HOPI USE AND DEVELOPMENT OF WATER RESOURCES IN THE LITTLE COLORADO RIVER DRAINAGE BASIN OF ARIZONA: AN ARCHAELOGICAL PERSPECTIVE TO 1700

Prepared for

The Hopi Tribe

In Conjunction with Adjudication of
Little Colorado River Water Rights

by

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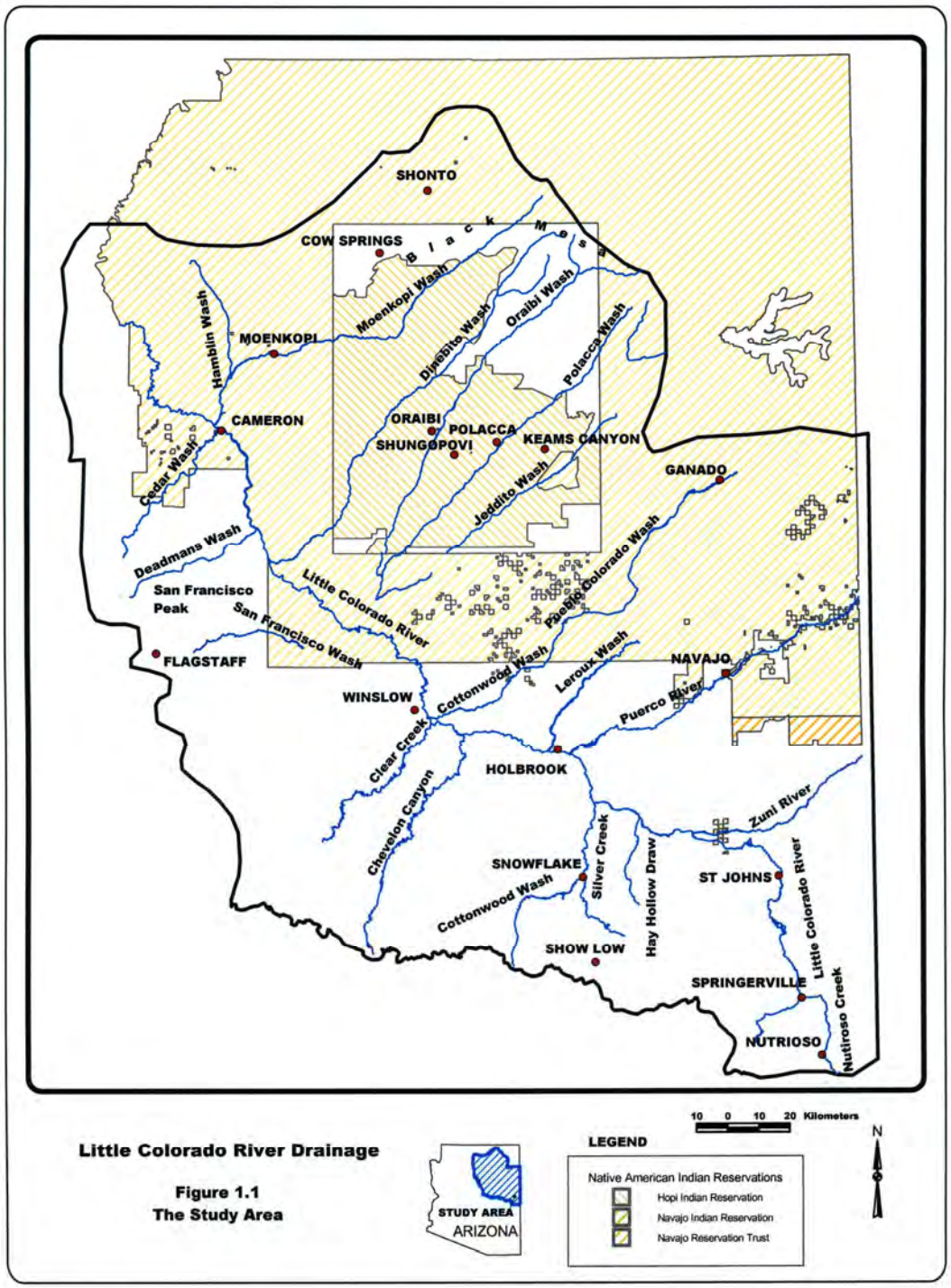
CHAPTER 1

Introduction

This report documents use of water within the Little Colorado River drainage basin of Arizona (hereinafter referred to as ñthe basinò) during the period of A.D. 1 to 1700 (Fig. 1.1). The data to evaluate water use by all ethnic groups was compiled using archaeological evidence supplemented by documents to contextualize the archaeological inferences. Whereas there is abundant archaeological evidence of Hopi and ancestral Hopi use of the basin during this period, archaeological evidence of use by Paiute, Havasupai, and Navajo is extremely sketchy and even questionable prior to 1700. Therefore, discussion of these groups will be left to the documentary evidence taken up in the reports of other experts. The missions at Hopi villages established in 1630 by Spaniards mean they are the only other group that has firm archaeological evidence of their existence in the basin predating 1700. The end date of 1700 is used because it corresponds with destruction of the Hopi village, Awatovi, with the relocation of its descendents to other Hopi villages. Both the Hopi and Spanish mission portions of Awatovi were excavated by archaeologists in the 1930s and thus there is an extensive archaeological record through this date. In chapter 4 on the historic period, some archaeological evidence of changes in Hopi land use derived from material collected by excavations at Walpi Pueblo on First Mesa is also reported.

Thus, the emphasis of the report is on the Hopi and their ancestors, as the principal occupants of the area during the time in question. The report provides support for the Hopi contention that they were the first occupants of the Little Colorado River drainage basin in Arizona and were the first to use the water resources in the area. This use was primarily domestic and agricultural, and occurred before ancestors of Euro-American, Paiute, Havasupai, or Navajo were in the basin using its water.



Little Colorado River Drainage

Figure 1.1
The Study Area

The Hopi people and their ancestors, whom the Hopi call Hisatsinom, have used or occupied nearly all of the Little Colorado River drainage basin in Arizona over a 20-century period. Throughout this period these prehistoric and historic people have been either sedentary or semi-sedentary ï depending at least in part on maize and other domestic crops for their subsistence. Much of the basin is arid or semiarid. To successfully grow the domestic crops essential to their existence the management or control of water was often required.

People of European descent, all associated with Spanish occupation of the New World, did not settle anywhere in the basin until the establishment of the mission at Awatovi in 1629, followed by others at Shungopavi and Oraibi before 1640. These missions and all Spanish occupation in the basin ended in 1680 with the Pueblo Revolt, although an abortive attempt to reestablish a mission at Awatovi by Franciscan friars was attempted in 1700. This ends the history of the region considered in this report.

Because the earliest observation of Paiute and Havasupai in the study area dates to 1776 in written documents, and there is no archaeological record prior to 1700 (Bolton 1950:120-21, 231), they will not be considered in this report. For similar reasons and because the evidence is also much more clearly addressed using documentary evidence, no discussion of archaeological evidence for Navajo presence in the basin prior to 1700 will be presented. The archaeological evidence derived from extensive computerized records kept at the Arizona State Museum, University of Arizona, indicates the only extensive occupation of the basin was by the Hopi and their ancestors prior to 1700.

The roots to the people known today as Hopi are traced by historical documents to 1540 and by the archaeological record to the 13th century (Brew 1949b). Ancestors to these large village builders can be traced back several hundred more years. There is no question that the

Hopi have lived in the present villages and in many others in the basin before any other known groups, including the Paiute, Navajo, Havasupai, and Euro-Americans based on the archaeological record. The agricultural basis to the Hopi and their ancestors has required water use and control for at least 1000 years.

The purposes of this report are: (1) to demonstrate the clear precedence of Hopi occupation and use of water within the Little Colorado River drainage basin in Arizona over any other claimants; (2) to demonstrate the nature, extent, and time depth of Hopi water use in the basin. To accomplish this task the report is divided into a number of sections based on three time periods and several spatial divisions, all of which will be discussed below.

1.1 The Archaeological Record

Preservation of water control features in the archaeological record is spotty at best. Often built where water flows, they have frequently been washed away or buried by alluvium. Nevertheless, in some areas patterns of water use have been preserved or extensive research has helped clarify the archaeological record. These areas will be focal points for discussions of the physical evidence and will help clarify the archaeological record that is present in the basin, but due to the paucity of archaeological work, simply is not well known. The areas that are relatively well known are: (1) Wupatki National Monument for the prehistoric period, which is situated along the lower Little Colorado River north of Flagstaff and southwest of the Hopi Mesas in the southwest quarter (rim area) of the basin; (2) the Homolovi Ruins State Park and vicinity for the protohistoric period, which is located along the Little Colorado River just north and east of Winslow and directly south of the Hopi Mesas in the plateau area; and (3) the vicinity of Awatovi in the Jeddito and Polacca valleys in the historic period.

As one approaches the present, up to Spanish contact, the general processes at work on the Puebloan people in the basin, those dependent on agriculture for their livelihood, is one of aggregation. Aggregation means that individual villages became larger with many more rooms, fewer in number, farther apart, and have larger populations. Population figures are almost impossible to predict for such a broad area as the basin (see Figure 1.2 [Dean et al. 1994:74; Fish et al. 1994:147] for three examples of population curves based on estimated number of structures inhabited that do not attempt to estimate actual population. The differences in the graphs indicated different perceptions of what the archaeological record is telling us [cp. Colton 1936; 1960:106]). The early historic records for the Hopi villages suggest that as many as 12,000 people lived in the villages in the late 1500s and this is supported by archaeological evidence (Adams, LaMotta, and Dongoske 2004:135-136; Hammond and Rey 1929:97). Certainly the entire basin could support this level of population once domestic crops became an important part of the subsistence base. There is no simple way with the present database to determine if population grew steadily, was up and down because of subsistence stress (principally droughts), or actually declined with the reduction in number of villages. By counting the number of sites it would appear that the population decreased; however, given the small size of individual habitations and their short occupation span, population may have, if not increased, at least maintained a steady state between 1200 and Spanish contact. There is no question that Spanish contact brought epidemic diseases that decimated native populations including the Hopi (Dobyns 1966). The effects of population decline may have impacted Hopi use of the basin before 1700, but the archaeological evidence is mute on this point as research has not focused on this period (Adams 1982:44-50). The devastation of the epidemics was particularly severe for village people, such as the Hopi, because the people lived in such close proximity to one another.

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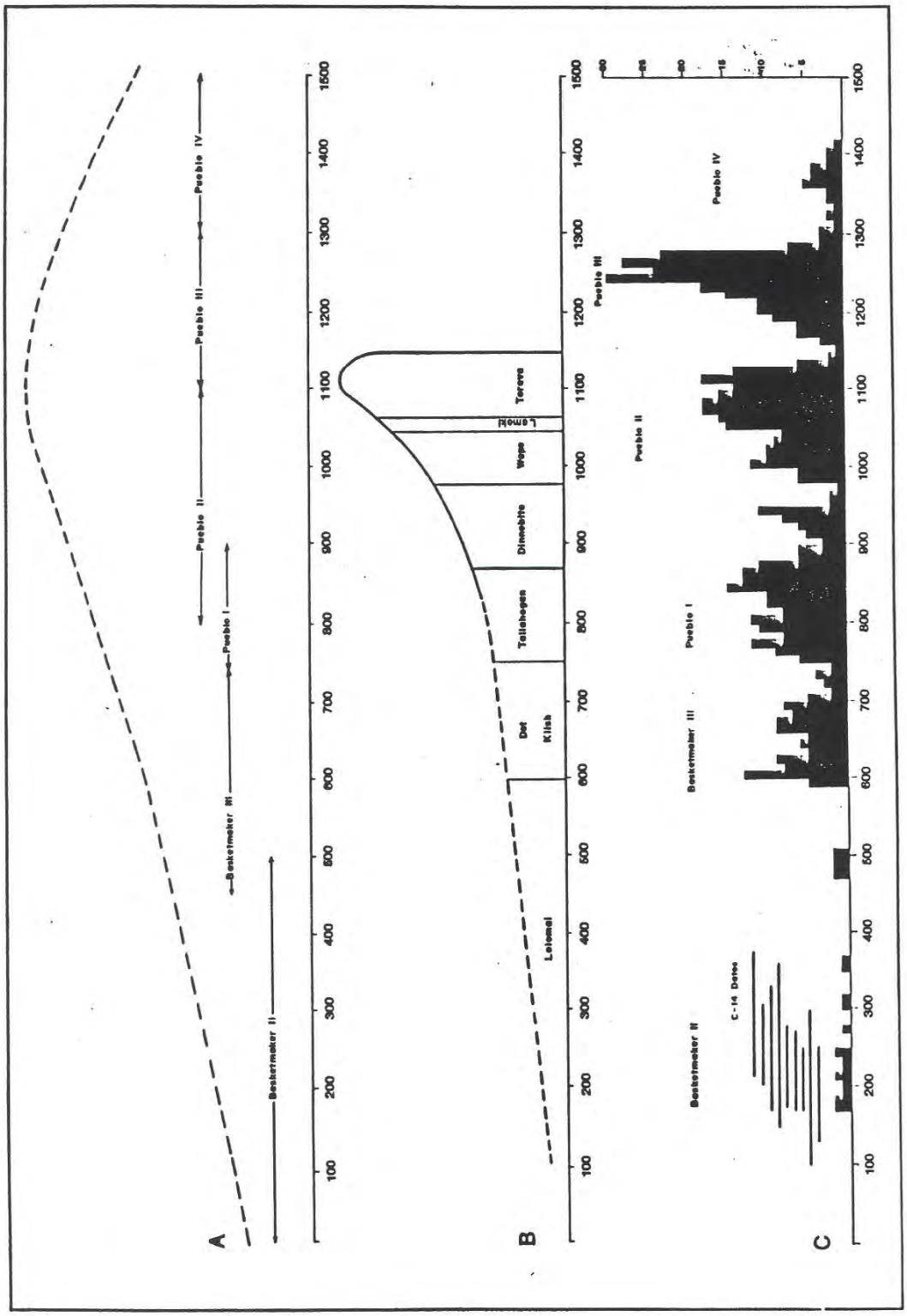


Figure 1.2 Three population curves for the study area.

To support aggregated populations in villages the size of those at Hopi required organizational structures and a subsistence strategy that evolved slowly between A.D. 1 and 1500. This development is eloquently expressed in the archaeological record of the basin. The development and maintenance of larger and larger habitations was possible because of the evolution of the social structure and the development of more sophisticated ways of growing food. The latter inevitably required the construction of systems to control water and an increase in the number, diversity, and distance of field houses from the central habitation village. Although fewer and larger sites characterize the period after 1275, water use in the vicinity of the sites both diversified and intensified. The cultural processes involved in aggregation are of considerable anthropological and archaeological interest and the basin is proving to be a rich resource area for their study (Adams and Duff 2004a; Adams, LaMotta, and Dongoske 2004; Adams 2002, 2004a). For this report, however, it is enough to say that the larger and more complex the site in the basin, the more likely water control features would have been associated with it (Bernardini and Brown 2004).

1.2 Environmental Setting

The Little Colorado River basin drains a 26,000 sq. mile area in Arizona and New Mexico, with the Arizona portion covering approximately 21,000 square miles. The basin comprises the southwest corner of the Colorado Plateau Physiographic Province. The headwaters for the Little Colorado are on the northeast flanks of the White Mountains, which rise over 11,000 ft on the Arizona-New Mexico border. Not surprisingly, the river itself cuts a low swath through the basin surrounded on the northeast and south by landforms that rise gradually to 7000 ft to 8000 ft. On the southwest the river drains the San Francisco Peaks (over 12,000 ft). The river, once it leaves the White Mountains, is at about 7000 ft at Springerville, leveling to about

4500 ft to 5500 ft through its central portion from St. Johns to below Leupp, dropping quickly in elevation to its intersection with the Colorado River at 2800 ft. The median elevation of the basin is 6000 ft (Hereford 1984:656). The Little Colorado River has dissected the Colorado Plateau in its present generally westerly path for 6 million years creating a low-relief basin. Fairly shallow washes have cut the generally gently sloped sides of the basin forming colorful mesas and cuestas (Hack 1942:3-5).

Although the basin is generally quite dry, there are precipitation and vegetation gradients that relate closely to elevation (Hack 1942:7). Table 1.1 graphically illustrates this relationship for the three plant communities in the basin and for towns in or adjacent to the basin. These differences are amplified in the summer rainy season where **convectional precipitation** (rain caused by moist air being cooled as it rises) and **orographic precipitation** (rain caused when wet air rises as it encounters higher elevations, which occur throughout the basin as high mesas and mountains, hence the name orographic or mountainous), both of which are directly tied to the effects of elevation.

Growing season is also directly tied to elevation. Elevations below 5000 ft have growing seasons over 180 days. Elevations between 5000 ft and 7000 ft have growing seasons between 130 and 180 days. Elevations above 7000 ft have growing seasons below 130 days. The growing season for the corn (maize) grown at Hopi historically is about 110 to 120 days (Hack 1942:23). Because Hopi maize also requires about 10 in (308 mm) precipitation (1942:23), the optimal conditions for dry farming maize in the Little Colorado River drainage basin occur between 5000 ft and 7500 ft. **Dry farming** is a term used by anthropologists and archaeologists to characterize fields that depend solely on snow and rainfall for moisture to grow crops, in contrast to fields that use runoff from mesas or drainages, or human-made features to enhance the natural moisture

(Hack 1942:32). Of course managing water or locating a field to profit from storm runoff can stretch productive agriculture into lower elevations or drier areas. Locating fields to avoid pockets of cold air, such as on geographic prominences, can extend the growing season above 7500 ft (2286 m). Therefore, as groups became more sophisticated in their agricultural strategies, including water management, they were able to occupy areas at lower elevations or in more arid regions. At the same time, occupation of the more marginal areas also carried greater risk.

Table 1.1. Precipitation values for selected plant communities and towns in the Little Colorado River Basin.

PLANT COMMUNITY	PRECIPITATION	ELEVATION
Ponderosa Pine	18-24ò (467-610mm)	6500-8000ô (1981-2438m)
Pinyon-Juniper	10-16ò (254-406mm)	5000-6500ô (1525-1981m)
Grasslands	<6-10ò (<152-254mm)	3500-5000ô (1067-1525m)
CITY	PRECIPITATION	ELEVATION
Flagstaff	19ò (483mm)	7000ô (2134m)
Springerville	15ò (381mm)	7000ô (2134m)
Ganado	11ò (280 mm)	6385ô (1946m)
Oraibi	9ò (229mm)	5925ô (1806m)
Holbrook	9ò (229mm)	5200ô (1585m)
Winslow	8ò (203mm)	4850ô (1478m)
Moenkopi	7ò (178mm)	4500ô (1372m)
Cameron	6ò (152mm)	4100ô (1250m)

The paleoenvironmental record of the Colorado Plateau has been painstakingly determined by an interdisciplinary research effort (Dean et al. 1985; Euler et al. 1979; Van West 1994). This research has clearly pointed out the marginal nature of the climate for the entire Colorado Plateau with the Little Colorado River drainage basin being no exception. Not only is the climate generally marginal for agricultural activities, but it is also subject to fluctuations. In the past some of these fluctuations were catastrophic to the local inhabitants resulting in relocation or a change in adaptation. For example, the division between the prehistoric and the protohistoric periods for this report occurs at 1275. This is because the last quarter of the 13th century marks the inception of a major erosional period triggered by an expansive, extended drought (Dean et al. 1985; Euler et al. 1979). The drought and erosion were at least partly responsible for the migration of Pueblo groups from the Four Corners area and subsequent changes in adaptation, in particular population aggregation.

The hydrology of the basin is fairly straightforward. By definition it is dominated by the Little Colorado River. The Mogollon Rim and San Francisco Peaks, which make up the southwest and south edge to the basin, create orographic precipitation patterns that remove moisture from most storms approaching the basin causing precipitation to concentrate along this edge and decreasing precipitation within most of the basin itself. The rim country averages about 24 in of precipitation annually. This is where the Little Colorado River begins and receives water flows along its course. The Mogollon Rim is dominated by ponderosa pine forests due to these climatic conditions. According to Hereford (1984:656), this forest increases infiltration and reduces runoff. The general low slope of the basin and the prevalence of Cenozoic soils also help absorb the precipitation (1984:656). Because most precipitation falls along the rim, over 80 percent of the rest of the basin is characterized as arid to semiarid, receiving less than 12 in of

precipitation (Hereford 1984:656). Thus the flow of the Little Colorado River is less consistent than might be expected and the present flow of water is also impacted by existing dams constructed beginning in the early 1900s. In recent years, upstream from Winslow the river is often dry in June. In dry years it can be dry in May, November, December, and January as well (Hereford 1984: Fig. 2). The lower reaches of the river below Winslow are ephemeral yearly, generally with no discharge in May or June and frequently through much of the fall and early winter. The basin lies within a climatic region that has a biseasonal precipitation pattern with maxima in July through September and February through April. These combined with the effects of damming of the river and overgrazing and drought over much of the basin between 1870 and 1920 have affected the riverôs discharge (Colton 1937; Miksicek 1991). Before livestock were introduced into the valley in the 1870s and 1880s, explorers from the 16th to 19th century described the Little Colorado River as lined with cottonwood and willow groves, having extensive bogs and swamps with abundant beaver. The river itself was nearly permanent and narrow with shallow banks (Colton 1937; Miksicek 1991). Nevertheless, even today the region bounded by the Puerco River on the north and east and Clear Creek Canyon on the south and west is characterized by drainages into the Little Colorado River that have spring fed water flow much or all of the year. This is especially true in the southeast corner of the basin above 7000 ft.

The region west of the Chevelon/Clear Creek area along the southwest corner of the basin has no free-flowing washes except in the spring from heavy snow melt and occasionally in the July to September rainy season from localized, heavy thunderstorms. Most of the precipitation sinks into the deep, volcanic cinder cover and comes out at springs scattered about the area. Thus although the precipitation patterns for the southwest quarter of the basin are similar to the southeast quarter, its hydrology is dramatically different.

The northern half of the basin is generally much more arid due to the rain shadow of the Mogollon Rim and associated geographic features. The deep sandy soil and relative flat nature of this region inhibits free-flowing streams, except along short spring-fed courses. Frequent, but localized, thunderstorms of the summer rainy season can cause high runoff.

The hydrology of the basin can therefore be divided into three large geographic areas: (1) the relatively water-rich southeast quarter termed the **upper Little Colorado River area**; (2) the relatively high precipitation, but hydrologically poor southwest quarter termed the **Mogollon Rim area**; and (3) the relatively low precipitation and hydrologically poor north half of the basin, the **Plateau area**.

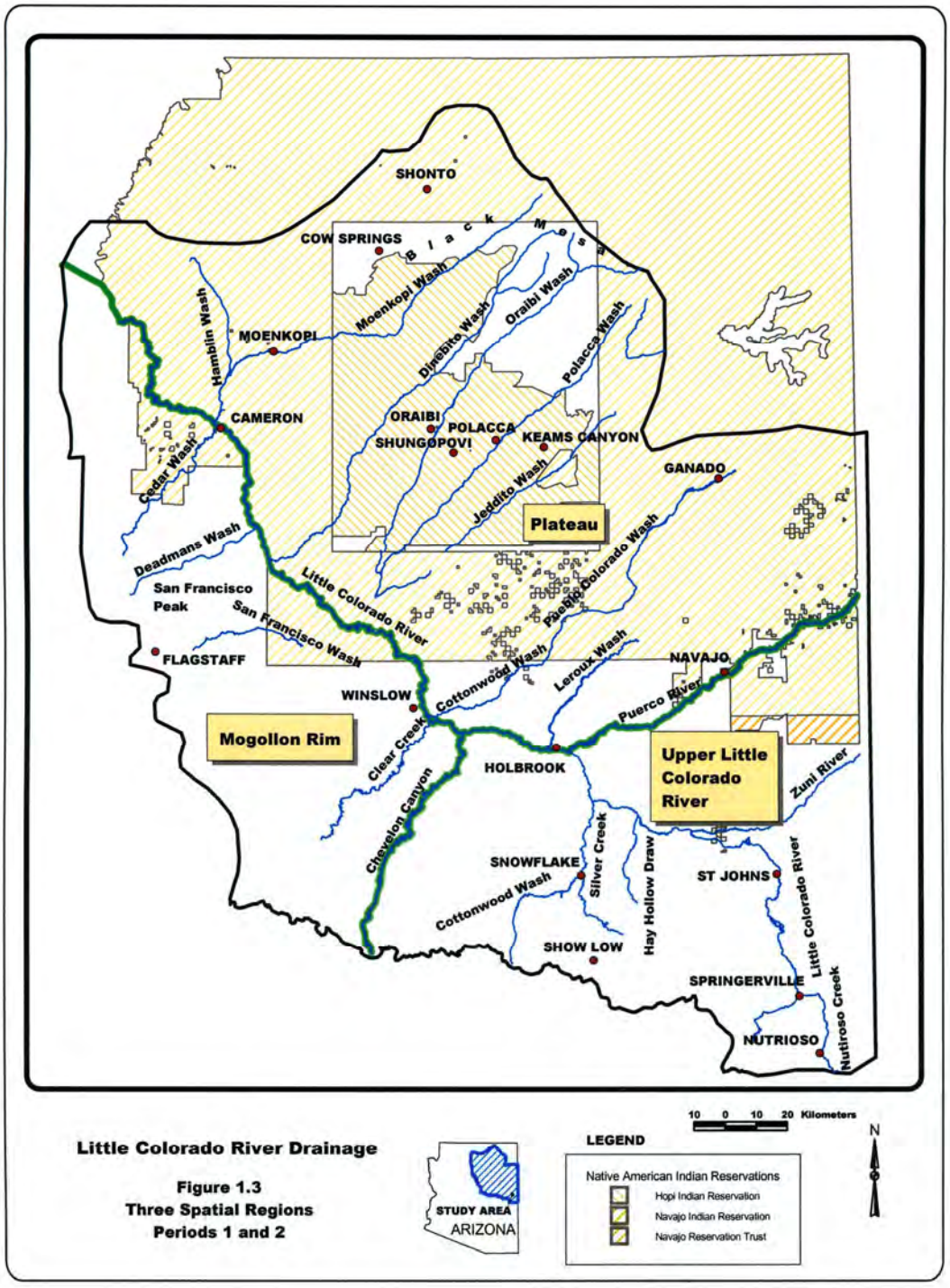
1.3 Spatial Division

Because this litigation is about water use, the availability of water both in quantity and type has been the deciding factor in dividing the basin into spatial categories. As detailed above, the basin can be divided into three spatial categories on the basis of regional hydrology ï the **upper Little Colorado River**, the **rim**, and the **plateau**. It is probably not coincidental that the three areas are also archaeologically distinct. The upper Little Colorado River, after A.D. 1000, is inhabited by the Western Pueblo, a cultural tradition that combines Mogollon and Anasazi groups. (These terms will be defined later.) The rim area was occupied by the Sinagua, the Anasazi, and to a lesser degree the Cohonina. The plateau occupants have been called Anasazi by archaeologists, which from its formal definition (Kidder 1936) was understood to apply to the ancestors of the Pueblo people, who still occupied the region, and not to any other groups. To the Hopi all of these groups are *Hisatsinom*. Therefore, to keep track of specific cultural groups, the archaeological terms will be used. Hisatsinom will be used where all groups are being referenced as one.

During the prehistoric and protohistoric periods, settlement and use of the entire basin will be discussed. For these periods the basin will be divided into the three regions discussed above: the Mogollon Rim (south of the Little Colorado River and west of Chevelon Creek), the upper Little Colorado River (the source area in the southeast quarter of the basin bounded by the Puerco River on the north, the Mogollon Rim on the south, and Chevelon Creek on the west), and the Plateau (north of the Little Colorado and Puerco Rivers). The three spatial divisions used for the report are illustrated in Figure 1.3. Figure 1.4 superimposes Hopi *tutsqua* (tutskwa) over the basin.

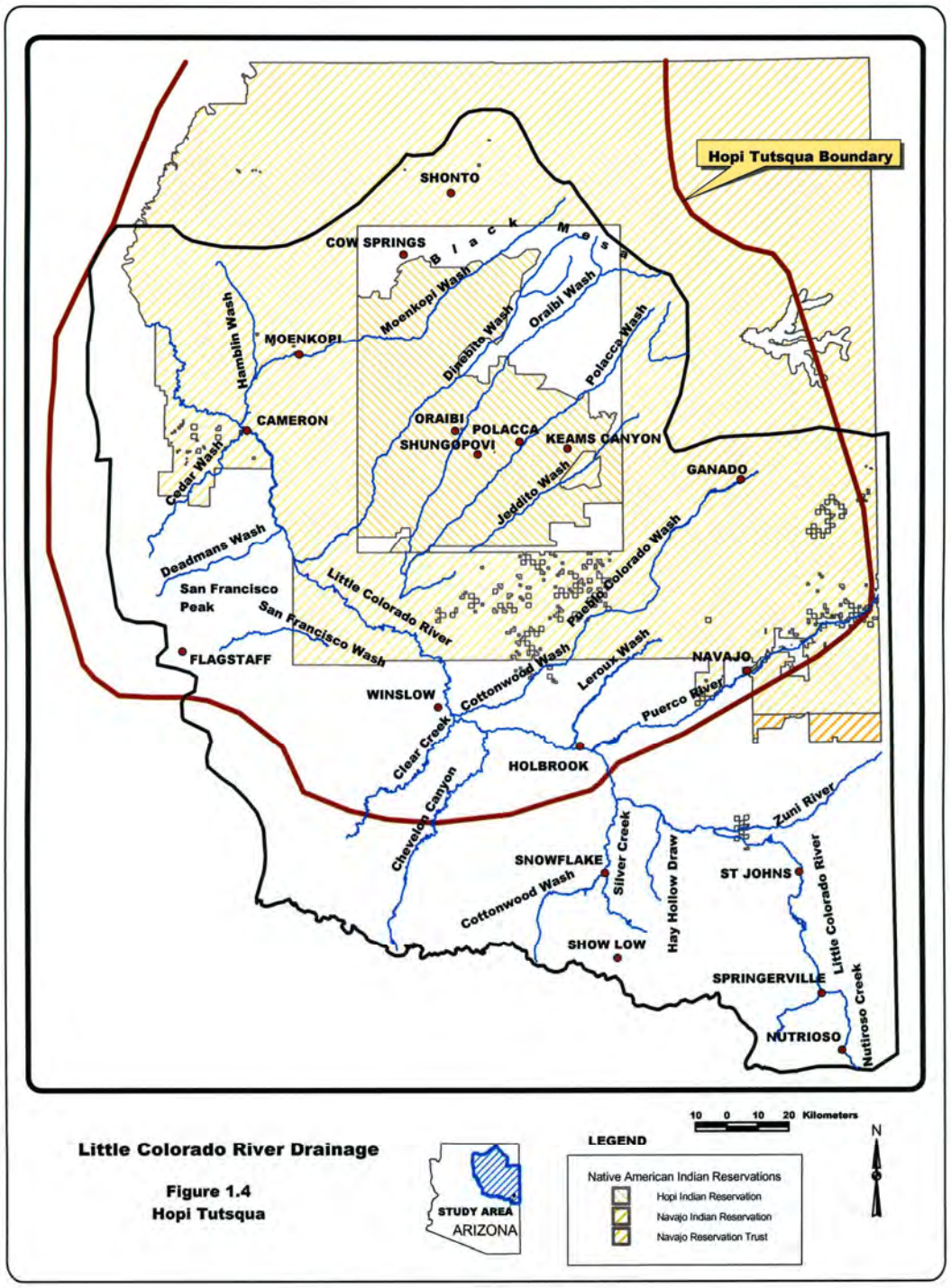
Tutsqua is a concept held by Hopi people that identifies the location of their aboriginal lands and their boundaries. The boundary defined in Figure 1.4 has remained virtually constant for more than 100 years predating major U.S. influence and surviving acculturation (Ellis 1974; Page and Page 1982:607-10). The concept of tutsqua reflects the extent of what the Hopi consider their sustaining area and which other Indian groups more-or-less respected and recognized in the past (Ellis 1974:104-109, Fig. 1; Page 1940b).

Thus the Hopi not only have aboriginal claims to much of the basin, but these boundaries were recognized by neighboring groups. Documentation through the Hopi Land Claims Case in the 1940s and 1950s and through the 1934 Boundary Case has substantiated historic use of virtually all the traditional tutsqua area (Colton 1974; Ellis 1974). Much of the Hopi use has involved farming and ranching (involving livestock introduced to the Hopi in the 17th century by Spanish missionaries), both activities requiring water and often necessitating its management or storage.



Little Colorado River Drainage

Figure 1.3
Three Spatial Regions
Periods 1 and 2


Hopi Tutsqua Boundary
SHONTO
COW SPRINGS
Black Mesa
Moenkopi Wash
Hamblin Wash
MOENKOPI
Dinnebito Wash
Oraibi Wash
Polacca Wash
CAMERON
ORAIBI
POLACCA
KEAMS CANYON
SHUNGOPOVI
GANADO
Cedar Wash
Jeddito Wash
Deadmans Wash
San Francisco Peak
Little Colorado River
Puerco River
San Francisco Wash
FLAGSTAFF
NAVAJO
Leroux Wash
WINSLOW
Cottonwood Wash
Puerco River
Clear Creek
HOLBROOK
Chevelon Canyon
Zuni River
SNOWFLAKE
Silver Creek
ST JOHNS
Cottonwood Wash
Hay Hollow Draw
Little Colorado River
SHOW LOW
SPRINGERVILLE
Nutrioso Creek
NUTRIOSO
10 0 10 20 Kilometers
N
LEGEND
Native American Indian Reservations
Hopi Indian Reservation
Navajo Indian Reservation
Navajo Reservation Trust
STUDY AREA
ARIZONA
Little Colorado River Drainage
Figure 1.4
Hopi Tutsqua

1.4 Temporal Division

One of the primary purposes for utilizing archaeological data is to build a chronological record of use in a given area. Table 1.2 charts the chronological periods according to cultural groups living within the spatial divisions defined for this research. The report describes each period by discussing the cultural groups known to be living within the spatial divisions. Specific site information for each period is summarized in map and table form. These data are derived from published reports and from archaeological site files at the Museum of Northern Arizona, Flagstaff; Arizona State Museum, Tucson; Coconino National Forest, Flagstaff; and Apache-Sitgreaves National Forest, Springerville. In all over 25,000 sites from the Colorado Plateau of northeastern Arizona are recorded in these files and are now stored in the computerized database called AZSITE. AZSITE is a state-wide database developed and managed by a consortium of land managing agencies, state and federal, and some private museums, and is available through the internet at Arizona State Museum. Approximately 13,000 of the 25,000 sites on the Colorado Plateau occur in the Little Colorado River drainage basin.

Cultural groups of a sedentary or semi-sedentary nature in the basin produced the type of remains that survived to become the archaeological record. Sedentism after A.D. 1 was possible due to the use of domestic crops for subsistence whose record in the basin goes back to at least 1000 B.C. (Smiley 2002:xx). The archaeological sites remaining from these sedentary groups represent several activities, including procurement of resources (hunting and gathering, etc.), farming, and the location of the primary residential area. The residential complex was almost invariably situated close to both a dependable water supply and arable land. Most small habitation sites, which characterized the basin before 1250-1300, were occupied fewer than 50

Table 1.2. Temporal division of the report and its relation to spatial divisions and pertinent cultural groups.

TIME PERIOD	SPATIAL DIVISIONS	CULTURAL GROUPS
Prehistoric (Hisatsinom) A.D. 1-1275	Entire basin divided into upper Little Colorado River, Rim, and Plateau	Ancestral Pueblo (Sinagua, Anasazi, Mogollon)
Protohistoric (Ancestral Hopi) 1275-1630	Entire basin divided into upper Little Colorado River, Rim, and Plateau	Ancestral Pueblo (Western Pueblo, Anasazi), Hopi after 1540
Spanish Mission Period, 1630-1700	Plateau only	Hopi, Spanish

years (Ahlstrom 1985). After 1300 this pattern changes for habitation (pueblo) sites, which generally grew in size and were occupied longer, often for one hundred to several hundred years.

Many archaeological sites are indicated only by artifacts because neither structures nor fields were preserved. These so called ñartifact scattersò, however, were probably most frequently the result of farming activities (Nichols and Smiley 1981:103; Pilles 1978; Pilles and Wilcox 1978; Rohn 1963; Woodbury 1961). They are usually associated with arable land and are usually near habitation sites. After A.D. 1000, typically half of the archaeological sites associated with sedentary groups dependent on domestic plants for subsistence were directly associated with farming, 10 to 20 percent were habitation sites, and the remaining third were non-agricultural special-use sites, such as for wild plant gathering or lithic (stone) procurement. The sites of interest for this report emphasize those associated with water use and other sites were not recorded.

Of the nearly 13,000 archaeological sites recorded in the AZSITE database for the Little Colorado River basin, almost 9000 are directly associated with food production, which is in line with the expectations noted above. About 6500 of these sites could be assigned to a cultural group. It should be pointed out that less than 10 percent of the basin has been intensively surveyed. This suggests that over 100,000 sites occur in the areas considered in this report. Table 1.3 summarizes the variety of archaeological sites recorded in the database for the prehistoric period for the archaeological cultures defined as Anasazi, Mogollon, Sinagua, and Cohonina. Table 1.4 summarizes the database for sites during the historic period for Hopi and Spanish. The Spanish presence at Hopi has been documented only within existing Hopi settlements at Awatovi (Brew 1949a), Walpi, Shungopavi, Mishongnovi, and Oraibi (Brew 1949b), thus this table does not reflect Spanish settlements as separate entities from Hopi settlements.

Table 1.3. Archaeological sites dating between A.D. 1-1630.

	Anasazi	Mogollon	Sinagua	Cohonina
Artifact Scatter	778	306	213	113
Field	348	84	295	26
Field/habitation	601	263	155	32
Field/Water Control	32	246	7	1
Habitation	1380	628	387	176
Petroglyph	129	8	5	1
Shrine	12	2	0	0
Water Control	9	11	8	0
Total	3289	1548	1071	349

Total = 6257

Table 1.4. Archaeological sites dating 1630-1700.

	Hopi
Cemetery/Burial	3
Field Location	2
Field/Habitation	3
Habitation	21*
Petroglyphs	0
Ranch/Barn/Corral	5
Shrine	2
Water Control	0
Total	36

*Spanish missions and visitas have been archaeologically documented at five Hopi villages: Awatovi, Walpi, Shungopavi, Mishongnovi, and Oraibi, but the Spanish presence is not physically separate from the Hopi villages and thus are incorporated here (Brew 1949b).

Total = 36

Total sites = 6293

Because of the large numbers of unknown sites and the incompleteness of the record, a strategy was developed for presenting the data in this report. There are two levels of information. A general search of AZSITE was used to illustrate the distribution of archaeological sites on oversize maps (Maps 1-5), which are illustrated in small scale associated with the text. These five maps include two each for the Prehistoric and Protohistoric Periods and one for the Mission Period. A total of 8,750 sites are listed on these maps, which includes over 2,000 sites with unknown cultural affiliation in addition to those listed in Tables 1.3 and 1.4. Some sites overlap more than one time period. These maps illustrate the density of the archaeological record of Ancestral Pueblo (Hopi and Zuni) use of the Little Colorado River basin over the past 2,000 years. Tables for each period and cultural group are also presented that detail the diversity of site types represented in these maps. Keep in mind that the clusters of archaeological sites present on these maps are a result of intensive archaeological surveys of these particular areas with areas of low density of sites generally caused by a lack of survey in those areas. Areas of intensive survey that have been published are used to illustrate broader patterns present in the archaeological record. For the Prehistoric Period, the Wupatki National Monument survey is presented (Downum and Sullivan 1990). For the Protohistoric Period, the Homolôvi settlement cluster survey is presented (Lange 1998). For the Spanish Mission Period, the study of the Hopi area by Colton (1974) and Adams, LaMotta, and Dongoske (2004) is used. Definitions of terms will be the subject of section 1.5.

1.4.1 Prehistoric Period (Hisatsinom, Period 1): A.D. 1-1275

This period includes the time when all areas of the basin were being farmed, albeit at varying intensities (Cordell 1997:221-222). Through time, dependence on domestic crops generally increased. Concurrent with this dependence was increased construction of devices to

control or manage water for crops. The archaeological record that remains from this lengthy period is rich due to the generally larger size of sites, the general increase in the use of masonry in architecture, the use of pottery as containers, and the better preservation of the later materials. After A.D. 900, habitation sites increase in size and specialized farming sites increase in frequency. These farming sites, generally called farmsteads or field houses, were usually isolated one or two room structures located near arable land. Therefore, remains of field houses are reliable indicators of the locations of arable land and suggest the dependence of the occupants on domestic crops for subsistence. Additionally, specialized features, such as lining fields or drainages with rocks to capture water became widespread (Cordell 1997:300).

The prehistoric period will be discussed in terms of three geographic areas that roughly correspond with prehistoric cultural groups as discussed in section 1.3. The Sinagua of the rim area, the Western Pueblo people of the upper Little Colorado River area, and the Anasazi of the plateau are all believed to be ancestral Pueblo groups and all probably contributed to the ancestry of the Hopi (Ellis 1974; Euler and Dobyns 1971; Fewkes 1904; Pilles 1987). Only the prehistoric Cohonina along the west edge of the basin do not seem to be ancestral to the Hopi, as viewed from the archaeological record (McGregor 1951).

1.4.2 Protohistoric Period (Ancestral Hopi, Period 2) : 1275-1630

The protohistoric period links the prehistoric period to the historic period. Although first Spanish contact with the Hopi occurred in 1540 (Brew 1949b:11; Winship 1896), Spanish priests did not establish their missions until 1629-1640 (Brew 1949b:12). Establishment of the Franciscan missions inaugurated the historic period and brought the protohistoric period to a close.

The 1275-1630 period is characterized by significant aggregation of ancestral Pueblo people into larger villages. After 1350-1400 there were no habitation sites smaller than 100 rooms. With this extreme aggregation came a restructuring of the settlement pattern of the prehistoric groups. This pattern is visible as clusters of one to five large pueblos surrounded by a constellation of smaller sites, including many field houses. To support population aggregates water control systems both for conservation and diversion became more diversified (Vivian 1974:102).

Although much of the basin lies within Hopi tutsqua, the southeast corner does not. Based on the archaeological evidence it appears that most of the people who occupied the large protohistoric pueblos of this area were both ancestral Hopi and Zuni (cp. Ferguson and Hart 1985:26; Fewkes 1891; Spier 1918). There are good archaeological data for the 1300s that document the movement of some groups out of the upper Little Colorado River area to intermediate points before the final migration to the Hopi villages (Duff 2004). As a result, ancestors of the Hopi probably originated from all areas of the basin.

1.4.3 Spanish Mission Period (Period 3): 1630-1700

This period is marked by the establishment of missions at three Hopi villages and visitas (chapels) at two more and ends with the destruction and abandonment of Awatovi on Antelope Mesa in 1700 or 1701 (Brew 1949a, 1949b).

In addition to farming needs for water dating from prehistoric times, the Hopi may have acquired livestock from the missionaries as early as the 1580s. After 1680, they raised sheep, goats, cattle, horses, and burros. Sheep and goats were without question prevalent as a food source (Adams 1982:102; Czaplewski and Ruffner 1981:17-18, Table 6; Olsen 1978:28-30).

1.5 Definition of Terms

Critical to any discussion of a fairly technical nature is the reduction of jargon and a definition of terms. This section is devoted to defining the set of terms that archaeologists use to describe the prehistoric peoples and area of concern for this report. Because this case is concerned with prehistoric and historic use of water, definition of these terms will also be presented.

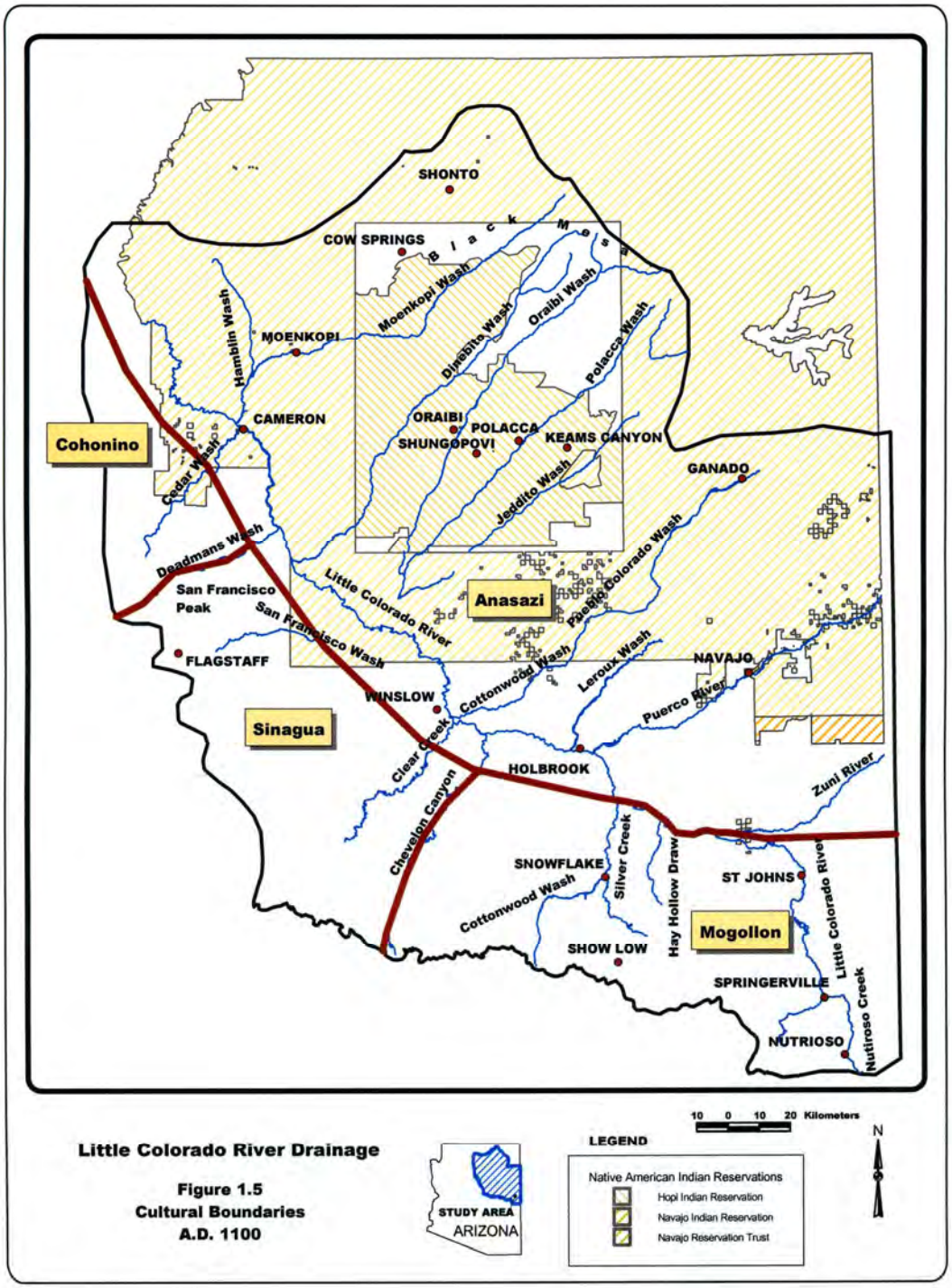
1.5.1 Archaeological Terms

A map indicating the approximate boundaries of the archaeological cultures described below is presented as Figure 1.5.

Hisatsinom: Hopi word for ñthe ancestorsò or ñpeople of the pastò. The Hopi apply this term to all groups they believe are ancestral to them (Pilles 1987). For this report the term will be applied to all groups or elements of cultural groups the author believes is supported by the archaeological evidence as ancestral to the Hopi, and primarily predating A.D. 1275. These will include the Anasazi, Sinagua, and elements of the Mogollon.

Ancestral Hopi: Convention requires that groups cannot be defined as Hopi until recorded in a historic document. Thus the term Hopi has been applied to the post-1540 occupants of the villages on the four Hopi Mesas. However, where there is no question that the pre-1540 occupants were Hopi, the term ancestral Hopi has been used. This term is restricted to the post-A.D. 1275 occupants of the basin, whereas Hisatsinom can be used for groups predating A.D. 1275.

Anasazi: Prehistoric occupants of the southern Colorado Plateau (Fig. 1.5). A term first coined by Kidder (1936) and interpreted by archaeologists to mean ancestral Pueblo. Therefore, when the term Anasazi is used it is more-or-less generic Pueblo and means the people have



Little Colorado River Drainage

Figure 1.5
Cultural Boundaries
A.D. 1100

characteristics in body form, artifacts (especially pottery), architecture (especially kivas), maize farming, etc. indicating they are ancestral to existing Pueblo groups, including the Hopi and the New Mexico Pueblos. From an archaeological perspective, then, it does not include Navajo or any other non-Pueblo groups. It is almost always impossible to identify a specific Pueblo group to which the occupants of a particular Anasazi site are ancestral. A frequently used developmental framework for the Anasazi, the Pecos Classification, was developed in 1927 (Kidder 2000). The sequence covers the entire prehistoric and historic Pueblo periods. Although the cultural sequence is fixed, there is flexibility in the dates that have been assigned this sequence according to area, but it still serves as a crude chronological framework. The Pecos Classification will not be used in this report. Instead the temporal framework presented in Table 1.2 will be followed.

Mogollon: Prehistoric occupants of the mountainous regions of central Arizona and the southwestern quarter of New Mexico have been classified by archaeologists as Mogollon (Haury 1936). The Mogollon are differentiated from Anasazi by having brown rather than white or gray pottery, different architectural characteristics, and the like (Reed 1948).

Western Pueblo: After A.D. 1000 and especially after 1200 the distinction between the Anasazi and the Mogollon becomes unclear. The Mogollon took on many Anasazi characteristics and this hybrid culture has been termed Western Pueblo (Reed 1948).

Sinagua: This is a term coined by Colton (1939) and refers to prehistoric occupants who lived in the area south and east of Flagstaff extending into the cinder cone areas. Although subsequently modified, the Sinagua culture has strong Mogollon characteristics but can be distinguished from both more ñeasternò Mogollon and Anasazi by ceramics and architecture (Pilles 1979).

Cohonina: The Cohonina have been defined by Colton (1939) and by McGregor (1951) and lived in the areas north and west of Flagstaff. They appear not to be ancestral Pueblo, but perhaps are ancestral to one of the Pai tribes, possibly Havasupai (Schroeder 1957). The Cohonina apparently relied less on agriculture than their Sinagua or Anasazi neighbors and probably occupied areas seasonally within the basin (McGregor 1951). The Cohonina are distinctive from other groups in terms of ceramics, architecture, and settlement patterns.

1.5.2 Water Feature Terminology

Archaeologists have developed a rather elaborate and sometimes confusing array of terms for features that were used for water control, catchment, diversion, storage, and the like (Woodbury 1961; Vivian 1974). The section to follow on terminology can be divided a number of ways. Figure 1.6 illustrates the system, adapted from Vivian (1974), that will be employed to help define the various prehistoric and historic technologies used by the people of the basin. Several generic terms will be used in discussing water use in the basin. These include water (control) feature, water system, and water control. These terms are used for this report to describe the diversity of features found in the archaeological record of the basin as detailed in publications and individual site records stored at institutions and agencies. Unfortunately, the AZSITE database does not describe water control features in the detail presented below. In these instances, the term, water control, was used to generally describe this class of features.

Water (Control) Feature: A water feature was used for holding, deflecting, or diverting water. Features were made or modified by human beings and were not movable objects. Water features include dams, ditches, rock alignments, and such.

Water System: A combination of water features used to provide water for farming or domestic use is a water system (Vivian 1974:96).

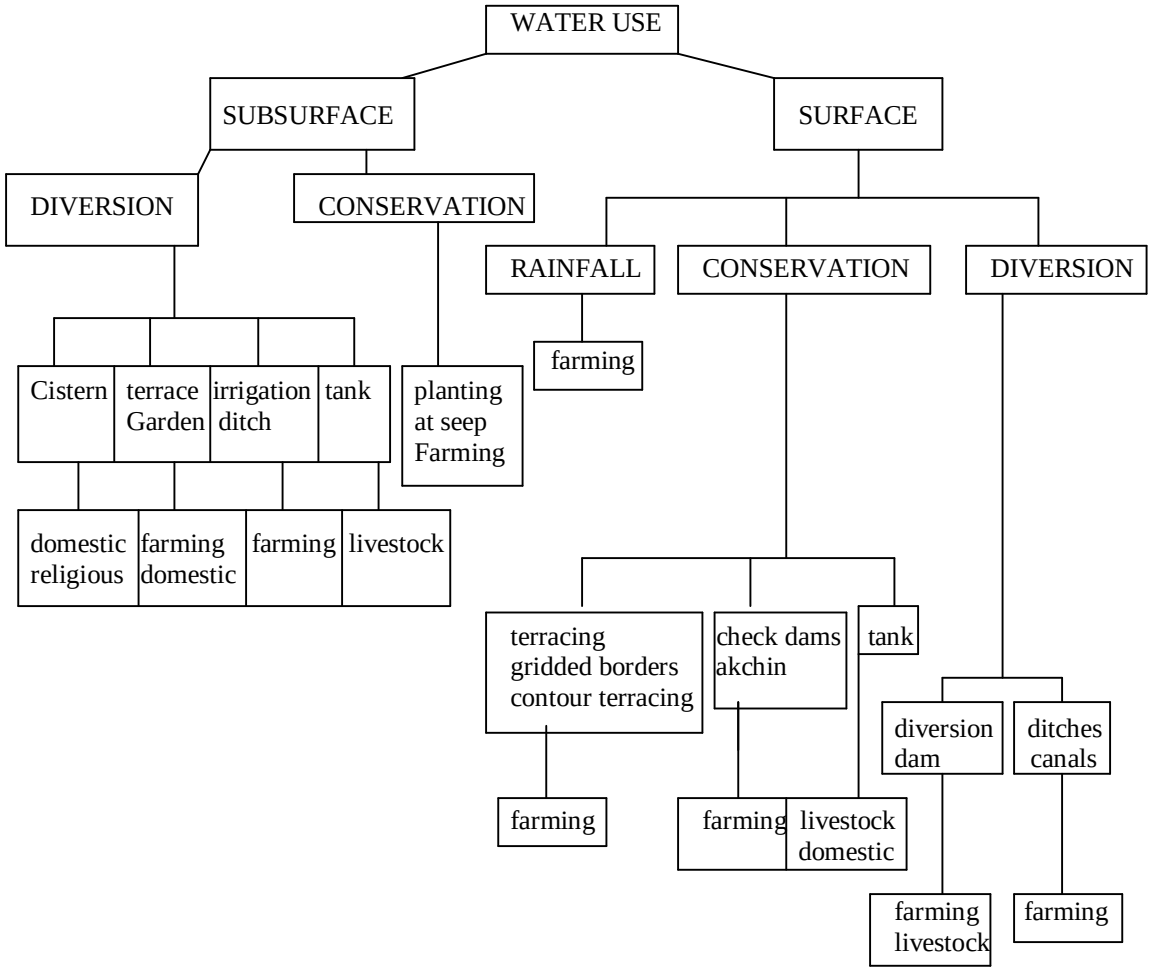


Figure 1.6. Flow chart of terminology for water systems and their cultural uses (adapted from Vivian 1974).

Water Control: Water control was accomplished using one of many techniques to capture and distribute water employing one or more water features (Vivian 1974). The water was primarily surface water but occasionally involved springs, some of which were developed for irrigation. There are many types of water control features that were used in the basin. The earliest water features predate A.D. 900; however, it was not until after 900 that they appear in any substantial numbers. By the late 1200s many of these features had become very large or elaborate. Mechanical control of water involving pumps, wheels, and the like are not known prehistorically and did not become commonly used until the Mormon period beginning in the 1870s. The features defined in this section represent the typical range found in the basin utilizing terms developed by Hack (1942:26), Woodbury (1961), and especially Vivian (1974). Discussion will primarily involve archaeological remains of these features, although historic equivalents may be noted.

Dam: An earthen, stone, or earth and stone structure built across a drainage to catch and collect water.

Diversion Dam: A dam, as described above, intended not to catch and collect water, but rather to divert it from the drainage it crossed into another area or drainage usually by means of a canal or ditch.

Spreader Dam: An earthen, or earth and brush dam, usually only partially across a drainage, whose purpose was to slow runoff and spread it across a field (Hack 1942:28-29). This technique was used to reduce erosion and often was associated with the technique referred to as akchin agriculture.

Akchin (runoff irrigation): A Papago (Tohono Oôodham) term for an agricultural technique where a field was planted at the point where a drainage left its narrow channel and

spread into a broader channel, often where it intersected another wash. At this point the water discharged from runoff lost its energy and spread out, often with the assistance of a spreader dam, over an alluvial fan where the field was planted (Hack 1942:26-29).

Reservoir: A feature for collection and storage of water. A reservoir may have been created by a dam, a natural or artificial depression, or a rock fissure. When small, excavated, and used for livestock these may be referred to as tanks (Vivian 1974:97).

Ditch: A narrow, shallow cut into the earth for carrying water (Vivian 1974:97). These may have been partially or totally stone-lined and were often associated with dams or reservoirs and, rarely, with larger streams (Lightfoot and Plog 1984:185). According to Vivian (1974:97), ditches were less than 1 m wide and deep.

Canal: A wide, deep cut more typically associated with larger flows of water, such as streams or even rivers. The Hohokam culture of southern Arizona built extensive canals. With the exception of side drainages to the Little Colorado River where Lightfoot and Plog (1984:185) identified several kilometers of canals, they are unknown in the basin until after 1850 when they were built by Mormons and other settlers in the middle and upper Little Colorado River, on tributaries of the Little Colorado River upstream from modern Winslow, and in the vicinity of the Moenkopi Wash area near modern Moenkopi village.

Stone Alignments: Archaeologists find many stone alignments preserved in the basin. Depending on their size, location, and specific characteristics they were either check dams, border gardens, contour terraces, or wind breaks. These are described in detail below.

Check Dam (terrace): Low stone, stone and earth, occasionally brush walls built across small ephemeral drainages to retain moisture and soil (Vivian 1974:97). Areas behind check dams were used for garden plots rather than for water storage. Check dams were often placed

like steps up drainages, occurring singly to over 100. Typically, however, they number fewer than 20 in a grouping within the basin.

Border Garden (grid border): These were small garden areas enclosed by low earth or stone borders. They were built to increase moisture in the area and often occur in conjunction with check dams and contour terraces (Vivian 1974:97).

Contour Terrace (linear border): Long rows of low stone walls built across hillsides, talus slopes, or concentrically around small knolls or buttes (Vivian 1974:97). These captured both soil and moisture.

Wind Break: One or more lines of rocks or earth that held brush and served as wind breaks on dry-farmed fields (Hack 1942:33, 70). A dry-farmed field is one that depends on moisture solely from rainfall. Because prevailing winds in the spring and summer are usually from the southwest, wind breaks would be expected on the southwest side of a field.

Additional miscellaneous features include boundary markers, cleared fields, and field houses.

Boundary Marker: These are localized accumulations of stone, often cairn-like, that were used to mark the edges of fields, where ownership changed, or marked the locations of field shrines (Woodbury 1961:16). In the latter case the stone pile may have associated artifacts.

Cleared Field: Areas cleared of rocks or other large natural materials, presumably deemed undesirable within the field, are termed cleared fields. The cleared materials were often stacked in corners or along the edges forming boundary markers or definable edges to the fields. Among the Hopi, these stones were also important in protecting plants from blowing sand (Hack 1942:33).

Field House: One or two (rarely up to four) room structure, ranging from pit house to jacal-walled (jacal walls are constructed of wood, often woven, with an earthen cover giving a stucco appearance) to masonry-walled, built near a field. Following modern Hopi practice, these were probably used to monitor the field during periods of environmental stress or potential predation (Bourke 1884:96-99; Hack 1942:28-29). Field houses may comprise a third to a half of all sites recorded in the basin, indicating the importance of agriculture to the subsistence base (Pilles 1978:128).

The uses of these various water features fall into two categories: conservation and diversion (Vivian 1974:102). Conservation Features were intended to retain water or hold it in place to prevent runoff and loss. Conservation features include check dams, contour terraces, border gardens, and reservoirs. Diversion Features transferred water from one place to another using such features as ditches, canals, and diversion dams. Diversion features are often used with permanent water sources.

1.5.3 Water Uses

To facilitate translating the archaeological remains of the basin into human systems this report will consider the use of water in each spatial and temporal division by the following categories: domestic, farming, livestock, and ritual (Table 1.5).

Domestic: Uses of water for the household is a fairly straight-forward concept. Every human needs water to survive. Domestic use of water involves drinking, cooking, and may involve washing clothes and bathing. Because these needs are daily or several times a day, settlements tend to locate relatively close to water sources. These water sources may be large or small, seasonal or year-round, depending on the size and needs of the settlement or settlements that were using them.

Table 1.5. Sources of water for various uses by people of the Little Colorado River Basin.

USE CATEGORY	TYPES OF USE	ARTIFACTUAL EVIDENCE
Domestic	Undeveloped spring Seep Developed spring Natural catchment Artificial catchment	None None Rock enclosure, dam, cistern Natural rock basin Dam creating a reservoir
Farming	Water conservation Water diversion Fields	Rock alignments, reservoir Ditches, diversion dams Field house, cleared areas, boundary markers
Livestock	Watering	Natural watering holes (seeps, springs, playas), artificial tanks, sheep corrals nearby
Ritual	Undeveloped spring Developed spring	Rock art, shrines, prayer feathers Rock wall, stone steps

Sources of domestic water are developed and undeveloped springs, seeps, running water in rivers or streams, natural catchments (playas, natural cisterns), or artificial catchments (reservoirs). Developed springs can have rock enclosures, dams, or cisterns to retain or deepen the water.

Farming: Farming is a generic term for the growing of domestic crops for human consumption. Domestic food crops were never grown for feeding livestock in the basin. Vivian (1974) and Woodbury (1961) have defined numerous techniques used by prehistoric people of the basin for controlling water in order to water their crops. Hack (1942) has done a similar study of 1930s Hopi and 17th century Awatovi water control technology. These include border gardens,

reservoirs, check dams, contour terraces in terms of water conservation; and ditches, canals, and diversion dams for water diversion.

Conservation or diversion features were possibly used as early as A.D. 700-800, but were not very common until after A.D. 900 on the Colorado Plateau (Cordell 1997:300-301). Within the basin elaboration of water control features for farming occurs primarily after A.D. 1100. The special site categories of field house, field/habitation, and field/water are used in this report to signal presence of farming in close proximity to them, which demanded water usage. Although large and small settlements were probably established in close proximity to agricultural land, construction of temporary or seasonal structures in conjunction with fields, the field house, is most closely associated with use of the basin after A.D. 1100, although their beginnings can be seen as early as A.D. 900.

Livestock: Livestock, including sheep, goats, cattle, horses, burros, pigs, and chickens, were a historic introduction to the basin people by Spaniards. The earliest report of possible livestock in the basin was in 1583 when members of the Espejo expedition noted flocks in the Hopi region, although possibly these were turkeys and not sheep (Hammond and Rey 1929:95). Livestock were part of the establishment of missions at Hopi beginning in 1629 with animal bones recovered at Awatovi by archaeologists from sheep, goats, cattle, horses, pigs, and chickens (Olsen 1978:19-30). Two different maintenance behaviors are involved with livestock: high maintenance and low maintenance. Sheep and goats are high maintenance animals because they need to be watered and herded daily in order to minimize predation and losses during lambing (Ellis 1974:134). This means that the herders could spend considerable time away from home (Ellis 1974:135; Titiev 1944:193-94). The Hopi were also cattle owners by the end of the Spanish Mission period, or 1700, based on excavations at Awatovi and Walpi (Czaplewski and

Ruffner 1981; Olsen 1978:29-30). These low maintenance animals could range over a several hundred square-mile area in a yearôs period. Cattle are basically free of predation in the basin.

Water is essential to the maintenance of livestock. Originally, natural flows of water either in the Little Colorado, washes, or as springs and seeps were used by livestock. The sheep and goats typically were watered near the villages, whereas cattle and horses found their own sources. Evidence of the extent and variety of Hopi water use for livestock is not reflected in the archaeological record before 1700 and thus can be discussed to only a very limited extent.

Ritual: Ritual use of water is an important element of modern cultures in the basin. This is particularly true of the Hopi who believe that katsinas live in springs and regularly use numerous springs as key elements to many rituals (Ellis 1974:182-187; Hough 1906; Stephen 1936:20). Identifying prehistoric ritual use or even historic before 1700 is a more difficult proposition. Any water source with evidence of prehistoric use, either through the presence of rock art or actual improvement of the spring will be noted. However, it is not possible to clearly attribute this use to ritual, as most springs had multiple uses. It is probably safe to say that every spring in the basin was known by one or more groups of people. Any source of water, a scarce and important commodity in almost all parts of the basin except perhaps the southeast corner, would have played a role in the survival of these groups. In these circumstances every water source capable of enhancing either farming or domestic consumption was probably a sacred place.

Major known water sources, including springs in the plateau area known at the turn-of-the-century and that have been developed, are noted in the figures associated with periods of occupation. Only those springs with physical evidence of use (rock art, some development) are listed in the site records and are included in the period and spatial discussions. It is likely,

however, that all springs were used at sometime during the known use of the basin. It is also important to note that many water sources in the basin have probably dried up before the modern period. Although these played a central role in development of many areas, many probably can no longer be located or dated to use. No attempt has been made to identify or locate spent water sources for this report.

Organization of the remainder of this report is straightforward. A chapter will be devoted to each period. The period will be discussed in terms of the archaeological data and the general literature discussing water control features and farming during the particular period. For Periods 1 and 2, the basin will be divided into three areas, which will be discussed separately. Period 3 will discuss only the plateau area of the basin. For each period, archaeological research will be used to take a closer look at a section of the basin detailing use of water. Implications of water use in these areas is used to examine its use in the entire basin.

CHAPTER 2

THE PREHISTORIC PERIOD (PERIOD 1), A.D. 1 TO A.D. 1275

For the prehistoric period the basin will be divided into the three areas, previously defined: the Upper Little Colorado River, the Mogollon Rim, and the southern Colorado Plateau. As presented in earlier discussions, Period 1 is characterized by many small settlements spread across almost every section of the basin. Nonetheless, there are significant differences among the three areas and within each area. These differences are greater early on and become less significant later in the sequence. Archaeological evidence of farming (in terms of field houses) and water control (in terms of actual features) is predominantly post-A.D. 900 in all areas. Information concerning water control features is most abundant in the upper Little Colorado River and Mogollon Rim area because both lie at least partly within national forests where relatively more research has been conducted. In contrast archeological knowledge of the plateau area is poorer due to a relative paucity of research. For these reasons and the recent nature of the research, the archaeological research at Wupatki National Monument will be used to characterize a cultural system and its use of the landscape to harvest and control water during Period 1.

2.1 The Mogollon Rim area

The prehistoric cultural groups most associated with the rim area are the Sinagua and the Cohonina, although Anasazi groups predominated between the Little Colorado River and the San Francisco Mountainsô volcanic field (Colton 1939, 1960:Fig. 26). Coltonôs (1960:Fig. 26) map locating the extent of the Cohonina, Sinagua, and Kayenta Anasazi (one of many subgroups of the Plateau-wide Anasazi) in the rim area has been reproduced as Figure 2.1. A chronological chart expressing the relations of the three groups and the foci or phases archaeologists assign to each group for each period is reproduced as Table 2.1

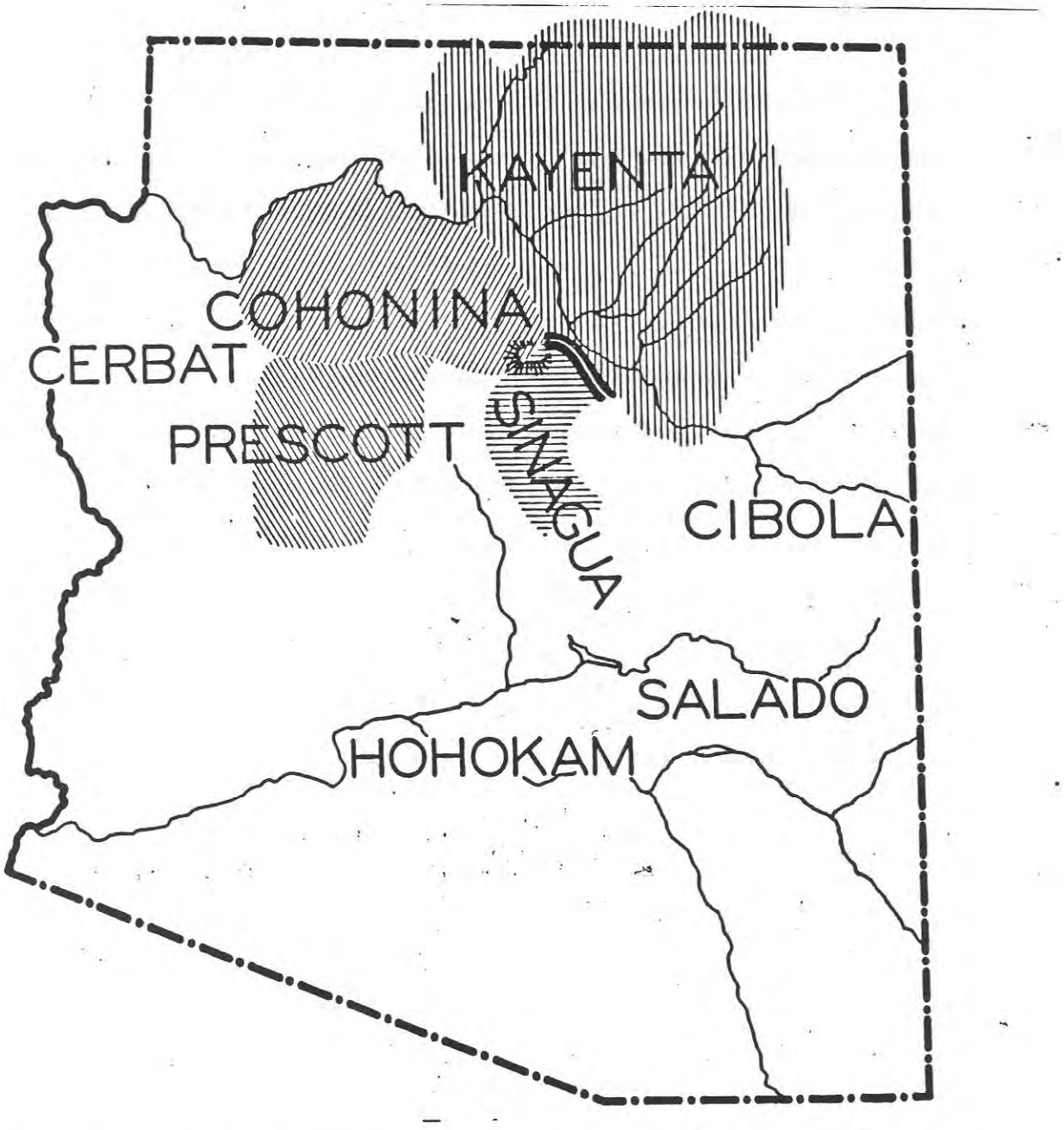


Figure 2.1 Cultural boundaries in the Mogollon Rim area about A.D. 1100.

Table 2.1. Temporal sequences associated with cultural groups in the Mogollon Rim area compared to those on the Plateau (Kayenta Anasazi), as reconstructed by Colton 1946:17).

Anasazi Stages	Approximate Dates	Foci of Sinagua Branch	Foci of Kayenta Branch	Foci of Cohonina Branch
Pueblo IV	1300-1400	Clear Creek	Jeddito	
Pueblo III	1200-1300 1120-1200	Turkey Hill Elden	Tsegi Klethla	 Hull
Pueblo II	1070-1120 900-1050	Padre, Angell, Winona Rio de Flag	Black Mesa Black Mesa	Medicine Valley Medicine V.
Pueblo I	700-900	Sunset	Marsh Pass	Coconino
Basketmaker III	500-700	Cinder Park	Lino	

Cohonina: The Cohonina culture is ancestral to the Pai tribes, probably the Havasupai according to Colton (1960:63), McGregor (1951) and Schroeder (1957). They occupied only the most western corner of the basin from about A.D. 700 to 1150 and then withdrew from the basin (Colton 1960:63). They lived in small groups and resided in semi subterranean to subterranean structures, called pit houses, and after A.D. 900 built ñfortsò or masonry above-ground structures having domestic, storage, and ceremonial functions. The Cohonina relied primarily on hunting and gathering with less reliance on agriculture than either the Sinagua or the Anasazi. They built field houses or granaries near their fields, which were located in open parks in the forests at the foot of the north side of the San Francisco Peaks. Although water control features have been found in traditional Cohonina areas, these probably postdate Cohonina occupation and can be attributed to Sinagua. No water control features are known for the Cohonina.

Sinagua: The Sinagua culture is defined by Colton (1939) and has been the subject of research since the late 1800s (Fewkes 1900; Colton 1946). Coltonôs (1946) book on the Sinagua is still a definitive work. Fewkes (1900) surveyed in the area and returned to conduct excavations

at Elden Pueblo in 1926 (1926). Cummings (1930) excavated at Turkey Hill Pueblo in 1927 and 1928. During the 1930 to 1941 period the Museum of Northern Arizona, based in Flagstaff, annually conducted survey and excavations in the Flagstaff area on Sinagua sites, including both Sinagua and Anasazi sites in Wupatki National Monument (Colton 1946:6-7). It was on these data that Colton based his 1946 synthetic work. Work in the Sinagua moved at a slow, but steady, pace over the next 20 years, accelerating since the mid-1960s primarily due to contract work, much of it on the national forest. Pilles (1978, 1979, 1987) has summarized recent research in a series of articles. Since 1981, Pilles (1996) has also excavated and stabilized Elden Pueblo. Pillesôs (1978, 1996) studies of settlement patterns in the Sinagua area note the dependence of the Sinagua on agriculture. As evidence he points to extensive constructions of linear borders, waffle gardens, numerous cleared areas where fields were located, and countless field houses. Field houses have also been discussed in detail for the Sinagua (Pilles 1978). Pilles (1978:128) noted that field houses (one to four room structures with specific artifact assemblages) comprise from 23 percent to 63 percent of sites in the area averaging roughly a third of all sites. Field houses first appeared between A.D. 900 and 1150 and many have associated check dams for controlling water runoff and curbing erosion (1978:129). After 1130 field houses increased in frequency and are found scattered in pinyon-juniper forests, as well as ponderosa pine areas. The frequency of field houses to total site count before 1050 is about 25 percent and may be 60 percent after 1130. The field houses are clearly associated with pockets of arable soils. These observations are reinforced by a look at the database in the Sinagua area in general and later with the analysis of the Wupatki material, which forms the northern boundary of the Sinagua.

There is little question that elements of Sinagua culture and some of the Sinagua themselves are ancestral to modern Hopi culture. These arguments have been eloquently made by Pilles (1987) and will be paraphrased below. Perhaps foremost is the focus of the San Francisco Peaks in Hopi religion and culture. The peaks are home to the katsinas, several important shrines in the vicinity of the peaks are still visited and maintained by the Hopi, and plants essential to Hopi religion are still collected from the peaks area. The Hopi also have a strong oral history about Sunset Crater and know details of features of the landscape about Sunset and surrounding areas (Malotki and Lomatuwaýma 1987). The Hopi also know the existence and location of many of the major 13th and 14th century pueblos in the Flagstaff and nearby Anderson Mesa areas and have Hopi names for most of them (Pilles 1987). The Hopi consider the occupants of these pueblos to be Hisatsinom ï ancestors.

Additionally, some of the springs near these villages are known today and are used in some Hopi ceremonies (Pilles 1987). Yellow-firing pottery manufactured in villages on the Hopi Mesas beginning about 1300-1325 is found in several of the later Sinagua sites. There is no question that Sinagua people were in contact with ancestral Hopi on the mesas. Establishment of such economic ties would be an almost necessary prerequisite to immigration to the Hopi villages by Sinagua people. This process began in the 13th century and was probably concluded by 1400.

Anasazi: The Anasazi occupants of the Mogollon Rim area (Fig. 2.1) are not well known. As with the Sinagua, the pace of research in the area has accelerated during the past 20 years. The research at Wupatki National Monument, which was conducted from 1981 to 1987, has contributed significantly to our understanding of the dynamics of the prehistoric occupation of the area. The Wupatki work, directed by Bruce Anderson of the National Park Service, Santa Fe,

resulted in a 100 percent survey of the monument recording nearly 2700 archaeological sites. All but two of the sites at Wupatki postdate 1064 (the first eruption of Sunset Crater) and none postdate 1275 (Downum and Sullivan 1990:5.82). About 72 percent of the prehistoric sites are clearly associated with agricultural pursuits, including over 900 field houses (Downum and Sullivan 1990:5.67; Travis 1990:4.9). Although some elements of Sinagua culture and Cohonina culture are present in the monument, the dominant cultural tradition is clearly Anasazi (1990:5.56-57, 5.84-85). In fact Wupatki National Monument can most profitably be viewed as the boundary between the three cultural traditions with the Sinagua on the south, the Cohonina on the far west, and the Anasazi elsewhere (1990:5.84-85).

As with the Sinagua, the Hopi consider the Anasazi to be Hisatsinom ï ancestors. The construction of pueblos, use of kivas, and depiction of symbols on rock art by Sinagua and Anasazi groups suggest a general ancestry to modern Pueblo groups, most closely the Hopi. The pueblo ruins in Wupatki National monument are known by the Hopi and several Hopi clans claim ancestry to one of more of the ruins, in particular Wupatki and Citadel. These relationships are spelled-out in the oral histories of specific clans (Courlander 1971). As with post-A.D. 1300 Sinagua sites, yellow pottery has been found at Wupatki. In this case its presence suggests reuse by later ancestral Hopi rather than a continued occupation of Wupatki (Colton 1946).

2.1.1 Prehistoric Database ï Mogollon Rim Area

The principal sources for the AZSITE database compiled for the prehistoric period have been described. Maps 1 and 2 illustrate the distribution of Period 1 sites by cultural group and are summarized in Tables 2.2. Another 61 (including Wupatki itself) with detailed information on water control are recorded in Table 2.3.

Table 2.2. AZSITE sites for the Mogollon Rim area dating to Period 1 by cultural group.

Site Type	Sinagua	Cohonina	Mogollon	Anasazi
Artifact Scatter	210	113	10	240
Field	296	26	19	167
Field/habitation	151	30	31	152
Field/Water Control	7	1	0	27
Habitation	374	176	2	446
Petroglyph	5	1	1	17
Shrine	0	0	0	0
Water Control	7	0	8	3
Total	1050	347	71	1052

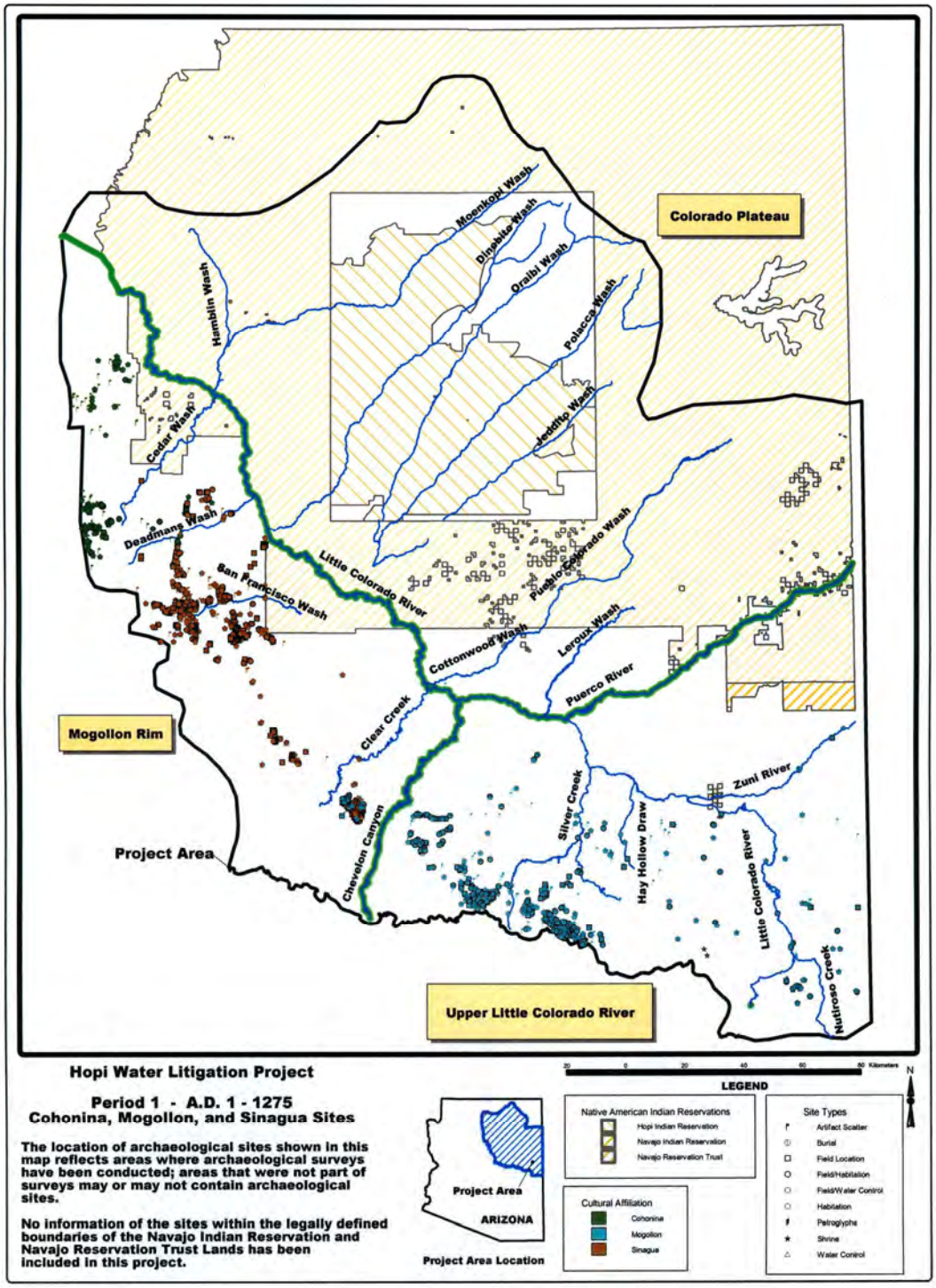
Table 2.3. Sites with water control features in the Mogollon Rim area dating to A.D. 1-1275.

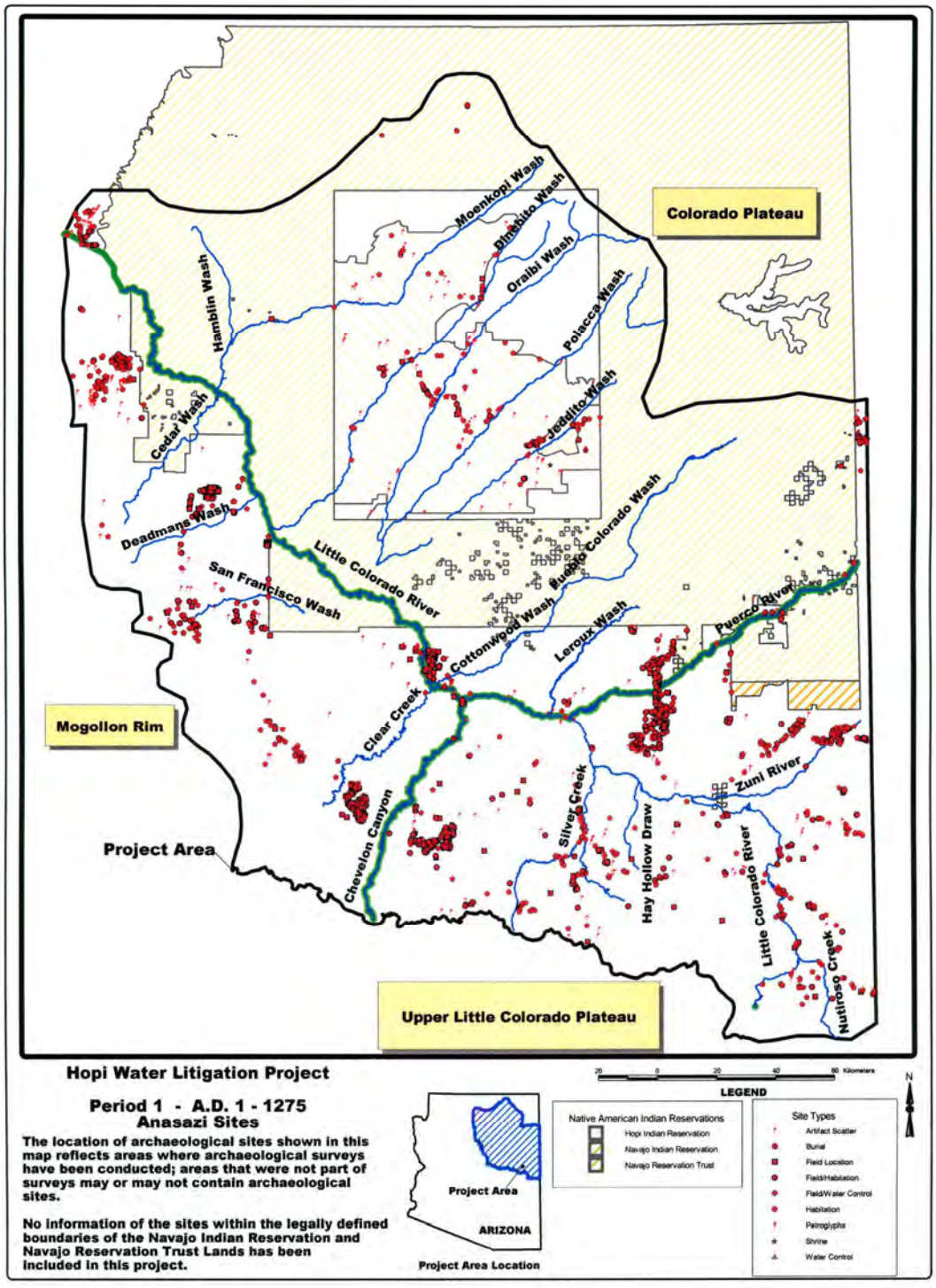
Number	Site Name	Features	Reference
1	AZ I:4:40	7 sites around terraces	Coconino Forest
2	AZ I:11:8	rock alignment	Coconino Forest
3	Kaibab 6	rock alignments, 76mx198m	Coconino Forest
4	Kaibab 9	5 check dams, 90m diam	Coconino Forest
5	D 3:228	rock alignments	Coconino Forest
6	D 2:1546	rock alignments	Coconino Forest
7	D 2:1540	linear border, 15m	Coconino Forest
8	D 2:1593	linear border	Coconino Forest
9	D 1:1726	rock alignment	Coconino Forest
10	D 2:2294	check dam	Coconino Forest
11	D 2:2301	2 rock alignments	Coconino Forest
12	D 2:2305	rock alignment, 17.1m	Coconino Forest
13	D 2:2299	check dam	Coconino Forest
14	D 1:1110	6 check dams	Coconino Forest
15	D 2:2450	water catchment, 5 depressions	Coconino Forest
16	D 2:2428	terraces, fields, canal	Coconino Forest
17	D 2:2426	bordered field, 3 rock aligns	Coconino Forest
18	D 2:1346	8 terraces	Coconino Forest

19	D 2:1312	4 terraces	Coconino Forest
20	D 2:1520	l-shaped rock alignment	Coconino Forest
21	D 2:2829	fieldhouse, rock alignment	Coconino Forest
22	D 2:2834	fieldhouse, rock alignment	Coconino Forest
23	D 2:206	3 check dams, rock alignment, field	Coconino Forest
24	D 2:2556	rock alignment, cist	Coconino Forest
25	D 2:2554	rock alignment, field	Coconino Forest
26	D 2:2553	rock alignment, field	Coconino Forest
27	D 2:1071	rock alignments, field	Coconino Forest
28	D 2:2394	cleared field	Coconino Forest
29	D 2:2393	cleared field, 3 rock aligns	Coconino Forest
30	D 2:2729	check dam, 25m	Coconino Forest
31	D 2:1477	2 check dams	Coconino Forest
32	D 2:420	6 linear borders, clrd field	Coconino Forest
33	D 2:188	2 terraces	Coconino Forest
34	D 5:428	cleared field+	Coconino Forest
35	D 5:337	2 terraces, rock alignment	Coconino Forest
36	D 5:317	cleared fields	Coconino Forest
37	D 5:341	terrace, fields	Coconino Forest
38	D 5:312	rock alignment/wind wall	Coconino Forest
39	D 7:623	Terrace	Coconino Forest
40	D 7:626	rock alignment	Coconino Forest
41	D 7:690	terrace, 42m x 42m	Coconino Forest
42	D 7:693	11-13 terraces, 55m x 110m	Coconino Forest
43	D 7:815	2 terraces, 30m x 5	Coconino Forest
44	D 7:808	5 terraces, 20m x 35m	Coconino Forest
45	D 5:134	terrace, check dams 37m x 100m	Coconino Forest
46	AZ I:15:21	Terraces	ASM Site File
47	AZ I:15:22	concentric terraces	ASM Site File
48	AZ 0:11:29	Reservoir	ASM Site File
49	AZ I:15:9	8 concentric terraces	AMS Site File
50	AZ I:15:15	Reservoir	ASM Site File
51	391	fieldhouse, check dam 5m	Sitgreaves For
52	393	fieldhouse, 12 check dams 16m	Sitgreaves For
53	Io-1	check dam	Sitgreaves For
54	209	2 check dams	Sitgreaves For
55	211	2 check dams, fieldhouse	Sitgreaves For
56	212	4 check dams	Sitgreaves For
57	214	check dam, fieldhouse	Sitgreaves For
58	216	check dam, fieldhouse	Sitgreaves For
59	218	4 check dams, fieldhouse	Sitgreaves For
60	239	2 check dams, fieldhouse	Sitgreaves For
61	Wupatki	habitation site, spring	1
62	Wupatki NM	86 fields, 15 reservoirs	2

1 Hartman and Wolfe 1977
2 Sullivan and Downum 1990

Map 1: Period 1, Cohonina, Mogollon, and Sinagua sites.





Map 2: Period 1, Anasazi sites.

Colton (1939, 1946) was the first to suggest that the eruption of Sunset Crater in 1064 affected the settlement pattern in the region and in particular the Wupatki National Monument area, which was down-wind from the erupting volcano. He proposed that the volcanic ash from the eruption in 1064 created a mulch that enhanced the productivity of the monument soils by improving nutrients and retaining much needed moisture, which allowed agriculture in areas previously deemed too dry. Thus the sites dating A.D. 1064 to 1275 are not just in the ponderosa pine forests but are also in the drier, warmer, and more agriculturally marginal pinyon-juniper forests (Pilles 1978). These sites are not just in the Wupatki National Monument area, but this pattern occurs regionally. By the 1200s the data indicate a further spread of field house sites beyond the forest areas into adjacent grassland areas, but only along major drainages, such as Chevelon Creek, Clear Creek, Jacks Canyon, and San Francisco Wash in the southeastern portion of the Rim area, and Deadmanôs Wash in the Wupatki area. In general this expansion was accompanied by increased use of water control features, which will be discussed in the following section.

The spread into the drier lower elevation areas was probably a result of increased population. The general paucity of dependable water sources in lower elevations forced the expanding populations into a more diversified settlement pattern, although Hargrave (1933:19) notes that numerous water sinks naturally occur in the limestones of the Mogollon Rim region extending from the cinder cones and lava flows to the Little Colorado River. The primary habitation sites remained near water sources, whereas field houses were built away from the habitation sites in conjunction with arable land. As populations moved into more marginal farming areas, strategies were developed to enhance productivity, i.e., focusing agriculture in drainages where runoff could be utilized through construction of water control features to

conserve moisture. These strategies worked until about 1275 when a major transformation in the climate took place throughout the basin.

2.1.1.1 Specified Sites. Excluding the Wupatki data, the sites in Table 2.3 consist of 54 rock alignments of various types, 3 cleared fields, and three water catchments. The distribution of the sites is clustered, probably due to sampling. The areas where sites are not plotted for the most part have not been studied by archaeologists. With the exception of the Wupatki data, nearly all of the sites are located on U.S. Forest Service land.

The cleared fields do not offer much evidence of water control technology, only that careful investigation or exceptional preservation can leave evidence of the location of prehistoric fields. The three water catchments are widely separated. Site 15 consists of six natural sink holes that hold water and would provide a dependable seasonal source of water. This site is south of Wupatki National Monument and is like many other sites within the monument. (There are 15 reservoirs within Wupatki National Monument itself.) Site 50 is a reservoir in the upper drainage of San Francisco Wash near other water control features. Site 48 is situated on the Mogollon Rim at the head of Clear Creek Canyon and might also be located near water control features, but archaeological coverage of this area is incomplete.

The 54 rock alignments can be divided into 17 miscellaneous rock alignments, 17 check dams, 16 terraces, 3 linear borders, and one border field. All, with the possible exception of the border field, were designed to hold water and soil. In fact every water control feature in the rim area can be characterized as built for conservation rather than for diversion. This is not surprising considering the general absence of running water in the area due to the predominance of cinder soils.

The rock alignments occur generally in four regions in the rim area: Deadmanôs Wash, upper San Francisco Wash and tributaries, upper Diablo Canyon, and central Clear Creek Canyon and tributaries. The Deadmanôs, San Francisco, and Diablo drainage areas are all dominated by terrace/rock alignment features, with check dams being rare. This is due to the abundant precipitation in these areas causing the occupants to emphasize agriculture on cinder cones or bajada areas of these cones rather than in the washes where check dams typically occur. At higher elevations most drainages would be subject to a phenomenon called cold air drainage. Cold air is heavy and sinks into topographic low areas making even shorter the already marginal growing season (Adams 1979).

In contrast in the Clear Creek area all of the plotted sites are check dams, which are designed to catch and retain moisture in drainages. This pattern is a logical choice because the Clear Creek area water control features are located in pinyon-juniper or grassland areas where rainfall is marginal for growing maize, but the growing season is not shortened significantly by cold air drainage.

It is characteristic in both areas that field houses are found in conjunction with rock alignment features. Given 10 percent coverage of the area by archaeologists, one would predict about 540 water control feature sites in the Rim area. These totals do not include Wupatki National Monument.

Almost all of the water control feature sites occur within the traditional area of the Sinagua. The exceptions could be the four to seven sites on the north side of the San Francisco Peaks in the upper Cedar Creek and Deadmanôs Wash area, and site 2, which is probably Anasazi. The 10 sites in the central Clear Creek drainage area may be Sinagua or may be Mogollon. Because both traditions are closely related, it is not critical to our analysis here. It will

be noted in the upper Little Colorado River area that water control features are found in the more traditional Mogollon region that are quite similar to Sinagua features.

The maps clearly show that access to Hopi from the Sinagua area would require simply following the major drainages to the Little Colorado River and to the main washes draining the Hopi Mesas. The documented contacts between the two areas and their easy access to one another support Hopi oral traditions that the Sinagua migrated to Hopi following abandonment of the Flagstaff area (Colton 1939:22; Courlander 1971:41; Ellis 1974:221; Fewkes 1900:449-50).

2.1.1.2 Summary: From the diversity, location, and density of sites having water control features, it is evident that their construction was essential to the successful farming economy of the Sinagua people. Without this technology, clearly adapted to the local environmental setting, the Sinagua culture would not have developed to the level it reached in the 12th century. The reliance on water conservation rather than diversion features was a reaction to the realities of surface water in the Mogollon Rim area. Water comes in short, violent bursts in the summertime. This water either runs off down the drainages or soaks into the deep soils of the area. Free-flowing streams, essential for water diversion, simply do not exist on the Mogollon Rim.

The pattern of water control feature location in the rim area also shows intensive use of the upper and central reaches of major drainages and their tributaries. Where precipitation was adequate and drainages were too cold for agriculture, terracing was used. Where precipitation was low and cold air drainage was not a problem, check dams were used. Natural sinks and springs were relied upon for drinking water. Although only crude estimates can be made, it is likely that 500-1000 acres were brought into cultivation using water control features, or about half an acre per water control feature site. It should be noted that a single site can have dozens of features. Sites with water control features complemented fields having no water control features,

or none preserved, and were probably relied upon in the event many of the more traditional fields failed.

2.1.1.3 Wupatki National Monument. The full coverage survey of Wupatki National Monument (the monument) was completed in 1987 with 2397 prehistoric (pre-1275) sites recorded in the 55 square mile area of the monument (Downum and Sullivan 1990:5.2; Figure 2.2). Fully 72 percent (1731) of the sites were used in agricultural pursuits comprising over 12,000 individual elements or features (Downum and Sullivan 1990:5.67; Travis 1990:4.9). A

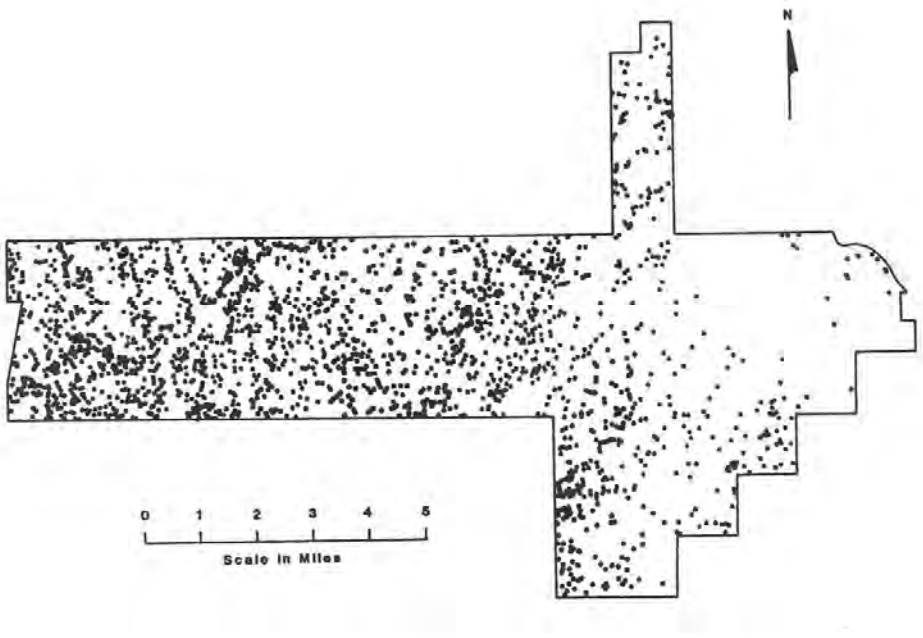


Figure 2.2. All sites recorded in Wupatki National Monument (Downum and Sullivan 1990:Figure 5.6).

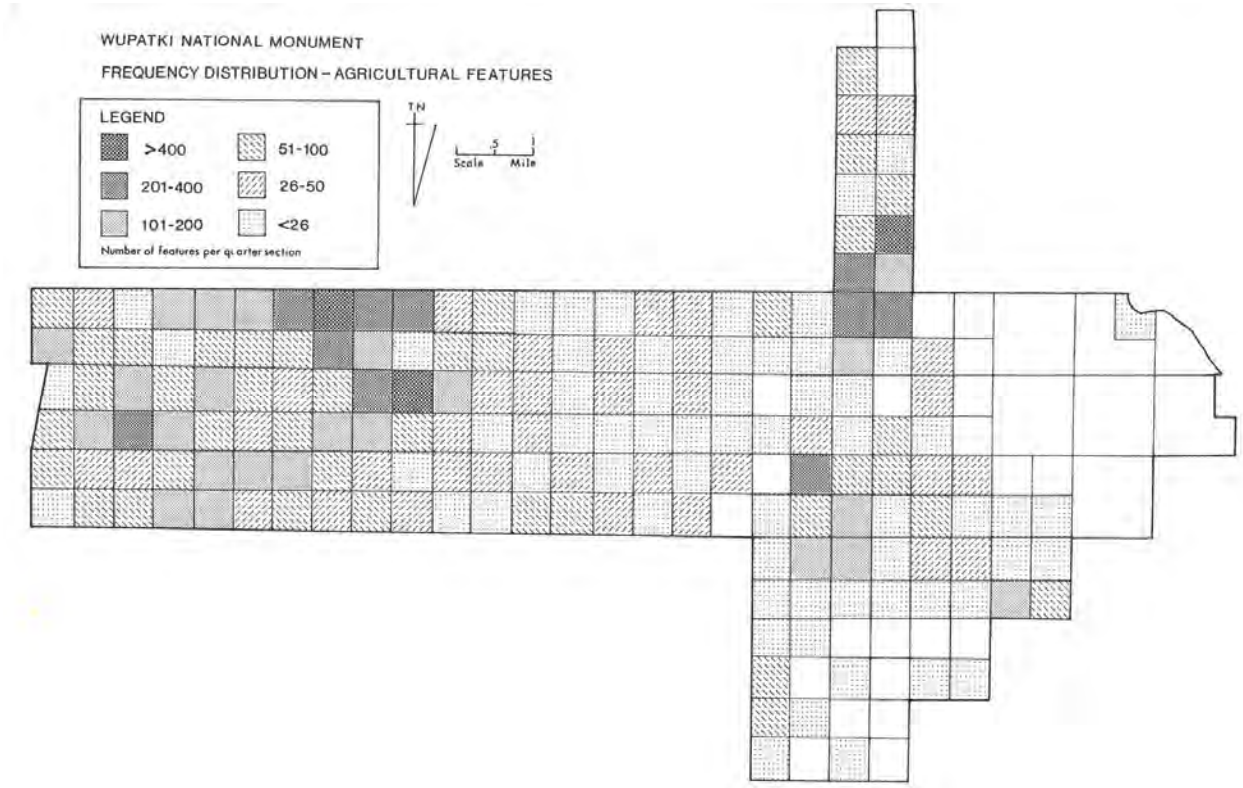


Figure 2.3. Agricultural feature frequency in Wupatki National Monument (Travis 1990:Figure 4.16).

total of 1456 of the agricultural sites were field houses (Downum and Sullivan 1990:5.60-5.64) (Figs. 2.3 and 2.4). Of more central concern to our study are the water control features and the agricultural systems in place. The Wupatki survey recorded 68 agricultural fields, 15 reservoirs, and 2 springs (Heizer and Wupatki) (Fig. 2.5). The fields were separated as a distinct category because there were no associated field houses or other features to categorize them otherwise.

The high density of agricultural fields and systems is a result of three processes: population growth, environmental change, and the arid conditions of the monument. Mean annual precipitation at the monument headquarters is 7 in. per year and certainly does not exceed 10 in. anywhere in the monument. Ground water is in short supply and the two springs are both in the southeast corner of the monument. The Little Colorado River, along the east edge,

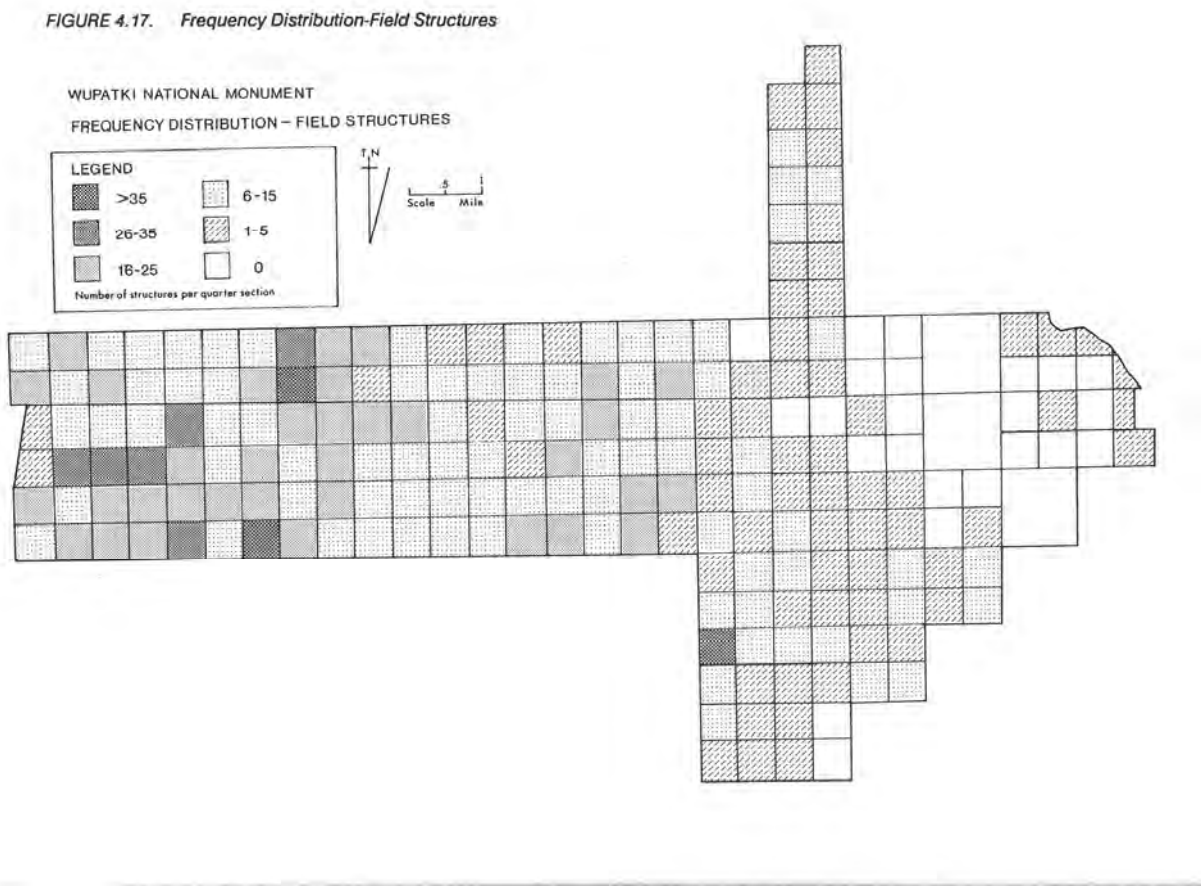


Figure 2.4. Frequency of field houses in Wupatki National Monument (Travis 1990:Figure 4.17).

probably flowed seasonally, but was a considerable distance from the principal habitation sites and arable land of the prehistoric period (Hartman and Wolf 1977:3-5).

Colton (1939, 1946) was the first to suggest that the eruption of Sunset Crater affected the settlement pattern in the monument area. He proposed that the volcanic ash from the eruption in 1064 created a mulch that enhanced the productivity of the monument soils by improving nutrients and retaining much needed moisture. Although this theory has often been criticized, the correlation between the sudden population increase in the late 1000s, contrasted with almost no

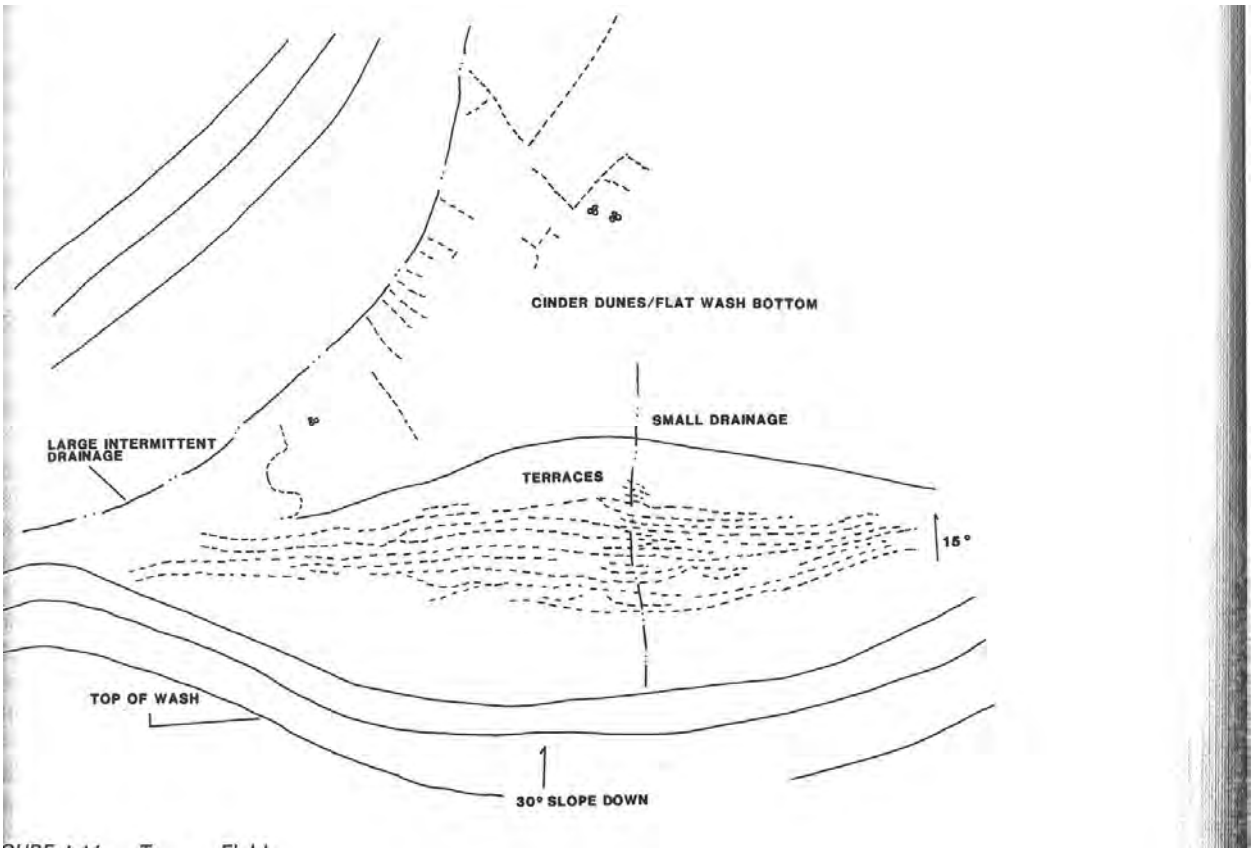


Figure 2.5. Agricultural terraces in Wupatki National Monument (Travis 1990:Figure 4.14).

occupation prior to the eruption is compelling. What may in fact have occurred was a fortuitous correlation of the eruption with a wetter cycle in the ever changing precipitation pattern in the arid Southwest that considerably enhanced the productivity of the soils of the area (Pilles 1987).

The result, whatever the actual cause(s), was a remarkable increase in population in the Wupatki area culminating in the construction of 10 pueblos having more than 20 rooms each. The largest is Wupatki with 102 rooms, with the Citadel second at 51 rooms. Only one other pueblo has more than 30 rooms (Downum and Sullivan 1990:5.39). Downum and Sullivan (1990:5.82) estimate that population peaked at over 2000 people in the middle 1100s from a population of zero before 1064, declining again to zero after 1275 or possibly as early as 1225.

People emigrated from the Wupatki area due to soil exhaustion and precipitation patterns that were inadequate to compensate. The severe drought of the last quarter of the 13th century was the final straw leading to total abandonment.

These remarkable figures help explain the complex settlement pattern that occurs at the monument. Although the soils may have been productive, the low annual rainfall and the almost total lack of ground water required adaptation by the new settlers. The response was a massive, and successful, short-term attempt to conserve water in every way possible. Reservoirs were built near settlements to catch and save runoff for drinking water. Natural catchments, which were sinkholes in the limestone, were relied upon for supplementing the water supply. Extensive rock alignments, both terraces and check dams, were constructed to conserve water for fields. Field houses were built near almost every field to secure precious foodstuffs from predators and perhaps competitors from neighboring settlements.

The development of extensive water control features and field houses were responses to the needs of a large population in a marginal environment. These responses resulted in a successful occupation of the monument by up to 2000 people for 200 years. Woodbury (1961) estimated 2.5 acres of fields to feed one person and provide storage and seed grain for the following season. Following this estimate, over 5000 acres (8 square miles or 20 square kilometers) would have been needed to support the maximum population in the monument area. Conservation of surface water resources made this adaptation possible. It is this same use of limited resources by the Hopi today that has allowed their adaptation to only a slightly less arid place than Wupatki (but with much better ground water) for over 700 years.

2.2 Upper Little Colorado River Area

The prehistoric cultural groups most associated with the upper Little Colorado River area are the Mogollon and the Anasazi. These two cultural traditions have deep roots in the area. The indistinct frontier between the two groups began to grow even fuzzier after A.D. 1000 as the Mogollon began to adopt many Anasazi characteristics, especially masonry architecture, and to share the ceramic tradition known as White Mountain Red Ware (Carlson 1970, 1982; Triadan 1997; Zedeño 1994). This shared tradition became the Western Pueblo culture whose distinctiveness crystallized in the late 12th and 13th century (Reed 1948). As a result, Western Pueblo will only be present in the AZSITE database in Period 2, although it is present in local databases in Period 1. Longacre (1964, 1970) has synthesized the regional prehistory into seven phases ignoring the distinctions of Anasazi, Mogollon, and Western Pueblo.

Mogollon: Mogollon culture, first defined in southwestern New Mexico (Haury 1936), was predominant at and below the Mogollon Rim. The elements to this culture were outlined and then defined through research by the University of Arizona under the direction of Emil Haury. Hauryôs (1987) work at Forestdale just south of Show Low below the Mogollon Rim best exemplifies this work. Prior to A.D. 1000 the Mogollon people lived in settlements of pit houses with circular or rectangular ñgreat kivasò as the principal integrative religious structures. These people, although farmers, where characterized as more reliant on hunting and gathering than their northern neighbors, the Anasazi. Prior to A.D. 900, no water control features are known to be associated with Mogollon sites in the upper Little Colorado River area.

Anasazi: The earliest definitive work in the Anasazi area of the upper Little Colorado River area was by Roberts (1931, 1939) along the Puerco River. Farther south, Paul Martin and

his students from the University of Chicago spent more than a decade from the mid-1950s through the mid-1960s, excavating sites from all periods, but emphasizing the late period (Martin et al. 1962:200-206).

Anasazi sites consisted typically of small masonry pueblos having fewer than 10 rooms (after A.D. 800-900) that were probably occupied by small kinship groups. According to Lightfoot and Plog (1984:185), the people south and west of Snowflake began using terraces before A.D. 900, whereas farther north in Snowflake and the Hay Hollow Valley, water control features did not appear until A.D. 950 or later (see also Lightfoot 1984:101-102). Field houses were common features throughout the area beginning perhaps as early as A.D. 900, but expanding in number and frequency after 1100.

Western Pueblo: People belonging to Western Pueblo culture represent a blending of Anasazi and Mogollon characteristics. Although the concept of Western Pueblo was defined by Reed (1948), the principal research in the upper Little Colorado River area was again directed by Martin and his students (Martin et al. 1960; Martin et al. 1961; Hill 1970; Longacre 1970). After 1050 pueblos began to grow, with the process accelerating in the late 1200s (Hill 1970:88; Martin et al. 1964:205). In conjunction with these developments Lightfoot and Plog (1984:184-185) noted a marked increase in water control features, including ditches, at least 5 km of canals, and possibly reservoirs. The latter were possible because of running water in numerous upper Little Colorado River area streams making this area unique in the basin. Field houses are known for the latest periods in the upper Little Colorado River area, although the nature of the settlement patterns is less well understood.

From A.D. 1000 to 1275 the sites of Western Pueblo groups become progressively larger, more complex, and fewer in number. This process of aggregation and assimilation of many

groups into single settlements or clusters of settlements has been noted in the Mogollon Rim area and is repeated in the upper Little Colorado River and Plateau areas. In all areas this process is accompanied by increased emphasis on agriculture and on elaboration of water control features (Lightfoot 1984:102; Lightfoot and Plog 1984:185).

2.2.1 Prehistoric Data Base ï Upper Little Colorado River Area

The principal source of data for this study is AZSITE. The principal sources for the database to Period 1 in AZSITE for the upper Little Colorado River area are the Sitgreaves Forest, Museum of Northern Arizona (MNA), and the Arizona State Museum (ASM) site files. These are recorded and plotted on Maps 1 and 2 and Table 2.4. In addition to this database Lightfoot (1984) has summarized prehistoric and protohistoric agriculture in the upper Little Colorado River area. These complementary studies will be used to synthesize our knowledge of water use in the upper Little Colorado River area. The general conclusions that can be drawn from the ñsamplingò of the forest by these projects are that field houses were nearly ubiquitous in the upper Little Colorado River area.

Field houses began to be used in the area in the A.D. 900-1100 period, increasing in frequency after A.D. 1100. This parallels the pattern observed in the Sinagua area by Pilles (1978). The field houses seem to be extensions of the prehistoric settlement pattern into the pinyon-juniper and especially into the grassland areas of the upper Little Colorado River with habitations, generally pueblos smaller than 20 rooms, remaining in the forested areas where fuel and protection from winter winds are afforded. The field houses are also typically located above shallow drainages. Such locations afford a better view of the area, would be cooler in the summertime due to breezes, and would be safe from flooding when heavy thunderstorms caused

Table 2.4. AZSITE sites for the upper Little Colorado River area dating to Period 1 by cultural group.

Site Type	Sinagua	Cohonina	Mogollon	Anasazi
Artifact Scatter	0	0	287	215
Field	0	0	60	102
Field/habitation	0	0	217	321
Field/Water Control	0	0	246	3
Habitation	0	0	615	546
Petroglyph	0	0	7	60
Shrine	0	0	2	1
Water Control	0	0	4	1
Total	0	0	1438	1249

Table 2.5. Sites with water control features in the upper Little Colorado River area dating to A.D. 1-1275

Number	Site Name	Features	Reference
63	AZ K:12:91	water control (check dam)	ASM Site File
64	AZ K:15:2	dam(check dam)	ASM Site File
65	112	habitation, 50+ rooms	Sitgreaves For
66	No number	tolapai spring	Sitgreaves For
67	AZ P:12:24	reservoir and field	ASM Site File
68	AZ Q:2:30	20-22 check dams	ASM Site File
69	AZ Q:4:65	terrace	ASM Site File
70	AZ Q:4:118	water control, check dams	ASM Site File
71	AZ Q:4:72	terrace	ASM Site File
72	AZ Q:4:101	terrace	ASM Site File
73	AZ Q:4:175	terrace	ASM Site File
74	AZ Q:4:177	canals, terrace, check dams, and fields	ASM Site File

75	AZ Q:7:56	check dams, terraces	ASM Site File
76	AZ P:10:13	rock alignment, fieldhouse	MNA Site File
77	AZ P:10:14	2 rock alignments	MNA Site File
78	AZ P:6:19	check dam, fieldhouse	MNA Site File
79	AZ P:8:41	rock alignment	MNA Site File
80	AZ P:8:34	check dams	MNA Site File
81	AZ Q:2:30	22 rock aligns, 20 check dams	MNA Site File
82	Twin Butte	several rock alignments	3
83	1697	54 check dams 1.2 mi, fieldhouse	Sitgreaves For
84	1708	3 check dams	Sitgreaves For
85	1733	check dam	Sitgreaves For
86	1767	check dam, fieldhouse	Sitgreaves For
87	1774	check dam, 3 fieldhouses	Sitgreaves For
88	1794	10 check dams	Sitgreaves For
89	129	terrace, fieldhouse	Sitgreaves For
90	NS29	canal	4
91	NS69	canal	4
92	AZ P:8:42	habitation, 40+ rooms	MNA Site Files
93	281	14 check dams, fieldhouse	Sitgreaves For
94	1273	2 terraces	Sitgreaves For
95	Bailey Pueblo	habitation	Sitgreaves For
96	007	habitation, 45 rooms	Sitgreaves For
97	137	2 terraces, 25-35 m	Sitgreaves For
98	12	3 check dams	Sitgreaves For
99	15	terrace	Sitgreaves For
100	AZ K:14:25	habitation, 30 rooms	MNA Site File
101	AZ K:14:7	habitation, seep (cottonwood)	MNA Site File
102	Hay Hollow area	canals ï 4 km+	4
103	Show Low Creek	canals ï 1 km+	4
104	AZ Q:15:11	check dam	1
105	AZ Q:16:16	check dam	1
106	Canyon Butte	habitation, water catchment	2
107	Woodruff	habitation, gardens, terraces	2
108	McDonalds Can	habitation, reservoir	2

1 Wood 1978:65
2 Hough 1903
3 Wendorf 1953
4 Lightfoot and Plog 1984:185; Lightfoot 1984:102

the washes to flow. The fields were usually located in the washes to take advantage of runoff and it is here that the remains of water control features are usually found.

2.2.1.1 Specified Sites. Sites having rock alignments (including dams and water control), two reservoirs, five sites with canals (including one also with rock alignments), one developed spring, and six habitation sites with 30 to over 50 rooms typify land use patterns in the region (Table 2.5). Lightfoot (1984:101-102) also discusses several areas, some with specific sites, having extensive water systems. Site 74 is an example of such a system having canals, terraces, check dams, and fields. Lightfoot and other investigatorsô use of the term ñcanalò is somewhat ambiguous. In one or two instances, such as the Hay Hollow Valley, Lightfoot (1984:184) may actually be referring to canals, as defined by Vivian (1974:97). In general, however, the more proper term, following Vivian, would be ditch. Because the investigators used the term canal, its usage will be retained here, but in general should be interpreted as ditch.

This discussion highlights the clearest difference between water control features in the upper Little Colorado River area versus those in the Mogollon Rim area ï the presence of water diversion features. As expected, the irrigation ditches and canals occur in drainage systems with a permanent or semi-permanent water flow. The absence of streams in both the rim and plateau areas of the basin eliminates the possibility for such features, with the exception of areas along the Little Colorado River itself. In the more arid pinyon-juniper and grassland areas of the western and northeastern upper Little Colorado River areas, the water control features are all rock alignments with check dams more common to the west and combinations of check dams and terraces in the Zuni and Puerco River areas in the northeast section.

Water diversion features are concentrated along relatively flat valleys with permanent or semi-permanent streams. According to Lightfoot (1984 :183-184), intermittent irrigation

occurred in the Hay Hollow Valley, along Silver Creek in the Snowflake area, along the Little Colorado River in the St. Johns to Springerville area, and around Chavez Pass. The expansive water system developed at Chavez Pass began as terraces in the 1150-1300 period. During Period 2 with continued influx of population, a complex water system involving reservoirs, ditches, terraces, and check dams was developed at Chavez Pass. Most of the other systems are also associated with Period 2 pueblos, although their beginnings may date to late Period 1. They will be discussed in the Period 2 chapter. Only the Hay Hollow system is clearly Period 1, associated with developments of medium size pueblos of 30 to 100 rooms (Longacre 1970; Hill 1970). The Arizona State University (ASU) and Chicago Field Museum (Museum) research in the valley has charted 5 km of canals. The system Lightfoot (1984:184) describes has major channels (canals) that transport water from runoff and Hay Hollow Wash into smaller lateral canals (ditches) that water fields. Depressions near the wash fed by these canals could be reservoirs. This extensive water system was probably developed between 1150 and 1280, when the valley was abandoned.

The ASU research, with which Lightfoot was associated, found extensive systems for agriculture in almost every major drainage and associated minor drainages below 7000 ft from the Silver Creek drainage eastward to the New Mexico border. This includes Hay Hollow Wash, Pinedale Wash, Show Low Creek, Zuni River, Little Colorado River, and Silver Creek itself.

2.2.1.2 Summary: The development of water systems reached its greatest extent in the upper Little Colorado River area during Period 1. This development is tied to the growth in population and the aggregation of villages in the most watered areas below 7000 ft. To support the concentrations of populations that occupied the most desirable agricultural areas, intensification of agricultural systems was developed by the construction of elaborate water

systems combining both conservation and diversion features. In the less desirable western half of the upper Little Colorado River area, the population density was lower and water systems were much simpler relying only on water conservation features such as check dams and terraces. In general the streams are too deeply incised in the west to permit water diversion.

The technology in water control features developed in the upper Little Colorado River area was eventually transferred to the historic descendents of these people in both the Zuni and Hopi areas. These developments and this continuity can best be traced in discussions associated with Period 2 sites and water systems.

2.3. The Plateau Area

The plateau portion of the basin was occupied by only one sedentary cultural tradition, the Anasazi. The Anasazi are best known for their impressive remains in the Mesa Verde area of southwestern Colorado, in Chaco Canyon in northwestern New Mexico, and Canyon de Chelly and Navajo National Monuments in northeastern Arizona. Their developments in the plateau area of the basin are much less spectacular, yet no less significant. Large pueblos are located only in the Hopi Mesas area and in major valleys of the eastern section of the plateau area (Adams 1996a; Colton 1974; Lekson et al. 1988). In the Hopi Buttes area between the Winslow portion of the Little Colorado River and the Hopi Mesas, Gumerman and Skinner (1968) recorded several hundred small sites of no more than five households who apparently used the area during periods of above average precipitation over most of the span of Period 1, from A.D. 600-1250.

Colton (1974:Tables I and II) identified 47 pueblos in the vicinity of the four Hopi Mesas (First, Second, Third, and Antelope) that were occupied in the 13th century. These generally were smaller than 100 rooms. Prior to the 12th century, settlements in the Hopi Mesas area were

uniformly small and dispersed. Lekson et al. (1988:108) have noted 10 to 15 aggregated settlements along drainages east of the Hopi Mesas that seem to have been established as early as the late 11th century, many of which continued into the 13th century. Lekson et al. (1988) have linked the 11th and 12th century elements of these sites to the massive regional system centered at Chaco Canyon. Although the basin sites evolved in place, they may have benefited from the extremely intensive and sophisticated water systems that were developed in Chaco Canyon as early as the 10th century (Vivian 1974). The Chaco water system included border gardens, reservoirs, contour terraces, and irrigation ditches that transferred water from the reservoirs to the border gardens in an elaborate runoff system (Vivian 1974:102). Although the research needed to locate and record these water systems has not been undertaken, it is likely that they will be located near most of the aggregated pueblos in the plateau area.

Using Lekson et al.ôs (1988:108) map, the 12th and 13th century aggregated pueblos are almost all adjacent to major drainages. Six are located along the Puerco River, a more or less permanent water source, and could have been attributed just as easily to the upper Little Colorado River area as the plateau area. The greater frequency of these sites on the plateau led to their assignment to the plateau.

Water control features in the Hopi Mesas area historically are concentrated around springs (Hack 1942:36). These springs have been the lifeblood to Hisatsinom (Anasazi) on the mesas for well over 1000 years. It is conceivable that development of these springs dates back to Period 1; however, historic renovation and development have obscured any evidence. Although development of water control features occurs by the 10th century in both of the other areas of the basin, there is no clear evidence of such features on the plateau much before the end of Period 1.

2.3.1. Prehistoric Database ï Plateau Area

Virtually the only source of AZSITE data for the plateau area of the basin is from the Museum of Northern Arizona (MNA) and the Arizona State Museum. Only four sites have specific water control attributes; however, there are over 300 sites that are associated with farming (Table 2.6). In addition to these data the aggregated settlements noted by Colton (1974) and Lekson et al. (1988) add another 60 or so sites. Finally, the database compiled by the Homolôovi Research Program (HRP) of the Arizona State Museum in the Winslow area will be drawn upon to discuss Period 1 water use along the Little Colorado River for the plateau area.

The farming sites are concentrated in several areas widely spread throughout the plateau area from the Petrified Forest National Monument area on the southeast, to the Hopi Buttes, to every major drainage in the vicinity of the Hopi Mesas. These sites all postdate A.D. 1000 and seem associated with two forms of agriculture: sand dune (dry or rainfall-dependent farming) and akchin (alluvial wash) farming. These two practices comprise 99 percent of historic Hopi agriculture (Page 1940b). The field houses located along major drainages were presumably associated with akchin fields and those situated away from drainages with dune fields.

Agriculturally-based settlements were first established in the Homolôovi area near Winslow about A.D. 650. Until about A.D. 1100, most fields were located in sand dunes and away from the river (Lange 1989) (Fig. 2.6). Sand dunes trap moisture critical for seed germination. Hack (1942:32) explains why sand dunes make good fields, especially in an area that receives only 8 in. of annual precipitation. Archaeological survey indicates that agricultural intensification began about A.D. 1100 as more akchin fields were placed to take advantage of runoff from surrounding land forms (Lange 1998). Although there are no water control features to suggest that the 1100-1250 occupants of the Homolôovi area diverted water to their fields from

Table 2.6. AZSITE sites for the Plateau area dating to Period 1 by cultural group.

Site Type	Sinagua	Cohonina	Mogollon	Anasazi
Artifact Scatter	0	0	0	169
Field	0	0	0	60
Field/habitation	0	0	0	99
Field/Water Control	0	0	0	2
Habitation	0	0	0	287
Petroglyph	0	0	0	37
Shrine	0	0	0	3
Water Control	0	0	0	4
Total	0	0	0	661

the Little Colorado River using canals, the clustering of their fields along the edge of the active floodplain may suggest they took advantage of seasonal flooding and recession farming (Lange 1998:xx) (Fig. 2.6).

Not much can be said concerning water control features in the plateau area during Period 1 because of the very limited database. Only four sites are listed, including one catchment along Moenkopi Wash north of Cameron and a spring with a nearby 12th to 13th century pueblo. It should be noted that nearly every spring in the vicinity of the Hopi Mesas had Period 2 use and that most of this use must have begun in Period 1. The overlay of later occupations and lack of real fieldwork on the problem of dating use at water sources anywhere on the plateau precludes any definitive conclusions.

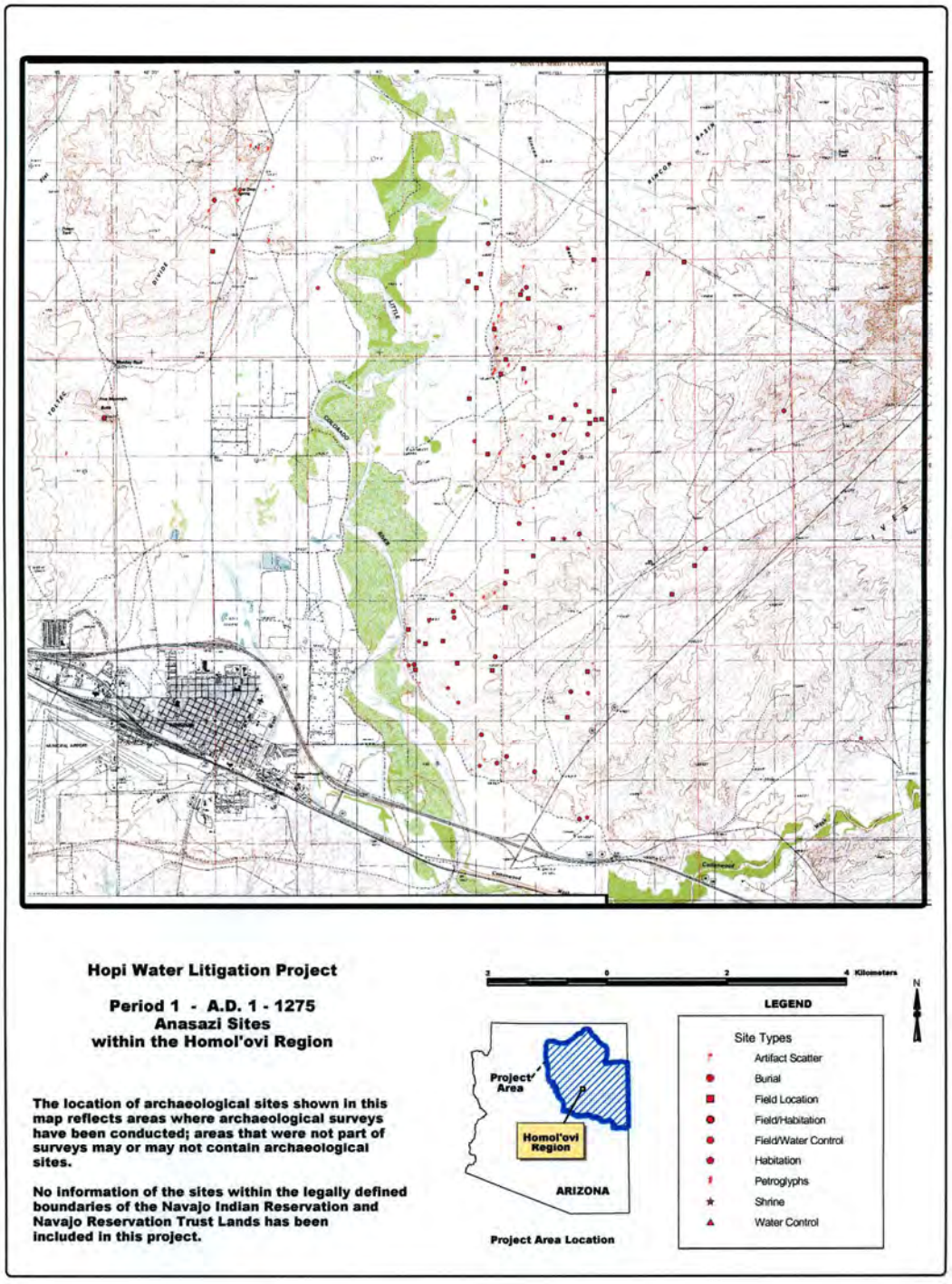


Figure 2.6. Period 1 Anasazi sites within the Homolôovi region.

2.4 Summary

The complex use of the landscape by prehistoric people is illustrated by the Period 1 database. Although over 5,868 sites are illustrated in Maps 1 and 2, not including the culturally unaffiliated sites, behind the data is an even more elaborate overlay of information. Most of the archaeological sites that define the prehistoric cultures are small pueblos, fields (some with field houses), and artifact scatters. The only exception is the large number of water control features in the upper Little Colorado River associated with Mogollon culture sites. Nonetheless, there are important parallels in all three areas of the basin, both in terms of the development of water use and its actual applications to support the distinctive cultural systems in existence in the basin during Period 1. Both water control features and field houses appeared in all areas after A.D. 900. Although they are known before 900, they are rare and highly localized. After 900 both water control features and field houses became widespread and a regular part of cultural development throughout the Mogollon Rim and upper Little Colorado River. These developments occurred after 1000 and were less complex in the plateau area. This process accelerated after 1100 and, as we shall see in chapter 3, intensified after 1300.

The development of more complex settlement systems in this perspective was the result of population increase. Increased population in the basin resulted initially in the spread of agriculture beyond the most desirable areas into more marginal ones. This eliminated the option of moving to new resources that was available before A.D. 900 because empty areas were now occupied. As a result, technology and techniques were developed or adopted to better exploit the limited resources. Small groups moving into marginal areas were supported by new techniques, such as akchin agriculture, and sometimes accompanied by water control features, such as check

dams. Other groups increased their use of good land with contour terraces and border gardens. This more desirable arable land was farmed by people living in nearby villages.

After 1100 the settlement pattern in the basin began to shift from many widespread, small settlements, each supported by very local arable land resources, to a more aggregated system with fewer settlements and greater distance between habitation sites. During this period the number of field houses increased markedly as people from the villages began to farm land that was located farther away. Field houses provided shelter for farmers who needed to spend time tending the fields and may have served as storage facilities for tools or temporarily for agricultural products. If the field near these field houses is now identifiable, it is by rock alignments, terraces, or check dams. Near the main settlement, fields without field houses might also have had intensive water control features. Thus the process at work in the basin, although expressed slightly differently in each area, was one of agricultural intensification using water control features and expansion using field houses.

In the Mogollon Rim area fairly large settlements of over 30 rooms were typical by the 12th century. These were supported by systems of field houses and water conservation features, such as check dams, various terraces, and, rarely, reservoirs. Similar water conservation features were developed in the upper Little Colorado River area, but augmented by water diversion systems in particularly fertile valley areas.

In the plateau area prior to 1275, the developments involved primarily field houses associated with intensified use of all major drainages. The eastern section of the plateau from the Puerco River to the Pueblo Colorado River witnessed the development of about 15 aggregated settlements (Adams and Duff 2004a:157-158; Adler 1996???). The archaeological data for this area are incomplete, yet it can be postulated that the water control features here are more similar

to those used in the Mogollon Rim and the upper Little Colorado River areas than those used elsewhere on the plateau.

In conclusion, during the 12th and 13th centuries water control features and field houses became a permanent part of the subsistence strategy employed by people living in the basin. By 1275 every major drainage and most secondary drainages were used to grow crops. Settlements concentrated between 7000 ft and 5500 ft; however, by using various successful techniques of water management and locating areas with longer growing seasons at higher elevations, settlements were viable between 7500 ft and 4500 ft. Larger populations and more complex settlement structures were supported by increased management and use of water and agricultural resources. Without the development of water conservation and diversion features, the 12th and 13th century Hisatsinom could not have evolved into the culture we recognize as Hopi.

CHAPTER 3

THE PROTOHISTORIC PERIOD (PERIOD 2), A.D. 1275 TO 1630

As with the prehistoric period, the protohistoric period will be divided into three areas: the Mogollon Rim, the Upper Little Colorado River, and the Plateau. The protohistoric period (Period 2) in the basin is characterized by significant shifts in population resulting in aggregation into fewer but larger pueblos. Spacing between the pueblos increased substantially. This does not mean, however, that use of the landscape diminished. The detailed study of the Homolôovi settlement cluster will be used to illustrate this broad use for Period 2.

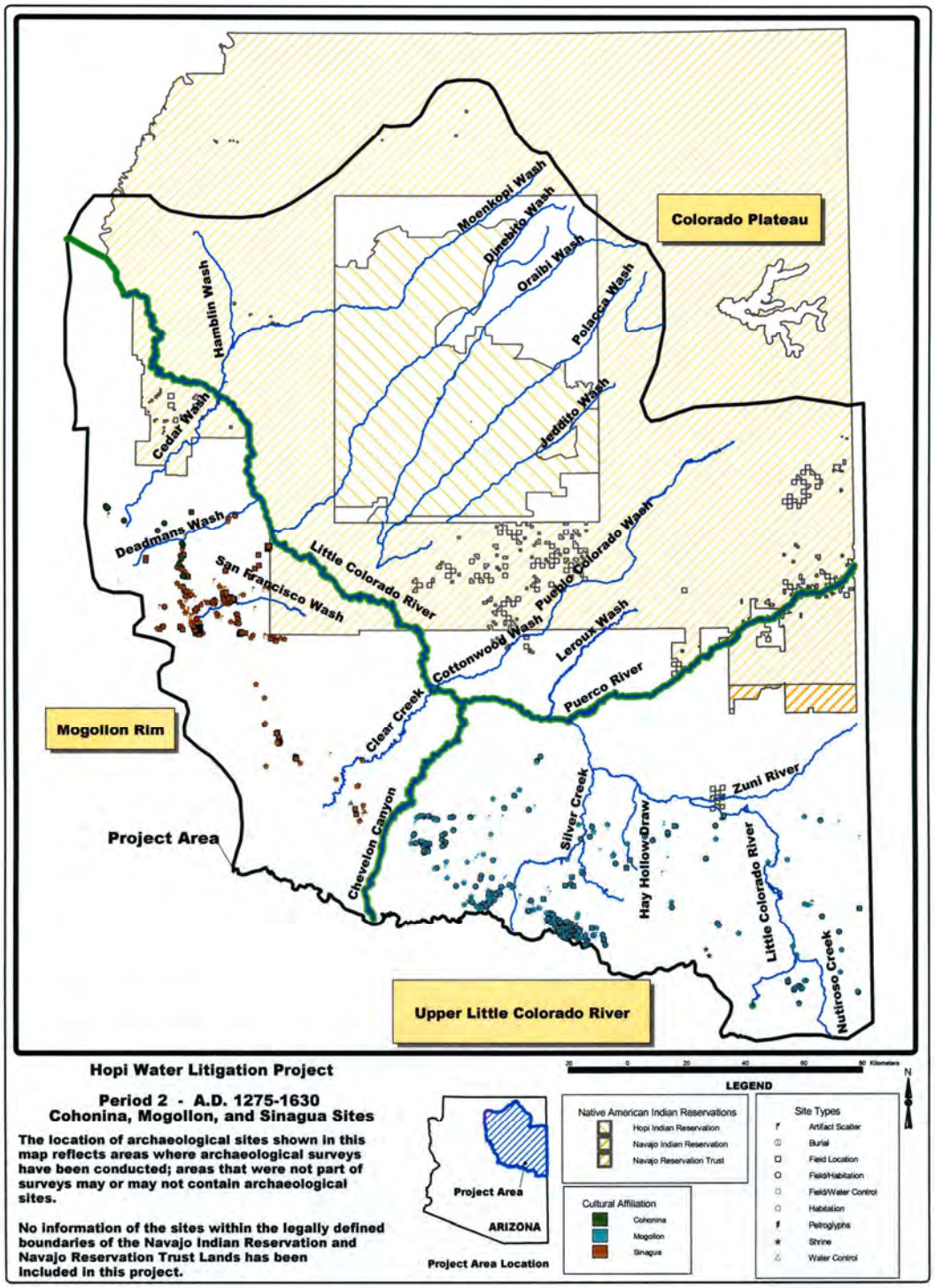
Archaeologists have used many techniques for estimating population - site size, room area, and so forth (Cameron 1999:210; Longacre 1970) with varying results. Until site longevity, site use, and site density can be better understood for the basin, or anywhere for that matter, estimates of population increase, decline, or stability are difficult to pinpoint. Therefore, the drop in population from the pre-A.D. 1275 period to the post-A.D. 1300 period projected by most archaeologists can neither be supported nor refuted (see Fig. 1.2; Dean et al. 1994:74; Fish et al. 1994:147) on the basis of existing data. What is known about the prehistory of the basin is that the population shifted significantly in location and in the nature of individual settlements. These changes also affected land and water use. For example, recent summaries for this period published in an edited volume by Adams and Duff (2004b) suggest 75-100 villages were still occupied after 1275 averaging over 100 rooms each (Maps 3 & 4). These will be the foci of the discussion to follow.

3.1 The Mogollon Rim Area

After A.D. 1275 the only cultural group still inhabiting the Mogollon Rim area was the Sinagua. Only seven habitation sites are known for the rim: Old Caves, Pollock, Grapevine,

Kinnikinnick, and the three villages at Nuvakwewtaqa (Chavez Pass) (Bernardini and Brown 2004; Pilles 1987:117; Pilles 1996). All are located on Anderson Mesa, southeast of Flagstaff with the exception of Old Caves, which lies just northeast of town (Map 3). By 1400 even these seven sites were no longer inhabited. The Hopi know about the prehistoric sites of Anderson Mesa, referring to the area as Nuvakwewtaqa or "one wearing a snow belt," because snow along its north side appears as a long white line when viewed from the Hopi Mesas (Pilles 1987). Enormous quantities of obsidian (volcanic glass) derived from the many local sources in the Flagstaff area have been observed at both Kinnikinnick and Grapevine (Brown 1990; Harry 1989:Table 1). Obsidian from these same sources begins to appear in large quantities at 14th century pueblos throughout the basin, but in particular at the Hopi Mesa villages and the Homol'ovi pueblos. This obsidian was probably acquired from the Anderson Mesa pueblos. Yellow ware pottery manufactured at villages on the Hopi Mesas has been found at all of the rim area pueblos, but in particular at Chavez Pass (Bernardini 2005:56; Bishop et al. 1988). The extensive nature of the trade between the Hopi Mesa people and the Anderson Mesa people certainly suggests familiarity of the groups with one another, probably by following the direct access provided to both areas by the Little Colorado River drainage system. Hopi legends tell of the Sinagua people being ancestral to the Hopi (Pilles 1987; Malotki and Lomatuqay'ma 1987) and existing evidence supports the view that the Period 2 Sinagua of the rim area are ancestral Hopi. Recently, Bernardini (2005) has argued that Hopi migration paths are represented in the exchange of pottery and rock art found at Nuvaqwewtaqa and Homolôovi

The Sinagua villages range from about 60-75 rooms at Grapevine, Old Caves, and Pollock to 166 rooms at Kinnikinnick and up to 700 rooms in the three pueblos at Nuvakwewtaqa, although no more than 450 were contemporary (Bernardini and Brown 2004:112-113; Colton 1946; Upham 1982). Increased village size may in part be a function of increased conversion of space to food storage as a buffer for an unpredictable environment. Such a shift would be expected where agricultural intensification was occurring. The seven Sinagua pueblos are situated at elevations between 6500-7000 ft in pinyon-juniper woodland with



Map 3: Period 2, Cohonina, Mogollon, and Sinagua sites.

ponderosa pines nearby. Each of the pueblos is located near a good spring, with the exception of Old Caves (Colton 1946). Because distribution of water control features is known only for the Chavez Pass villages, this will be the focus of discussion.

3.1.1 Protohistoric Database - Mogollon Rim Area

Information concerning Period 2 occupation and use of water resources of the rim area is from the AZSITE database derived from Museum of Northern Arizona (MNA) and Coconino National Forest records (Table 3.1). The Forest Service data are from the Arizona State University (ASU) research project, which operated in the Chavez Pass area in the late 1970s. These data are summarized in Lightfoot and Plog (1984) and Upham (1982). Colton (1946), Bernardini and Brown (2004), and Pilles (1979, 1987, 1996) also discuss the Period 2 pueblos of the post-1275 period in the rim area. Although no other Period 2 sites were recovered from the site file searches of the various institutions, three field houses dating to Period 2 were

Table 3.1. AZSITE sites for the Mogollon Rim area dating to Period 2 by cultural group.

Site Type	Sinagua	Cohonina	Mogollon	Anasazi
Artifact Scatter	90	7	2	134
Field	117	1	1	31
Field/habitation	47	15	2	55
Field/Water Control	0	0	0	1
Habitation	116	1	2	139
Petroglyph	6	0	0	16
Shrine	0	0	0	0
Water Control	3	0	1	3
Total	379	24	8	379

recorded during survey of the vicinity of the Chavez Pass pueblos (Bernardini and Brown 1984:113.

3.1.1.1 Specified Sites. The specified sites consist of the five pueblos and 40 water control features (Table 3.2). Thirty-seven of the plotted features are in the Chavez Pass area and associated with the occupation of Nuvakwewtaqa. Lightfoot and Plog (1984:183) note the presence of up to five reservoirs that were used either to water adjacent terrace plots or supplemented springs for domestic use. The total agricultural system, primarily terraces, at Chavez Pass covers more than 0.7 sq. mi (1.9 sq. km) or 17 percent of the 4.4 sq. mi (11.3 sq. km) area surveyed. The system consisted of terraces, some with feeder ditches; possibly reservoirs for watering some terraces; border gardens; and occasional check dams and field houses.

The other three sites consist of two terraces and a check dam. These all occur 3-6 mi (5-10 km) from Nuvakwewtaqa and could represent extensions of the agricultural intensification or isolated plots associated with the Nuvakwewtaqa occupation. Because the intervening areas were not surveyed by ASU, it is not possible to determine if the isolated water control features are part of a continuous distribution of sites, or appear isolated only as an artifact of the lack of research. Hopi and Zuni both farm at distances comparable to or greater than these fields from Nuvakwewtaqa.

3.1.1.2 Summary. Clearly, the settlement pattern in the rim area for Period 2 is greatly different from Period 1. The hundreds of small settlements have aggregated into seven large pueblos. Areas, such as Wupatki National Monument, were no longer occupied, although Wupatki Pueblo itself was evidently reused after 1300. The absence of characteristic artifacts of the 14th century in field houses or other agricultural features near Wupatki makes it unclear whether this reuse was seasonal or related to agriculture. Most likely it was the product of travelers stopping and spending the night because of the availability of water at two nearby springs.

Table 3.2. Major pueblos and terraces in the vicinity of the Chavez Pass community dating to Period 2, A.D. 1275-1630.

Number	Site Name	Features	Reference
1*	D 7:145	terraces, 7350 sq m	MNA Site Files
2	D 7:146	terraces, 400 sq m	MNA Site Files
3	D 7:186	terraces, 200 sq m	MNA Site Files
4	D 7:187	terraces, 25 sq m	MNA Site Files
5	D 7:131	10 terraces	MNA Site Files
6	D 7:132	terrace	MNA Site Files
7	D 7:443	terraces	MNA Site Files
8	D 7:441	2 check dams	MNA Site Files
9	Chavez Pass	3 habitation sites, terraces, reservoir, 3 field houses	1, 4
10	HOP31	agricultural feature	2
11	Wupatki	habitation, spring	Wupatki NM
12	Kinnikinnick	habitation, spring	3, 4
13	Grapevine	habitation, spring	3, 4
14	Pollock	habitation, spring	5, 4
15	Old Caves	habitation	3

* Over 30 other sites with terraces in this D:7 area total 20-25,000 sq meters
1 Lightfoot and Plog 1984
2 Adams et al. 1993
3 Colton 1946
4 Upham 1982
5 Pilles 1987

The only detailed study of one of the Period 2 sites and surrounding area is at Chavez Pass. It is obvious that enormous intensification of land use occurred in conjunction with the growth of Nuvakwewtaqa. An almost 2 sq. km area of poor agricultural land within a 2 km radius of the pueblo was converted to productive agricultural land through the use of terraces in

combination with other water control features (Lightfoot and Plog 1984:185). Additionally, numerous field houses were built within this 2 km radius to monitor the fields. The reason for intensification of agricultural land was the increase in population at Nuvakwewtaqa. The process of aggregation was supported by the construction of terraces in the 13th century. As population grew in the pueblo, so did the number of terrace features and field houses (Lightfoot and Plog 1984:185; Upham 1982).

The rim area was depopulated of Pueblo people (the Sinagua) by about 1400. Although later Hopi use of this area continued throughout Period 2, probably due in part to the religious nature of much of the area, permanent occupation was discontinued. Post-1400 use concentrated on the springs and the higher elevations of the peaks themselves (Pilles 1987).

3.2 The Upper Little Colorado River Area

The post-A.D. 1275 occupation of the upper Little Colorado River area was significantly different from that of Period 1. Groups from northern Anasazi regions migrated into the area at the beginning of the period (Adams 2002, 2004a; Carlson 1970, 1982; Duff 2002; Haury 1958; Lyons 2003; Mills 1998). To accommodate this influx new social systems, such as katsina religion, developed to integrate the divergent groups (Adams 1991b). These social systems allowed the growth of larger pueblos, typically over 100 rooms in the early 14th century and over 250 rooms after 1350 (Adams and Duff 2004a; Duff 2004; Kaldahl et al. 2004; Mills et al. 1999) (See Map 3). Where archaeological research has been conducted, water control systems and field houses have been found in association with these large pueblos. Both intensification and extension of the use of arable land for fields were parts of the strategy used to support the large habitations.

3.2.1 Protohistoric Database - Upper Little Colorado River Area

Information concerning the Period 2 occupation and use of water resources of the upper Little Colorado River area is derived from Sitgreaves National Forest, Museum of Northern Arizona (MNA), and Arizona State Museum (ASM) records in AZSITE. Much work has been conducted in the area by anthropologists and archaeologists beginning with Adolf Bandelier in

1892. Discussion of the habitation sites utilized the work of Hough (1903), Fewkes (1891), and Spier (1918), supplemented by the work of Paul Martin and colleagues (Martin et al. 1961), as well as others (Schroeder 1961). For the most part the focus of research has been on the pueblos themselves with little attention on extramural features, nearby small sites, and the like. The data on water control features have been summarized for a major part of the upper Little Colorado River area by Lightfoot and Plog (1984) and will be relied upon substantially in the discussions to follow.

3.2.1.1 AZSITE Sites. The sites in the AZSITE database for the upper Little Colorado River area for Period 2 are listed in Table 3.3. These indicate widespread use of the area for farming (Maps 3 and 4). Included as habitation sites are many small pueblos whose occupation ended very close to 1275, but AZSITE does not discriminate sites at such a fine temporal level and thus they are include as part of Period 2.

3.2.1.2 Habitation Sites. Table 3.4 lists 22 habitation sites (only those with over 50 rooms are included), seven of which have associated water control features. The pueblos range in size from 50 rooms at Casa Malpais to several hundred at Fourmile, Pinedale, Show Low, Wallace Tank, Sherwood Ranch (Raven), and Stone Axe. After 1275, these villages contained the vast majority of the regionôs population. There are also water control features between Springerville and St. Johns along the Little Colorado River not directly associated with a specific large pueblo; however, both Casa Malpais near Springerville and Table Rock Pueblo near St. Johns could have used the ditches (Danson 1957; Lightfoot and Plog 1984; Martin and Rinaldo 1960).

The absence of water control features at the pueblos of Shumway, Table Rock, and Puerco may be due to inadequate survey of the surrounding areas. All three pueblos are located near semi-permanent to permanent water sources that could have been managed by irrigation

Table 3.3. AZSITE sites for the upper Little Colorado River area dating to Period 2 by cultural group.

Site Type	Sinagua	Cohonina	Mogollon	Anasazi
Artifact Scatter	0	0	197	146
Field	0	0	31	84
Field/habitation	0	0	161	213
Field/Water Control	0	0	0	2
Habitation	0	0	206	359
Petroglyph	0	0	6	58
Shrine	0	0	2	7
Water Control	0	0	2	1
Total	0	0	605	870

ditches or canals. In many cases ditches and associated water control features have been located at considerable distances from habitation sites, such as along Show Low Creek and the Little Colorado River, and earlier in the Hay Hollow Valley. Thus water control features could be a distance from the habitation sites. Other problems in locating water control features in drainages where water continually flows are the dual threats of erosion and alluvation. Either process could destroy or hide water control features, such as canals or ditches located in the floodplain.

3.2.1.3 Summary. As with the Mogollon Rim area, the shift in settlement pattern from Period 1 to Period 2 in the upper Little Colorado River area was dramatic. Although numerous pueblos may have been occupied to 1275 or a little later, only 19 were occupied past 1300

Table 3.4. Major pueblos within the upper Little Colorado River area dated to Period 2, A.D. 1275-1630.

Number	Site Name	Features	Reference
16	Stone Axe	habitation, natural reservoir	1
17	Bailey	Habitation	3, 9
18	Fourmile	habitation, reservoir, canal	2,3,4
19	Pinedale	habitation, terraces - 10-15 m	2,4
20	Pottery Hill	habitation, terraces	1, 9
21	Shumway	Habitation	1
22	Casa Malpais	habitation, ditches	6
23	Adamana, Puerco	Habitation	1
24	Table Rock	habitation	5
25	Show Low Creek	canals - 100+ m	4
26	Showlow Ruin	habitation	3
27	Wallace Tank	Habitation	7
28	Rattlesnake Point	Habitation	8
29	Baca Pueblo	Habitation	8
30	Sherwood Ranch	Habitation	8
31	Danson Pueblo	Habitation	8
32	Hooper Ranch	Habitation	8
33	Spier 175	Habitation	8
34	Spier 176	Habitation	8
35	Flake	Habitation	9
36	Spier 212	Habitation	9
37	Garcia Ranch	Habitation	8
38	Seven Springs	Habitation	1
39	various sites	ditches along upper Little Colorado River	4

1 Hough 1903
2 Fewkes 1904
3 Haury and Hargrave 1931
4 Lightfoot and Plog 1984; Lightfoot 1984
5 Martin and Rinaldo 1960
6 Danson 1957
7 Spier 1918
8 Duff 2002, 2004
9 Mills et al. 1999

(Adams and Duff 2004b: appendix). All are located on the edge of well-watered side drainages or major drainages in the area, each with a spring or flowing water. Where extensive archaeological work has taken place, major water control systems have been found associated with each pueblo. These systems generally take advantage of the availability of water and arable land by tying in canals or ditches to reservoirs and fields, such as in Hay Hollow Wash during Period 1. Check dams and terrace features are often located in surrounding dry washes and especially on small hills or buttes. It would seem that at least some of these pueblos had occupants who practiced a varied agricultural strategy for growing the crops they needed for subsistence. Many diverted periodic or permanent water flows to irrigate crops in valleys. Others conserved water for fields by using such features as terraces and check dams. Field houses were evidently located near fields that were at distances away from the main pueblo.

This intensification and extension of resources to capture or conserve water can be directly tied to the increased habitation size that began in the 12th or 13th century and intensified in the 14th century. The successful feeding of an increasing population required a diversity of agricultural techniques employed to ensure adequate subsistence. A comparable situation might be the strategy employed by the Hopi who plant in many environments requiring quite diverse water needs (Hack 1942:26). Thus, in heavy precipitation years some fields may be washed away, while those remaining are productive. By the same token in dry years some fields may wither whereas others in better watered areas will survive. The diversity of features associated with some of the large pueblos in the upper Little Colorado River reflects a similar strategy to minimize risk and maximize return. To ensure some production of domestic crops utilizing this strategy, a broader land base is required than for a single-technique approach, such as irrigation. Thus, although an irrigation system would have allowed greater intensification (or higher

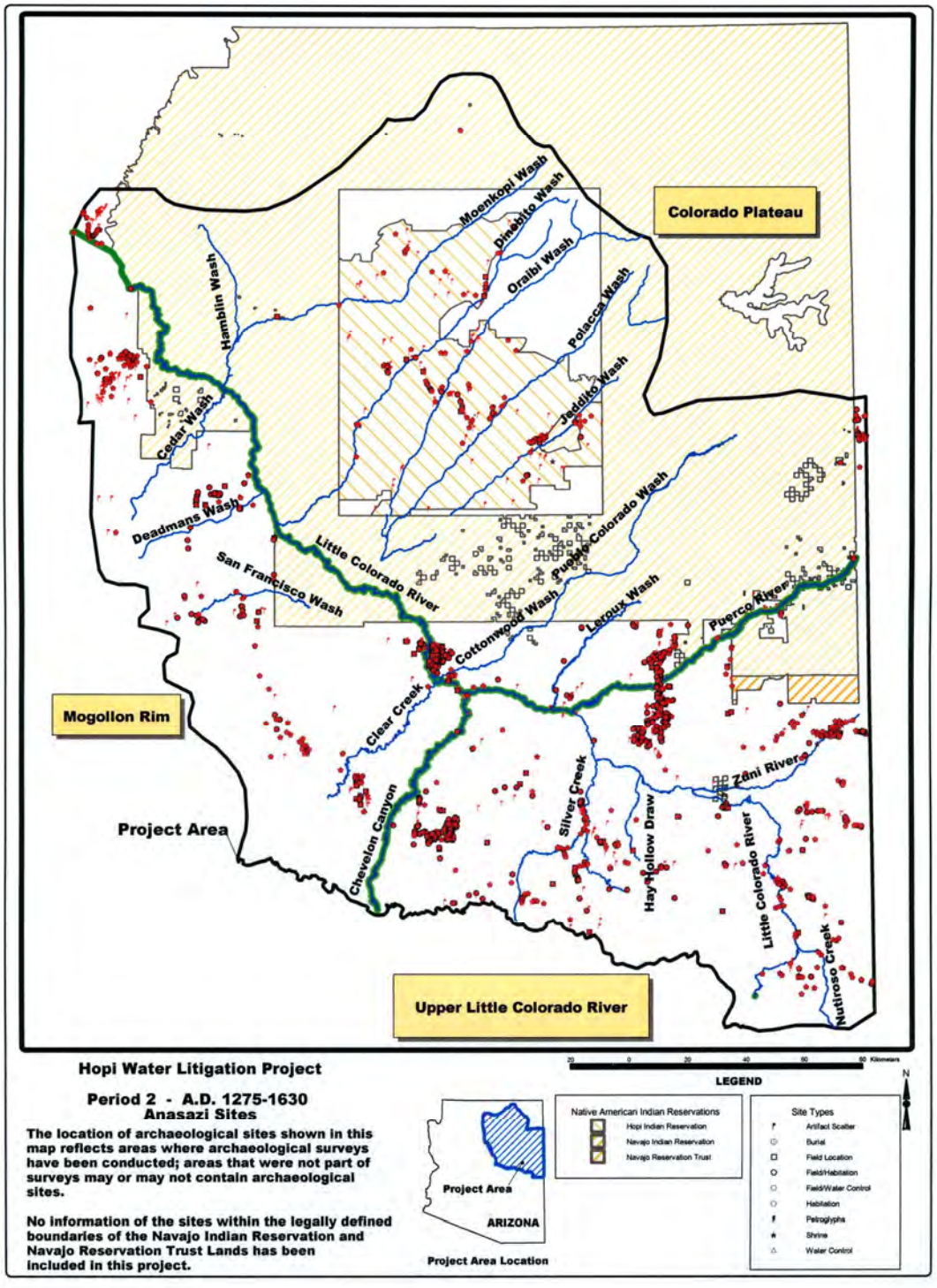
production) of fields, the inability to control the devastating effects of flooding or to overcome lengthy droughts led these protohistoric occupants to resist risking all of their crops on one technique. The extension of agriculture to non-irrigation systems had to be maintained in case the irrigated fields did not produce. The larger the population of the pueblo, the greater the land base needed and the more necessary it became to employ this diversified strategy for growing subsistence crops.

The year-round occupation of the Arizona portion of the upper Little Colorado River area of the basin ended early in the 15th century. Subsequent use by Zuni and Hopi of this area centered around springs, lakes, or shrines (Ferguson and Hart 1985; Page and Page 1982:607).

3.3 The Plateau Area

The post-A.D. 1275 occupation of the plateau area, as elsewhere in the basin, was quite different from that of Period 1. As in the upper Little Colorado River area, population immigrated into the area. Perhaps unlike elsewhere in the basin, population probably increased in the plateau area. These populations concentrated in two areas: along the Little Colorado River (the Homol'ovi and related pueblos) and on and around the four Hopi Mesas. Two pockets outside the major areas were in the Pueblo Colorado drainage and Moenkopi Wash (Map 4).

In the Hopi area at 1275-1300 there were approximately 50 pueblos ranging in size from fewer than 50 rooms to perhaps 150-200 rooms (Adams, LaMotta, and Dongoske 2004; Colton 1974). In the Homol'ovi area were five pueblos ranging in size from about 40 rooms to between 100-200 rooms (Adams 2002, 2004a). The Bidahochi area had three pueblos ranging from 50 to over 100 rooms, and there may have been a single pueblo of fewer than 50 rooms at Moenkopi (Adams 1996a; Kintigh 1996)



Map 4: Period 2, Anasazi sites

By 1350 the Hopi area had been reduced to 15 pueblos ranging from 150 to over 500 rooms, the Homol'ovi area near modern Winslow continued to have five pueblos ranging from over 120 to perhaps 600 rooms, and the Bidahochi area on the Pueblo Colorado had two pueblos at 150 and 250 rooms (Adams 2002, 2004a; Adams et al. 2004; Adams and Duff 2004b: appendix)

Around 1400, or slightly later, another population shift occurred. The Little Colorado River and Pueblo Colorado areas were totally depopulated with their occupants migrating to pre-existent villages on the Hopi Mesas (Adams et al. 1993; Adams and Duff 2004a:9; Adams et al. 2004; Fewkes 1904). At this time there were 13 pueblos occupied at the Hopi Mesas with the village of Moenkopi established as a farming village to Oraibi and used seasonally (Adams et al. 2004). Village size at Hopi doubled by the early 1400s to an average of over 500 rooms, ranging from about 300 to over 1000 (Adams et al. 2004). When the Spanish arrived in 1540 the number of occupied villages had diminished to between five and seven. By 1583, the Espejo expedition reported only five villages remained (Hammond and Rey 1929:102). The early 16th century pueblos were as large or larger than their counterparts of 50 years earlier (Adams et al. 2004:134). Moenkopi was still in use, even if not occupied year-round (Adams et al. 2004).

Although superficially it would appear that gradually the plateau area was losing population throughout the protohistoric period, such was not the case. Average village size increased five-fold between 1300 and 1500 and offset the two-thirds reduction in number of pueblos at Hopi and reduction in the total number of pueblos in the plateau area from about 22 to seven in the early 1500s (Adams and Duff 2004a:9). Although some anthropologists (Dobyns 1966) have argued for pre-contact or early contact epidemic disease from European populations, there is no evidence for such epidemics in the Pueblo Southwest until the latter half of the 17th

century. There are no reliable figures for Hopi population at contact, but Luxán, reporting in 1583 for the Espejo expedition, estimated population at Hopi at about 12,000 (Hammond and Rey 1929:97). Given the absence of evidence for epidemics and the total number of rooms being used on the plateau during the protohistoric, population may have been fairly stable throughout Period 2.

Woodbury (1961), citing Stephen in Parsons (1936), estimated that 3-4 acres were needed to support one Hopi. Bradfield (1971:21), using data from the Third Mesa area, estimated that 2.5 acres per person and 12 acres per household were planted. Using Bradfield's more conservative figures, a population of 12,000 would therefore require about 30,000 acres (47 sq. miles or 121 sq. km). Ellis (1978:Fig. 1) noted that clan lands, those usable for agriculture, were distributed over an area of about 150 sq. miles (400 sq. km) concentrated in the valleys and dune areas surrounding the mesas and villages. Forde (1931) detailed field locations around First and Second Mesas that cover several square miles. Bradfield (1971:19,36) did the same for Third Mesa. Luxán commented on the vast acreage devoted by the Hopi to their crops (Hammond and Rey 1929:100-01) in 1583. As the historic documents note, Hopi agriculture extended at least to the Moenkopi area and may have involved continued use of areas as distant as the Homol'ovi area, even after its occupants migrated to Hopi Mesa villages.

Substantial acreage was required to support the protohistoric populations of the plateau area. The archaeological data for Period 2 are only slightly helpful in identifying the nature and extent of water use; however, later historic records help clarify the situation. Land used for agriculture was located in the valleys or floodplains surrounding the pueblos. The inhabitants used both dry farming and akchin technology. Except for the areas immediately adjacent to the springs, few water control features have been preserved from the protohistoric period.

3.3.1 Protohistoric Database - Plateau Area

Information concerning the Period 2 occupation and use of water resources of the plateau area is derived almost exclusively from the archaeological site files of the Museum of Northern Arizona (MNA), and Hopi Cultural Preservation Office accessed through AZSITE. Information on the large pueblos themselves has been derived from numerous studies by archaeologists and anthropologists beginning with Victor Mindeleff (1891) in the 1880s and followed by Fewkes (1899), Hough (1903), Haury and Hargrave (1931), the work at Awatovi and Kawaika-a and surrounding area (Brew 1941), and by Colton (1974). Probably even more so than elsewhere in the basin, the focus of research has been on the large pueblos. Only the Awatovi expedition supplemented their excavations on the large pueblos of Antelope Mesa with a survey for smaller archaeological sites. This work concentrated in the Jeddito Valley. The work of John Hack (1942) on Hopi agriculture and geology was another valuable facet of the Peabody Museum's research led by Brew.

3.3.1.1 AZSITE Sites. The sites plotted on Maps 3 and 4 indicate the vast extent of farm-related activities and are summarized in Table 3.5. Modern Hopi field houses can be located in conjunction with any type of field - sand dune (rainfall-dependent or dry farmed), akchin (floodwater farmed), or near terraced springs. The field houses listed in Tables 3.5 -3.7 were apparently associated with both rainfall-dependent and floodwater farmed fields. Assuming that historic Hopi and Zuni fields and field houses are analogous, the protohistoric fields should be very close to the field houses. The pattern at Homol'ovi differs from that around the mesas. The number of field houses per field area is much lower at the Homol'ovi sites than at Hopi. The difference is probably in part due to topography and in part to distance. The distance to the fields

Table 3.5. AZSITE sites for the Plateau area dating to Period 2 by cultural group.

Site Type	Sinagua	Cohonina	Mogollon	Anasazi
Artifact Scatter	0	0	0	271
Field	0	0	0	64
Field/habitation	0	0	0	82
Field/Water Control	0	0	0	3
Habitation	0	0	0	255
Petroglyph	0	0	0	40
Shrine	0	0	0	3
Water Control	0	0	0	2
Total	0	0	0	717

at Hopi is generally farther than at Homol'ovi. Additionally, the 600 ft high mesas, where many of the villages were located, made the trip at Hopi more arduous. These factors may have contributed to the perceived need for a temporary dwelling, or field house, at Hopi more so than at Homol'ovi. A detailed discussion of the Homolôovi data will be presented later in this chapter.

3.3.1.2 Specified Sites. A total of 78 sites are listed in Table 3.6 for the Plateau area, excluding the Homolôovi area sites. These include 22 habitation sites, 16 of which have associated springs, some of which were developed or improved. These and other Period 2 sites from the Hopi Mesas area are shown in Figure 3.1. Development of springs always involved multiple terraces and probably construction of reservoirs and ditches to direct water flow from the spring. Hack (1942:34-37) illustrates examples of improvements recorded in the 1930s that would be similar to those of the protohistoric period.

The remainder of the sites include a small scattering having features or artifacts suggesting they were fields, and a group of 51 rock alignment sites that Hack (1942:71) recorded in conjunction with the Awatovi expedition of 1935-1939. Hack (1942:70-71) identified these as sand dune fields with associated rock alignments. These occur in the deep dunes just below the mesa edge where the Period 2 villages of Awatovi, Kawaika-a, Chakpahu, and Kokopnyama are located. Thus, the rock alignments are associated with the major occupation of these pueblos in the 14th and 15th centuries. Hack's (1942:70-73) sketches and descriptions suggest that the rock alignments also included border gardens, terraces, and check dams, plus windbreak features for the sand dune fields. The density of the sites and the extensive features associated with each suggest that agricultural intensification was occurring. Hack (1942:70) notes that the fields were situated to take advantage of runoff from the mesa rim and seepage from shale formations underlying the sandstone cap of the mesas. In the Hopi Mesas area the unique topography or physical environment combined with aridity caused the intensification to be expressed differently than in either the upper Little Colorado River or the rim areas.

Table 3.6. Period 2 agricultural features from the Hopi Mesas area of the Plateau.

Number	Site Name	Features	Reference
40	Kokopnyama	fields near springs	1, 4, 8
41	Chakpahu	fields near springs	1, 4
42	Kawaika-a	fields near springs	1, 4
43	Lululongturqui	garden plots	1
44*	Awatovi	terraces	1, 4, 5
45	Sikyatki	fields near springs	5
46*	Kuchaptavela	habitation, spring	3
47*	Old Mishongnovi	habitation, spring	3
48	Antelope Mesa	51 sites with rock alignments	11
49*	Old Shungopavi	habitation, springs	3

50*	Oraibi	cisterns	3
51	Tuba City area	springs	1, 2, 3
52*	Moenkopi	fields near springs	1, 3
55	Kintiel	walled spring	6, 8
56	NA9165	terrace	7
57	AZ J:2:2	fieldhouse, water control	ASM Site File
58	Kwaituki	habitation	2
59	Chukubi	habitation, spring	2
61	Nesuftanga	habitation	1
62	Pink Arrow	habitation	4
63	Chumalisko	habitation	9
64	Lamehva	habitation, spring	9
69	D:8:1202	sherds & lithics	10
70	D:8:1222	sherds & lithics	10
71	Bidahochi	habitation, spring	1
72	Hukovi	habitation	12
73	Hoyapi	habitation	12
74	Bidahochi Southwest	habitation	1

* sites in more than one time period

1 Hough 1903
2 Mindeleff 1891
3 Ellis 1974
4 Brew in Hack 1942
5 Fewkes 1899
6 Fewkes 1904
7 Gumerman 1969
8 Haury and Hargrave 1931
9 Colton 1974
10 Klesert 1983
11 Hack 1942
12 Adams, LaMotta, and Dongoske 2004

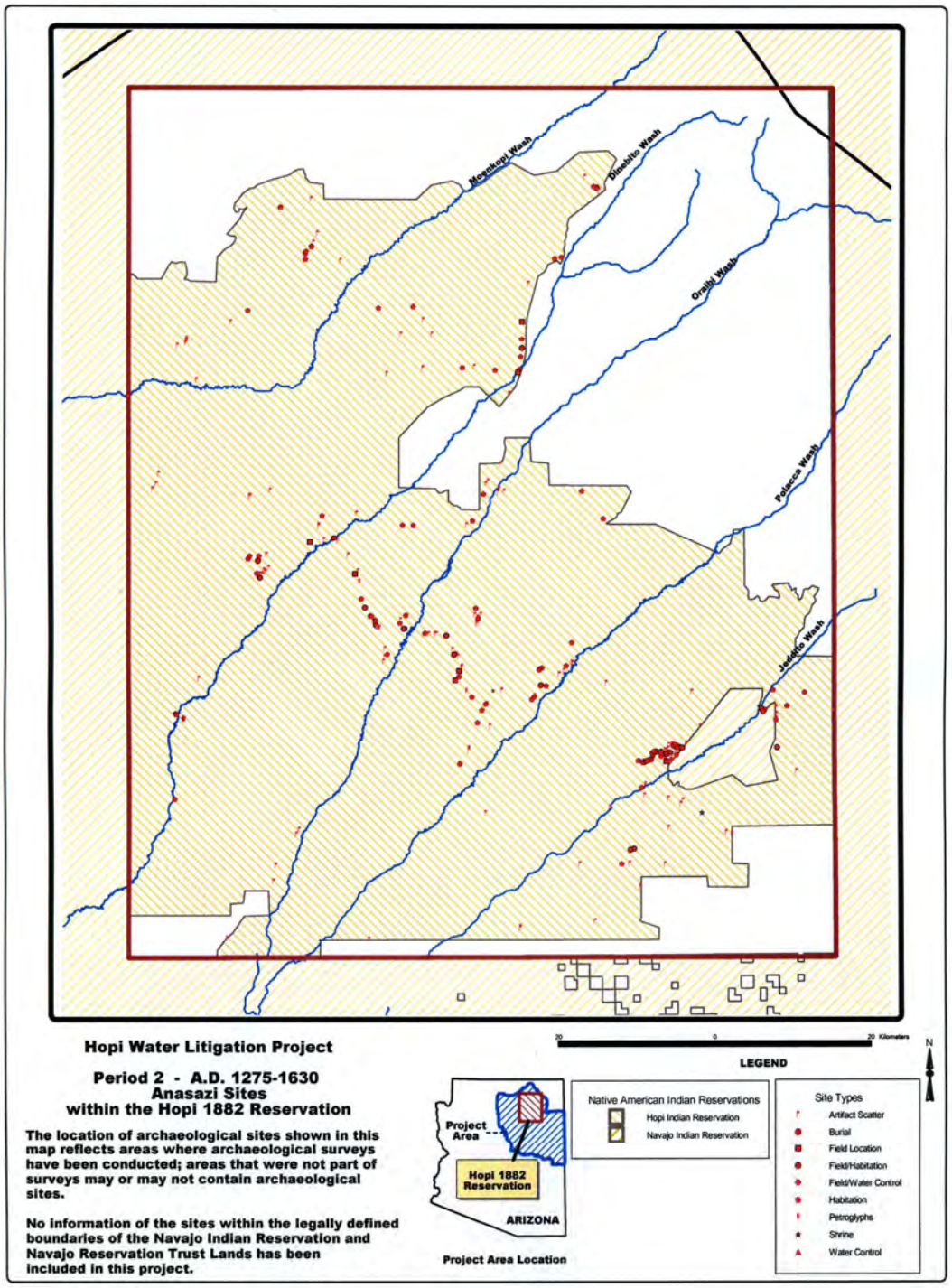


Figure 3.1. Period 2 Anasazi sites on the Hopi 1882 reservation.

3.3.1.3 Analysis of Site Distribution. The centralization of populations into fewer and larger pueblos and the associated intensification and extension of related agricultural activities occurred on the plateau, as elsewhere in the basin. It is evident in the Hopi area that this process continued past 1400 and on to the 16th century, to Spanish contact. Although more subtle, the intensification and extension of land use was a necessary companion to supporting the aggregation. As the Hack data show, the ancestral Hopi on the mesas were intensifying their agriculture around seeps and springs. Extension, accompanied by field houses, occurred in suitable areas in drainages and sand dune areas surrounding the mesas. Unfortunately, much of ancestral Hopi (and Hopi) agriculture used water control features that do not preserve well in the archaeological record, such as earthen dams and brush windbreaks. There is no question that protohistoric land use will be under represented in the archaeological record. As noted by Hack (1942:76-78), environmental change has played a significant role in changing patterns of land use in the Hopi Mesas area and this is certainly true of the rest of the basin and for all time periods.

Research by ethnographers on Hopi land use in the 1920s and 1930s (Forde 1931; Hack 1942: Figure 13; Page 1940a,b) indicated an extensive use of land for agriculture that Ellis (1978:132) estimated was distributed over a 150 sq. mile area. There are hints to this pattern in the protohistoric database, but the combination of inadequate survey, poor preservation, and the perishable nature of water control features limits the understanding of this use. Nevertheless, since village size and location in the Hopi Mesas area has remained stable from the 14th century into the 20th century, the patterns of water use and requirement are clear. First, every available water source in the Hopi Mesas area within 5 km of a pueblo was utilized. This use included springs for domestic use and for watering small, intensive agriculture plots, seeps for intensive

agricultural use along mesa edges, sand dune agriculture using only rainfall, and akchin plots utilizing runoff irrigation (cp. Hack 1942:26-37).

Measurements of catchments and farm plots in Hack's (1942:31) report suggest that each unit of field to be watered by runoff irrigation (akchin farming) required 20 units of catchment. In other words each acre of akchin agricultural land required 20 acres to provide adequate water from runoff. Hack (1942:71) estimated that akchin farming was less important in the protohistoric period than in the 1930s, where it comprises 73 percent of agriculture, but was still the principal method of farming. Assuming a protohistoric population of 12,000 each requiring 2.5 cultivated acres (Bradfield 1971:21), even if only 50 percent of fields were akchin, to water 15,000 acres would require an additional 300,000 acres (469 sq. miles or 1214 sq. km). The Black Mesa landform that provides the catchment for the valleys surrounding the Hopi Mesas is about 3000 sq. miles (7770 sq. km) and could provide enough flow to water the area needed by Hopi akchin fields. Thus, to support the occupants of the Hopi Mesas during Period 2, land needed to provide water for fields, plus the fields themselves, may have included an area as large as 330,000 acres (516 sq. miles or 1335 sq. km). There is no documentary or physical evidence of non-pueblo use of the plateau during Period 2. Thus ancestral Hopi and Hopi were the only users of water resources through Period 2, A.D. 1630.

3.3.2 The Homol'ovi Pueblos' Use of Water

Since 1984, the Homol'ovi Research Program (HRP) of the Arizona State Museum (ASM) has been conducting research in the vicinity of the Homol'ovi pueblos. Fewkes (1898, 1904) did the first excavations in the area in 1896. He learned of the existence and location of the pueblos during his stay on the Hopi Mesas in the early 1890s. On the basis of his research, Fewkes was convinced of the validity of Hopi oral histories, which recount how the Hopi clans

that lived at Homol'ovi moved north and joined villages on the Hopi Mesas (Fewkes 1900a). The ASM research (Adams 1996b, 2001, 2002, 2004a, 2004b; Adams and Hays 1991; Adams et al. 1993; Lange 1998) has also established a strong tie between Hopi villages and the Homolôovi pueblos, outlining settlement growth and changes both at Hopi and at Homol'ovi that provide evidence for the migration of most Homol'ovi people to the Hopi Mesa villages about 1400.

This section will detail the understanding of the settlement of the area and the use of land and water by the Homol'ovi occupants of the 14th century using data collected by ASM archaeologists. This is intended to characterize the nature of water use for the protohistoric period for the basin because of the breadth of the archaeological database and the author's detailed knowledge of this research as director of the Homolôovi Research Program. The book, *Homol'ovi: an Ancient Hopi Settlement Cluster* (Adams 2002) will form the basis of this discussion.

The Homol'ovi area was lightly settled prior to 1260 and in fact may have been only seasonally utilized prior to that time (Lange 1989, 1998). Between 1260 and 1300 people from the surrounding area began settling along the Little Colorado River in what were to become the Homol'ovi pueblos. Four pueblos, Homol'ovi I, II, III, and IV, are located within about 7 km of one other. Three others, Cottonwood Creek, Chevelon, and Jackrabbit are located along another 25 km stretch upstream from the Homol'ovi pueblos. Six of the seven pueblos were settled between 1260 and 1300, but two, Homolôovi III and IV, were no longer used for year-round occupation by 1300 with their occupants probably moving to and perhaps establishing Homolôovi I (Adams 2002:175). Only the three largest villages, Homolôovi I, Homolôovi II, and Chevelon, were occupied to 1400. These three villages combined have 2800 rooms. About A.D.

1400, all occupants of the Homolôovi area moved to existing villages on the Hopi Mesas (Adams 2002:244-251).

This discussion will center on the four Homol'ovi villages and a 20 sq. mile (52 sq. km) surrounding area that has been intensively surveyed (Lange 1998). Within this area over 330 archaeological sites having over 400 components have been located, recorded, and plotted on maps (Fig. 3.2). Excluding the four Homol'ovi pueblos, 74 other sites within this area were used by the Homol'ovi occupants during the protohistoric period (Table 3.7). This does not include several sites that have rock art. Additionally, a one to two mile-wide swath of the Little Colorado River floodplain has either eroded away or buried with sediment all evidence of protohistoric use (cf. Adams and Hedberg 2002; Kolbe 1991). Fewkes's (1904) report of prehistoric canals and ditches near both Homol'ovi I and III suggests extensive irrigated farming in the floodplain during the occupation of the Homol'ovi pueblos. Severe erosion of the floodplain began about Fewkesôs time and was followed by alluviation, which started about 1937, that covered ancient terraces for the first time (Kolbe 1991). Thus although Fewkes reported prehistoric ditches in the vicinity of Homol'ovi III during his 1896 visit, all evidence has subsequently been covered.

3.3.2.1 Homolôovi Land Use. The development and growth of the Homolôovi pueblos caused a major shift in land use patterns involving both more intensive use of the floodplain and more extensive use of surrounding areas for agricultural purposes (Adams 2002:229, 235-237; Lange 1998). Langeôs (1998) monograph describes land use by the Homolôovi residents from 1260 to 1400. Archaeological survey and excavations indicate that prior to 1250 there were probably fewer than 200 people living in the Homolôovi area (Lange 1998). Remains of probable field areas dating to the 13th and 14th centuries are concentrated along the floodplain edge, as well as in dry farmable margins of the side drainages (Adams 2002:229; Lange 1998). These

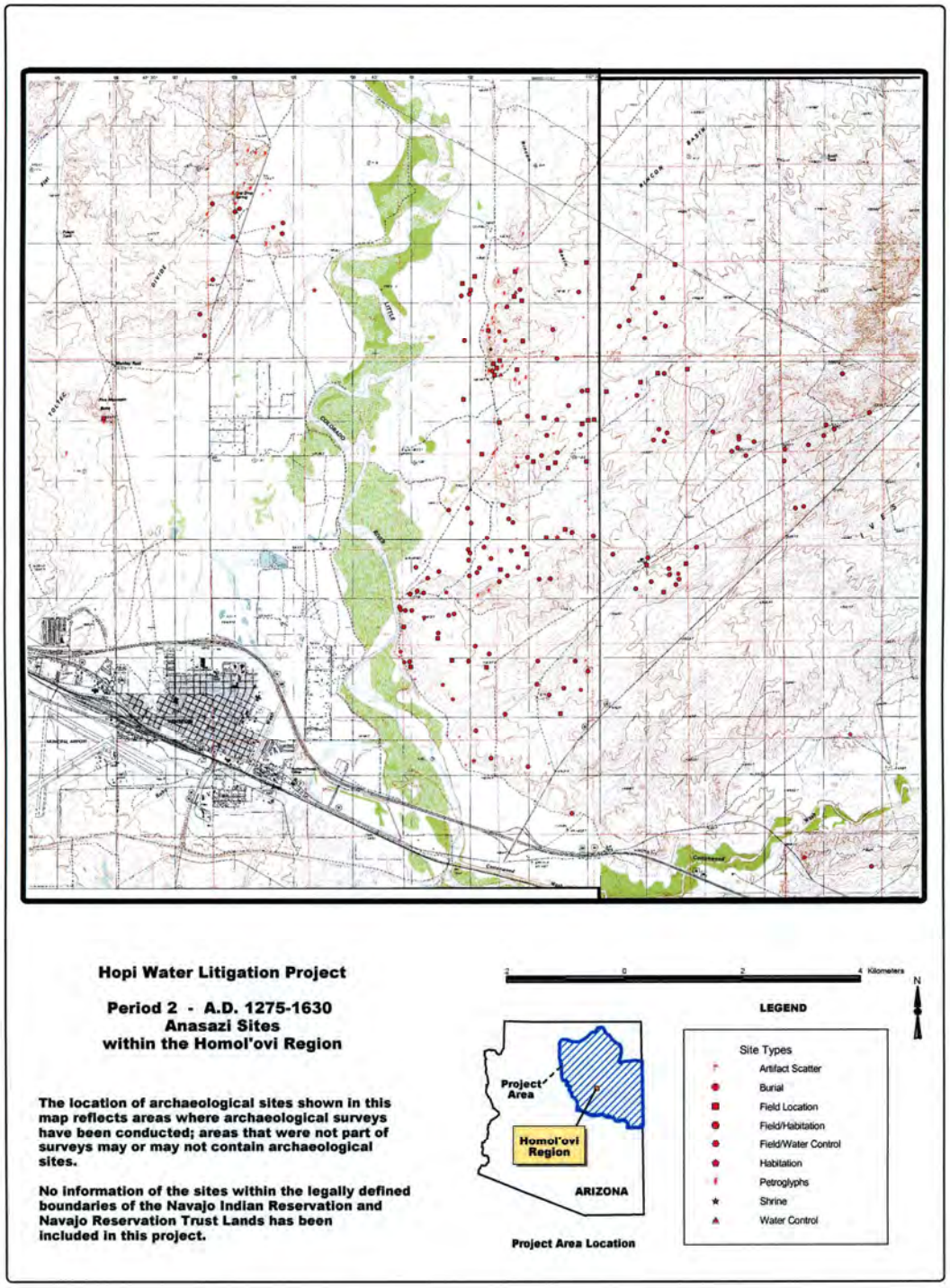


Figure 3.2. Anasazi sites within the Homolôovi region.

Table 3.7. Farming and habitation sites from the Homolôovi area dating to Period 2.

Site Name	Location	Feature	Reference
53	Homol'ovi I	ditch	1, 2
60	Homol'ovi II	habitation	1, 2
54	Homol'ovi III	ditches	1, 2
66	Homol'ovi IV	habitation	1, 2
67	Jackrabbit	habitation	2
65	Chevelon	habitation, spring	1
68	Cottonwood Creek	habitation	3
HRP-2	Winslow area	field	Lange 1989
HRP-19	Winslow area	field	Lange 1989
HRP-31	Winslow area	Field house	Lange 1989
HRP-41	Winslow area	field	Lange 1989
HRP-76	Winslow area	field	Lange 1989
HRP-80A	Winslow area	field	Lange 1989
HRP-91E	Winslow area	field	Lange 1989
HRP-91F	Winslow area	field	Lange 1989
HRP-91G	Winslow area	field	Lange 1989
HRP-92A	Winslow area	field	Lange 1989
HRP-100	Winslow area	field	Lange 1989
HRP-105	Winslow area	Field house	Lange 1989
HRP-124	Winslow area	field	Lange 1989
HRP-126	Winslow area	field	Lange 1989
HRP-127	Winslow area	field	Lange 1989
HRP-136A	Winslow area	field	Lange 1989
HRP-136C	Winslow area	field	Lange 1989
HRP-136D	Winslow area	field	Lange 1989
HRP-139A	Winslow area	field	Lange 1989
HRP-147	Winslow area	field	Lange 1989

HRP-149A	Winslow area	field	Lange 1989
HRP-149B	Winslow area	field	Lange 1989
HRP-166	Winslow area	field	Lange 1989
HRP-167	Winslow area	field	Lange 1989
HRP-169	Winslow area	field	Lange 1989
HRP-187	Winslow area	field	Lange 1989
HRP-204	Winslow area	field	Lange 1989
HRP-220	Winslow area	Field house	Lange 1989
HRP-271	Winslow area	field	Lange 1989
HRP-308	Winslow area	field	Lange 1989
HRP-312	Winslow area	Field house	Lange 1989
HRP-313	Winslow area	Field house	Lange 1989
HRP-316	Winslow area	Field	Lange 1989
HRP-318	Winslow area	Field	Lange 1989
HRP-319	Winslow area	Field house	Lange 1989
HRP-321	Winslow area	Field house	Lange 1989
HRP-324	Winslow area	Field	Lange 1989
HRP-332	Winslow area	Field	Lange 1989

1 Fewkes 1904
2 Adams 2002
3 Colton 1956

remains suggest that their agricultural strategy emphasized placing fields in sand dunes along the edges of side drainages into the Little Colorado River and along the edges of the floodplain to take advantage of seasonal flooding of the river. This pattern was continued and intensified with the construction of the first aggregated Homolôvi village, Homolôvi IV about 1260. Although no irrefutable evidence is preserved, earthen diversion dams could have been used by these early

village farmers to push water into their field areas along the margins of the floodplain or water could simply have been trapped as flood water receded (recession farming).

Between 1275-1300, the river system changed (Adams 2002:74; Kolbe 1991; Van West 1996). A severe drought precipitated a major erosional episode that plagued the sedentary occupants of the plateau until 1500 or later (Dean et al. 1985: Euler et al. 1979). It is expected that this environmental transformation caused the Little Colorado River in the Homol'ovi area to degrade, downcutting into the floodplain. The result was a stream channel that better controlled the spring and summer flooding within its banks reducing the threat and damage of over-bank flooding (Kolbe 1991). As a result, a two-mile wide floodplain through the Homol'ovi area became available for farming. The evidence uncovered by Fewkes (1904) suggests that in order to enhance the productivity of floodplain farming, canals were cut to draw water from the river, such as at Homol'ovi I, and lateral ditches were used to irrigate the fields, such as at Homol'ovi III. This ability to intensify agricultural production drew a large population into the area. Whereas around 1300 the four occupied Homolôovi cluster villages had a total of 800 rooms with a population of perhaps 700, by 1375 the three occupied villages had 2800 rooms with a population of perhaps 2000 (Adams 2002: 98; 2004a).

Although the floodplain was being exploited during the 1350-1400 period, there was also considerable expansion into arable land areas away from the floodplain. The most densely utilized areas were the side drainages where akchin, or runoff irrigation, agriculture was probably being practiced. Alignments of rocks parallel to drainages from the mesa on which Homol'ovi II sits may have been used to channel water into fields on the floodplain. Fields 1 ï 6 miles or more from the river were dry farmed or used akchin agriculture. Occasional field houses are found in the vicinity of both dry farmed and floodwater farmed fields. The majority of the

sites recorded in the area have artifact scatters where fields were located. A good indicator that most of these sites were used for agriculture is the presence of stone hoes with notches indicating they had wooden handles attached that were used for cultivation in fields (Lange 1989, 1998).

Thus the Homolôovi occupants practiced a diversified agricultural strategy. Not only did they diversify their farming strategy, but they also diversified their crops. Plant remains recovered from excavations at Homol'ovi II (Miksicek 1991) and Homol'ovi III (K. Adams 2001) indicate that cotton was grown in a frequency second only to maize (Adams 2002:162). The alkaline soils and ability to irrigate the floodplain made it an ideal location for growing cotton. Maize's intolerance to the alkaline floodplain soils made the side drainages and upland areas more suitable for their production. The site of Homol'ovi III, although abandoned for year-round habitation shortly after 1300, was used seasonally in the production of cotton and became a field house for Homolôovi I (Adams 2001:336-38). It is situated 3 miles from the main village.

Total area available for agriculture along the Little Colorado River floodplain corridor occupied by the Homol'ovi villages probably exceeded 30 sq. miles (80 sq. km) (Lange 1998). The narrow corridor of the floodplain was substantially augmented after 1350 by movement into upland areas at least 6 miles from the floodplain on the north and east sides of the river where deep soils could accumulate from wind blowing floodplain sediment onto surrounding terraces and broad, shallow valleys. Thus, total area needed to support an estimated population for the area of about 2000 between 1350 and 1400, exceeded 60 sq. miles (150 sq. km) (Adams 2002:56-58).

The devotion of considerable agricultural acreage to cotton might have been encouraged by the salty soils, but was truly stimulated by its high desirability as a trade item. After 1350 the people living in the Homol'ovi villages traded for all of their decorated pottery and undoubtedly

exchanged cotton for the ceramics, which were manufactured at the Hopi Mesa villages (Adams 1991, 2001: 228-29; 2002:200-201, 2004a:122-25; Bernardini 2005:131; Bishop et al. 1988; Hays 1991). Thus, by the mid-14th century there was a strong, mutually beneficial reciprocal trade relationship between the two areas.

The 16th century Spaniards who visited the Hopi Mesas were quite impressed by Hopi cotton textiles (Hammond and Rey 1929:102). Hopi textiles were traded throughout the Pueblo world during and preceding the Spanish period (Riley 1987:186-87). It is suggested by the archaeological evidence that 14th century Hopi began specialization in cotton textiles both at the mesas and at Homol'ovi (Adams 1991, 2002:200-201). It is probably not coincidental that the abandonment of the Homol'ovi area about 1400 coincided with the establishment of Moenkopi, a small farming village used by Oraibi inhabitants. Moenkopi was noted in the 18th and 19th century by Spanish and Mexican expeditions for specialization in cotton (Coues 1900:357-58).

Thus, plateau-wide economic ties were developed and maintained in the 1300s involving substantial trade. A major component of their trade was cotton, a crop produced by irrigation agriculture in the Little Colorado River Valley. Irrigation features were noted by Fewkes (1904) at Homol'ovi I and III and are extensive in the Moenkopi area, beginning no later than the 1400s. Irrigation features were used in these areas because they were appropriate technology for the nature of the water sources available. That is, where running water was available and dependable, irrigation systems involving canals and ditches were developed to take advantage of the situation. Where running water was generally not available, such as in the Hopi Mesas area, the use of ditches was much more restricted. Therefore, the presence and availability of surface water for runoff irrigation was a primary factor in how water was used in the basin by prehistoric agricultural people. The restricted areas of surface water and limited access to subsurface water

via springs clearly dictated where population could concentrate. Environmental factors not detailed in this section played important secondary roles in making areas more or less suitable at different points in time.

3.3.2.2 Homolôovi Domestic Water Use. Nineteen years of excavations in six of the seven large pueblos in the Homolôovi Settlement Cluster have resulted in information from 177 structures and the recovery of millions of artifacts and the analysis of several hundred thousand. These results are summarized in various books and monographs (Adams 1996b, 2001, 2002, 2004b; Adams and Hays 1991), and form the basis for the following discussion on domestic water use, which involves both secular and religious uses.

It is estimated that the population of the Homolôovi area of the Little Colorado River valley ranged from a low of 200 from 1260-1280 to a high of 2000 between 1350 and 1400 (Adams 2002:98). The substantial water needs of this population, which was not exceeded until the early 20th century by residents of the town of Winslow, were met by drawing water from the permanent flow of the Little Colorado River along which six of the seven Homolôovi villages are located. This flow is provided by large springs several miles up (south) the Clear Creek and Chevelon Creek canyons, which are east of modern Winslow. It is known there was a permanent flow of water when the Homolôovi villages were occupied based on recovery of dozens of fish remains from excavations in several of the villages (Pierce 2001; Strand and McKim 1996). Water would have been used for drinking, cooking, washing, bathing, and for social and ceremonial purposes. All of these needs continue to the present in the descendents of the Homolôovi people who now reside in Hopi Mesa communities.

Water, however, provides much more than just the needs of individuals and a community for physical survival. The Little Colorado River also provided and still provides a habitat for

important plants and animals. In addition to fish, the river provides habitat to mollusks, turtles, frogs and tadpoles, and numerous water birds including herons, ducks, teals, sandhill cranes, and the like. Many of these birds are migratory and can only be taken at specific seasons of the year. We know these animals were present in the Homolôvi area in the 13th and 14th centuries because we find their remains in the archaeological deposits that were excavated (Andronescu et al. 2004; Pierce 2001; Strand and McKim 1996; Szuter 1991). With the exception of fish, the animals were typically not eaten but were used for feathers or shells in rituals performed by the Homolôvi inhabitants (Adams and LaMotta 2006; Walker et al. 2000). Fewkes (1898:525) reported Hopi trips to the Little Colorado River, Chevelon and Clear creeks to collect turtles and water for ceremonies when he excavated at Chevelon and Homolôvi I in 1896.

Similar patterns of use are found with the plant remains (K. Adams 2001, 2004; Miksecek 1991). In these cases plants associated with riparian habitats, including reeds, sedges, willow, cottonwood, and others are found in hearths, roofs, and as floor mats in many excavated rooms. Along with cotton, a major crop in 14th century Homolôvi village fields, these plants were important in Homolôvi rituals much as they were historically and are today at Hopi (Whiting 1939). As with the animals, water-associated plants found along the Little Colorado River have important and continued ceremonial uses (Hough 1897; Whiting 1939).

These ritual plant and animal remains are found most often in kivas and other ritual structures in all Homolôvi Cluster villages. Frequently, the animals are found whole or nearly whole, which is evidence of their use not as food but for ritual. For example, frequently articulated birds are found with their wings missing, indicating their removal to obtain feathers important in ceremonies, just as today (Strand and McKim 1996). Murals from kivas found at Homolôvi II, Awatovi, and Kawaika-a, another village from Antelope Mesa and dating between

1375 and 1630, depict ceremonies or scenes of mythical places filled with water creatures, birds, and human forms decorated in feathers and wearing cotton kilts and sashes (Pond 1966; Smith 1952). Many of these plants and animals were found in Homolôovi Cluster villages and recovered from excavations. These murals provide clear contexts and identify specific plants and animals used in ceremonies at Homolôovi at the same time and later on at Antelope Mesa. The important association with water in all historic Hopi ceremonies represents a tradition that goes back at least to the 14th century. The importance of plants and animals associated with water in ancient, historic, and modern Hopi ceremonies is an attempt to increase moisture through rain or snow for the arid land in which the Homolôovi and Hopi settlements are located. Documentation of the continued pilgrimages to Homolôovi Cluster villages and to the permanent water flows in the creeks and river near these villages symbolizes the connection between water and survival to the Hopi and their ancestors (Fewkes 1898, 1900).

This connection is found in the riparian plant and animal remains recovered from ritual structures in the Homolôovi villages, the presence of similar animals recovered from Awatôovi excavations (Olsen 1978:4-9), murals from both areas, pilgrimages to the Homolôovi area to visit the ancestral villages and to collect plants and animals from wet places, and the oral traditions of the Hopi concerning their migration from specific Homolôovi villages (Courlander 1971; Fewkes 1898, 1900, 1904; Hough 1897; Nequatewa 1936:35, 127). Thus, the Little Colorado River, Chevelon Creek, and Clear Creek are essential components to continuity of Hopi culture through ritual and ceremony that has clear beginnings in the Homolôovi villages. The fact that many of the riparian plants and animals found in the Homolôovi area are rare or nonexistent near the Hopi Mesa villages makes it likely that 14th century exchange between Hopi Mesa villages and Homolôovi villages included not only cotton, but also turtles, water birds, and other riparian

plants and animals (Adams 2002:220-01; 2004:122-25). In fact Homolôovi II, which was the largest of the Homolôovi Cluster villages at 1200 rooms and possibly 1000 people, was built after 1350 by immigrants from the Hopi Mesas who may have moved along the Little Colorado River to increase the trade of much needed cotton, animals, and plants back to Hopi Mesa villages (Adams 2002:238). Ubiquity of cotton in excavated Homolôovi II deposits is the highest of any Homolôovi village (Adams 2002:210).

3.3.2.3 Homolôovi Summary. The ubiquity of water birds in the Homolôovi Cluster villages is higher than in villages in any surrounding area, including Awatovi and Walpi (Czaplewski and Ruffner 1981:19; Olsen 1978:29; Pierce 2001; Strand and McKim 1996). Capturing these birds was obviously important to the Homolôovi people because the majority of these remains, including numerous partial or intact articulated carcasses, come from ritual structures, in particular kivas (Pierce 2001; Strand and McKim 1996). These strong associations with ritual represent a powerful continuity between 14th-century ritual at Homolôovi and their Hopi descendents, first at 17th-century Awatovi, then 17th-, 18th- and 19th-century Walpi, and finally at historic and modern Hopi villages recorded in ethnographies and documented by other experts in this case. The combination of domestic and farming water needs among the Homolôovi villages, which may have housed 2000 residents in the late 1300s, could only be met by the permanent flow of Chevelon and Clear creeks into the Little Colorado River. Without the presence of these water sources and the ability of the residents to manage the water to support domestic food crops, the area would not have seen large or lengthy residence. This is known because for the 10,000 or more years of use of the area by indigenous groups, the Homolôovi Cluster villages established in the latter half of the 1200s were the first and only large, permanent villages constructed in the area (Lange 1998). Prior to that time, settlements were consistently

small (fewer than 50 occupants) and short-lived (less than a generation) (Young 1996). Only through management of the natural water resources of the area were the Homolôovi village occupants able to change the equation enabling them to prosper in an otherwise arid and agriculturally inhospitable environment.

3.4 Summary

Use of water by prehistoric populations in the basin changed considerably during Period 2. This was due to a major demographic shift that included not only movements of populations from some areas into other areas of the basin, but also to the nature of the settlements. Thus, scattered use of the basin and its water resources, which characterized Period 1 occupation, was replaced by concentrated, intense, but isolated, use of the most dependable water resources, which were located in only a few areas. Extensive drought and erosion of arable land areas restricted where populations could successfully pursue agriculture. It also required a mixed strategy involving both diversion and conservation type water control features. The realignment of population resulted in the establishment of larger villages around the most productive farming areas. The establishment of large villages was not a simple process of just adding more people to existing villages. It required new social systems to organize the populations so more intensive and extensive agricultural systems could be developed. By the later 14th century, population of the largest villages exceeded 1000 (Adams 2002, 2004; Adams and Duff 2004a; Adams et al. 2004).

In the early 1300s there were about 50 pueblos having 50 or more rooms in the basin: 27 in the plateau area, 16 in the upper Little Colorado River area, and 7 in the rim area (Adams and Duff 2004). By the late 1300s the figures had been reduced to 36 pueblos. By the early 1400s the number of pueblos in the basin had been reduced to 13, all in the plateau area associated with the

Hopi Mesas area (except the seasonal hamlet of Moenkopi). By 1500 the number of pueblos had shrunk to seven and to five by the end of Period 2 at 1630. Reduction in number was more or less offset by increase in village size from 1300 to 1500. Most of the people in the pueblos in the upper Little Colorado River area probably relocated to the Zuni area after 1400 and most of those in the plateau and the rim areas relocated to the Hopi Mesas.

With the exception of Old Caves, all major pueblos on the Mogollon Rim were located within a kilometer of a major stream or spring. These were necessary sources of domestic water and were absolutely essential to the location of these large pueblos. Arable land was the second essential characteristic of the areas settled by every pueblo of Period 2. Where considerable survey around a pueblo has been conducted, such as at Chavez Pass, in the upper Little Colorado River area, near the Homol'ovi pueblos, and in the Jeddito Valley, extensive development of arable land areas in the immediate vicinity of the pueblos was found. Generally, this strategy involved both agricultural intensification (utilizing the technology appropriate to the resources of the area) and extension into outlying areas needed to sustain the large, diverse occupants of these villages. Where surface water was abundant the intensification involved canals or ditches in irrigation systems, which occurred in the vicinity of upper Little Colorado villages and probably also in the Homolôovi area. Where running water was essentially absent, such as around the Hopi Mesas, rock alignments designed to conserve rather than divert water were typical and focused on springs.

Catchments capable of supporting the late prehistoric pueblo populations of 10,000 or more in the Hopi Mesas area could have required an area of nearly 500 sq. miles (1200 sq. km) concentrated around the Mesas themselves and in the drainages upstream from the villages. Figures from the partially surveyed Homolôovi area suggests an area of 60 sq. miles (150 sq. km)

was needed to support a population of about 2000 in a basin where agricultural production could be intensified by managing water in the Little Colorado River. Extensive water control features to conserve or divert water to support the population of perhaps 20,000 or more people occupying the basin in the late 1300s may have required up to 1000 sq. miles (2500 sq. km) or 4 percent of the total area of the basin. As we shall see in the following chapters, after 1630 an even denser use is indicated when only the area around the Hopi Mesas continues to be occupied.

CHAPTER 4

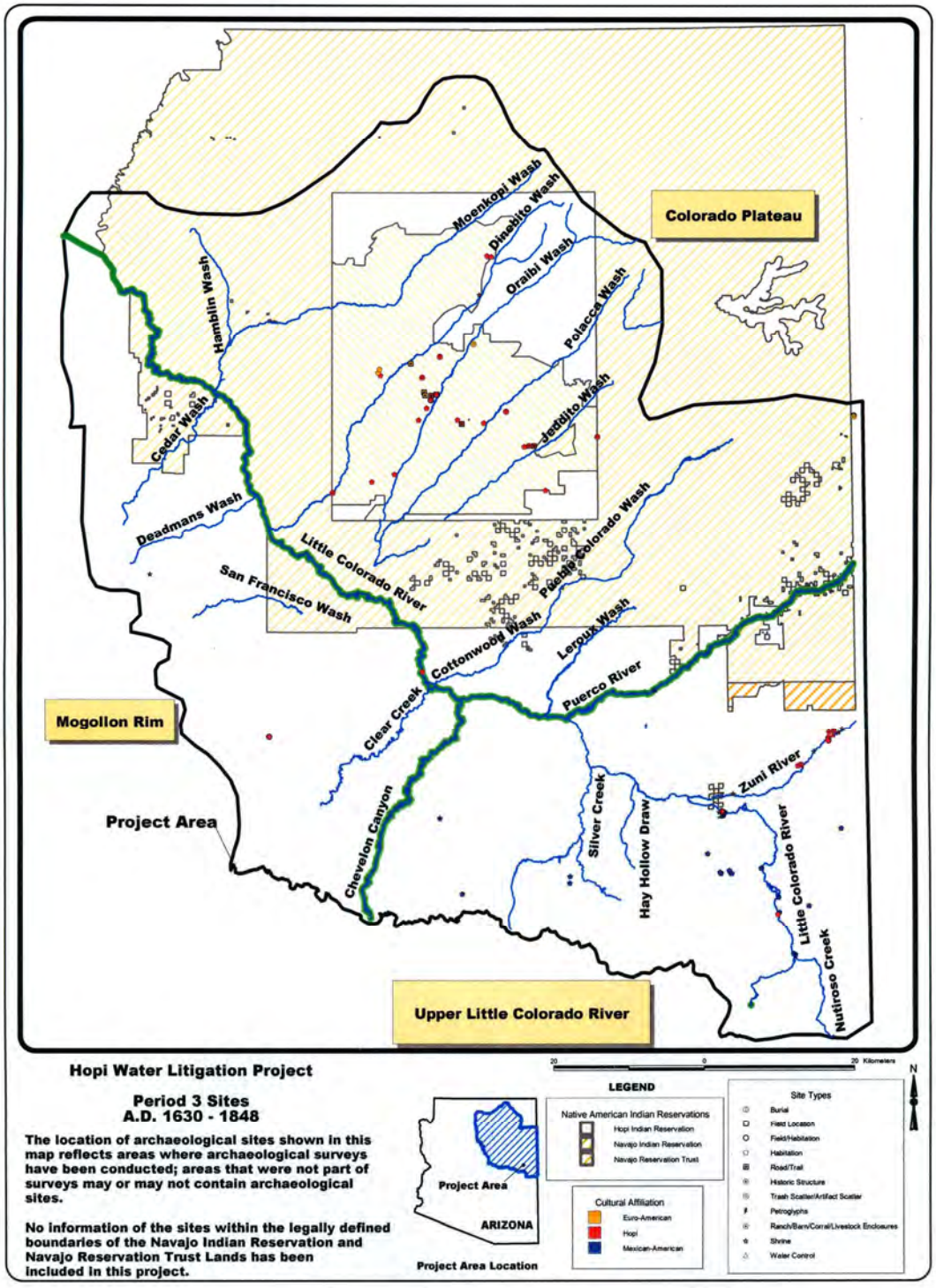
THE HISTORIC PERIOD (PERIOD 3), A.D. 1630 TO 1700

With the historic period the area of concern will be limited to the combined Hopi and Navajo reservation areas because there is no archaeological evidence of settlements elsewhere in the basin. This area will be termed the reservations area. The reservations area consists of about half the Little Colorado River basin, or about 10,000 sq. miles (26,000 sq. km). All but about 700 sq. miles (1800 sq. km) occurs in the plateau area with 100 sq. miles (260 sq. km) in the upper Little Colorado River area and the remaining 600 sq. miles (1550 sq. km) in the rim area (Fig. 4.1, Map 5). Neither of these areas contains any known archaeological material from Period 3 pertinent to the discussion in this report. Thus, for this report the only area in which data for the reservations area are pertinent is the plateau area.

The discussion in the previous chapter highlighted the late prehistoric shift of pueblo population into large aggregated villages and their withdrawal into only the Hopi Mesas area, including Moenkopi, after about 1400. The occupation of the basin through Period 2 was characterized by only Pueblo people leaving physical evidence of occupation of the basin. This occupation during the later prehistoric period consisted of an estimated 10,000 to 12,000 people living in seven villages and relying primarily on domesticated crops for subsistence (Hammond and Rey 1929:97; Hodge, Hammond, and Rey 1945). The extremely arid climate of the plateau area required adjustments by the sedentary ancestral Hopi people to enable them to produce adequate food for such a large population. Using figures derived from Bradfield (1971:21) and Hack (1942:30-33), water catchment of over 330,000 acres (516 sq. miles or over 1335 sq. km) would have been needed to support a population of 12,000, assuming 50% was akchin farming.

During the historic period, use of the basin became more complex as there is archaeological evidence of two groups using the reservations area during Period 3: the Spanish and the Hopi. Use of the reservations area by these groups will be discussed separately and then

Figure 4.1. Period 3 Sites.



summarized in a concluding section. As with the other maps, Map 5 (Fig. 4.1) excludes AZSITE data from the Navajo Reservation per request of the Navajo Nation.

4.1 Spanish

Spanish use and occupation of the reservations area during Period 3 has been defined by extensive documentary evidence left by chroniclers of various expeditions between 1630 and 1700. Spaniards occupied the reservations area only between 1629, with the establishment of a mission at Awatovi, and 1680, when the Pueblo Revolt at Hopi resulted in the execution of the only four Spaniards in the reservations area, all Franciscan missionaries (Brew 1949b). There was an abortive attempt in 1700 to reestablish a mission at Awatovi. The village was destroyed by Hopi from other villages to prevent this. The Spanish government failed to reoccupy any part of the reservations area after the revolt and this report ends with the destruction of Awatovi in the fall of 1700 or winter of 1701.

Following the brief and limited occupation of the reservation by Spaniards, all areas used by the missionaries, both within and outside the villages, were subsequently taken over again by the Hopi (Brew 1949a). In fact the mission structures themselves were dismantled; original beams for the mission structures have been found in kivas and elsewhere in at least Walpi, Shungopavi, and Oraibi (J. Adams 1980:85; Mindeleff 1891:119). Although Spanish and Mexican governments continued to consider the reservations area to be part of their domain, no occupation of reservations area soil by either nation occurred after 1680.

4.1.1 Spanish Land Use

When the missionaries moved to Hopi they sought, as elsewhere, to establish a new order. In addition to tending to the spiritual needs of the community, the economic needs were also paramount and in need of adjustment (Spicer 1967:288-298). The goal of the mission was to

convert the souls of the populace to Catholicism and to reorient the structure of each village to parallel Spanish society. For our concerns the emphasis will be on Spanish economic policy and eventually the impact of Spanish policy on the Hopi.

Ordinarily, missionaries brought cattle, sheep, goats and horses or burros along with new crops, principally wheat, but also peaches and apricots (Spicer 1967:291). These were intended to supplement and sometimes replace the existing economic basis of the society. The aridity of the environment in the Hopi country forced the missionaries to adapt the domestic plants of their subsistence base to Hopi traditional land use practices. In other words, corn was substituted for wheat. The introduction of domestic animals, however, was a much different matter and forever altered Hopi subsistence practices and concomitant water uses in the reservations area (Czaplewski and Ruffner 1981:26-27; Olsen 1978:28-30). Thus, the Hopi adopted from the Spaniards only what was practical.

Prehistoric technology present throughout the basin to A.D. 1400 suggests that the Hopi had the ability to construct intensive water control systems both to conserve water and to divert it. Therefore, the expansive developments of springs around modern Hopi villages as illustrated by Hack (1942:35-36) and described by early ethnographers (Stephen 1936; Hough 1906), could certainly be aboriginal. It is likely that the missionaries used the springs to grow specialty foods that required inordinate amounts of water, such as chilis and tomatoes. Orchards were also planted by the missionaries, probably near springs or seeps, much as they are today.

Construction of buildings by the Spaniards was limited to the villages - always in the plaza area, with the exception of Awatovi. At Awatovi the mission complex consisted of the church and an elaborate friary, which were situated in the plaza. The latter was a quadrangle filled with various rooms surrounding an open space for a garden (Brew 1949a). The entire

missionary complex at Awatovi was contained within a 250 ft by 165 ft area (Brew 1949a:Fig. 3). Also only at Awatovi were there stables for housing missionary livestock and these were adjacent to the village. The missions at Old Shungopavi and Oraibi were likely of similar size to that at Awatovi. The chapels at Old Walpi (Koechaptevela) and Old Mishongnovi would have been much smaller.

With at most four Spaniards at the three missions in 1680 (Brew 1949b:18), and the likelihood that this figure was never very much larger, the need for substantial space and the ability to control and transform large tracts of land was not realistic. The readiness of the Hopi to execute the missionaries during the Pueblo Revolt reveals the general absence of support for Catholicism and the Spanish mission program. This is indicated in the rapid dismantling of the churches themselves and the reuse of the Awatovi mission area after the revolt, as revealed through archaeological excavations (Brew 1949a).

In summary Spanish land use was restricted to the area in the immediate vicinity of the three missions. With the possible exception of refinement of developments at springs for irrigation, their effect on agricultural technology was minimal.

4.1.2 Effects of Spanish Land Use

The introduction of both domestic plants and animals affected Hopi land use. Today, spring areas are used to grow domesticated plants introduced by the Spaniards, such as tomatoes and chilis, and this was probably the case from the time of Spanish introduction. Water from seeps was diverted at least in part from fields to orchards. Because even as early as Period 3, domestic animals were an integral part of Hopi diet, to support them required more land, well beyond the traditional areas where crops were grown (Ellis 1974: 133-138, 159; Page 1940b).

Land use patterns in the 1930s around the Hopi villages have been well defined (Ellis 1974; Forde 1931; Nagata 1970:99; Page 1940a,b). Nagata (1970:99) has divided these into four categories: village site land, community land, clan and society land, and outland. Village site land is the location of the village. Clan and society land is used for farming and is controlled by these social units. Clan lands extended at least 4.5 miles from Oraibi (Bradfield 1971:21), and Hack (1942), Forde (1931), and Page (1940a) have produced maps indicating similar areas for the other mesa communities. Communal land is so designated because of short supply and strong demand and is located just outside the pueblo around springs and seeps. Outland was traditionally used for hunting, but with the introduction of domestic animals, especially sheep and goats, outland areas to 12 miles became reserved for sheep herding (Ellis 1974; Page 1940b). Beyond this 12 mile limit Hopi cattle grazed 50 or more miles from the villages (Ellis 1974:159; Page 1940b; see also Bolton 1950:231-32). Therefore, the daily use of water sources expanded to 12 or more miles from the villages and involved major drainages as far south and west as the Little Colorado River and north to the limits of the basin. These changes in use of water resources resulted from Spanish contact and were apparently in effect by and after the Pueblo Revolt of 1680.

4.2 Hopi

The best documentation of occupation and use of the reservations area within the basin during Period 3 is of the Hopi. This is because large, sedentary villages have been occupied by the Hopi throughout the historic period. The Spanish viewed the Hopi villages as ideal points for missionary conversion, as stopping points for rest and food during expeditions through the area, and as sources for guides into surrounding areas.

Hopi population at the time of Spanish contact is not known, but Luxán's account of the 1582-83 Espejo expedition lists the population at 12,000 (Hammond and Rey 1929:97). This is probably a reasonable approximation given that the Franciscan friar, Benavides, estimated Hopi population in 1630 at about 10,000 (Hodge, Hammond, and Rey 1945). Estimates of 8,000 to nearly 11,000 Hopi have been made for the 1740s (Page 1940a:15; Spicer 1967:195), suggesting that 10-12,000 Hopi is a reasonable estimate for the population throughout Period 3.

Supplementing our knowledge of Hopi affairs are two archaeological excavations in villages occupied during Period 3. The first, the excavation of the village of Awatovi, covers the period 1630 to 1700 (Brew 1941). Information about Hopi economy of the 17th century at Awatovi can be derived from Brew (1941), Olsen (1978), and Hack (1942). Excavations at Walpi uncovered material dating from 1690 to 1975 and complete the archaeological picture of the historic period (Adams 1982). Because the analysis of the Walpi plant and animal data sometimes grouped material from the 17th century in with material dating as late as 1840 or 1850, this section of the report will discuss Hopi plant and animal use derived from archaeological remains and implications for water use to the 1840s to provide insights on the water needs up to 1700. Data on Hopi economy from Walpi can be derived from Adams (1982), Czaplewski and Ruffner (1981), and Gasser (1981). Therefore, discussion of Hopi plant and animal use can be more accurately reconstructed than that of other groups for Period 3.

Olsen (1978:19-30) identifies the presence of greyhound, cat, horse, burro, cow, pig, sheep, goat, and chicken in Awatovi deposits during and following Spanish contact. All of these animals were introduced to the Hopi by the Spaniards. Clearly the Hopi had access to and adopted a wide-range of domestic animals. Olsen (1978:30) notes that 39 percent of animal bones recovered from the excavations in the Awatovi mission area dating from 1680 to 1700

were sheep or goat. Czaplewski and Ruffner (1981:26) identified dog, cat, horse or burro, cow, sheep, and goat in deposits dating 1690-1840 and noted that sheep and goat represent 56 percent of the butchered animal remains from this period and 25% of total animal bone (1981:Tables 6 and 27). Thus sheep and goat replaced rabbits, hares, deer, and antelope as the predominant animal food source during the historic period. No particularly accurate figures of domestic livestock populations are known for the Hopi prior to 1700. Two figures, one of 30,000 sheep and goats in 1775 and the other of 300 in 1780, probably indicate that the correct figure is somewhere between the two (Czaplewski and Ruffner 1981:Table 1). Given their preponderance in the diet of the Awatovi and Walpi people prior to 1700, livestock minimally in the several hundreds to low thousands must have been present.

The Spanish impact on Hopi agriculture was much less profound. The missionaries found it necessary to adapt their agricultural techniques to the harshness of the arid environment of the mesas. They were unsuccessful at creating substantial change in the techniques used by the Hopi. These techniques do not differ significantly from those used prehistorically in the basin, suggesting little effect by Spanish technology. The only areas where changes may have occurred were in the degree of development of terracing and irrigation at springs near the villages, and in the makeup of crops grown in the fields (Hack 1942:37-38). The terraced garden areas, comprising between 11-14 acres, or less than one percent of total Hopi agriculture in the 1930s (Hack 1942:37; Page 1940:63), were devoted to growing ceremonial and water-dependent plants, such as onions, chilis, and tomatoes (Hack 1942:19). Spanish introductions, such as peaches, watermelons, and melons, were readily adopted by the Hopi and by the 18th century may have become second only to maize as principal food crops (Gasser 1981:196). Of the 30 or more domestic crops introduced by the Spanish, many were not found in the Walpi deposits of 1690-

1800. Those found include peach, apricot, watermelon, melon (cantaloupe), chili, and onion, with peach pits and watermelon seeds the most plentiful (Gasser 1981:Table 47).

Spanish accounts suggest that cotton and maize were the principal crops (Hammond and Rey 1929:94-104); however, not until 1878 were detailed records kept. In the 1880s when the most reliable records were made, corn production accounted for 53-91 percent of total crop production (Gasser 1981:233-234), with the average about 68 percent. Hack (1942:19) estimated 72 percent devoted to corn in 1937. Cotton production had declined and been replaced by wool as the preferred textile for everyday clothing (Adams 1982:100-102). This is supported in the archaeological evidence at Walpi, where wool garments were dominant throughout the 1690-1800 period, while cotton continued to be used for ceremonial needs such as sashes and kilts (Adams 1982:100; Kent 1979). In the 1880s melons (watermelon and cantaloupe), peaches, apricots, and apples, all Spanish introductions, seem to have comprised about 15-20 percent of the domestic crop production. Hack (1942:19) arrived at a figure of 15.8 percent, a figure supported by Bradfield (1971:21).

Clearly, Hopi subsistence was affected in a major way during the historic period due to Spanish-introduced domesticates. The greatest changes, however, were not in the agricultural base, but rather through the addition of domestic animals as a source for meat replacing hunted animals. Thus the water needs of livestock were added to the traditional (pre-1630) agricultural base of the Hopi.

4.2.1 Hopi Land Use ï The Database

Table 4.1 lists 41 sites (site 19 is equivalent to 22 sites in association with Awatovi) in the reservations area that date between 1630 and 1848, with the end of use of sites having a pound sign dating to between 1630-1700 (Figure 4.1; Map 5). Extension to 1848 is a

Table 4.1. Sites on Map 5 related to Hopi use of the Plateau during Period 3.

Number	Site Name	Features	References
1* #	Awatovi	habitation	1, 2, 3
2*	Walpi	habitation, springs	4, 6
3*	Mishongnavi	habitation, springs	4, 6
4*	Shungopavi	habitation, springs	4, 6
5*	Oraibi	habitation, springs	4, 6
6*	Old Moenkopi	habitation, springs	1, 4, 6
7	AZ J:3:64	fieldhouse, arable+	MNA Site File
8	Payupki	habitation	5
9*	AZ J:3:7	field shrine	MNA Site File
10*	AZ J:3:8	Field shrine	MNA Site File
11*	AZ J:3:13	fieldhouse arable @	MNA Site File
12*	AZ J:3:44	fieldhouse, arable @	MNA Site File
13 #	Kuchaptavela	habitation	4, 6
14 #	Old Mishongnovi	habitation, spring	4, 6
15 #	Old Shungopavi	habitation, spring	4, 6
16	Shipaulovi	habitation	4, 6
17	Sichomovi	habitation	4, 6
18	Hano	habitation	4, 6
19 #	Antelope Mesa	22 sites with rock alignments, terraces, check dams	7
20	Antelope Mesa	developed spring	7

@ dune field
\+ alluvial field
* site in more than one time period
\# site whose use ended between 1630 and 1700

1 Hough 1903
2 Brew in Hack 1942
3 Fewkes 1899
4 Ellis 1974
5 Mindeleff, V. 1891
6 Colton 1974
7 Hack 1942

result of the lack of a finer chronology for the archaeological materials from the sites in the MNA site files. All of these sites were used by Hopi. Thirteen of the 41 sites are pueblos or habitation villages. All have associated springs, many developed, that lie within a kilometer of the village.

Not all of the habitation sites were occupied simultaneously. Awatovi, Old Mishongnovi, Old Shungopavi, and Kuchaptevela were no longer occupied after 1700, and, except for Awatovi, were relocated to the top of respective mesas. Old Mishongnovi became Mishongnovi, Old Shungopavi became Shungopavi, and Kuchaptevela became Walpi. Oraibi, which was also occupied during the 17th century, continued in its same location after 1700. Payupki, located on Second Mesa, was a Southern Tiwa refugee village founded about 1696 and abandoned about 1748 as the refugees were relocated by Spanish missionaries to Sandia, a Pueblo in New Mexico (Brew 1949b; Spicer 1967:195). Hano, founded by Tewa refugees from the Galisteo Basin in 1696, and Sichomovi, founded about 1750, are located on First Mesa (Adams 1982:86). Shipaulovi, on Second Mesa, was founded shortly after the 1680 Pueblo Revolt. Old Moenkopi was seemingly a seasonal agricultural village of Oraibi throughout Period 3. Thus the five pueblos occupied during the mission period had grown to seven by 1700. This was due to fear of retribution by the Spanish for the 1680 revolt, which caused the founding of Shipaulovi, and to immigration from New Mexico Pueblos, which caused the founding of Hano and Payupki

Detailed archaeological survey in the vicinity of the Hopi Mesas has been conducted in two fairly large areas: the Jeddito Valley, in conjunction with the Peabody Museum project in the 1930s (Brew 1941; Hack 1942), and Keams Canyon Wash (MNA site files), in conjunction with the construction of the Hopi high school east of First Mesa. The third area of information on Hopi land use can be deduced from the Moenkopi area. Although only Old Moenkopi is known

to have been used during this period, Nagataôs (1970: 16-19) summary of agriculture in the Moenkopi area permits one to draw conclusions concerning the nature and extent of agricultural use in the area during Period 3.

4.2.1.1 Hopi Agricultural Use. Population estimates for Period 3 for Hopi range from 10,000 in 1630 to 10,846 in 1745 (Hammond and Rey 1945; Page 1940:15). Spicer (1967:195) supports a figure of 8000 for the 1740s. A figure of 2.5 acres/person has been calculated as typical of Hopi planting through the 1930s (Bradfield 1971:21; Stephen 1936:954-55), although Hackôs (1942:19) figures for 1937 would have it at 3.2 acres. Given the conservative 2.5 acre figure, 25,000 acres (39 sq. miles or 101 sq. km) would have been needed in 1630 to support 10,000 people and 20,000-27,115 acres (31-42.4 sq. miles or 81-110 sq. km) for the 8000 to 10,846 people in the 1740s. Estimates, based on data already presented, are that about half of this acreage was akchin and half dry-farmed with 72 percent in maize, 16 percent in melons and orchards, and 9 percent in beans and vegetables (Bradfield 1971:21; Hack 1942:19). The catchment needed to water the akchin acreage using a 20:1 ratio of catchment to farmland, would range from 250,000 acres (391 sq. miles or 1012 sq. km) in the 1630s, to 200,000 to 271,150 acres (312.5-424 sq. miles or 809-1098 sq. km) in the 1740s.

The survey data from the north side of the Jeddito Valley indicate an intensive use of the dune and seepage areas at the base of the mesa cap as described in chapter 3 (Fig. 4.1; Map 5). The concentration of 22 fields, indicated by rock alignments, around Awatovi suggests their use throughout the 17th century up to the abandonment of Awatovi in 1700 (Hack 1942:Figs. 48 & 51) (Table 4.1). Tallahogan spring just north of Awatôovi was a primary water source for Awatovi and was developed into terraced irrigation plots when Awatovi was still occupied (Hack

1942:36-37; Figures 20 & 21). The south part of the Jeddito Valley was not surveyed nor were systematic surveys conducted by Hack for early historic fields elsewhere in the Hopi area.

The survey of the vicinity of the Hopi high school in the Keams Canyon Wash area in the early 1980s indicated an extensive, long-term use for dry-farming and akchin farming in the area. In the 1 sq. mile area studied for the high school, 15 fields were recorded that date to Period 2 (A.D. 1300 to 1630); nine with field houses, two with field shrines, and two with roasting pits (Table 3.5). Four of the fields, two with field houses and two with field shrines, were also used during the 1630-1848 period (Table 4.1). These data suggest that in the vicinity of the Hopi villages, wherever intensive archaeological inventory work is done, agricultural use will be identified. The high school area is almost five miles from the nearest Period 2 or Period 3 village. The distribution of fields in Hackôs (1942:Fig. 13) map of Land Management Unit (LMU) 6 in 1934 at up to 10 miles from any village is suggestive of just how far fields might be located from habitation sites. All of Hackôs fields are Hopi (1942:71-72). They are clearly grouped in the washes or at the heads of washes to utilize akchin techniques of floodwater irrigation farming. Both Forde (1931) and Page (1940a) suggest that farming was traditionally concentrated within 3 miles of habitation sites at First and Second Mesa, although population size would dictate if fields farther away were needed and whether external threats, such as raids by Navajo, might restrict such expansion. This is clearly the case for Oraibi, the largest Hopi town in the 1800s, where clan fields ranging to 4.5 miles from the village were in use in the late 1800s to accommodate a population of 900 (Bradfield 1971:19). Given that Hopi villages dating to the 1630-1700 period seemed to have populations as large or larger than Oraibiôs, it is reasonable to assume Hopi clan lands and farms extended to more than five miles from the villages. Hackôs (1942:Fig. 13) map indicates that, excluding the Moenkopi area 40 miles west

of Oraibi, 90 percent of Hopi fields were within 5 miles and 99 percent within 10 miles of the villages in the 1930s; however, raids by Navajo or Ute and the absence of arroyo cutting during the first half of the 19th century could make Hackôs map an inaccurate reflection of Period 3 land use. Thus, given the larger Hopi population and archaeological evidence of fields five miles from any village dating to this period, and better environmental conditions for rainfall-based and akchin farming, it is likely that Hopi farming extended farther than five miles from their villages during Period 3.

According to Page (1940a:56-61) the Hopi traditionally built dams of earth and timber to retain or divert water from washes to irrigate nearby fields. Hack (1942:28) observed this technique as well and was able to locate Period 3 fields near Awatovi that used these same techniques. Page added that these diversion dams were only used for a season or two before being destroyed by flooding requiring construction of a new one. The predominant location of fields in and around washes in the 1930s and indications of similar locations from archaeological evidence dating 1630-1700 suggest similar technology was employed.

Observations by early ethnographers and government officials in the late 19th century and Spanish expeditions to Hopi between 1630 and 1781 imply that Hopi agriculture was extensive and varied covering virtually the entire area between the mesa location of their villages. The protohistoric and historic fields near Awatovi and the systems described by Forde (1931), Page (1940a), and Hack (1942:70-76, Fig. 13) point to water control features being used extensively in the early 1600s and continuing to 1700. These include the development of springs, the conservation of water in dune fields including those near seeps, and the diversion of irrigation water from floods into fields located in or alongside drainages.

The exception to farming within 10 miles of a village is the farming village of Moenkopi. Moenkopi is 40 miles west of Oraibi and the original village may have been destroyed in the 1830s (Colton 1974). Archaeological data collected by Colton and observations by the author suggest that use of Moenkopi from 1400 to after 1700 is likely. The village was never large and was described by Garces in 1776 as partly in ruin (Coues 1900:357-358). His contacts with Indians in the area indicated it was a Hopi village and that Hopi farmed the area. Vizcarra in 1823 noted Hopi farming in the Moenkopi Wash, which was called by the Mexicans ï *place of the cotton planting* (Brugge 1964). Third Mesa Hopi regard Moenkopi as originally being an extension of Oraibi, as a farming village, and thus used only during the growing season. Page (1940a:78) indicates that it was a center of cotton and wheat growing due to springs and irrigation.

Nagata (1970:18, 160) considers the Moenkopi area generally too dry for reliable rainfall-based (dry) farming and the wash unsuitable for akchin farming, although he (1970:137) notes a few rainfall-dependent fields farmed by Hopi from Moenkopi just east of the village in the 1960s. Nagata believes that the Moenkopi area was used only because of its irrigation potential and that is why crops requiring more water and thus needing irrigation, such as cotton and wheat, were grown in the area (1970:195). The use of Old Moenkopi from 1400 to 1700 would therefore suggest the development and use of irrigation systems by Third Mesa Hopi. The extensive sand dune activity in the area, severe erosion of the channel, major modifications and improvements in irrigation agriculture by Mormons between 1875 and 1903 (Nagata 1970:126), and 20th century improvements by the U.S. Government and the Hopi have obscured any pre-1700 irrigation developments. The plan of Old Moenkopi drawn by Mindeleff (1891:Fig. 4) indicates about 20 rooms and, for a warm-weather settlement, may have housed up to 10

households. Bradfieldôs (1971:21) estimate of 12 acres per household would indicate that perhaps 120 acres were being irrigated in the Moenkopi area by Hopi between 1630 and 1700.

4.2.1.2 Hopi Livestock Use. Nagata (1970:99), Page (1939:727), and Bradfield (1971:19) note that livestock were grazed to avoid the fields. Because Hopi agricultural fields during the 1630-1700 period were still the basis of Hopi subsistence and were unfenced, livestock had to be grazed to keep the animals from eating or trampling the crops. Page (1940b) indicates that in the 1930s Hopi herded sheep and goats within about a 12-mile radius of the villages. Given the evidence presented above of the location of Hopi fields in the 1630-1700 period, almost certainly Hopi sheep and goats were grazed five miles and more from the villages. These flocks had to be watered every day. Generally, springs near the villages are used only for domestic water or, if developed, for limited agriculture. Water for flocks would have been obtained from sources outside the core agricultural area.

There is no doubt Hopi were managing horses and cattle by 1680-1700 when Spanish were no longer in the area, given that there is cattle and horse bone in the Awatovi and Walpi archaeological material (Czaplewski and Ruffner 1981:26-27, Table 6; Olsen 1978:19-28). Hopi cattle grazing was quite different from sheep and goat herding. Cattle were free-range and allowed to graze uncontrolled outside the sheep and goat range and away from fields. This practice was learned from the Spanish missionaries.

Although it is possible that Hopi owned livestock as early as 1583 (Hammond and Rey 1929:97), they definitely acquired livestock after missionaries brought herds to establish their missions in 1629 (Brew 1949a,b). This had an immediate and substantial effect on Hopi subsistence that has been documented in both the Awatovi faunal assemblage (Olsen 1978:50) and the Walpi assemblage (Czaplewski and Ruffner 1981:26-27). In November, 1776, traveling

from the north, Padres Dominguez and Escalante observed extensive cattle and horse herds in the vicinity of Preston Mesa and Coal Mine Mesa, northwest of Oraibi and northeast and east of Moenkopi (Thomas 1932). Escalante, writing in October, 1775, noted that First Mesa had small herds of horses, some cattle, and many flocks of sheep and that Third Mesa possessed larger horse herds, droves of sheep, and some cattle. Escalante also observed that to the west and southwest of Oraibi, Hopi raised cattle herds and mustang horses (Thomas 1932:259-261). In July, 1776, Garces passed through the Monekopi area and reported horse pastures in the Moenkopi Plateau or Coal Mine area (Coues 1900). Thus Hopi livestock covered extensive portions of the reservation area in the 1770s and their range seems to have extended as much as 50 miles or more from the villages. Given the extensive consumption of sheep, goat, and cattle documented in the faunal remains at Awatovi and Walpi during the period from 1680 to 1700 when Spanish were no longer present and all livestock belonged to the Hopi, it is not unreasonable to believe Hopi livestock ranged to an extent similar to the 1770s.

4.2.2 Summary of Hopi Water Use

With Hopi population estimated by the Spanish at 10,000 when the first missions were established in 1629-30 and between 8-11,000 in the middle 18th century, it is reasonable to assume a population of about 10,000 Hopi for Period 3. They occupied five to seven villages on four mesas and used one other, Moenkopi, seasonally between 1630 and 1700. Population estimates based on archaeological evidence indicate that prior to the Pueblo Revolt Awatovi was the largest village with 2000-3000 occupants. Oraibi was second in population with 1500-2500 residents. Shungopavi and Mishongnovi on Second Mesa and Walpi on First Mesa each had about 1000-1500 residents (Adams and Duff 2004b: appendix; Adams et al. 2004). After 1700 when Awatôvi was destroyed and Antelope Mesa was no longer occupied, the population was

apparently fairly evenly split among First, Second, and Third mesas. Each of the mesas had several springs (Page 1940a:8) that were sources of domestic water. These were located within a half mile of each village. At least some of these springs were improved using terracing during the 1600s, possibly from technology acquired from the missionaries (Hack 1942:30-35).

The irrigated gardens comprised less than one percent of the acreage devoted to agriculture by the Hopi, but supported many small, communal vegetable gardens and orchards, if historic documents can be extrapolated back to 1700 and based on Awatoviôs use of Tallahogan Spring before 1700 (Hack 1942:36-37). The primary agricultural use involved the major and minor drainages and sand dune areas within five miles of the villages where several thousand acres were planted, supported in part by at least 200,000 to 250,000 acres of catchment, which funneled runoff water into akchin fields.

Beyond the agricultural land, but within a 12-mile radius, was the grazing area for sheep and goat flocks, both major subsistence animals used for food, skin, wool/mohair, and bone tools (Adams 1982:102). Domestic springs could not be used to water livestock. Therefore springs, natural tanks, and the like not used for domestic purposes between 1 and 12 miles from the villages were available to water the flocks on a daily basis. The intensive agricultural and grazing use of land requiring all surface runoff and surface water sources within 10 miles of the villages would have supported a population of 8000 people. This figure was likely exceeded between 1630-1700. Beyond a 12-mile radius, Hopi cattle utilized and depended on water resources up to 50 miles away. Although perhaps less essential to subsistence, cattle nonetheless provided meat and leather. Horses and burros grazing in these same areas provided meat, pack animals, and transportation.

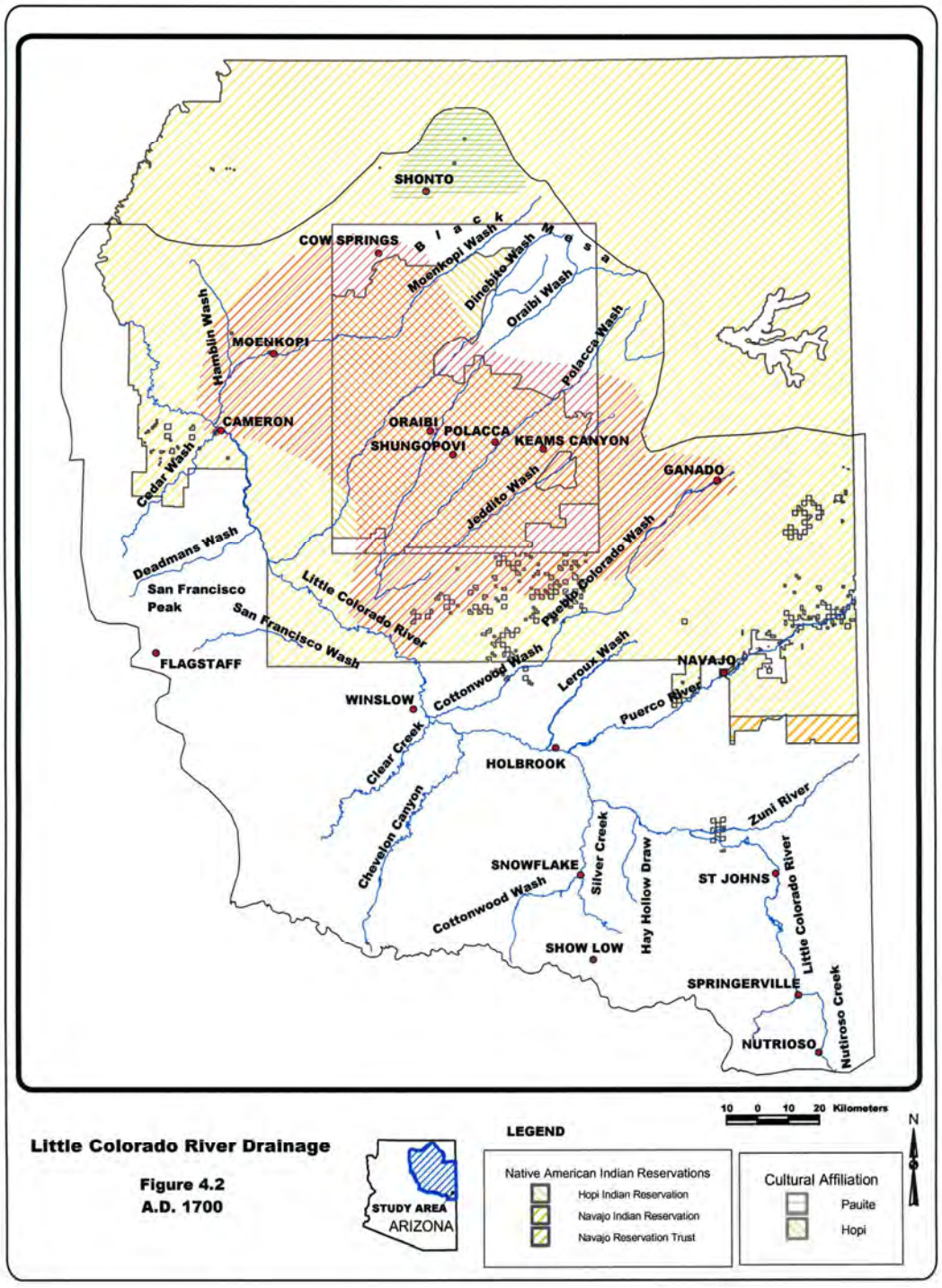
Separation of the agricultural and grazing areas was an essential element to the Hopi subsistence economy in the reservation area between 1630 and 1700. There were no fences; thus the Hopi had to use space to keep the sheep, goats, and cattle out of agricultural areas. Separate water sources were needed for domestic use and livestock use. Additionally, sheep/goat and cattle/horse ranges were kept separate to reduce overgrazing problems and to manage animal husbandry needs. Hopi also frequently brought their sheep back to the village, even daily when possible.

4.3 Summary

Because Spanish use of the reservation area was restricted, short-lived, and subsumed by Hopi use after 1680, it will not concern us here. Two subjects are significant for this summary: land use and water use. Water use is dependent on land use but can vary considerably by the nature of the activity. In terms of intensity, domestic use is predominant followed by agricultural use and ending with livestock use.

4.3.1 Hopi Use of the Reservations Area

Figure 4.2 illustrates the use of the reservations area in 1700 by the Hopi. Hopi population (including two villages occupied by Pueblo groups from New Mexico) in the reservation area was about 10,000 in 1700. Archaeological evidence indicates that by 1700 livestock had been substantially incorporated into the subsistence base of the Hopi. Although intensive land use was still primarily agricultural, the need to accommodate livestock required extensive land use to at least a 12-mile radius of the four mesas in order to support a population of 10,000. In addition to the four mesas, the Moenkopi Wash area was being actively cultivated. Grazing of Hopi livestock documented by Spanish missionaries in the 1770s suggests there was


SHONTO
COW SPRINGS
Black Mesa
Moenkopi Wash
Dinebito Wash
Oraibi Wash
Polacca Wash
Hamblin Wash
MOENKOPI
CAMERON
Cedar Wash
ORAIBI
POLACCA
SHUNGOPOVI
KEAMS CANYON
GANADO
Jeddito Wash
Deadmans Wash
San Francisco Peak
Little Colorado River
San Francisco Wash
Pueblo Colorado Wash
FLAGSTAFF
NAVAJO
Leroux Wash
WINSLOW
Cottonwood Wash
Puerco River
Clear Creek
HOLBROOK
Chevelon Canyon
Zuni River
SNOWFLAKE
Silver Creek
Hay Hollow Draw
ST JOHNS
Little Colorado River
Cottonwood Wash
SHOW LOW
SPRINGERVILLE
Nutrioso Creek
NUTRIOSO
10 0 10 20 Kilometers
N
LEGEND
Native American Indian Reservations
Hopi Indian Reservation
Navajo Indian Reservation
Navajo Reservation Trust
Cultural Affiliation
Pauite
Hopi
STUDY AREA
ARIZONA
Little Colorado River Drainage
Figure 4.2
A.D. 1700

already general use of a 50-mile radius around the Hopi villages. This pattern may well have been in place by 1700.

4.3.2 Hopi Water Use in the Reservations Area

The only archaeologically documented water use is by the Hopi. Hopi water use in 1700 was agriculturally intensive and just beginning to involve sheep/goats and other livestock (Olsen 1978:30). With a population of 8000, 20,000 acres would have been cultivated to agriculturally support the population. With half in akchin, over 200,000 acres (312.5 sq. miles or 810 sq. km) would have been necessary to provide the watershed and ensure the agricultural diversity needed by the Hopi to survive the exigencies of their climate. A five mile radius around each of the four mesas occupied in 1700 would provide 314 sq. miles, but much of this land was unsuitable for successful maize farming. The incipient sheep/goat pastoralism certainly occurred outside the minimum five mile radius needed for farming to sustain the villages and probably extended close to the 10-12 mile radius that allowed the herdsmen to return to the village nightly, which was their preference.

Thus, Hopi water use was intensive and all-encompassing within 12 miles of the villages and extended in decreasing intensity up to 50 miles in most directions to support feral cattle and horses, both important to Hopi economy. Hopi water use in the reservations area in 1700 may have included the southern end of Black Mesa, the western part of the reservation from Preston Mesa on the northwest to the Little Colorado River on the southwest, and Steamboat on the east, if land use described in Spanish documents from the 1770s can be extrapolated back.

CHAPTER 5

CONCLUSIONS

Archaeological evidence for water use in the Little Colorado River basin through 1700 includes primarily the Hopi, with Spaniards only minor players during the 50 years from 1630-1680 when they built and used three missions and two visitas spread over the four Hopi mesas. Spanish importance to water use in the basin is much more a result of the Old World domesticated plants and animals and some New World domesticated plants they introduced to the Hopi. Especially important were the grazing animals that caused an extension of Hopi water use to 50 or more miles from their villages as early as 1680-1700, when remains of domestic sheep, goat, cattle, horse and burro became common in the archaeological remains at Awatovi and Walpi.

5.1 Hopi

Antecedents to the Hopi have left traces of their existence for at least 2000 years, according to archaeologists. These antecedent groups are considered ancestral to the Pueblo people of the Colorado Plateau because of a number of characteristics, perhaps the most important of which were their occupation of compact pueblos and their ability to grow maize. To successfully grow food in the arid-to-semiarid basin it was necessary to plant in areas that received adequate rainfall, or to develop techniques to augment rainfall. Techniques used to augment rainfall are dated by archaeologists to as early as A.D. 700, but did not become widespread in the basin until between A.D. 900 and 1100.

Development of more sophisticated water control and diversion systems burgeoned in the 12th through 14th centuries spurred by a severe erosional cycle that began about 1275 and continued into the 16th century. Erosion, drought, and more sophisticated water control

techniques structured the aggregation of populations into complex villages comparable in size and layout to the modern Hopi villages during this period, referred to as Period 2 in this report. Within the basin 50 aggregated villages date to the 14th century: 7 in the Mogollon Rim area (four with springs), 16 in the upper Little Colorado River area (seven with springs and water control features), and 27 in the Plateau area (16 with springs). By the end of Period 2 in the early 17th century, there were only five inhabited pueblos, all on the Hopi Mesas. Each of these pueblos was first occupied before 1400, with most having roots traceable to before 1300. When first visited by the Spaniards in 1540, the occupants were called Hopi. Thus Hopi occupation of the basin can be traced to at least 1300. Occupants of the Homolôovi sites and Mogollon rim sites on Anderson Mesa, dating to the 14th century, have clear contacts with the Hopi during this period. Hopi oral histories documented as early as 1896 indicate the ancestry of the Homolôovi and Anderson Mesa sites is tied to the Hopi (Fewkes 1898, 1900, 1904). Archaeological evidence supports this claim (Adams 2002, 2004; Bernardini 2005).

Springs and sophisticated and elaborate water control features are nearly always prominently associated with the 14th century pueblos. Control of water for domestic use and increased agricultural production are essential to the development of large pueblos after 1300. The Hopi have oral histories relating each of these prehistoric villages to people who have moved to the Hopi Mesas. Thus, the Hopi technology for water use in the 20th century was developed by their ancestors before 1300.

During the 14th century ancestors to the Pueblo people occupied the entire basin and used its water sources for domestic and agricultural purposes. Ancestors to the Hopi probably occupied all of the basin except the upper Little Colorado River area south and east of the Puerco River, which was occupied by ancestors to the Zuni, although archaeological evidence suggests

some groups from these villages found their way to the Hopi Mesa villages in the 1300s (Duff 2002, 2004). In 1583 the Hopi occupied five large pueblos with a population estimated at 12,000 by Luxán, chronicler of the Expejo expedition.

During the historic period, the Hopi obtained many domestic plants and animals from the Spaniards. In terms of land and water use, the livestock had the greatest impact. By 1700 the Hopi seem to have developed the land use, and attendant water use systems, that they maintained into the 20th century. This consisted of intensive agriculture involving mostly runoff irrigated (akchin) fields. Akchin fields were located within a five mile radius of the villages, extending to 10 miles in some cases (Hack 1942). Sheep and goats were grazed beyond the farm lands within 12 miles of the villages. Because no fences were present, it was essential to have a buffer to keep livestock out of the fields. Sheep and goats were closely tended and were handled separately from cattle, horses, mules, and burros. Except those animals used for packing and transportation, the larger livestock grazed beyond the sheep and goat range to 50 miles from the villages.

Thus, by 1700 Hopi land and water use within 12 miles of the villages was probably very intensive. From 12-50 miles use was more localized and ephemeral as livestock tended to concentrate in valleys and to favor water sources in such areas. The major exception to this pattern was the Moenkopi Wash area, near modern Moenkopi village, where intensive irrigation agriculture was practiced along a two mile (3 km) stretch of the wash from at least 1400-1700 by farmers who resided permanently in Oraibi village 40 miles to the west of Moenkopi.

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