 1626, placing it well within the possibility of a salvaged timber from the Ortega/Juárez 1620s church.

Church Deterioration and Reuse of Beams

With the abandonment of the pueblos and mission in 1838, many activities detrimental to the preservation of the buildings occurred. By the late 1700s and early 1800s, a Hispanic population had founded the small town of Pecos and encroached on the puebloan lands (Hall 1984; Hayes 1974:17; Levine 1999:25). Later in the mid-1800s, soldiers camped in its ruins, used it as a prison, and burned much of its wood; it also became a rest stop for travelers along the Santa Fe Trail while the local inhabitants scavenged and burned many of its materials (Hewett 1943:140-141; Kessell 1979:474; Kidder 1926:6, 1958:225; Weigle and White 1988:68).

For this report, the fate of the structural wood is of particular interest. The majority of the remaining in-situ original Pecos church viga stubs have been saw cut, attesting to their purposeful removal. Kidder (1924:87) remarks that locals habitually robbed the structures of beams and timbers for firewood, a sentiment echoed by Governor Prince (1915:328): "Every 'vecino' who desired a massive timber or one with ornamentation upon it, naturally came to the Pecos church as to mine wealth." Prominent in the destruction of the church, however, was a Polish immigrant, Martin Kozlowski, who came to the area as a Missouri volunteer in 1846. Nearby, he built a stagecoach stop and trading post (see below) using timbers from the mission roofs (Gustafson 1997:12; Hewett 1943:140-141; Kidder 1924:87; Lange and Riley 1966: 412; Weigle and White 1988:68). Between the 1840s and 1870s, much of the convento had been converted to corrals and sheep pens (Ivey 1996:9-12). By 1882, Father Mailluchet had fenced the cemetery and church for some protection (Lange et al. 1984:119, 504n757). But as late as post-World War II, a local Pecos dude ranch ran pothunting forays to the ruins (Ivey 1996:Appendix II-17). A detailed description of the structural wood and its loss is provided by Ivey (1996:12-20 to 12-25).

Finally, some remains were carted off to other buildings, churches, and museums: Kubler (1972:Figure 158) illustrates Pecos Mission corbels (see Las Colonias below) photographed in 1931 adorning the chapel sanctuary of Lower Las Colonias, located 10 km to the east, built without parish sanction in 1867 (Residents of Las Colonias 1867). If roofing was transported to Las Colonias, then surely others went to the church in the Village of Pecos, which burned at about 1900, destroying any possibility of verification. A new church was started in 1903. Other beams were secured for the National Museum of Natural History (see below), in Washington, DC, and the Museum of New Mexico in Santa Fe (Kessell 1979:133; Morley 1915:287). Others may have been carted off for vigas in Santa Fe homes, like the two documented from nearby San Miguel (see Table E.6) and the Pecos Mission beam relocated to the Hollenbeck home (Ivey 1996:12-30). Others (e.g., PEC-2) were cut for souvenirs (Figure E.6) and carted across the country (Douglass 1936).

Dede Snow (personal communication 2000) states that beam collecting was common among prominent Santa Fe anthropologists of the time; Morley (1915:289-290) describes many salvaged corbels ("capitals") used in Santa Fe buildings. Scavenging at Pecos was not dissimilar to that at Taos, where the discarded corbels and railings from the Taos Pueblo

Mission church found their way into village homes (Hooker 1996:50-51). Vigas, corbels, and other timbers from the San Juan Pueblo Mission church were sold during remodeling and reinstalled in the Fred Harvey Hotel *El Ortiz* in Lamy, New Mexico (Anonymous 1914:335; Morley 1915:290).

Stabilization

By the late 1800s, photographs document the deterioration of the church (Hayes 1974:Figures 7, 9; Kessell 1979: 476-477; Kubler 1972: Figures 55, 66, and 90; Weigle and White 1988:66, 71), when many of the roof vigas and door lintels had collapsed. Ivey (1996) has recently completed a thorough detailed analysis of the church remains from the early photographic record. Clearly, the church was in a much-ruined state before the first repairs occurred in 1915 by Jesse Nusbaum of the New Mexico State Museum. Another round of stabilization took place in 1939 and 1940 by the Civilian Conservation Corps and the National Youth Administration led by Edwin Ferdon and William Witkind (Hayes 1974:xiii; Hewett 1943:226-229) after it became a state monument in 1935. Additional repairs were made to the church between 1966 and 1970 by Jean Pinkley and Alden Hayes (Hayes 1974:xiii-xiv). Stabilization of the mission buildings has continued since. Despite the scavenging and repairs, many original structural elements still exist, only one of which had been previously sampled before this project.

The Mission Sample

The earliest ("Lost") church (Figure E.2) was excavated by Stubbs et al. (1957), but only a small sample of wood was collected (Table E.5) and none dated. A total of 124 tree-ring samples have been collected from the last mission church (Figure E.7, Table E.5); of these 97 have dated (78 percent). By 1940, Witkind felt little original wood was left in the church (Ivey 1996:8-25), but of the total reported here, only 24 (19 percent) were modern stabilization replacements, although it is possible that original timbers were reset out of their original position. With some exceptions, modern replacements were obvious because of their condition, preservation, degree and method of treatment, and lack of surface ornamentation. While every piece of in-situ structural mission wood (n=116) was recorded in 1996-1998 and given field specimen (FS) numbers, not all were sampled. Those ignored (n=23; 22 percent) were small, tabular pieces (obviously modern), were too rotted, or were original roof boards in the northeast sacristy.

A few timbers collected in the nineteenth century ended up at the National Museum of Natural History, Washington, DC, where they were eventually sampled for tree-ring dating by A. E. Douglass. These had been collected by Dr. F. V. Hayden in 1869 or 1870 (KL-6 and KL-7) and by Colonel Luddington in 1870 (KL-8).

Many more samples were collected by Kidder during his excavations in 1925 (KL25/series) and by the New Mexico Historical Society in 1931 (RG series); at least one (RG 323), if not others, was obtained by W. S. Stallings in 1932. In 1939 and 1940, Marjorie Lambert and Deric O'Bryan collected samples for Gila Pueblo (GP-series) and then Stanley Stubbs in 1956 for the Laboratory of Anthropology (RG-series). Unfortunately, other than provenienced as "mission" samples, it is uncertain whether these previous samples came from the church or surrounding mission buildings. Large-size, squared beams, however, almost certainly derive from the church nave. These samples must have come from fallen timbers because only one of the recent samples collected in the church matched these earlier samples. The majority of the new samples (PEC-43 to PEC-134, 289-290) came from corbels, lintels, and wall intramurals (bonding beams)—architectural wood that was anchored into the walls and, thus, the least likely to have been dislodged in the past unless the walls had tumbled. Still, it is odd that more duplicate matches were not achieved given the present sample from the 28 vigas

and support beams, which all have broken or were cut off next to the walls. The lack of matches suggests that the majority were cut for salvage rather than for tree-ring dating.

Dominguez's 1776 visit to the Pecos Mission documented the numbers of vigas employed in the post-Revolt church (Adams and Chavez 1956:209). The nave exhibited 38 vigas, the transept 20, the sanctuary (apse) 10, and the sacristy 10. None of the nave or transept vigas now remain except for the modern ones marking the division between the nave and transept. In 1880, however, vigas were photographed collapsed on the floor and on debris in the nave (Figure E.8) (Kubler 1972:Figure 55; Prince 1915:335) where fragments may have been sampled decades later. Ivey (1996:12-36) describes corbels littering the nave in an 1882/1883 photo by A. F. Randall, while even Witkind's 1940 excavations exposed several beams in the northeast and main sacristies and the convento (Ivey 1996:7-10 to 7-21). None of these were sampled. Stabilization has altered the original placement of vigas in the apse and sacristy because the vigas and viga holes do not now match the numbers reported by Dominguez.

Previous Sample Proveniences

Samples collected from the mission prior to this study can only be interpreted at face value without the added strength of provenience. Seventeen of these samples were squared and presumed to derive from the mission church. Many were badly weathered and just three exhibited carvings, thus suggesting viga fragments from the nave or transept. Only a single specimen was given specific provenience ("the balcony"; KL25/15), and this was the only sample matching a recent specimen from the tribune (balcony; PEC-74/FS 41). The lack of matches suggests that the remainder came from the church roof beams in the nave or transept —a probability supported by records at the tree-ring laboratory.

Interpreting the Sample Results

The recent sample has been interpreted by Jeffrey Dean (1998), Laboratory of Tree-Ring Research, and his apt findings are paraphrased here. A few rules of interpretation, however, are necessary first. Several of the samples (Table E.5) include the transition year between the tree's heartwood and its sapwood. Because almost all of the mission elements were squared, eliminating an unknown number of outer rings and preventing an accurate assessment of the tree death (cutting) date, the number of sapwood rings provides a relative assessment of closeness to the true death date. In short, a large number of sapwood rings (i.e., between 50 and 90 rings) is cause to suspect the true outside death date is near. Samples with few, if any, sapwood rings must be far later than the given laboratory date, probably by a century or more (Nash 1997). When Nash's formula for estimating the number of sapwood rings once present was applied to the church sample, many produced results earlier than the known outer date. This problem is not unexpected given the statistical error generated by the Nash formula. Others extended the outer dates to periods within the known historical records when various churches were built. Thus, while many samples failed to fit the Nash formula, none produced large additions of rings to the given outer date. While our sample is small (n=43), it does suggest that ring loss is generally minimal. Given that the historic record indicates three major mission construction and renovation periods at about 1620, 1706, and 1795, one can assign many of the non-cutting early-dated samples to the proper construction period.

Provenience can also help in assessing probable tree death dates if a series of associated samples generate roughly similar dates—like those from the southeast sacristy. To minimize the amount of labor spent squaring beams, wood cutters would probably have felled trees close to the size needed for the desired squared construction element. Thus, although larger, older trees add many narrow outer rings during growth, which would be lost by squaring the element, we still might expect that with an adequate sample some clustering of dates near the actual death date might occur. Squared beams from a log cabin along the upper Pecos River

near Terrero (see below) yielded dated samples with a loss of 6, 14, 16, and 51 rings from the probable cabin construction date. These pine beams were similar in size and growth age to those in the Pecos Mission. On the other hand, squared beams with massive loss of exterior rings suggest either excessive laborious trimming or trees cut for multiple products. The northeast sacristy exhibits a pine board planking covering the vigas (see specimen PEC-52, dating at 1473vv), although shakes covered the nave vigas (Ivey 1996:12-32). If boards were common for roofing, as Kubler (1972:43) suggests, then these may have been adzed from the same logs that produced the vigas, massively reducing the outer rings in the vigas and producing dates far earlier than the actual harvest event. On the other hand, boards and planks may have come from timbers specifically cut for such use. Of course, the single board sample is inadequate to suggest one alternative over the other.

Another aspect of the squared-beam problem arises from the samples themselves. Unless bark is present, cores are seldom given cutting or near cutting dates because the analyst rarely can determine such from the cores limited exterior surface (Table E.1). Note in the present sample how often "non-cutting" dates have been assigned to group clusters that almost certainly represent the actual cutting date. Field observation helps to assist in the outer ring determination. In all church cases, a near or actual outer surface noted in the field corresponds with other evidence for the near or actual cutting date. In the tables, the field observation is listed as a subscript to the given laboratory designation (e.g., 1500vvr, where "r" is the field observation). In some cases, the squared beam still exhibits a rounded edge that reflects the true or near-true outer tree surface. All samples from squared beams were taken from corner edges to obtain the fullest series of rings possible. Sometimes, observing the ring pattern at the end of the element allowed selection of the corner with the greatest number of rings present. Conversely, the inner date determination and its nearness to the pith ring is treated in the same manner as above—the field observation is listed as a subscript. These notations are important for assessing the true age of the tree (or specimen), the use of the heartwood/sapwood formula (Nash 1997), and the relative completeness of the specimen size (e.g., diameter).

Deadwood is sometimes found among the samples. These are marked by the laboratory with "+ +" outer rings for dated specimens, which are compressed and difficult to read—evidence of a stressed or slowly dying tree. One would not expect such trees to be suitable if they were long dead because of their poor physical properties and the difficulty of working them. In one large prehistoric sample, such trees routinely did not exceed dates a decade or two prior to their probable collection date (Windes et al. 1994); such is also the case here. Thus, although routinely dismissed as unworthy of temporal interpretation, deadwood samples may date relatively close to the actual harvest event.

A subscript of the field observation for both the outer ring and innermost ring has been appended to the laboratory dates (Table E.1). A subscript "C" or "I" for church samples, however, denotes, in the few rare cases, the laboratory-determined complete or incomplete condition of the outermost terminal ring at tree death. In some tables, the terminal ring is listed in a separate column. This ring identifies whether the tree was cut during the summer growing season ("incomplete" outer ring) or the dormant ("complete" outer ring) season (see Ahlstrom [1985], and Windes and McKenna [2001] for a fuller explanation).

Replacement beams reflect each of the three major periods of stabilization conducted at the present mission church. Major repairs were made for the south wall of the transept by Nusbaum in 1915, at which time, judging from photographs (Hayes 1974:Figure 10; Weigle and White 1988:66), the entire south door and the main sacristy beyond it required substantial stabilization. Dates between 1811vv and 1910vv for the first story south door lintels (Figure E.9) indicate that all (Field Specimens [FS] 59-65: PEC 92-98) were added during Nusbaum's work. On the other hand, the upper window lintels in the north (FS 1-6:

PEC 43-48) and south (FS 67-71: PEC 99-102, and 289-290) walls (Figures E.9-E.10) probably are the original beams placed by Arranegui during the 1706 construction. The only tree-ring dates of 1706 from the sample came from these lintels. The PEC-47 sample (1706vv), whose heartwood/sapwood boundary is at 1632, is suggestive of a procurement date (Dean 1998). The present author noted that this church sample in the field as one of the few with a potential original outer surface. Other lintel dates of 1697vv and 1698vv (PEC-100 and PEC-45), with estimated harvest dates of 1707 and 1699, respectively, are supporting evidence for beam procurement in 1705 or 1706.

Fortuitously, a window lintel in the south wall (PEC-99) shares the same distinction: a 1706vv date with a field observation of an original outer surface, although it appeared modern. The lack of sapwood in this specimen indicates to Dean (1998) that it was procured much later (estimated at 1813+) than the date, probably an historic replacement by Nusbaum or from remodeling in the 1780s. Bennett's 1880 photographs (Kessell 1979:479; Weigle and White 1988:66) reveal that the outermost second-story south-window lintel or two had fallen out (PEC-99/FS 67 is next to an outermost lintel), while repairs to the interior were also carried up to the interior second-story south window lintel in 1915 (Hayes 1974:Figure 10). Both outer lintels (PEC-289 and -290) were noted as recent introductions during field work, but these dated at 1630vv and 1680vv (estimated cutting dates at 1673 and 1685+, respectively), attesting to post 1680s Revolt harvests and probably from the 1705/1706 church construction.

Finally, several of the corbels and support beams on both sides of the south wall of the transept were clearly recent additions (Figures E.9 and E.13). Among the balcony (tribune) supports, PEC 77-78 (FS 44-45) did not date, but they were clearly recent. PEC-83 (FS 50), however, dated at 1937vv, with a field observation of an original outer surface linking it to the Ferdon-Witkind stabilization period. Several nearby corbels set to carry vigas separating the nave and the transept also dated at 1937B (PEC 69-70, 72: FS 32-33, 35). These yielded complete terminal rings that place the felling of PEC-69 and -72 between the ponderosa pine non-growing seasons of 1937 and 1938 (between September 1937 and June 1938). Although Ferdon began his stabilization work in the fall of 1938 (Hayes 1974:xiii), the terminal rings indicate that beams were procured in anticipation of the project at least as early as the spring of that year and perhaps even late in 1937 (Dean 1998). The incomplete outer rings for PEC-83 (FS 50) and PEC-106 (FS 75), however, suggest that procurement occurred in the late summer/early fall of 1937, probably giving the beams a needed year to cure before installation. Two beams cut from the same tree dating at 1939vv (PEC-62 and —64: FS 25, 27; Figure E.11) installed in the northeast sacristy, however, indicate a final procurement by Witkind late in the stabilization project.

Nusbaum and Ferdon-Witkind also carried out repairs in the main sacristy. Dates of 1784vv and 1882vv reflect replacement by Nusbaum in 1915 of the main bounding beams under the corbels. Ferdon and Witkind later replaced several of the corbels with new ones, which yielded dates between 1921vv (see below) and 1937vv (PEC-106) (Figure E.13). During the present project, stabilization crews attested to the placement of PEC 114-115 corbels in the main sacristy, cut from the same tree, in 1966. These dated at 1921vv and 1928vv, however, and can only confirm placement during either the Ferdon Witkind or the Pinkley-Hayes stabilizations.

Four architectural clusters of dates remain from the sample for interpreting initial construction events: the three sacristies and the tribune between the south door and window. The best preserved are the partial roof remains in the northeast sacristy (Room 58; Figure E.11; FS 8-17). Ten of the eleven non-cutting dates were compatible with procurement and use in the early 1700s (Dean 1998). Those closest to their probable procurement in 1705 or 1706 dated at 1687vv, 1692vv, 1693vv, and 1695++vv. The latter represents deadwood, but

fits the prehistoric model for deadwood collection (Windes et al. 1994) that suggests that only recent deadwood is suitable for monumental architecture. The estimated outer ring date for specimens with sapwood counts (see Nash 1997) yielded dates of 1571+, 1665, 1710, 1711, and 1723+, which suggest that the latter three, at least, were derived from the 1705/1706 church construction (as suggested above). The sacristy still contains a partial roof covering of boards over the vigas with dirt on top. These boards (FS 10-15) are clearly original based on the one sample that yielded a date of 1473vv (PEC-52). Dominguez (Adams and Chavez 1956:251) observed that this room or the southeast sacristy was used to store church belongings.

The southeast sacristy (Room 57; Figure E.12) yielded eight non-cutting dates from the first story roof that probably came from the early 1700s, although it is possible they were reused (Dean 1998). As a group, all produced dates in the 1400s (1) and early 1500s (7). The latter are remarkably temporally consistent for beams that exhibit massive ring loss: 1522, 1528, 1529, 1537, 1539, 1542, and 1556. All estimated cutting dates (Table E5; see Nash 1997) except one place these in the mid- to late-1600s, evidently salvaged from the mid 1600s convento construction after the 1680 Revolt. The main sacristy north wall (Figure E.13) revealed a similar set of clustered early non-cutting roofing dates to those in the adjacent southeast sacristy suggesting origins in the 1620s: 1466, 1504, 1506, 1515, 1523, 1527, and 1539. None contained sapwood, indicating massive ring loss, but estimated dates from these range between 1570+ and 1639+ and may represent beams salvaged from the destruction of the 1620s church during the 1680s Pueblo Revolt, if not from remodeling in the mid 1600s.

A different set of dates is evident for the tribune (Figures E.9 and E.14) on the opposite side of the baptistery north wall (south wall of the transept), where dates of 1521, 1526, 1532, 1549, 1567, 1572, 1577, 1579, 1602, 1650, 1659, and 1665 were recorded. Dean (1998) placed the tribune supports to the early eighteenth century based on the heartwood/sapwood boundary for PEC-85 and PEC-86 (FS 52-53). On the other hand, the spread of dates could reflect mixed elements from constructions in both the 1620s and the early 1700s. PEC-85, dating at 1659 with 54 sapwood rings, could easily be a 1690s or early 1700s element. But PEC-86, dating at 1521 with 37 sapwood rings and an estimated outer ring date of 1579, suggests a much closer affinity to an early 1620s procurement. Otherwise, it would have an unusually high number of 222 sapwood rings to place it within the 1706 era—this for a element that now exhibits only 102 rings, well within the normal range for the overall sample.

The potential reused elements in the southeast and main sacristies, suggestive of origins in the 1620s construction(s), have two things in common that the later (e.g., probable 1705/1706 construction) groups do not share. None of the potential 1620s specimens contained sapwood and many had inner dates in the 1300s. Trees that started growth in the 1300s might be explained by procurement of extraordinarily old trees or that their growth ages were relatively normal and the early inner dates reflect trees cut in the early 1600s.

The temporary construction of the third church in the 1690s period has not generally been considered here because of its closeness in time to the 1705/1706 construction. Without cutting dates, distinguishing the two episodes is not possible here except when the non-cutting dates post-date 1696. Only some of the sample had sapwood determinations that made it possible to estimate the original outer date. Many of these lacked a pith date, indicating a loss of heartwood rings, although the loss is probably not substantial. Nevertheless, an accurate heartwood ring count is essential to the Nash (1997) date estimation formula; estimated dates appended with a plus symbol (+) are under-estimated.

Forty-three of the original mission pine beams yielded estimated dates ranging between 1565 and 1745+. Only one produced an estimated date younger than the given laboratory date (1683 verses 1706). A small group of six estimated dates in the late 1500s suggest origins

from the initial Lost Church or the 1620s church built by Ortega and Juárez that was destroyed during the 1680s Pueblo Revolt. This group of dates is separated from all other estimates by 32 years but even with the standard error of 24 years for ponderosa pine (Nash 1997:265), it still falls mostly decades short of the anticipated harvests for the 1620s church construction. Three of the six, however, had missing heartwood rings, while the latest two specimens, with 24 rings added, would date at 1610 and 1603, not unreasonable for 1620s harvests. Given the size and shape of the beams, they only could have been procured after the arrival of the Spanish at the pueblo rather than from reused Puebloan beams.

The remaining 37 samples date between 1618+ and 1745+. Dropping those with missing heartwood rings reduces the span to 1665 and 1739. Of these, most (14 of 17; 82 percent) date between 1683 and 1717, as would be expected for timbers derived from the Fray Zeino church construction between 1705 and 1706 and keeping in mind the standard error for the pine calculations. Only a few dates in the overall batch suggest beams that might have derived from later remodeling in the 1790s.

Another way to interpret timbers from potential 1620s reuse is to examine the tree growth. In the overall sample from the Upper Pecos Valley, large-diameter pine timbers seldom exhibit growth over 200 years. In fact, a large percentage are less than a century old before being harvested. The church sample reveals no timber element over 265+ years, with the oldest modern sample (after 1900) revealing 144+ rings. Of course, all these have lost an unknown number of outside rings but how much loss is reasonable? Use of the proxy date of 1706 for the present church construction (with perhaps some beam replacement at about 1790), means that the 1500s non-cutting sample clusters from the southeast and main sacristies have lost between 150 and 184, and 167 and 202 rings, respectively (mean of 170 and 187 rings, respectively). This ring loss added to the remaining material pushes the sample (n=13) age between 228 and 355 years (mean=299 years)—excessively old trees considering the overall valley sample. If the timbers had come from the 1620s construction, however, the ring loss would drop about 80 rings, putting the overall growth pattern more in line with the valley sample. Obviously, if these had been harvested during the 1780s/1790s remodeling, the growth would be even more askew.

None of the cutting dates from the valley sample (70 pine elements over 18 cm diameter) exceeded 175 years of age (giving some allowance to those that did not quite have the pith ring) except one (at 250 years), although a few non-cutting and undated samples exceeded 200 years (7 of 109). Most (60 percent) were under 100 years of age. Many very large vigas from the Pecos and San Miguel village samples exceeded the size of the mission timbers and yet were less than a century old. Although some old trees were harvested, it would be extremely unusual to have selected a group that were all extremely old—such a sample does not exist in the pueblo nor the Terrero samples, where we might expect old trees to have been still available before logging was prominent. Of course, the vexing problem of cutting boards from the exterior of squared timbers remains an unresolvable factor. The single board sample from the church (PEC-52) has lost so many rings (estimated outer date of 1571+) that it might be assumed that it came from the interior of the original tree—that is, it suggests entire logs were cut into boards rather than that boards were removed from just the exterior of viga-destined elements.

On a final note, four small-diameter, unshaped pieces of wood once projected from the mission walls. These were designated as wall pegs, although most were high in the walls (277, 340, 412, and 608 cm above the ground) and only one dated. PEC-68 (FS-31), a peg 608 cm up on the west facing wall in the northeast area of the transept (Figure E.14), dated at 1660vv. Despite its non-cutting date, it is a mere 8-cm diameter element with 43 growth rings. It was field recorded as having the original outside surface, and it is clearly a cutting or near-cutting date. This may mark a minor addition to the church or part of a wider effort of

some construction in adjacent buildings ushered in by the new missionary, Juan González, in 1660. A second story was added to the convento in 1655 or 1663 (Kessell 1979; Ivey 1996:Chapter 11:17, 19), possibly when an adjacent hacienda complex was built (White 1996:352).

Overall, the present structural elements in the Pecos Mission Church represent a mixture of origins. The majority probably date from the 1705/1706 construction of the present church, along with some modern additions from stabilization. However, as a group, elements from the main and southeast sacristies probably came from church buildings built before the 1705/1706 church and may represent elements salvaged from the 1680s church destruction. These appear to represent materials from two construction episodes: from the massive 1620s construction and from expansion of the mission in the mid-1600s.

The Convento

Tests and excavations in the Pecos convento (Figure E.7) started with William Witkind in 1939-1940, followed by Jean Pinkley, Alden Hayes, and Gary Matlock in the 1960s and 1970s, then Larry Nordby and Todd Metzger in the 1980s and Jake Ivey and Courtney White in the 1990s. Several pieces of wood were documented by the author in 2000, although notes on the majority of these attesting to their originality were largely absent. Only Kiva 23, in the convento, was excavated during the last five decades. Juniper ventilator tunnel roof slats were discovered by Matlock in 1971 (Ivey 1996:Appendix IV-61), the only wood noted for the ventilator. Several rotted upright posts between 15 and 20 cm in diameter (Ivey 1996:Appendix IV-61) were found in the north kiva wall, but were left unsampled. The use of a specific mortar and black adobes suggested to Ivey (1998:138-140) that kiva construction by Franciscans between 1620 and 1640 and may have been used as a teaching facility for new converts to Christianity.

Several posts in the adobe convento room walls or fragments scattered around the stone-lined postholes in Area F were sampled in 2000. The loose ramada posts rotting in the stone-lined postholes and lying on the ground nearby probably are from the Witkind excavations, based on the single dated specimen of 1885vv, which yielded an estimated cutting date after 1926. The post incorporated in the wall of Room 22, may also date to the same period; this specimen dated at 1932rG, the tree-death and probable harvest date. Finally, the rotted specimen lying within Room 11 dated at 1558vv, indicative of a former colonial piece. Based on sapwood rings, its estimated date of 1647+ places it during the mission renovations of about 1660. Ivey (1996:Appendix 11-1) records that Victor Ortiz of the park staff found the beam during excavations in Room 11 for Jean Pinkley in 1966 and Mr. Ortiz re-confirmed its identity in the 1990s.

Early Hispanic Settlement along the Upper Pecos River

The Hispanic settlement of the Upper Pecos Valley followed the Puebloan decline at Pecos, creating a new chapter in the history of the region. Official sanction was first given for settlement in 1784 when a large land grant and colonization was authorized for San Miguel del Vado (Saint Michael of the Ford), located 23 highway miles (37 km) southeast of Pecos along the Pecos River. Despite a lack of present-day name recognition, this settlement became one of the most important towns in northern New Mexico in the nineteenth century, becoming the sixth largest town in the state (Bancroft 1889:342). Soon, satellite communities at San Jose and San Juan, among others, were established nearby, and settlement slowly extended north along the river to Pecos, eventually reaching Terrero and the upper headwaters of the Pecos River by the late 1800s.

In 1973-1974, Gary Matlock, the National Park Service archaeologist at Pecos National

Monument, instigated a tree-ring study of some of the earliest structures in the Village of Pecos and the Village of San Miguel del Vado to supplement John Kessell's (1979) work on Pecos and to investigate the extent of early settlement. Matlock's work was expanded for the present report. In addition, in 1974, the Historical American Buildings Survey (HABS) planned aerial photography of the two villages and selected structures; only those at San Miguel were completed.

San Miguel was one of many Hispanic settlements established along the frontier, which served to stimulate growth along the Pecos Valley (Levine 1999:90). The village was built as a *plaza* community, surrounded on all sides by houses with windowless outer walls and access into the plaza through heavy gates. By 1803, non-Indian colonists, along with some Pecos Indians, *gen&icute;zaros,* and a few converted Comanche, had settled along the Pecos River at San Miguel (Boyd 1967; Hall 1984:5), marking the death knell for Pecos Pueblo. Subsequently, San Miguel became the parent town of most if not all villages founded in the Upper Pecos before the arrival of the Americans (Nostrand 1992:77). The town later served as the prominent port-of-entry for travelers and goods of the Santa Fe Trail entering Old Mexico from the United States. By 1841, a few traders were living at San Miguel, where profits could be made by storing and repacking goods to avoid tariffs at the customs house in Santa Fe (Boyd 1971:22).

An expanding Hispanic community at San Miguel and a population decline at Pecos Pueblo finally forced the Pecos church offices to be relocated to San Miguel in 1829 (Levine 1999:26). When the United States took possession of New Mexico in 1846, the grant fell into the hands of unscrupulous land dealers, depriving the settlers of their common lands and resources and, eventually, the livelihood of the town itself. San Miguel served as the county seat until it was moved to Las Vegas (founded in 1835) in 1864 (Nostrand 1992). By the early 1920s, only about 200 people still inhabited the town from a high of at least 2,000 listed in the 1827 census (Boyd 1971:19). Photographs of some of the older San Miguel buildings are illustrated by Boyd (1971), whereas HABS drawings of the Territorial House and the warehouse can be viewed on the WEB at http://rs6.loc.gov/_ammem/hhhtml/hhhome.html (search for HABS NM-139). Most structures, however, are in serious disrepair, with some roof collapse.

During the 1995-1997 survey of Pecos National Historical Park, four Hispanic homesteads occupied in the 1800s along the Pecos River were documented (Figure 10.6). Cultural materials on these sites often included an array of wood construction materials from house remains, fencing, and other features. Three of these sites, evenly spaced and adjacent to one another near the south end of the park, exhibited enough wood remains to warrant tree-ring sampling. All specimens were sawn for sampling at these sites because of the poor condition of the wood.

The Sample

One-hundred and twenty-eight samples were obtained from San Miguel, 61 from the Village of Pecos, one from Las Colonias, 27 from the Terrero homestead, and 65 from the three homesteads in Pecos National Historical Park (Tables E.6-E.8). Two other timbers from San Miguel were found in the Amelia Hollenbeck House in Santa Fe but their former location within San Miguel is unknown. These two timbers were taken from San Miguel by J. G. Meem in 1932. Ten structures in the Village of Pecos were sampled in 1974, generally a few vigas or wall logs from each structure. Only two structures were resampled in 2000-2001, while three have disappeared in the last 25 years. Those from the Village of Pecos came from several buildings reputed to be old and scattered on both sides of the Pecos River and in nearby Rincon.

A final sample was obtained by the author in December 1994 from Terrero, 19 km up the Pecos River from the Village of Pecos, during a U.S. Forest Service land dispute with descendants on Christino Rivera's homestead tract, settled in the 1880s. This sample provides evidence for settlement in the Upper Pecos River canyon by the late 1800s and provides a small sample from which to assess the interpretation of construction events from squared logs, similar to those used in the Pecos Mission Church.

Overall, this far-flung sample from scattered old buildings in three different communities along the Pecos River reflect the historical record of Hispanic settlement (e.g., Levine 1999). Despite oral tradition that Pecos Pueblo and Mission were scavenged for beams in the mid-1800s, evidence for this was not confirmed by the present sampling. Kidder's (1924:87) notes that locals ravaged the ruins for firewood cannot be discounted, although if the beams had been in good condition, as undoubtedly many were considering the pueblo was used in 1846 for army quarters, and there were large, ornately carved mission beams available, it is probable that many would have been curated and reused for structural purposes, as Prince (1915:328) implies. Only a single specimen, from the Martinez House at St. Anthony's Parish, yielded a 1700s date (none were earlier), but an unknown number of outer rings were missing. The sampling was sparse, however, so that unsampled early beams are still profuse in many old buildings. Unverified rumors also suggest that some beams from the Pecos church were taken to Santa Fe and reused in buildings there.

San Miguel del Vado

The Village of San Miguel was the earliest Hispanic settlement in the Pecos Valley but was in an exposed frontier area subject to intrusions by French and American traders and from raids by Indians off the Staked Plains to the east. By 1821, the perilous position of the village necessitated a resident detachment of about 21 soldiers (Spanish Archives of New Mexico, Santa Fe, microfilm roll 21, frame 419). But even the Navajo, located far to the west, raided the village, leaving five dead in November 1843 (Locke 1992:195). At one time, the entire plaza might have been enclosed with buildings and by a defensive wall (Julian Bustamonte, village resident, personal communication 2001) to resist raids. A 1936 Soil Conservation Service aerial photo shows two plazas in the village, a large central one and a smaller one in front of the church, which may reflect the original layout of the village. Wood sampling at San Miguel concentrated around the old central plaza east of State Road 3 and in the church (Figure E.15, Table E.6).

The Church

The fortress-like church (Figures E.16-E.19) may have been built first to serve as protection. Records suggest that the church was built between 1805 and 1811 (Boyd 1971:17; Hill 1992:159-160; Kessell 1979: 122-123, 550n14), while a state historical sign on State Road 3 in the front states construction occurred in 1806. Bandelier (in Lange and Riley 1966:351), however, states that the church was "begun" in 1796, which has some support from new tree-ring dates. The bell towers were rebuilt in 1866 (Kubler 1972:122-123), although the present bell in the south tower was cast in 1830. The exterior plaster was recently removed from the church in preparation for a new lime-stucco coat, which has not been added as of January 2002. This work exposed a former blocked door in the north wall and the original round steel-ax-cut choir-loft vigas visible above the front east door (Figure E.19). Under the pitched roof are the original roof vigas but these are now covered by insulation and planked over. A large square bonding beam above the east door and below the vigas is carved with a "rope" design (as described by the caretaker) symbolizing some aspect of Christ's crucifixion, perhaps the ropes that tied him to the cross or the crown of thorns. Permission granted by Father Ortiz allowed recent sampling of the church before the renovations took place.

The round nave and choir-loft vigas appear as physically distinct sets of harvested beams (Figure E.19). The earliest church dates derive from the four choir-loft samples, the underlying bonding beam set within the east wall, and the north door lintel, all which dated in the 1790s or earlier. Field observations suggest that most samples were taken with the original exterior rings or close to them, yet analyses reveal that the two groups of beams were not harvested at the same time. Thus, one of two probable interpretations are likely. The underlying bonding beam, dated at 1793vv but inscribed "1805" suggests that the beam was installed in 1805, but still predates the nave harvest dates by two years (see below). If the inscription is reliable, then the choir loft beams may have been harvested in the late 1790s but installed in 1805 or later. Two choir-loft beams (SMV-20 and -21; FS 2 and 4) were cut in 1769 and 1797, while two others (SMV-23 and -24; FS 8-9) were probably cut at about 1793. The diverse harvest dates for this batch suggests that the group was not cut for a single construction episode. Because the church probably was the first village structure to be built, these early beams may have come from some non-local structure(s). The remodeling at the Pecos Mission Church between 1794 and 1798 (Ivey 1996:12-18 to 12-19) and the subsequent deterioration of the mission is a likely source for the San Miguel beams, especially in view that the Catholic Church was responsible for the care of both buildings.

On the other hand, the choir-loft beam dates match Bandelier's assertion (in Riley and Riley (1966:351)) that construction started in 1796. The early construction also is supported by mention of a chapel that was present before license was given to build a church in 1804 (see below). Given the small sample, it cannot be determined which interpretation is most likely. Were the beams reused from some other structure elsewhere and placed in 1805 or do the dates mark the initial construction in the late 1790s?

Eight of the nine sampled nave and apse vigas and one sanctuary corbel dated at 1807 (a fifth was 1798+ + B), although all but one reflect a "+" symbol that indicates one or two years may have been missing from the outer ring dates. The presence of one 1807 date without a plus (SMV-103/FS 72), however, suggests that there are no missing rings and that all the trees were cut in 1807 (Dean 2001). The mix of complete and incomplete outer growth rings places the cutting of these timbers at the end of the ponderosa pine growing season in August or September 1807 (Dean 2001). Dates from the nave seem to confirm Boyd's (1967) notes from the Archives of the Archdiocese of Santa Fe (Baptismal Records for Pecos 1776-1829) for a license to build a church at San Miguel in 1804, where a chapel had already been started. Actual construction was ongoing by at least 1805, however, based on a letter detailing the refusal of a local resident to the order to help with the church construction (Kubler 1972:105).

Twelve pairs of massive round vigas (25-36.5 cm in diameter) and rectangular, undecorated corbels roofing the sanctuary (visible in the attic; Figure E.19) are salvage materials taken from other architectural sources. Most reveal weathering and considerable variation in size and shape; three exhibited worn mortise holes in their ends. However, of the nine samples, the four latest dated at 1816 or 1817, which marks the harvest date or shortly afterwards. We have no records suggesting remodeling at the Pecos Mission in this era, although it would have been the closest source for such materials in the early nineteenth century. Thus, the 1816/1817 sanctuary beams and corbels suggest a re-roofing episode in 1817 or shortly afterwards. Given the lengthy period over which the church was built and remodeled, it is not surprising that the historical documents are unclear as to the specific church construction date.

The Plaza Structures

Eight of the old plaza buildings have been dated, although more remain to be mapped and sampled. These eight structures have yielded a range of beam harvest events spanning 1807

to 1936, but with the majority clustering between the 1820s and 1870s, when most of the village may have been built. The earliest village dates come from Structure 8, an abandoned house across State Road 3 from the church (Figure E.20) and attached to Structure 7. Beams in Room 7 were cut during the non-growing season of 1807, meaning that the harvest occurred sometime in the late fall of 1807 to early spring in 1808. The Room 7 beams may have come from remodeling the church sanctuary at about 1817, when some sanctuary beams and corbels from presumably the 1807 harvest period were removed in lieu of more massive timbers. The older beams, about 9 m long, could have been cut into shorter lengths for reuse in house construction, but only one piece from each cut would have spanned Room 7's 5.3 m width. Room 7 beams differ from the in-situ 1807 church beams, however, in procurement season, lack of "+" rings, and the presence of bark. Nevertheless, some link between construction of Room 7 and remodeling at the church can be suspected.

The long subdivided room (Rooms 1-5) later attached to the north of Room 7 yielded two cutting events. Two vigas on the ground within the structure (FS 16 and 18) dated in 1823 (SMV-97 and 98), consistent with building elsewhere on the plaza. Although several in situ beams were also sampled, only two dated (SMV 96 and 96; FS 6 and 10), and these suggest remodeling of the structure after 1898. More rooms were abutted to Room 7 on the south (not sampled) and to the east (Structure 7). Structure 7 (Figure E.20) yielded three rooms (Rooms 3, 6, and 7) with visible ceiling beams, but the roof of Room 3 was rebuilt in about 1990 using beams taken from a building in a nearby village (El Ancon) to the north. Those beams suggest construction in the late 1870s or 1880s. Rooms 6 and 7, with beams physically distinct from the Room 3 vigas, also suggest construction in the 1870s.

The largest house complex still existing is the Territorial House (also called the Custom's House although it never served in this capacity) comprising Matlock's Structures 2-4, in part, on the northeast side of the plaza (Figures E.15, E.21). This house, consisting of 16 rooms enclosing a courtyard, had wagon access directly onto the Santa Fe Trail. It served as a saloon and dance hall and later as a general store, becoming the social hub of the town through the Great Depression in the 1930s (Boyd 1971:24). Behind the house were quarters for servants and animals, storage for hay, and a blacksmith shop. The building may also have housed a detachment of about 20 presidial troops by the 1820s (Harry Myers of the Santa Fe Trail Association and the National Park Service, personal communication 2001). Some renovations to the buildings were made in the 1970s. The adjacent Santa Fe Trail crossed the Pecos River nearby as it entered the village from the east and passed by the church on its way north to Pecos and Santa Fe.

This multi-room structure reflects construction in the 1820s, with additions in the 1830s, 1840s, and 1850s. A few 1820s dates from Rooms 1-5, bordering the alley and the Santa Fe Trail to the north, suggest that these and Rooms 12-14 were the earliest built. Room 6 appears to have been an open space later roofed over with 1936 piñon logs. Room 7 was reroofed with fresh juniper splints that appear recent but the 1830s vigas may be original. Reroofing or replacement beams cut in the early 1930s also came from Rooms 2 and 5, suggesting major renovations at the house.

Finally, a series of smaller buildings, some once part of larger structures that have disappeared except for stub walls and foundations, were sampled (Figures E.15, E.20). Structure 1, consisting of four rooms with large vigas often flattened on one side, presumably to facilitate a covering of boards, yielded dates in the 1860s. Bark dates in 1868 and 1869 indicate that all were harvested during the pine summer growing season, with Structure 1 built in 1869 or shortly afterwards.

Structure 5, once part of a larger hacienda building, contains three intact rooms with sequential beam dates suggesting construction (Room 1) in the 1830s and additions in 1834

(Room 2) and 1837 or later (Room 3). This building exhibits the most varied roof construction of any in the village. Room 1 was set with six widely spaced beams spanning the east-west walls. Room 2 was roofed with a multitude of closely-spaced beams also running east-west. Finally, Room 3 was composed of a multitude of beams wedged tight against one another and running north and south. Unlike the other rooms, beams in Room 3 had been carefully stripped of bark with a draw knife. Room 3 also had a rare south-facing window, lined with boards but partially screened by a series of short upright piñon posts *(rejas).* This style of window has been observed in several buildings in the village (e.g., Figure E.16).

Structure 6, isolated along the east edge of the plaza near the Pecos River, consists of a single room. It was roofed with beams and splints cut in the fall of 1851, undoubtedly its construction date. One beam was cut between 1837 and 1839 and represents a reused timber. The northernmost beam, cut in the summer of 1891, is clearly a later replacement.

The San Miguel buildings are an interesting mix of roof construction styles, reflecting temporal trends and individual tastes if not family-taught patterns. The earliest roofs are closely patterned after Puebloan techniques, with widely spaced beams covered by splints and mud. In no case were secondary poles used as an intermediate construction step common to pre-historic Southwestern construction. Most beams were trimmed with a draw knife, although the thoroughness of this varied, often allowing a bark date to be obtained where narrow strips or fragments of bark were left. Few elements were left with the bark intact. Late constructed rooms, probably dating to the late 1800s when saw mills were common, reflect a trend towards the use of board-like beams. These were set with the narrow end vertical and inscribed with grooves parallel to the edges in a decorative fashion that is similar to the early squared beams at the Pecos Mission. A switch from a splint covering to one of boards over the vigas also occurs but dendrochronological sampling from boards and milled beams has not been attempted.

The sampled plaza buildings (Figure E.20) reflect similar constructions and repairs as those found at the Village of Pecos in the 1800s. The concentration of cut timbers in the 1830s through the 1860s might be expected for village expansion in response to increased traffic along the Santa Fe Trail. The present sample, however, fails to support widespread construction in the 1820s or earlier at San Miguel that would correspond to the nearly 2,000 residents listed in the 1827 census (Boyd 1971:19). While the census probably reflects the regional population, it does suggest that San Miguel would have been a thriving village by the 1820s. Oddly, no dates have been obtained that indicate any house beam harvests in the 1810s, although a scattering of dates between 1821 and 1824 indicate some construction had started at San Miguel. Between the 1830s and 1870s, however, beam harvests for building construction were common. At San Miguel there is a long period without evidence of wood harvesting before two structures reveal possible replacement vigas cut in the 1930s.

Evidently, there has been some resurgence in population since 1974, with a number of new houses and trailers added to the plaza area. It appears that residents have generally abandoned the older homesteads or have used them for storage and, in many cases, have moved into trailers instead. None of the eight house buildings sampled at San Miguel are now used as residences.

Like Pecos, beams from San Miguel village found their way into distant towns as new roofing. Two vigas from somewhere in the village ended up in Amelia Hollenbeck's Santa Fe home, which was full of timbers from other places, including a huge inscribed dated beam from the Bernalillo convento (Dede Snow, Laboratory of Anthropology, email communication 2000) and a beam from the Pecos Mission (Ivey 1996:12-30). As more samples are obtained, a more thorough picture of construction and beam movement will

become apparent.

Park Homesteads

Standing architectural remains were lacking at the three homesteads sampled in Pecos National Historical Park. Instead, wood was sparsely scattered about the site or mostly limited to upright posts marking corrals and other enclosed areas. The largest site, Pecos-540 (Figures 10.7, 10.8, E.22), just below the Cañon de los Trigos, fits the description for the original homestead in the area in perhaps as early as 1816 (though see Chapter 10). This was described as having small summer shacks *(jacales)* located at the bend of the Pecos River ten miles below the Pecos *ciénaga* (Hall 1984:26). By 1821, these locales had small gardens and some livestock, both which would have required fencing. Dates between 1858 and 1911 were determined from the survey artifact assemblage (Table 10.5). The site yielded 40 post stubs (Table E.7; not all were sampled), of which many linear sets, sometimes in pairs, were found. Paired posts suggest railed fencing of corrals and yards, while short linear sets associated with adobe and masonry mounds may have been porch and wall supports. All homestead specimens were juniper, presumably obtained in the immediate site areas. Many samples revealed complacent growth, unusual for junipers, that is detrimental for tree-ring dating. Three posts from the same possible corral dated at 1796+vv, 1807++vv, and 1832vv. Although all three posts were badly weathered, the latest date appears reasonable, in light of the artifact assemblage, for some activity at the site after 1832. This date would correspond with the interpretation given in Chapter 10 that most of the visible features relate to the 1840s occupation of the site.

A solitary sample from Pecos-541 (Figures 10.15-10.16), at the confluence of the Pecos River and Arroyo de los Torreones, dated, yielding a surprising date (despite much outer ring loss) of 1542vv. This date suggests that the specimen might have been procured from deadwood or from Pecos Pueblo. The latter origin seems unlikely given the large size of the post, distance to the ruins, and the availability of juniper within the immediate area. This site produced an artifact assemblage dated between 1865 and 1933 (Table 10.5). Finally, Pecos-175 (Figures 10.11-10.12), yielded no tree-ring dates. Samples were scattered near the stone structures and some distance away, perhaps in a corral. Survey artifacts suggested a temporal range between 1873 and 1928 for occupation of this homestead.

Village of Pecos

Along the Pecos River just upstream from the homesteads is the Village of Pecos. This village is dispersed into three sub-communities: Pecos, East Pecos on the eastern side of the river, and Rincon, just north of the village. Gary Matlock sampled nine of the 15 reputed oldest structures in Pecos (Figure E.23, Table E.8); additional samples were obtained recently from two of them. Three others that Matlock sampled no longer exist, with the most recent (PV 6) removed in May 2001 for a new trailer home. Without records of the specimen field condition where the samples were procured, it is not possible to assess the non-cutting dates with the possible harvest dates given the small samples. In addition, with reuse and remodeling, the small samples fail to provide the resolution necessary for detailed interpretations. Three community structures were sampled: a grist mill (PV 3 on the map; now gone), the Catholic church rectory garage (PV 9), and an old post office (PV 10). Of these, the religious building might be considered initially the most important for a Catholic community, and, therefore, the earliest structure, followed by the grist mill when enough grain was produced to necessitate community grinding, and then, finally, connections to the outside world with an official post office. Tree-ring dates follow this predicted temporal progression, with dates in the 1830s, 1880s, and 1913s, respectively, for the three structures.

Traditionally, structures were made with flat, dirt roofs (Figure E.24), but by the 1880s,

pitched metal corrugated roofs became common (Weber 1972:19); often these were placed over the original flat roofs, thus preserving them. There would have been some prestige in having a pitched roof because it precluded problems of snow removal and the inevitable rain of dust dropping from a flat, dirt roof. Pitched roofs were built of imported lead and tin terneplate as early as 1850 in Santa Fe (Nostrand 1992:123) but it is unknown when smaller towns, like San Miguel and Pecos, constructed them. In 1844, at least, San Miguel had only flat roofs (Boyd 1971: 19).

The initial settlement of Pecos is poorly known (Weber 1972:25), but may have occurred by the 1820s. Pecos was a thriving community by the 1830s centered around the largest hacienda and central plaza. The county census of 1860 (Chapter 10, this volume), reports four mills (although some were for non-food products), many farmers, and a preference for corn crops. By the 1880s, hard times had apparently hit forcing the population to become more occupationally diversified. Perhaps, our sample mill was new or remodeled at this time—the tree-ring evidence is too sparse to know. The 1920 census appears to reflect the population "high water mark" at Pecos, and this is tentatively reflected in the new or remodeled houses with tree-ring dates in the 1910s, including the post office. But by 2001, a new influx of settlement occurred. The earliest dates overall came from the rectory garage, which was probably built at about 1835 or 1837. Afterwards, dates tentatively suggest a steady span of community remodeling and expansion through the 1800s.

Besides the rectory garage, only the Martinez hacienda (PV 7 in Figure E.23) next to the present Pecos parish was resampled, with 25 new samples added to the 9 previous ones (Table E.8). This structure (Figure E.25) has a pitched roof over it protecting the original flat dirt roof. The first rooms (Rooms 1-3, 5, and 8), built in an L-shape, were constructed at about 1840, with Room 4 added at about 1848. One viga, from Room 2, was a non-cutting date at 1763 and may have come from a Pecos Mission building—the only one in the village sample. Rooms 6, 7, and an unnumbered corner room may have followed in 1851 or shortly afterwards. Roof vigas in Room 1 dated between 1833 and 1841, although a series of small horizontal poles stacked over the north end of the vigas yielded bark dates at 1865 and 1868. These dates indicate some sort of secondary roof construction along the north side supported by two upright juniper posts. Otherwise, the room vigas were covered by planks and dirt. Eventually the interior courtyard was enclosed, probably early in the construction, but the other structures that form it are owned separately and could not be sampled. The interior eastern portico yielded dates in the 1840s and at 1850 for posts and vigas visibly older than the majority now present. The newer porch remodeling dated at 1933. Despite the increased sample, the overall structure is complex and could benefit from more sampling. In addition, ceilings in several rooms no longer have the vigas exposed, which prevented sampling.

A broader sampling program would provide a much clearer picture of the growth and decline of the village in the 1800s. The scattered dates do indicate that some building activity had begun by the 1830s, somewhat later than at San Miguel del Vado, with increased construction in the following four decades. A more detailed examination of the Pecos village community organization and development (i.e., Levine 1999) would provide deeper insights into linking various structures and their uses within the community. Unless this happens soon, many of the older structures will soon be gone, as has already happened to three buildings since Matlock's investigations.

Las Colonias

Across the foothills, a mere 10 km southeast of the Village of Pecos, is the small Hispanic community of Lower Colonias. Timbers in the small church there were examined in January 2001 with the kind permission of the Pecos parish priest, Father Bennett Voorhies. The church interior, 5.8 by 14.5 m, exhibits 18 round vigas (23-28 cm diameter) supported by

corbels. Some change has occurred in the roof since a 1931 photograph (Kubler 1972:Figure 158), and the vigas, along with the corbels supporting the southern eight vigas, look fresh (yellowish in color). These corbels have been crudely cut to shape and exhibit no decoration. The northern corbels (n=24), however, are clearly old based on their rich natural dark color. These are all carved with an array of decorations that show considerable skill in carpentry (Figure E.26). Nevertheless, a mixture of sizes (14 small: 21 cm high, 17 cm wide, and 50+ cm long; 8 large: 24 cm by 21 cm by 62+ cm long), and decorative styles are evident—matched in pairs by style and size with each viga. In addition; two very long corbels set over small corbels divide the nave/transept from the apse. The different decorative styles and level of workmanship suggest multiple carvers and/or corbels produced at different times or for different rooms.

Although the author was not allowed to sample any corbels, the physical characteristics of the corbels support oral tradition that these were, indeed, salvaged from the Pecos Mission, consistent with collection from multiple rooms at the mission. Their carvings resemble the Pecos corbels illustrated by Morley (1915), primarily in their use of chiseled flutes and overall shape. But otherwise, there are wide differences in designs observed among the various vigas and corbels found in different locations reputed to be from the mission church. These might represent different sections of construction at the mission before its demise. Without tree-ring dating these various specimens, however, it will be difficult to verify their origins.

Tony Ruiz, an 84-year old resident (as of 2001) who lives near the Las Colonias church, said that the church roof had not been replaced during his life, but its appearance suggests otherwise. Certainly, the pitched galvanized steel roof postdates the original construction. The single viga sampled indicates that the roof was replaced at about 1922 or shortly afterwards. The corbels illustrated by Kubler (1972:Figure 158), however, are those observed still in place at the millennium.

Terrero Rivera Homestead

This homestead lies just north of the former USFS Willow Creek Campground, now closed for toxic waste removal from the Terrero mine just across the river (Darden 1967; Weber 1972:101-102). This mine was one of the nation's top producers of lead and zinc between 1926 and 1939, with the ore transported by aerial tram 12 miles to a mill west of the Village of Pecos. All structures on the Rivera homestead were in use in 1994. Three dwellings exist on the property while a fourth, a log cabin under construction that ignited the dispute, was being built nearby (Figure E.27). The latter was later dismantled. The owners' descendants describe the small log cabin as the kitchen and residence used during the construction of the larger log house. A large barn is located on a slight rise about 150 m to the south. The area was surveyed and monumented in 1883 and these monuments were relocated in 1925. The descendants claim the tract was homesteaded in the 1880s and the buildings built at that time.

Only a single December day was devoted to sampling the homestead (Table E.8), as a result the buildings were not sampled as thoroughly as possible. Nevertheless, the nine samples from wall logs and vigas in the small cabin (Figure E.28) confirm both legal documents and oral history, showing that the cabin logs were clearly cut during the summer of 1882. Walls in the adjacent large house were all trimmed square, so that the outer rings were lost. Despite a huge number of wall logs in the large house, time permitted only five to be sampled. These were drilled at the outermost edges in an attempt to get the maximum number of outermost rings. In some cases, the log ends were exposed that allowed sampling to proceed at the edge showing the rings closest to the original outer surface. Oral history suggests that the large house was built just after the small cabin was built in 1882. Thus, despite squared beams, two (at 1875vv and 1877vv) of the five dates are extremely close to the probable cutting period in

the early to mid 1880s. This confirms the field estimate that perhaps 10-20 rings might have been lost from trimming. At least one, at 1823+ +vv, or two (1785vv), reveal that deadwood was also collected. A larger sample probably would have yielded more dates close to the true harvest event.

Finally, the nearby barn (Figure E.28) produced a tight assemblage of cutting dates at 1891. Probably the barn construction would have post-dated the house construction, thus bracketing construction of the large house between 1882 and 1891. Interestingly, all house construction was of ponderosa pine, not surprising given the site location, but the barn sample (n=13) consisted only of Douglas fir. Although Douglas fir might have been specifically targeted for harvesting, a stand might have existed nearby and supplied the bulk of the barn materials. Two employees of Pecos National Historical Park, long-time residents of Pecos and active viga craftsmen, related that Pecos Village tradition said Douglas fir was selected because it required far less limb removal effort than ponderosa pine (Steve Bustos and Joe Dalton, personal communications 2000). The sample is large enough to pinpoint harvesting of the barn logs in the late fall or later of 1891, when except for one tree, the bulk of the sample trees had finished growth for the year (see Windes and McKenna 2001).

Kozlowskis Stagecoach Stop and Trading Post

Martin Kozlowski came to the Pecos Valley in 1846 and by 1859 had set up farming and ranching operations a short distance from the Pecos ruins. He and his wife operated a stagecoach stop for travelers, which became a main stop in 1866. Oral history (see above) suggests that much of the construction materials obtained by Kozlowski came from the Pecos Mission Church. During the nearby 1862 Civil War Battle of Glorieta, the Kozlowski building was used for the Union headquarters, as a main encampment for troops, as a hospital for the wounded, and as a point for the advance on the Confederate supply train (Franzwa 1989:190-193; Haecker 1999; Kajencki 1990:47). Kozlowski moved to Albuquerque to be with his son in 1898. Later, his son, Tomás, reappeared in the community in 1911 (Chapter 10, this volume) and rebuilt part of the old trading post.

In time, the buildings (Figure E.29) and adjacent properties were taken over in 1925 or 1926 by rodeo producer Tex Austin, who formed the Forked Lightning Ranch (Gustafson 1997:13; Levine 1999:180) as a cattle and dude ranch and as a trading post. The ranch brochures offered the added enticement of digging in the four ruins on the property partially excavated by A. V. Kidder "if you are archaeologically inclined and care to dig in the past" (Forked Lightning Ranch 1920s: 13).

Recent interviews conducted by the park staff with surviving relatives of Tex Austin point to a 1923 ranch ownership instead, while Kajencki (1990:64-65) claims the property was lost for taxes in about 1924. The main ranch house was built above the Pecos River shortly afterwards, but was not been examined for this study. Bankruptcy shifted ownership of the ranch to Texas oilman, E. E. Fogelson, in 1939; ten years later Fogelson married movie actress Greer Garson. By this time the ranch had become locally famous (Alford 1952; Fitzpatrick 1960). The ranch was sold in 1991 and donated to the National Park Service in 1993. The shift in ownership to the Park Service prompted a historic structures' report of the former stagecoach-stop structure and adjacent outbuildings, which were being used as housing by the foreman of the ranch, Gilbert Ortiz. The foreman was then employed by the National Park Service, who turned part of his housing into offices. Gilbert Ortiz, nevertheless, continued to live in the same housing until 2000, when hired by actress Jane Fonda at a neighboring ranch.

The interpretation of the Kozlowski buildings was aptly covered by Jeff Dean (1998) in his report of the tree-ring analysis. This is paraphrased here, with additions from the architectural

analysis conducted by Catherine Colby and Jake Ivey (1998).

The Sample

A large wood sample (n=115) was obtained from six buildings and attached architectural features at Kozlowski's (Figures E.29-E.31; Table E.9); the vast majority of these dated (101 of 115; 88 percent). From this sample, the tree-ring analysis revealed about nine tree procurement events, although the exact felling episodes are obscured by the profusion of "+" dates, indicating the possible absence of one to two rings near the end of the sample's ring series (Table E.9). Ten non-cutting and one cutting date from Structures 17, 20, and 21 suggest wood procurement in the late nineteenth century, probably the 1880s. The widespread distribution of these indicates that many were salvaged from earlier contexts and reused. Based on Windes observations of KTP-77 (FS 200) and KTP-114 (FS 201; which did not date) in the Carpentry Shop, the two juniper posts may be elements secured by Kozlowski from his original homestead. The nineteenth-century samples include Douglas fir, ponderosa pine, and the only dated junipers. The 1897+ +vv date (KTP 5/FS 31) probably represents a dead or dying tree acquired during one of the twentieth-century harvests.

One or two harvest episodes occurred during the 1907-1913 period, coinciding with Jones (1913) report that Kozlowski's son, Tomás, returned to Pecos and rebuilt part of his family's house. The possible absence of rings (for + samples) prohibits an unambiguous decision regarding the number of harvest events; the preponderance of evidence favored a two-harvest alternative: two 1902+ +vv non-cutting dates and two 1907+ B near-cutting dates probably represent cutting in 1907, 1908, or 1909, depending on whether 0-2 rings were missing. Two 1909vv, one 1910vv, four 1911+vv non-cutting dates, three 1911+v, and three 1911+B near-cutting dates indicate cutting in 1911, 1912, or 1913 depending, again, on how many rings were missing. Windes field observations suggested that all were near or actual cutting dates, with the possible harvest event in 1911. All these samples were Douglas fir with incomplete outer growth rings, indicating that cutting occurred during the growing season between spring and mid-summer.

Thirty-nine dates reflect strong evidence for wood harvests in 1924 and 1926. Although many 1924 dates were assigned a vv symbol, indicating an unknown number of exterior rings missing, Windes' field notes suggest that many of these were cutting dates. The fact that no dates later than 1924 occur in Structure 20, Rooms 2-7, while in all other rooms, 1924 dates are associated with later dates, strongly supports the assignment of major wood procurement in 1924. The 1924 procurement indicates that the Continental Insurance Company (see Levine 1999:179-181 for a summary of land ownership) allowed expansion of the original building just prior to its sale to Tex Austin in 1925 or 1926. Given the closeness of the two harvest events and their procurement from similar if not the same locales (see below), it is possible that both events were guided by Tex Austin. Alternatively and agreeing with recent interviews with Austin family members, Austin may have procured some of the property by 1923 and shortly afterwards expanded the Kozlowski building. Incomplete outer growth rings of the specimens indicate that procurement occurred during the growing season; the unequivocal cutting date of 1924 for KTP-55, a Douglas fir, places this episode during spring to mid-summer. The variety of species involved, unlike the sole use of Douglas fir in the 1907-1911 episode, reflects that the 1924 harvest occurred in a locality different from the 1907-1911 harvests.

Non-cutting and near-cutting dates in 1925 (many with a + symbol) and three non-cutting and one cutting date in 1926 identify another wood harvest in 1926. All but three of the seventeen 1925 dates was given a + symbol because of the probable but undetectable absence of the 1925 growth ring. Addition of this ring would shift all these samples to 1926. The mix of species suggests that procurement could have come from the same location as that of 1924,

except for the unusual presence of piñon. The combined presence of incomplete and complete outer growth rings among the different species indicates a long or staggered procurement period from spring to late summer/early fall (incomplete outer spruce or true fir rings [spring] and complete outer piñon and ponderosa pine rings [fall]).

Non-cutting dates between 1914 and 1923, associated with proveniences yielding clusters of dates between 1924 and 1926, probably represent timbers acquired during those harvests. Several of these were dead trees (indicated by a + + symbol), apparently still viable structurally and procured simultaneously during the cutting of live trees. A short span between the natural death of trees and the harvest year has also been documented for prehistoric structural use of dead trees in the San Juan Basin (Windes et al. 1994).

A few dates specify minor procurements in the 1930s. Two posts in Room 9 (the Ortiz living room) have non-cutting dates of 1930, but field observations suggest they exhibit original exteriors. Three dates at 1932 indicate cutting in the spring/early summer (incomplete and complete outer rings from all three spruce/true fir specimens). One non-cutting date at 1933 and near (+) cutting dates at 1934, 1935, and 1937 probably relate to events in 1934 and early 1937, when some upkeep was continued despite financial failure and placement of the land into receivership in 1933.

Structure Dating

Main Building (Structure 20; Figure E.30)

The dating of Room 3 (natural resource and ranger office) depends on whether the original roof components were subsequently remodeled by replacement of some beams or were elements reused from older, perhaps demolished, structures. Assuming beam replacement, the room probably was roofed with timbers procured during the 1880s, of which KTP-4 and 7 (FS 28 and 36) are examples. Reuse of old timbers yields two alternatives that rest on how this room relates to Room 9 (Ortiz's living room). If the 1897+ + log (KTP-5/FS 31) is part of the 1909 or 1911 procurement episodes in Room 9, Room 3 could have been built in or shortly after 1909 or 1911. Otherwise, Room 3 could have been built in 1924 with a mix of freshly cut and reused timbers. The portico added to Room 3, however, yielded a single date of 1926, as did Room 2 (the chief ranger's office), suggesting that construction actually took place in 1926 with reused logs and a stockpile cut in 1924.

Room 9 (Ortiz's living room and the probable original home) was roofed entirely with beams from the 1907-1909 and 1911 episodes by Tomás Kozlowski, reportedly in June of 1911 (Jones 1913:14), which coincides with the tree-ring evidence. Two short partition walls indicate that either the room was once two rooms that subsequently were joined by demolishing a dividing wall or that the larger chamber was divided by addition of the partition walls. Dates from the posts indicate that this remodeling took place in 1930 or shortly thereafter. The dates also indicate that the two bedrooms (Rooms 10 and 11) were added or reroofed at the same time in 1911. The Ortiz kitchen (Room 8) appears to have been built in 1926 or it was a 1911 room (unlikely) or portico that was reroofed in 1926 to complete the rectangular arrangement of rooms.

Room 2 (Chief Ranger's office) probably was built in 1926. If it had been built in the 1880s, Room 3 would have connected it with Room 9 at the same time that the Room 3 roof was repaired. On the other hand, if Room 3 was added in 1926 with new and reused timbers, it and Room 2 would have formed a new western addition to the pre-existing Room 9 (living room) structure.

In 1926, a southern wing comprising Rooms 4-7 was added to form a J-shaped roomblock open to the south with timbers cut primarily in 1924 and with reused wood. At least one

reused beam (KTP-16/FS 50) was used during this construction. The arrangement, with narrow rooms, two of them now used as bathrooms, next to three new square units suggests the addition of self-contained apartments for renting rather than use by a single domestic group. At the same time, a similar architectural unit (Rooms 12-15) was appended to the original living room structure (Rooms 9-11) in 1926. This suggests another two apartments were added, as, again, both large rectangular units were joined to narrow rooms that served as bathrooms (as of 1998). This completed structure was now U-shaped, open to the south. It appears, then, that the structure was being prepared as a dude ranch before the purchase by Tex Austin in 1925 or 1926, that Austin was responsible for the newer construction before he actually owned the property, or that the shift in ownership date is in error and occurred before 1925. At the same time, in 1926, porticos were added to the north side and facing east from the 1924 apartments into the courtyard, as well as the east side of Ortiz's kitchen.

The final room (Room 16; recreation room) was added to the south of the 1926 apartments. It produced a range of dates, but clearly the roofing came from the 1926 harvests. However, two massive roof support posts dated at 1918+ +vv (deadwood) and 1933, the latter a probable harvest date. It is unclear whether Room 16 once comprised two rooms built in 1926 that were later subdivided in 1933, or if it had been one room and the support posts replaced in 1933, or if the room had been built in 1933 using beams cut entirely during the 1926 harvests. It seems unlikely that the posts would have needed replacing after just seven years unless there had been modifications to the structure. On the other hand, a stucco-covered adobe and jacal wall extended south from Room 16 (forming the western or back wall of the roofed carport) has harvest dates indicating 1926 procurement. Thus, Room 16 and this stucco wall probably completed the overall structure and enclosing walls in 1926, when Austin's dude ranch was in operation. The post additions in Room 16 may have been a reconfiguration of the roof (to a pitched roof) using the same roof vigas. The size of Room 16 suggests it may have had kitchen and dining facilities for the apartment guests or served some other function for the ranch guests, as shown in the ranch brochure (Forked Lightning Ranch 1920s).

The only outlying building that appears coeval with the 1926 work is the carpentry shop (Structure 17; Figure E.31). Although it could have been built in the 1880s, with two wall posts yielding 1800s dates, the tree-ring evidence strongly indicates it was built with timbers from the 1926 harvests, along with a few timbers salvaged from earlier structures. The tack room (Structure 22; Figure E.31) next to it yielded a single viga date of 1936+v. The two juniper door posts may have been old wood or timbers salvaged from Pecos Pueblo—only one dated, at 1792vv. The building also contained a creosote-soaked railroad tie door lintel, the only such piece recorded. The 1936 date suggests construction of the room at the same time as the large barn or stable (Figure E.31) located nearby to the south. The stable was probably erected in 1937 or 1938, based on a 1937+B roof support post sample. Two other elements may have been leftovers from procurements in 1932 and 1934/1935 (KTP-80 and 83; FS 205 and 216), while two others were salvaged from late 1800s stock. The use of late 1800s timbers (n=12) throughout the buildings suggests a stockpile somewhere that contained the timbers from the late 1800s house. Finally, the root cellar or greenhouse (Structure 23; Figure E.31), cut into the bank just east of the main building, suggests construction during or shortly after the summer of 1932.

CONCLUSIONS

Changing aspects of wood use for construction (Table E.10) mark the temporal trends in the various sites sampled for this study. These trends may reflect different cultural needs of the groups that procured and used the surrounding forests for wood. While impacts to the local tree stands must have been severe given the large populations that once lived in the valley, the greater region is heavily forested permitting available resources for whatever construction

was desired depending on the transportation restraints. As land passed from the community into private and federal hands, and wider markets became available with access to the railroad in 1880, fundamental shifts in access and procurement to wood resources occurred.

The earliest occupations in the valley should have encountered relatively pristine woodland conditions unaffected by the massive wood use that followed in later centuries. In this case, the Pecos Valley pithouse builders, as those on the Colorado Plateau, selected wood for construction that was in the immediate vicinity of the site. This seems borne out by the species represented in the burned roofing of the two pithouses (Sewerline and Hoaglund's Haven): mostly piñon, with some juniper and ponderosa pine. Charcoal, probably from fuel found in macro-botanical remains at the pithouses, confirms the ready availability of piñon and juniper, as well as the presence of oak and shrubs (Nordby and Creutz 1993:4-42, 4-46). Today, the valley bottom is dense with juniper, with scattered piñon and ponderosa pine.

Because of its long, straight stems, ponderosa pine is the preferred wood for construction, as is later evident. Its sparse numbers for the pithouse construction suggest that suitable numbers of the young stems were not immediately available for construction and that groups were not sufficiently organized nor large enough to travel any distance to specifically harvest ponderosa pine. Considering the environmental conditions of the valley today, ponderosa pine probably was scattered amongst the smaller juniper and piñon trees. While piñon may have been preferred over juniper for construction, both species have reflected much use for pithouse building throughout the Southwest. Thus, either piñon was selected from a dominant forest of juniper or it was common in the area, if not the dominant species. In the 800s the effort to gather construction wood was probably minimal and restricted to family-size groups suggesting that piñon trees were much more common than today.

The use of piñon for construction continued into the Coalition Period, based on our sample of roofing remains from Forked Lightning and Rowe Pueblos, when groups began to construct large pueblos with hundreds of rooms. Although larger cooperative efforts may have been under way in such communities, it is not reflected in the use of wood, which appears primarily local. Much of this supply would have been obtained as the area was cleared for cropland. A corresponding use of piñon for firepit fuel in future excavations would strongly indicate that the primary tree cover was piñon rather than juniper, marking the widespread succession-growth of juniper forest today as a result of centuries of tree clearing.

Some depletion of the piñon and juniper must have occurred before the founding of Pecos Pueblo. The size and complexity of the dwellings at Pecos Pueblo would have required a substantial cooperative effort in the new constructions on the mesa. Historic accounts reveal that the buildings were three and possibly four stories high, containing about 900-1,100 rooms (Kidder 1958:121-122; Orcutt and Powers 2001:Table 2). Kidder (1958:81) reports 4-6 pine vigas per room roof, with these normally covered by juniper or pine slats, rushes, or occasionally secondary poles (Kidder 1958:Figures 30-32). Secondary poles were sometimes set in pairs or covered the entire roof, employing up to 35 or more poles. Vigas in plaza-front rooms were commonly supported by a room-length beam along one wall, which in turn was support by 2-4 posts under each viga end (Kidder 1958:81, 83). Remains of many of these post tops are evident today in linear arrangements along the lower slopes of the buried roomblocks (Figure E.4, Table E.3). In addition, a similar series of vigas and posts supported the porticos that ringed the various levels of the roomblocks facing the inner quadrangle.

From these observations, one can extrapolate that approximately 3,300 vigas, 1,000 to 2,000 posts, and perhaps 1,000 to 2,000 secondaries were required during the construction of the 660 North Pueblo rooms (see Kidder 1958: Table IV). Altogether, approximately 5,000 to 9,000 wood elements may have been used. Overall, the effort could have been accomplished without massive control and organization of the pueblo population (see Windes and

McKenna 2001 for comparative Chacoan examples). Multiple elements taken from the same tree, of course, would greatly reduce the true number of trees harvested, as well as those salvaged from earlier contexts. In addition, the large population at Pecos, estimated at between 900 and 2,000 at its height (e.g., Kessell 1979:12, 104, 129-130, 188; Orcutt and Powers 2001:4) would make the harvest of thousands of timbers relatively easy. The numerous variations in roof construction illustrated by Kidder (1958) may reflect individual household or clan responsibility (Orcutt and Powers 2001:3) for construction materials and building rather than oversight by a larger suprahousehold or corporate group. If most of the South Pueblo wood elements were obtained from the North Pueblo, then little additional timber harvesting would have been necessary for its construction.

Clearing the valley for farming would have thinned the former valley forest cover, increasing costs for future wood procurement in terms of travel and physical effort. Nevertheless, wood was probably always plentiful within relatively short distances. While piñon and juniper were suitable and desirable for fuel and early construction needs, construction beams tended to be selected from long, straight conifers (ponderosa pine, Douglas fir, spruces, and true firs) when they were easily available. In contrast, for example, the mission pueblo at Las Humanas, near Mountainair, New Mexico (Hayes 1981:42), located some distance from ponderosa pine forests, relied primarily on piñon vigas (101 of 113 specimens; 89 percent), whereas ponderosa pine and Douglas fir timbers were rare (2 of 113; 2 percent). Juniper, while readily available, was mostly rejected for such use (9; 8 percent).

By the time of the founding of the Pecos North Pueblo, construction in the valley reflected the use of these desirable resources for the last half millennium. The major exception is the use of rot-resistant juniper for posts, a standard throughout time still applicable today. At Pecos Pueblo, posts were almost always juniper, although many were used on upper stories where protection from the ground and natural elements would have allowed more easily-cut ponderosa pine to be used. Nevertheless, either tradition, practicality, or both helped to perpetuate the nearly exclusive use of juniper for portico posts (Table E.10). This tradition was wide spread in the Rio Grande region and can be observed in the mounds of other Pueblo IV sites (e.g., Sapawe and Tsama in the Chama River Valley, northern New Mexico) where juniper posts still are evident after 500 years. Ponderosa pine in porch settings facing south would quickly weather and lose its aesthetic appeal. In addition, the distance to obtain such pine may also have made the local juniper trees preferable for both construction and firepit fuel.

All the in-situ wood found at the Hispanic homesteads were juniper posts used for enclosing areas and for wall supports. Juniper may also reflect the harsh times, when raiding was common and isolated parties, wood cutters for instance, may have felt at peril harvesting wood far from their settlement. Homestead occupants also needed to clear the thick juniper growth from their lands for gardens, livestock, and defense. At Tex Austin's ranch, the small sample of fence posts was juniper, and it is evident that the remainder were also juniper. At Kozlowski's, however, porch posts, set on concrete slabs, were of ponderosa pine. This shift in species probably reflects the ease of obtaining commercial-cut timbers, the lack of soil contact when in use, and the esthetics of straight, uniform-shaped posts.

When the railroad arrived in 1879/1880 and mining became a prominent industry, the appetite for wood in the Upper Pecos Valley soared. Woodcutting provided the first widespread opportunity for wage labor for the inhabitants of Pecos (Weber 1972:29-30). The first camps for procuring railroad ties were established by 1881 (Hall 1984:176), but within twenty years, the federal government established the first New Mexico Forest Reserve to protect the surrounding mountains from ravage. The demand for railroad ties and mine shaft timbers led to extensive harvesting of the forests in the Pecos Valley. By the 1910s and 1920s, census figures (see Chapter 10) report that many residents in the region were

employed in forestry. It is also probable that by the turn of the century (1900), milled lumber from local mills shipped via the railroad began the shift away from the use of local-cut logs for construction. Only one sample, from Kozlowski's tack shop, reflects this aspect of the railroad economy (although unsampled milled lumber is common). By the early 1900s, then, most construction probably relied on mill products rather than direct forest procurement, reducing specialized viga treatment to a few village craftsmen.

Tree-Ring Dating Success

Because of its tough, resilient wood and availability, juniper was favored for much of the construction material in the valley. Almost all posts were juniper throughout the ages, and it was also a favorite material for roof closing materials and slat wall liners in kivas. Unfortunately, in the Upper Pecos Valley juniper is exceedingly difficult to date. This is surprising given the presence of *J. scopulorum,* a species common north of the San Juan River and a reliable producer of tree-ring dates at Aztec and Mesa Verde. Precipitation at Mesa Verde (Erdman et al. 1969:19) is similar to that at Pecos. Only a mere 18 specimens of 257 juniper elements dated—a success rate of seven percent. Many of these were afflicted with the usual maladies that cause poor dating success: erratic ring growth was found in 52 specimens (20 percent), sometimes along with double ring growth (12; 5 percent).

Also surprising is the widespread growth of juniper with inadequate ring series for dating. In this study, these were tallied as "short" in the laboratory, generally meaning less than about 50 rings. Here, 100 specimens (39 percent) were short, products of rapid growth. These were particularly evident among the Pecos Pueblo posts (Table E.5) sampled recently: 59 of the 115 (51 percent) juniper samples had a short ring series. Fourteen others were noted with complacent growth (5 percent), many from the Hispanic homestead site PECO-175, where 5 of 13 samples (38 percent) were complacent. The location of this site along the Pecos River, where many juniper grow, may account for this unusual pattern. Other nearby homesteads, however, failed to repeat this pattern. Complacent and short juniper specimens are extremely uncommon in the drier San Juan Basin or in Mesa Verde. Perhaps less evapotranspiration of the available moisture in the Upper Pecos Valley allows for faster juniper growth. Clearly, the mountainous region in which Pecos is located has far less summer moisture deficiencies than the northwestern plateau (Tuan et al. 1973:128-142). However, piñon, with growth similar to juniper and favoring the same conditions, exhibited very little short or complacent growth (2 and 3 each, respectively; 2 and 3 percent).

Douglas fir provides the best dating success: 96 of 103 specimens (93 percent). Piñon, like juniper, sometimes suffers from erratic growth 14 of 94: 15 percent), here the chief cause of non-dating. Nevertheless, it yielded a successful dating record: 66 of 93 samples (71 percent). Unidentified spruces and true firs also were reliable specimens for dating: 10 of 18 (56 per cent). At Aztec Ruins, spruce and true fir seldom date, whereas in Chaco Canyon they are reliable at Pueblo del Arroyo, but poor at other great-houses. Ponderosa pine, a favored building material used primarily for roof vigas, also yielded an excellent return in the Pecos Valley: 423 of 554 specimens dated (76 percent). Naturally, the profuse use of ponderosa pine for vigas and other large-diameter items helped the dating success, which would have been considerably lower for smaller elements with few rings. Given the plentiful availability of trees preferred for structural uses, it is not surprising that the less desirable cottonwoods and aspens were not present in the sample. Their absence from the pueblos may stem from their unsuitability for tree-ring dating. Nevertheless, some aspen or cottonwood roof secondaries might be expected in the local puebloan construction.

Harvest Timing

Throughout the valley occupation, the harvest of building timbers was conducted primarily in

the warmer months of the year. Certainly, much of the area was snowbound during the winter months, making tree-harvests a more difficult task in the higher elevations. Of the 1,025 samples, only 283 yielded determinations of the outer growth ring's completeness. Few historic samples yielded outer ring determinations because the vast majority were squared timbers (the mission samples) or had the bark removed with a draw blade, resulting in uneven outer surfaces that forced laboratory determinations of non-cutting dates. In addition, many historic samples were badly weathered juniper posts, which rarely dated.

Of the sample, the vast majority of timbers over the past 1,100 years were cut during the tree's growing season (77 percent; 220 samples). The highest percent (95%) of samples harvested during the growing season came from Kozlowski's. This could be skewed by the almost exclusive use of a draw knife to remove bark, which probably removed much of the outer growth ring and prohibiting seasonal assessment for most of the historic sample. The earlier Puebloan sample also follows a preference for summer tree harvesting (99 of 116; 85 percent). At the Hispanic villages of Pecos and San Miguel, however, the preference for summer growing season harvests was not as dramatic (54 and 61 percent of the sample, respectively). When Douglas fir and undifferentiated spruce-fir elements were found in the samples, notably at Pecos Pueblo and Kozlowski's, the majority reveal harvesting during the very short growing season in the late spring. If these were collected during the same period when other species were harvested, it suggests that much of the work was scheduled in the spring before major commitments to farming. The differences between the Puebloan and Hispanic harvests may reflect different levels of group cohesiveness or cultural preferences. Nevertheless, the overall trend in the valley was to harvest construction timbers during the warmer months when trees were in the growth stage.

Pecos Pueblo was one of the most prolific arenas for cutting dates, but the scattered results suffer compared to a more robust sample of clustered dates from individual proveniences. Two eras provide glimpses of harvesting schedules. Some harvesting of ponderosa pine, perhaps indicative of a massive effort, took place between 1433 and 1435. In 1433, the sole two samples were cut during the dormant season ("complete" outer ring) between about October 1433 and March 1434. This was followed by several cut during the growing season ("in complete" outer ring) of 1434—indeed, the two episodes could have been coeval in the late spring of 1434 (see Windes and McKenna 2001 for non-Pecos examples). Others yielded 1434 dates from the dormant season—again, sometime between October 1434 and March 1435. More samples were cut during the growing season in 1435, etc. Two probable harvest scenarios are indicative from this small sample. Either harvesting was a biannual event, occurring during the growing and non-growing seasons, or, as suggested here, harvests occurred in the spring, coeval with the beginning of the growing season between about April and May. Thus, most trees had started growth when cut, yielding dates for the year in which they were cut. Others, however, had not yet begun to grow, thus producing dates for the previous year.

Spruce/true fir and Douglas fir cutting dates can provide a narrow temporal window for dating harvest episodes. Of the 16 samples from Pecos Pueblo, 12 were cut during their extremely short spring growing season. Although studies have not been done to identify this exact period for the Pecos Valley, it probably mirrors other high-altitude, cool terrains—probably between late March and mid-June (Windes and McKenna 2001:124). The A.D. 1427 samples of spruce/true fir were cut during the growing season, too. Early spring is the ideal time to harvest trees to avoid scheduling conflicts with other activities and the best time to remove the bark by hand (Windes and McKenna 2001:125). Although tree resources were clearly always close and abundant, random or intermittent harvesting through out the year does not seem to be a prevalent pattern.

Labor Investments

The use of wood in the Pecos Valley sheds some light on the cultural organization of the various procurement groups. The settlement shift through time from scattered pithouses to a large communal dwelling housing hundreds of people and to a population scattered in hamlets about the valley might reflect shifts in labor demands for construction. The amount of structural wood needed for Pecos Pueblo would have been high, but spaced over centuries. Nevertheless, Pecos Pueblo does not seem to have been built by suprahousehold groups or highly organized labor gangs that characterize, for instance, Chacoan great-houses. Nevertheless, the wood data is poor from the pueblo, which prevents confident assessments of population dynamics and aggregations (i.e., see Crown 1991).

Construction of the mission churches, however, would have required a short massive effort on the part of the Puebloan Indians. Wood requirements alone would have required cutting and hauling large trees at some distance from the pueblo, though nowhere near the 30 miles required to haul in the 35-foot long beams used for the mission church at Acoma (Playdon and Vallo 2000:21). In addition, shaping the logs, splitting out boards, decorating the beams, and then hoisting them into place would require labor crews and supervisors. Given the mere 78 beams reported by Dominguez (Adams and Chavez 1956:209) for the 1706 Pecos Mission Church, such an endeavor would not have required extensive long-term demands on the populace.

Harvesting and transportation of the massive mission beams to the site would have required substantial coordination and effort, however. Construction at the Taos Mission Church in about 1815 is illustrative for understanding earlier events at Pecos (Hooker 1996:30, 34-37). The Taos church construction may have been primarily a warm-month effort. The 80 or more vigas and columns, up to 32 feet long, were cut in the fall before the snow fell or in early spring before the thaws and deep mud hampered progress. Logs were pulled from the mountains by teams of oxen. Whether such prized and valuable animals were available earlier on the Pecos frontier for similar tasks is not known. The Taos timbers were peeled of bark at the church with draw knives or hand adzes and then trimmed with hand saws. Those at Pecos were squared with a broad ax. Boards or split lengths of wood covered the Taos vigas (Hooker 1996:37), but these were hewn from juniper. The largest beams spanning the Taos church nave, weighing between 700 and 800 pounds, would have required teams of men to hoist them to the wall tops and carry them into position. The 42-foot-long Pecos beams, of course, would have been even more arduous to place. Beams needed to span the smaller rooms were sometimes brought to the work site two or three times longer than required to be temporarily employed for scaffolding and then later subdivided as need dictated (Montgomery et al. 1949:158).

Eight men would have taken about 70 days to produce the needed 85,000 adobe bricks needed for the Taos church (Hooker 1996:34); requirements at Pecos would have been greater, although a larger work force could have substantially reduced production time. The Pecos "Lost" Church required 82,000 bricks and 27 months to build (Ivey 1996). Construction of the Ortega/Juarez church, completed in 1625, could have been built at a rate of 5,500 to 6,500 adobe bricks a month (Ivey 1996:3-9, Chapter 11:10), utilizing about 224,000 to 300,000 bricks (Kessell 1980:224; Noble 1994:45) and taking 34-41 months to complete. When the Pecos church and convento were stabilized in 1939-1940, about 89,000 adobe bricks were required to complete the work (Hewett and Fisher 1943:229). Church building was clearly an arduous but short-term task.

All metal tools needed to facilitate construction had to be brought great distances by caravan (Montgomery et al. 1949:145), while engineering skills in building such huge edifices were borne by the resident friars. "Possessing little knowledge of the science of architecture, and no engineering background, the friars relied upon common sense judgment and casual experience. They depended particularly upon an over-abundant use of materials; this offset,

so they thought, their ignorance of the exact strength and properties of the structural elements.... That any of this poorly constructed work stands today is rather miraculous" (Montgomery et al. 1949: 154).

The Pecos Indians, widely known for their skill in carpentry, did considerable finishing work and carving of the beams. Chavez (1971:32) remarks that all the vigas and corbels, on which the vigas sat, were "thickly decorated with carvings." Some carvings are still evident for in-situ specimens, although their workmanship cannot be considered superior. A distinctive set of corbels was carved for the temporary 1692-1696 Zeinos chapel sacristy (Ivey 1996:12-16). These were not reused later in the new church. Perhaps they eventually ended up in Los Colonias.

Their renowned skills drew the Pecos carpenters to projects outside the Pecos Valley (Kessell 1979:292). They worked on the Governor's Palace in Santa Fe in 1660 for Governor Lopez de Mendizabal, who failed to pay for the services (Dede Snow, email communication 2000)—surely an aggravation to the Pecos carpenters. They may also have provided the craftsmanship for the carved beams in the Salinas Province missions (Ivey 1988:219) and they worked on the mission at Santa Ana Pueblo (Kessell 1979:292) in 1696. The demand for skilled carpenters throughout the Spanish provinces may have been one factor in drawing away inhabitants from Pecos Pueblo, resulting in its population decline in the late 1700s and its ultimate demise (Chavez 1971:33).

This traditional skill failed to carry-over to the emerging Hispanic settlements, where building materials fulfilled expedient construction goals. Buildings from the earliest Hispanic period generally exhibited a range of finished wood suggestive of multi-family or community projects where neighbors and kin helped during construction. Much of this period, as reflected in the surviving buildings rich in Pecos River Valley history, is slowly being lost to building deterioration and to replacement by trailer homes and new frame houses.

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<<< Previous <<< Contents>>> Next >>>

Last Updated: 13-Feb-2006

PECOS

From Folsom to Fogelson:

The Cultural Resources Inventory Survey of Pecos National Historical Park

APPENDIX F:

Site Number Concordance

List of Tables

F.1. Sites listed by PECO number, LA number, and Site Name. (PDF Format)

F.2. Sites listed by LA number, PECO number, and Site Name. (PDF Format)

<<< Previous <<< Contents >>> Next >>>

peco/cris/appf.htm
Last Updated: 13-Feb-2006

PECOS

From Folsom to Fogelson:

The Cultural Resources Inventory Survey of Pecos National Historical Park

APPENDIX G:

Pecos Cultural Resources Inventory Survey Euro-American Artifact Data Base: Functional and Descriptive Data Tables

Table G.1. National Park Service data base: number of cans by site and general function.

PECO No.	General Function	Count
135	Food Production/Consumption	5
135	Indulgences/Entertainment	1
135	Unknown	1
143	Food Production/Consumption	83
143	Indulgences/Entertainment	39
143	Construction/Maintenance	7
143	Personal Effects	2
143	Unknown	11
175	Food Production/Consumption	3
175	Unknown	1
226	Food Production/Consumption	38
226	Indulgences/Entertainment	1
233	Food Production/Consumption	13
233	Indulgences/Entertainment	5
233	Construction/Maintenance	1
233	Transportation	1
233	Unknown	37
234	Food Production/Consumption	51
234	Indulgences/Entertainment	1

240	Food Production/Consumption	1
249	Food Production/Consumption	1
249	Indulgences/Entertainment	1
249	Unknown	2
288	Food Production/Consumption	95
288	Unknown	5
329	Food Production/Consumption	1
339	Food Production/Consumption	20
339	Indulgences/Entertainment	5
339	Unknown	33
357	Food Production/Consumption	11
357	Unknown	5
366	Food Production/Consumption	18
366	Domicile	1
366	Transportation	1
366	Unknown	1
367	Food Production/Consumption	48
367	Indulgences/Entertainment	1
367	Unknown	33
378	Food Production/Consumption	8
378	Indulgences/Entertainment	1
378	Unknown	5
425	Food Production/Consumption	59
425	Indulgences/Entertainment	9
425	Transportation	1
425	Unknown	2
426	Food Production/Consumption	2
439	Food Production/Consumption	1
446	Food Production/Consumption	15
446	Indulgences/Entertainment	2
446	Multi-function	1
446	Unknown	24

475	Food Production/Consumption	45
475	Indulgences/Entertainment	20
475	Domicile	36
475	Construction/Maintenance	13
47	Transportation	6
475	Unknown	4
495	Food Production/Consumption	500
495	Indulgences/Entertainment	43
495	Domicile	5
495	Construction/Maintenance	373
495	Transportation	21
495	Unknown	10
504	Food Production/Consumption	6
504	Construction/Maintenance	1
540	Food Production/Consumption	2
548	Food Production/Consumption	4
548	Indulgences/Entertainment	7
548	Domicile	1
548	Construction/Maintenance	3
548	Multi-function	1
548	Unknown	2
560	Food Production/Consumption	2
560	Unknown	1
615	Food Production/Consumption	3
615	Unknown	1
638	Food Production/Consumption	6
659	Food Production/Consumption	325
659	Domicile	15
659	Construction/Maintenance	6
6S9	Medical/Health	1
659	Unknown	8

Table G.2. National Park Service data base: number of sherds by site and ceramic type.

PECO No.	Ceramic Type	Count
139	White ware, untyped	1
139	White ware, annular	2
143	White ware, untyped	2
143	White ware, flow blue	3
143	White ware, annular	2
143	Fiesta ware	2
175	Tewa Polychrome	1
175	Plain Black	1
175	Cimarron Micaceous	1
175	White ware, untyped	29
175	White ware, annular	3
175	White ware, flow blue	4
175	Stoneware	1
175	Porcelain	13
175	Unknown	1
226	White ware, untyped	2
226	White ware, decalcomaina	3
240	Unknown	7
251	White ware, untyped	4
251	White ware, annular	14
251	Stoneware	2
270	Unidentified gray ware	5
270	Plain gray	1
270	Micaceous Plain	6
270	Unidentified Native White ware	2
270	Tewa Polychrome	1
270	Plain Black	1
270	Unknown Euro-American	2
270	White ware, untyped	1
270	White ware, annular	7
270	White ware, flow blue	2
270	Pearl ware, overglaze handpainted	1
270	Stoneware	1
270	Stoneware	2
270	Rockingham[a]	1

475	White ware, untyped	1
475	White ware, flow blue	11
475	White ware, transfer print	6
475	White ware, annular	1
475	Fiesta ware	6
495	Unknown Euroamerican ware	5
495	White ware, untyped	20
495	White ware, decalcomania	3
495	White ware, annular	10
495	White ware, ironstone	5
540	Tewa Polychrome	4
540	Pojoaque Polychrome	1
540	Ogapoge Polychrome	3
540	Plain Black	5
540	Kapo/Tewa Black	3
540	Ocate Micaceous	6
540	White ware, untyped	6
540	White ware, annular	4
540	White ware, sponged	1
540	White ware, transfer print	1
540	Pearl ware	9
540	Pearl ware, Gaudy Dutch	1
540	White ware, blue shell edge	1
540	White ware, annular	1
540	Porcelain	7
540	Unknown	1
541	Biscuit B	1
541	Ocate Micaceous	1
541	White ware, untyped	38
541	White ware, annular	1
541	White ware, flow blue	1
541	Pearl ware	3
541	Porcelain	18
541	Rockingham*	1
541	Yellow ware	1
656	White ware, transfer print	4
659	White ware, flow blue	2
659	White ware, annular	1

[a]Rockingham examples are probably Albany-slipped stoneware. The one sherd classified as Rockingham that was available for analysis was indeed Albany-slipped stoneware. Rockingham was almost universally applied to yellow wares.

Table G.3. National Park Service data base: number of glass artifacts by site and type.

PECO No.	Type	Count
135	Liquor	14
135	Medical	13
135	Unknown	6
139	Plate (dish)	2
139	Beer	15
139	Plate glass	3
139	Unknown	1
143	Bottle, food	5
143	Jar	6
143	Canning jar	3
143	Bowl	1
143	Soda	2
143	Liquor	20
143	Perfume	1
143	Medical	2
143	Jar	2
143	Windshield	3
143	Other	3
143	Unknown	16
175	Bottle, food	9
175	Wine	4
175	Medical	46
175	Plate glass	3
175	Unknown	82
226	Bottle, food	2
226	Wine	1
233	Bottle, food	1
233	Jar	5
233	Beer	200
233	Wine	52
233	Liquor	9
233	Unknown	27
234	Bottle, food	41
240	Unknown	6
249	Cup/glass	1

249	Unknown	1
270	Medical	1
270	Plate glass	15
270	Windshield	1
270	Unknown	16
288	Medical	12
294	Unknown	7
301	Bottle food	30
329	Liquor	15
329	Unknown	47
339	Bottle, food	239
339	Jar	2
339	Cup/glass	8
339	Wine	1
339	Cold cream	4
357	Bottle, food	9
357	Unknown	3
366	Bottle, food	29
366	Beer	21
366	Wine	42
366	Liquor	1
366	Unknown	22
367	Unknown	1
367	Bottle, food	1
367	Jar	12
367	Wine	1
367	Cold cream	8
367	Perfume	2
367	Medical vial	1
367	Medical bottle	5
367	Other	2
367	Unknown	247
378	Bottle food	18
425	Bottle, food	4
425	Beer	4
425	Unknown	3
426	Beer	1
426	Unknown	1
439	Liquor	1
475	Bottle, food	4
475	Canning jar	3
475	Soda	10
475	Liquor	7
475	Cold cream	1

475	Perfume	1
475	Medical vial	1
475	Medical bottle	1
475	Unknown	6
495	Bottle, food	11
495	Jar	1
495	Canning jar	1
495	Beer	4
495	Soda	31
495	Wine	23
495	Liquor	18
495	Cold cream	3
495	Perfume	2
495	Medical vial	1
495	Medical bottle	10
495	Other	3
495	Unknown	3
495	Unknown	22
540	Wine	5
540	Plate glass	2
540	Unknown	1
541	Bottle, food	2
541	Soda	1
541	Wine	2
541	Cold cream	4
541	Perfume	4
541	Medical bottle	5
541	Plate glass	13
541	Unknown	3
548	Bottle, food	1
548	Soda	5
548	Liquor	9
548	Other	1
548	Unknown	4
638	Bottle, food	45
638	Medical	2
656	Plate glass	2
659	Bottle, food	5
659	Jar	8
659	Beer	1
659	Wine	1
659	Liquor	1
659	Medical vial	1
659	Medical bottle	2

659	Other	1

Table G.4. National Park Service data base: number of glass artifacts by site and color.

PECO No.	Color	Count
135	Amber	6
135	Natural (light green)	14
135	Other	13
139	Purple (solarized)	1
139	Clear	15
139	Green	5
143	Amber	12
143	Purple (solarized)	8
143	White	2
143	Clear	36
143	Green	2
143	Natural (light green)	5
175	Amber	43
175	Purple (solarized)	25
175	Aqua	1
175	Clear	13
175	Black	4
175	Natural (light green)	58
226	Clear	2
226	Green	1
233	Amber	208
233	Purple (solarized)	11
233	Clear	61
233	Other	14
234	Amber	31
234	Aqua	6
234	Clear	4
240	Amber	6
249	Amber	1
249	Natural (light green)	1
270	Amber	1
270	Purple (solarized)	1
270	Clear	30
270	Natural (light green)	1
288	Clear	12
294	Amber	5

294	Natural (light green)	1
294	Other	1
301	Natural (light green)	30
329	Purple (solarized)	19
329	Aqua	4
329	Black	1
329	Natural (light green)	20
329	Other	18
339	Amber	75
339	White	4
339	Clear	165
339	Green	2
339	Other	8
357	Amber	1
357	Purple (solarized)	2
357	Natural (light green)	9
366	Amber	74
366	Purple (solarized)	24
366	White	1
366	Aqua	11
366	Clear	1
366	Black	1
366	Natural (light green)	3
367	Amber	44
367	Purple (solarized)	37
367	White	9
367	Clear	98
367	Black	1
367	Green	5
367	Natural (light green)	85
367	Other	1
378	Green	18
425	Amber	5
425	Purple (solarized)	2
425	Aqua	1
425	Clear	2
425	Natural (light green)	1
426	Amber	1
426	Aqua	1
439	Clear	1
475	Amber	8
475	White	1
475	Clear	19
475	Green	2

475	Natural (light green)	4
495	Amber	22
495	Purple (solarized)	1
495	White	4
495	Clear	70
495	Green	24
495	Natural (light green)	8
495	Other	4
540	Purple (solarized)	1
540	Black	5
540	Natural (light green)	2
541	Amber	1
541	Purple (solarized)	7
541	White	4
541	Black	1
541	Natural (light green)	21
548	Amber	9
548	Purple (solarized)	3
548	Clear	2
548	Green	5
548	Natural (light green)	1
638	Natural (light green)	47
656	Clear	2
659	Amber	1
659	Purple (solarized)	1
659	Clear	16
659	Green	1
659	Natural (light green)	1

<<< Previous <<< Contents>>> Next >>>

PECOS

From Folsom to Fogelson:
The Cultural Resources Inventory Survey of Pecos National Historical Park

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<<< **Previous** <<< **Contents**>>>
