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Prehistoric Pinyon Exploitation in the Southwestern Great Basin: A View From the Coso Range

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A rich archaeological record spanning much of the Holocene exists in the Coso Range of southeastern California. An archaeological survey of over 2,564 acres was focused within the pinyon-juniper zone of these uplands at Naval Air Weapons Station, China Lake. In total, 184 prehistoric sites were recorded, and are used here to evaluate a series of alternative models regarding the origins of intensive pinyon nut use in the southwestern Great Basin. These findings indicate that fully-ripened nuts were probably used on a regular basis deep into antiquity, but the more intensive (and expensive) harvest of green-cone pinyon nuts largely occurred after 1,350 B.P. This conclusion has important implications for interpreting prehistoric land-use patterns in the region, and supports earlier hypotheses about the mechanisms responsible for the spread of Numic populations during the later phases of prehistory.

The pinyon-juniper vegetation community of the Great Basin has been a focus of research for archaeologists for many years, largely due to the conspicuous nature of its archaeological record and numerous ethnographic accounts of pine nut use. Sites found in this zone typically include hunting camps (characterized by projectile points and butchering tools), pinyon camps (characterized by milling gear, rock rings, and midden), and—in some cases—sites with structural remains (e.g., ruins of wooden houses, wind breaks) and other perishable artifacts (e.g., wooden poles/hooks for obtaining pine cones).

Based on these archaeological findings and ethnographic accounts, most early researchers concluded that pine nuts were a primary contributor to the Native American diet throughout the prehistoric past (Davis 1963; Lanning 1963; Meighan 1955). This general notion was later questioned by Bettinger (1975, 1976), based on a survey of Owens Valley and the adjacent White Mountains. His work indicated that the pinyon zone was used only for hunting prior to 1,350 B.P., after which pinyon nuts became a focus of the aboriginal diet. This conclusion was based on the association between pinyon camps and projectile point types post-dating 1,350 B.P. (i.e., Rose Spring, Cottonwood Triangular, Desert Side-notched) and the evident lack of this association among earlier types of projectile points (e.g., Elko, Pinto).

Although this model received some confirmation from the later research of Delacorte (1990), more recent work by Reynolds (1997) led her to posit an earlier onset of pinyon nut intensification. Her analysis of survey data from the Papoose Flat area of the Inyo Mountains indicates that the pinyon zone was regularly used for a variety of purposes during the middle Holocene, when (she argues) temperatures were warmer than current temperatures and the pinyon zone expanded to higher elevations. Reynolds (1996:155) also found that between 3,500–1,350 B.P. there was a strong association between Elko projectile points and pinyon processing areas, indicating that the intensive use of pinyon occurred much earlier than anticipated by Bettinger and Delacorte.

A recent archaeological survey of the Coso Range pinyon zone at Naval Air Weapons Station, China Lake has provided a good opportunity to address the changing economic role of pinyon within this portion of the southwestern Great Basin (Figure 1). The project was divided into two phases: (1) a random sample survey of the pinyon zone, followed by (2) a non-random survey focused on military targets. The random sample survey covered nearly 16% of the 12,050-acre

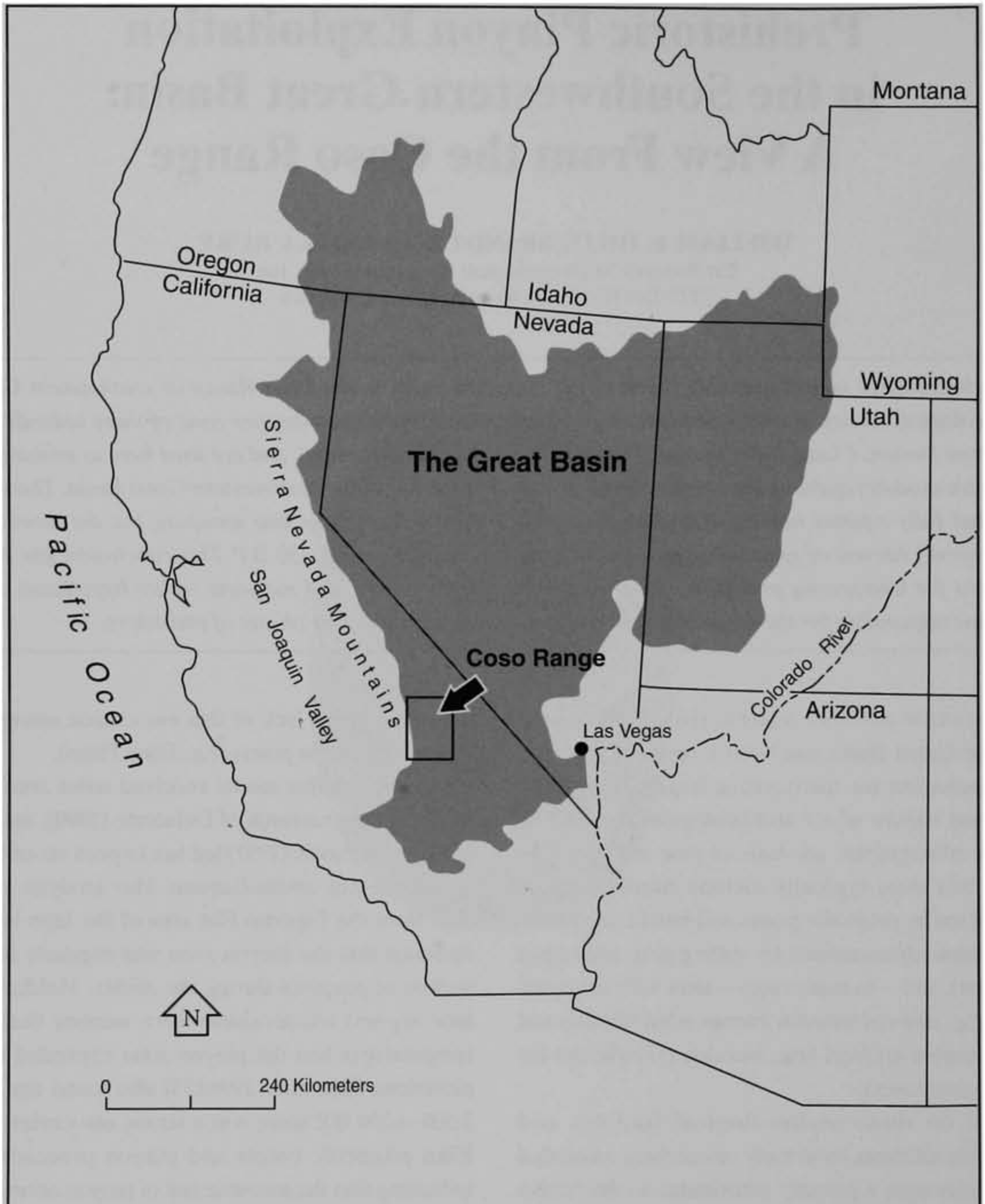

Figure 1. Geographic Location of the Coso Range.

pinyon zone (1,860 acres), and encountered a very high density of archaeological sites (one per 12.7 acres). These included 112 sites with prehistoric components (39 with a substantial number of rock art panels), seven with historic components, and 28 dating to both the historic and prehistoric periods. Isolated findings included 30 prehistoric rock rings, 75 historic surface charcoal ovens, as well as several tools, rock art panels, and other artifactual materials. Encompassing 704 additional acres, the target units revealed a comparable density of sites (one per 15.0 acres of survey), including 38 sites with prehistoric components, three with historic components, six with dual components, and several isolated tools and features. These findings are described elsewhere in detail by Hildebrandt and Ruby (1999); important aspects of the prehistoric components are summarized here.

RESEARCH ISSUES PERTINENT TO THE COSO PINYON ZONE

Since the original work of Bettinger (1975, 1976), a great deal of research has focused on the subsistence value of pinyon nuts, particularly with regard to the costs associated with their harvest and transport across the landscape. McGuire and Garfinkel (1976) questioned Bettinger's conclusions about the late use of pinyon, arguing that he only documented the initiation of intensive pinyon harvest strategies and not necessarily the earliest use of pinyon nuts in the diet. They proposed that prior to 1,350 B.P., pinyon harvesting may have left few physical remains because it occurred during the relatively short interval when nuts could be easily knocked out of their cones and transported to winter encampments. This procurement strategy is commonly known as brown-cone harvesting. With increasing population pressure after 1,350 B.P., requiring larger, more intensive periods of pinyon exploitation,

> ...a whole new regimen of pinyon harvesting, including the roasting of green cones and the prolonged habitation of sites in the pinyon-juniper zone may have been initiated. This would explain the abrupt rise in Bettinger's diagnostic "pinyon camp" attributes. However, this model in no way rules out pinyon exploitation prior to A.D. 600 [McGuire and Garfinkel 1976:84].

Although Bettinger (1977), and later Bettinger and Baumhoff (1983), appreciated the green-cone/brown-cone distinction proposed by McGuire and Garfinkel (1976), they questioned the economic importance of the brown-cone harvesting strategy. Brown-cone harvesting appears relatively efficient because it requires little energy expenditure and can be accomplished with simple technology, but competition with birds and rodents during the short time when nuts were accessible limited the overall productivity of this strategy. According to Bettinger and Baumhoff (1983:832–833), "non-intensive brown cone procurement is cheap but offers low potential yields [and only] makes sense where the contribution of pine nuts to the diet is limited because demand is low with respect to [other more] preferred resources." Green-cone harvesting, by contrast, requires more elaborate processing and produces lower yields per unit time than brown-cone procurement; however, "because green cone procurement begins well in advance of full cone ripening, competition with animals is virtually eliminated, and the period of harvest—and thus the overall take of nuts—is much greater than with brown cone procurement" (Bettinger and Baumhoff 1983:832). Based on these considerations, Bettinger and Baumhoff (1983) concluded that pinyon nuts could not have been a primary subsistence resource until the green-cone harvesting technique was adopted.

Harvesting experiments elsewhere in the Great Basin (see Simms 1985a, 1987; Barlow and Metcalfe 1996) indicate that brown cone pinyon may have been a more valuable resource than proposed by Bettinger and Baumhoff (1982), as the nuts have higher caloric return rates than most other economic plant foods used by Great Basin peoples. Based on optimal foraging theory, Simms (1987) hypothesized that pine nuts would enter the diet as soon as they were locally available (i.e., as soon as the pinyon-juniper woodland entered a local ecosystem). An inter-regional analysis of archaeological data from the Great Basin showed that this was the case in Reese River Valley and Grouse Creek, but apparently not in the Owens Valley area. Based on this finding, Simms (1985b, 1987) suggested that the transport costs of moving pine nuts from the mountains to the lowland habitats of Owens Valley may have constrained the use of pinyon in the local area.

Several other researchers have also addressed the issue of pinyon transport costs (e.g., Barlow and Metcalfe 1996; Jones and Madsen 1989; Rhode 1990; Rhode and Madsen 1998; Zeanah and Simms 1999). These studies show that there are major differences among resources with regard to their "maximum transport distance"—the distance a resource can be carried before incurring a net caloric loss. According to these analyses, brown cone pinyon nuts could be harvested and carried great distances (easily from the Sierra or the Inyo-White Mountain groves to the Owens Valley), while other lowland plants like pickleweed essentially had to be harvested and consumed at the same location. Based on these findings, it was concluded that residential sites should be located next to resources "that cannot be field processed into high utility loads," while high utility foods like brown cone pinyon nuts would be obtained during non-residential, logistical forays.

The excavation of several important sites during the 1980s and 1990s revealed a clearer picture of the regional subsistence-settlement systems of the western Great Basin, and provided support for the logistical acquisition of brown cone pinyon. During the latter half of the Newberry period (ca. 2,000–1,550 B.P.), for example, it appears that people of the Owens-Rose Valley region occupied a limited number of lowland, seasonal residential bases for much of the year. These sites were occupied and reoccupied for substantial periods of time, judging from the presence of house structures, other domestic features, and a variety of resources obtained from distant habitat zones (Basgall and McGuire 1988; Bettinger 1989; Delacorte 1990; Gilreath and Hildebrandt 1997; McGuire and Hildebrandt 2005). Some of these lowland residential sites, particularly INY-30, produced charred pinyon nuts and the bones of mountain sheep and marmots, probably reflecting the exploitation of upland areas by logistically organized, task-specific groups. Given that the upland archaeological record consists largely of hunting camps, Bettinger (1989, 1991) and Delacorte (1990) argued that pine nuts recovered from lowland residential bases probably reflect an expedient, brown-cone strategy of procurement by people primarily interested in hunting mountain sheep and other important animals.

A major restructuring of the above settlement system appears to have emerged sometime after 1,350 B.P. and continued until historic contact. Excavations at a variety of sites indicate that seasonal movements had become more spatially confined, resulting in more intensive use of resources within progressively smaller foraging areas (Basgall and Giambastiani 1995; Basgall and McGuire 1988; Bettinger 1989; Delacorte and McGuire 1993; Nelson 1999). These trends toward resource intensification were likely a reaction to increased population pressure and were reflected in the increased exploitation of riparian and lacustrine resources in lowland settings (e.g., freshwater shellfish, water fowl, tule seeds), and a greater use of pine nuts and a variety of other vegetal resources, such as those obtained from the higher alpine zone of the White Mountains. According to Bettinger (1991), vegetal resources from the pinyon and alpine zones did not become important until after 1,350 B.P., when the productivity of lowland resources had been depleted by increasing densities of human populations:

> This dramatic shift in...land use appears to have been a response to regional population growth that decreased rate of return for lowland subsistence activities to the point where it became cost-effective to use alpine plants and other costly resources (e.g., pinyon, small seeds) previously used casually or ignored altogether [Bettinger 1991:675].

The final outcome of this adaptive process was the "processor strategy" employed by local Numic populations, where the intensified use of seeds and other lower-ranked resources (including green cone pinyon) allowed them to out-compete other, neighboring groups and ultimately expand throughout the Great Basin (Bettinger and Baumhoff 1982).

Madsen (1986) also provided some interesting insights regarding the initiation of bow and arrow technology and its influence on the local resource base. He proposed that the introduction of the bow and arrow (at roughly 1,350 B.P. in eastern California) may have increased the efficiency of hunting, resulting in a depletion of large game populations (i.e., mountain sheep and deer) within the pinyon zone and other upland areas. Animal populations could have dropped to a point where the energetic benefits of hunting no longer surpassed the collection of pinyon nuts, triggering a shift in subsistence focus. Since mountain sheep "appear to have been hunted primarily in late summer and fall, a decrease in fall procurement efficiency would make other fall resources more attractive" (Madsen 1986:37).

Reynolds' (1997) critique of the post-1,350 B.P. intensification model was based on her analysis of a large data set from the Papoose Flat area of the Inyo Mountains. She found that between 3,500 B.P. and 1,350 BP an "88% association of projectile points from this phase with domestic facilities, including rock rings, suggests use of the more intensive...green cone method during this time, not after ca. 1,350 B.P." (Reynolds 1996:155). Although she does not specifically address the implications of her findings relative to the Newberry period settlement system outlined above (i.e., residential bases in the lowlands supported by a specialized, logistically organized use of the uplands), it follows that green-cone processing would be part of the logistically organized system; that is, task-specific groups focused on green-cone procurement, and transported the processed nuts down to lowland residential bases for later consumption.

While the "maximum transport distance" for brown cone pinyon is quite high, and works well within a logistically organized system (Barlow and Metcalfe 1996; Jones and Madsen 1989; Rhode 1990; Zeanah and Simms 1999), green cone harvesting experiments have not yet been completed, making it difficult to know the caloric return rate for this type of behavior. Assuming that the costs are quite high, as the Bettinger-Delacorte perspective would argue, would imply that residential sites should occur in the pinyon zone where processing-transport costs could be minimized. Reynolds, in contrast, would expect that the added field processing costs would not diminish the "maximum transport distance" such that a settlement pattern shift would be required. Although the current study does not attempt to measure return rates for green cone pinyon processing through experimental means, analysis of survey data from the Coso pinyon zone does clarify when green cone processing was initiated, thus providing important new information on this important issue of Great Basin prehistory.

NATURAL CONTEXT OF THE COSO TARGET RANGE

The Coso Target Range is a 15 km. by 9 km. management unit within the northernmost reaches of Naval Air Weapons Station, China Lake. Ranging in elevation between 5,500 and 8,160 feet, it is characterized by steep mountain peaks, rugged basalt flows, deeply incised stream channels, and broad alluvial plains. Due to the relatively high elevation of this region, annual precipitation is significantly higher than in the surrounding area, probably averaging about 10 inches per year (see Hall 1991). The combined effects of elevation and precipitation have created extensive tracts of pinyon-juniper woodland, which covers about 36% of the Coso Range. This plant community is concentrated above 7,000 feet on rocky, well-drained soils, particularly on north-facing slopes (Holland and Keil 1990; Silverman 1996). Pinyon pine (*Pinus monophylla*) is the dominant component of the community, followed by much lower frequencies of Utah juniper (*Juniperus osteosperma*). Common understory plants include Great Basin sagebrush (*Artemesia tridentata*), blackbrush (*Coleogyne ramosissima*), bitterbrush (*Purshia tridentata*), and Morman tea (*Ephedra viridis*).

Great Basin mixed scrub fills in the upland areas that lack pinyon-juniper woodland, usually occupying open flats where soils are poorly drained. This vegetation zone also extends downslope below the pinyon-juniper zone (i.e., below 7,000 feet), occupying a wide range of topographic settings. Similar to the understory component of the pinyon-juniper community, it is dominated by bitterbrush, Great Basin sagebrush, and Morman tea. Below 6,500 feet, Great Basin mixed scrub often gives way to sagebrush scrub. Although similar to Great Basin mixed scrub, this community includes more desert-adapted plants such as rabbitbrush (*Chrysothamnus nauseosus*) and four wing saltbush (*Atriplex canescens*). Sagebrush communities also have a significant herbaceous component, dominated by perennial grasses such as bluebunch wheatgrass (*Agropyron spicatum*), California brome (*Bromus carinatus*), Indian ricegrass (*Achnatherum hymenoides*), squirreltail (*Elymus elymoides* ssp. *elymoides*), needle grass (*Achnatherum* spp.), and Great Basin wild rye (*Elymus cinereus*). Wild rye was commonly observed at the mouth of rock shelters and other occupation areas within the pinyon-juniper zone.

Perennial water is available at a handful of springs, all located on the eastern slopes of the Coso Range. Three of these springs are named on the Coso Peak 7.5' Quad (Mill Spring, Chappo Spring, and Crystal Spring), while four others are marked but not named. Additional springs lie just outside the Target Range to the southeast and include Mariposa, Cole, Wild Horse, and Lost Cabin.

A variety of rodents and rabbits were observed during the survey, including wood rats (*Neotoma lepidea*), ground squirrels (probably *Ostospermophilus beecheyi*), cottontail rabbits (*Sylvilagus* sp.), and jackrabbits (*Lepus californicus*). Deer (*Odocoileus hemionus*) were also relatively common, both as lone individuals and in small herds. Fresh prints and scat of black bear (*Euarctos americanus*), mountain lion (*Felis concolor*), and bobcat (*Lynx rufus*) were found, although the animals were not directly observed. Upland game birds were plentiful, including mountain quail (*Orertyx pictus*), California quail (*Callipepia californica*), and the non-native chukar (*Alectoris chukar*). Prior to their elimination from the region, mountain sheep (*Ovis canadensis*) and perhaps pronghorn (*Antilocapra americana*) would have also been available in the local area.

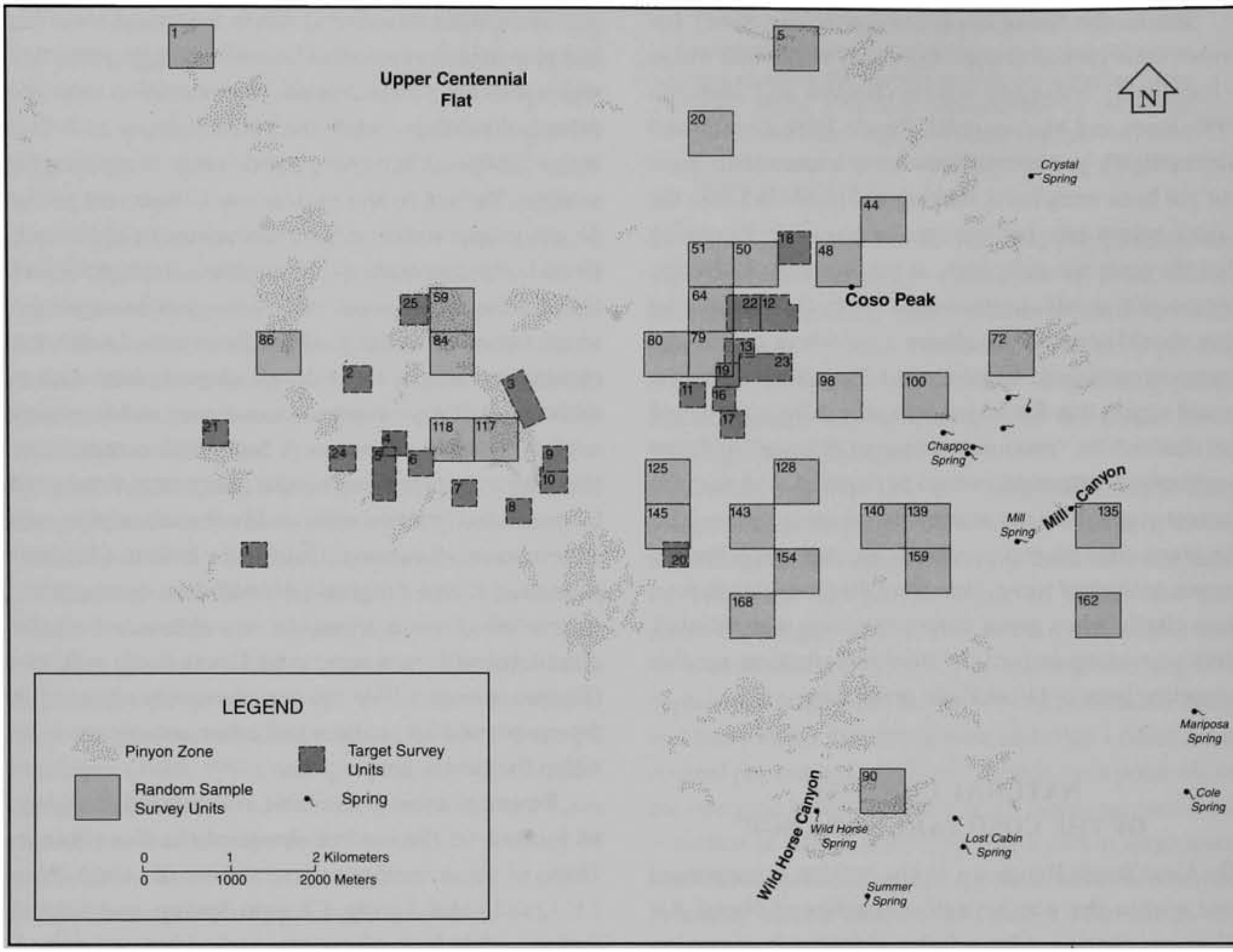

Figure 2. Survey Units Within the Coso Target Range.

Given the presence of year-round water and the wide range of important subsistence resources associated with the pinyon-juniper zone, the survey area was likely the focus of human activity for a very long time. Surrounded by desert on all sides, it is truly an island of abundant resources, a fact that is clearly documented by the archaeological record. As will be demonstrated below, people used the area for at least 8,000 years, creating a robust archaeological record that is reflected in the high density and diversity of artifacts, features, and rock art that characterize the local landscape.

SURVEY SAMPLE DESIGN AND FIELD METHODS

To gather information regarding the density, character, and significance of cultural resources within the Coso Target Range, a 16% sample of the pinyon-juniper zone was subjected to intensive archaeological survey. Sample units were generated from a 500 x 500 m. grid placed over the entire Target Range, creating 540 possible 500 x 500 m. survey units. Due to the high archaeological sensitivity of the pinyon-juniper zone, the Target Range was divided into two sample domains: Pinyon and Non-Pinyon. Pinyon units included 500 x 500 m. quads where pinyon-juniper vegetation covered at least 20% of the area (n=191), while the Non-Pinyon units included quads with less than 20% pinyon-juniper (n=349). The 16% random sample was selected from the Pinyon domain (equaling 30 units; see Figure 2). An original plan to survey a sample of the Non-Pinyon domain was not feasible due to the high density of sites in the pinyon zone.

The 30 500 x 500 m. sample units were intensively surveyed, using transect intervals of 25–30 m. Because several important research issues concern the antiquity of pinyon use in the western Great Basin, all diagnostic projectile points were mapped and collected; a small sample of obsidian was also collected for hydration analysis.

Survey strategy for the target areas differed slightly from the random survey, as a field review of the targets revealed that a 300 x 300 m. area would sufficiently cover each of the 25 impact areas and a buffer zone surrounding them. As a result, a 300 x 300 m. area was placed over each target, and intensively surveyed using the same methods applied to the other units.

CHRONOLOGICAL CONCERNS

The chronological sequence used in this study represents a synthesis of the work of Warren (1984), Bettinger and Taylor (1974), and Gilreath and Hildebrandt (1995; Table 1). The terminology applied to each interval is derived from Bettinger and Taylor's (1974) original eastern California scheme, while the calendric dates assigned to each of the intervals are adapted from Warren (1984). Several types of chronological information generated by the current project can be used to place archaeological sites into the chronological sequence outlined above. These include temporally diagnostic projectile points (many with corresponding obsidian hydration readings), ceramic sherds, glass and stone beads, and a radiocarbon date obtained from one of two cached wooden bows.

Table 1

CHRONOLOGICAL SEQUENCE FOR THE COSO TARGET RANGE.

Time Period	Temporal Range
Marana	Post - 650 B.P.
Haiwee	1,350 - 650 B.P.
Newberry	4,000 - 1,350 B.P.
Little Lake	7,000 - 4,000 B.P.
Mohave	10,000 - 7,000 B.P.

Projectile Points and Obsidian Hydration Data

A total of 280 diagnostic projectile points was recovered, including 17 Desert Side-notched, 39 Cottonwood Triangular, 106 Rose Spring, 16 Saratoga Spring, 25 Humboldt Basal-notched, 39 Elko series, one Gypsum series, 11 Humboldt Concave-base, 18 Pinto, two Silver Lake, two Lake Mojave, and four Fish Slough Side-notched (see Figures 3–5). To facilitate comparisons with artifacts recovered during previous studies in the region, points were classified into the above types using metric attributes defined by Thomas (1981).

For the most part, the classification of the current collection was a straightforward task using traditional methods. One exception involved the Elko series, which are typically assigned to the Newberry period (4,000 B.P.–1,350 B.P.; Bettinger and Taylor 1974), but some variants are known to extend back into the middle Holocene. Gilreath and Hildebrandt's (1997) research within the Coso Volcanic Field found that specimens with a maximum thickness > 6.5 mm. produced obsidian hydration readings that were much greater than the thinner variants (12.3μ versus 7.4μ), and they therefore created two subtypes: Thin and Thick Elko. Within the present sample, thick specimens are very rare and have not been segregated from the larger sample; the term Thin Elko is, therefore, applied.

Obsidian hydration data were collected from 272 of the points. None of the specimens were subjected to geochemical analysis because previous studies in the local area have shown that the vast majority (98%) of obsidian tools originate from the Coso Volcanic Field (Gilreath and Hildebrandt 1997). Of the 272 specimens analyzed, 42 produced diffuse hydration, one had no visible rim, and one was too weathered for accurate hydration measurement. The remaining 228 specimens produced clear results, providing insight into the chronological ordering of projectile points, as well as information on how differential temperature influences the rate of hydration rim development.

Obsidian hydration data outlined in Table 2 largely conform to the chronological expectations for the projectile points, although the absolute values are much reduced when compared to adjacent lowland areas where temperatures are much higher (see Gilreath and Hildebrandt 1997; Hildebrandt and Ruby 1999; King et al. 2001). Desert Side-notched and Cottonwood series points both produced mean hydration values of 2.3μ, while Rose Spring and Saratoga Spring series points yielded larger mean values of 3.0μ and 2.9μ, respectively. Hydration values continue to increase among the Humboldt Basal-notched and Thin Elko series (4.0μ and

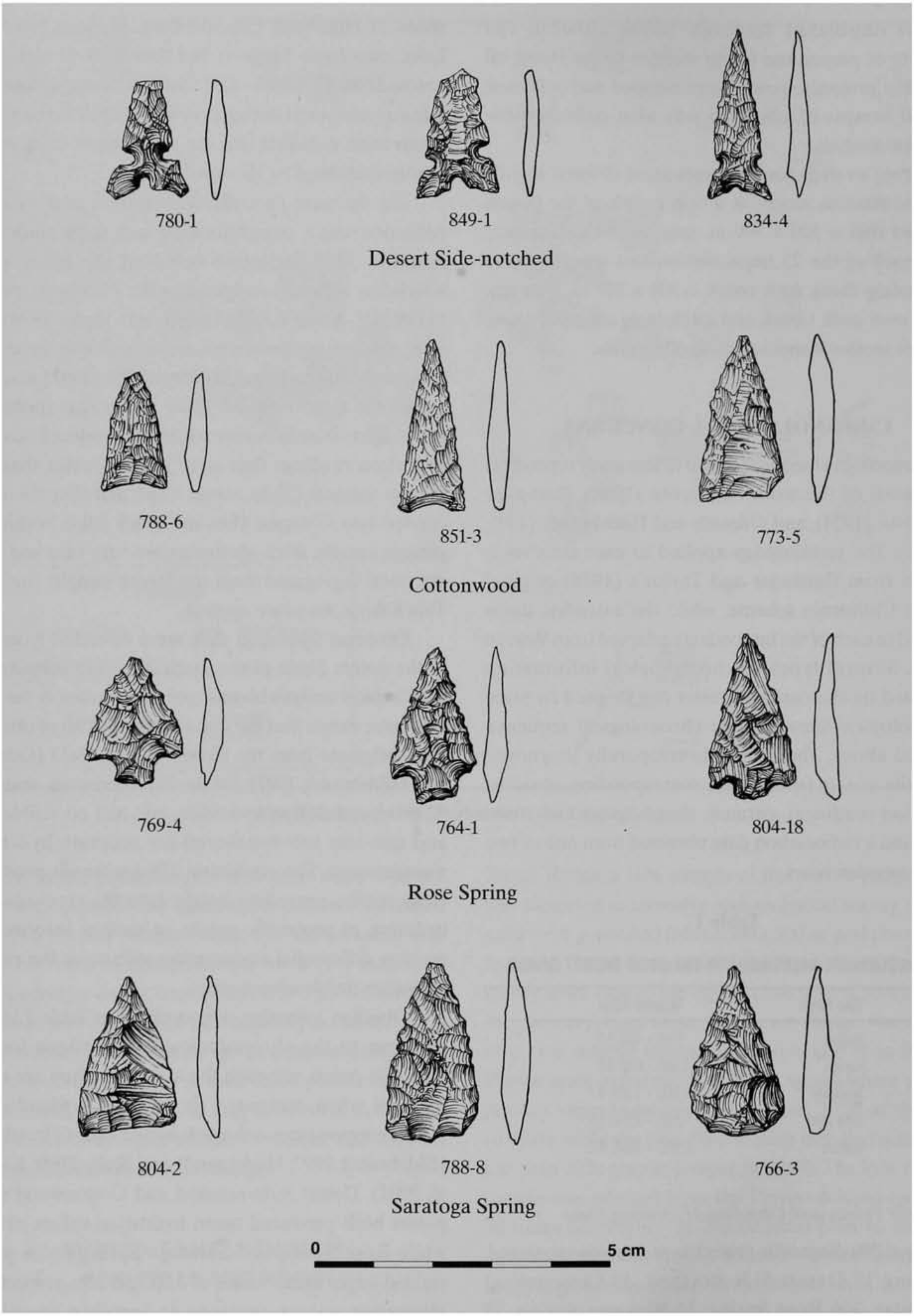

Figure 3. Selected Desert Series, Rose Spring, and Saratoga Spring Projectile Points from the Coso Target Range.

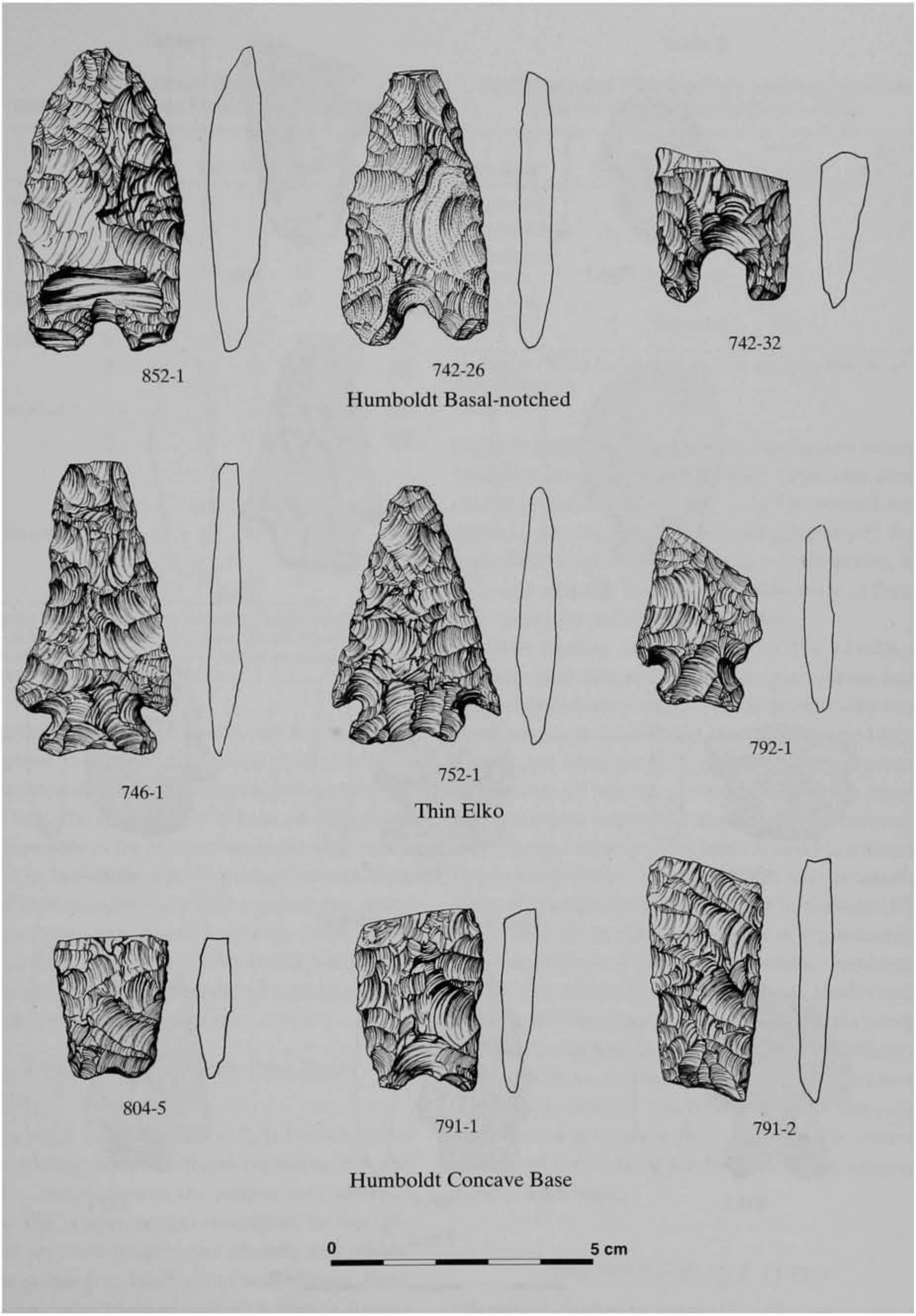

Figure 4. Selected Humboldt and Elko Series Projectile Points from the Coso Target Range.

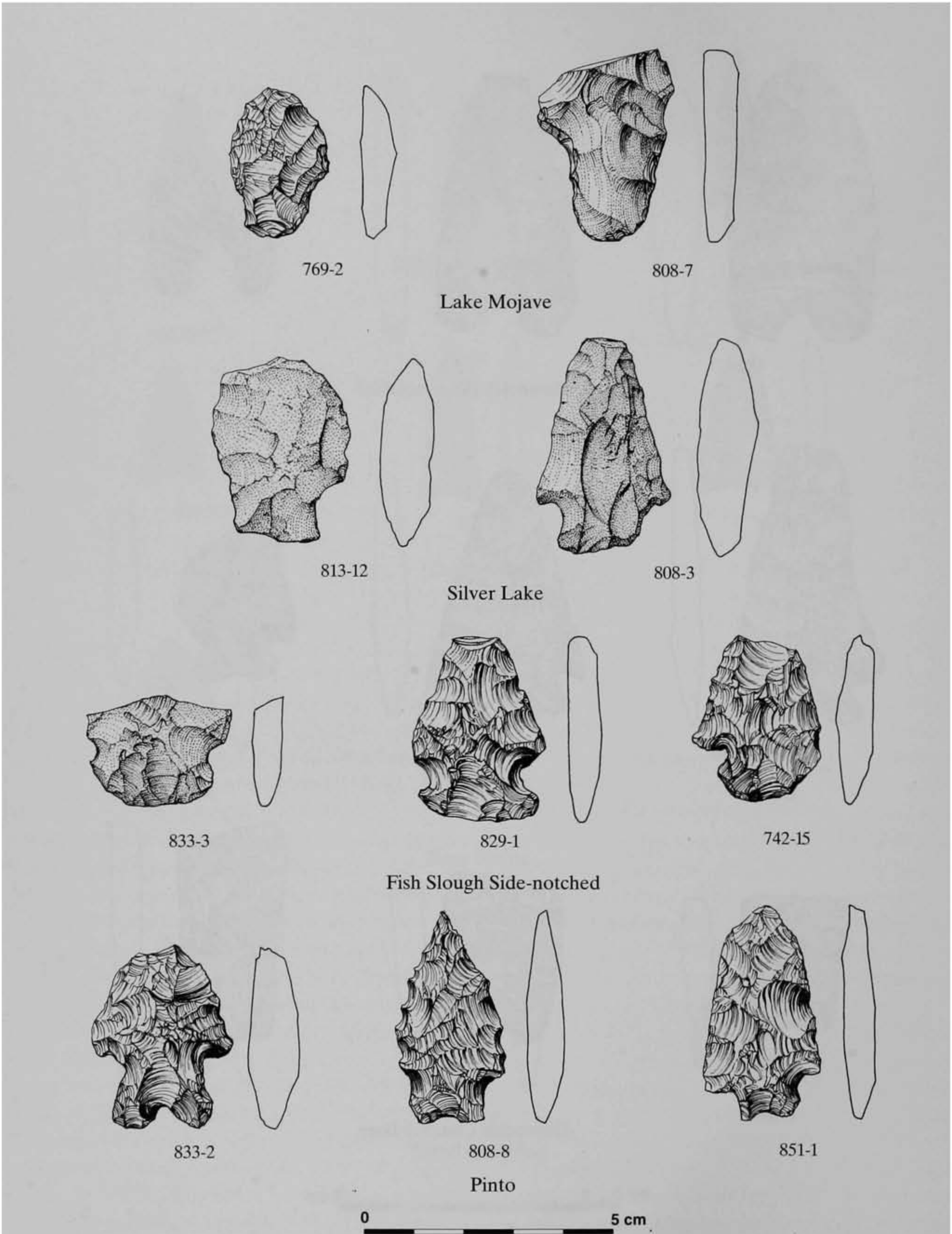

Figure 4. Selected Fish Slough Side-notched, Pinto, and Great Basin Stemmed Series Projectile Points from the Coso Target Range.

Table 2

OBSIDIAN HYDRATION DATA FROM TIME SENSITIVE PROJECTILE POINTS.

	Total Found	Hydration Sample	Min	Max	Mean	SD	CV
Desert Side-notched	17	16	1.0	3.5	2.3	0.80	35%
Cottonwood	39	33	1.1	3.8	2.3	0.70	30%
Rose Spring	106	92	1.0	5.7	3.0	0.97	32%
Saratoga Spring	16	12	0.9	5.2	2.9	1.43	49%
Humboldt Basal-notched	25	18	1.2	8.4	4.0	1.88	47%
Thin Elko	39	30	1.6	6.5	3.9	1.24	32%
Humboldt Concave-base	11	8	3.4	8.4	6.1	1.48	24%
Pinto	18	11	2.2	11.1	6.6	2.90	44%
Silver Lake	2	–	–	–	–	–	–
Lake Mojave	2	2	3.8	6.7	5.3	2.05	39%
Fish Slough Side-notched	4	1	8.2	8.2	8.2	–	–
Gypsum	1	1	3.3	3.3	3.3	–	–

Note: Min – minimum band width in microns; Max – maximum band width in microns; SD – standard deviation; CV – coefficient of variation. 272 points submitted, 224 with good measurements; of the problematic rims, 43 had diffuse hydration, one had no visible rim, and one was weathered. 3 measurements excluded: Pinto 1.1, 1.6 and Rose Spring 9.1.

3.9μ, respectively). This is also the case for Humboldt Concave-base (6.1μ) and Pinto (6.6μ) points; the latter value was calculated after excluding anomalous values of 1.1μ and 1.6μ. The small sample of Lake Mohave points (n=2) falls outside of the expected sequence with a mean value of 5.3μ; however, temporal overlaps between Pinto and Lake Mohave points have been reported in a variety of settings throughout eastern California (see Gilreath and Hildebrandt 1997; Warren 1984). Finally, a single Fish Slough Side-notched point produced a mean of 8.2μ, supportive of an early Holocene age.

Frequency Distribution of Projectile Point Types by Time Period

Projectile point frequencies and their hydration rim readings provide several insights regarding how the intensity of occupation of the pinyon zone changed over time. The random sample assemblage, for example, produced very low frequencies of early and middle Holocene points (i.e., Humboldt Concave-base, Pinto, Silver Lake, Lake Mohave, and Fish Slough forms), averaging about 4 points per 1,000 years of time (Table 3).

Table 3

PROJECTILE POINT FREQUENCIES BY TEMPORAL INTERVAL FROM THE RANDOM SAMPLE SURVEY UNITS.

Random Sample	Number	Temporal Interval[a]	Probable Interval Length	Number per 1000 years
DSN/Cottonwood	34	650 - 100	550	61.8
Rose Spring/Saratoga	107	1,350 - 650	700	152.9
Thin Elko/Humboldt Basal-notched	50	4,000 - 1,350	2650	18.7
Humboldt/Pinto/ Stemmed/Fish[b]	23	9,500 - 4,000	5500	4.2

Note: [a]Years B.P.; [b]includes Humboldt Concave-base, Pinto, Lake Mohave, Silver Lake, and Fish Slough Side-notched.

Projectile point frequencies increase significantly between 4,000 B.P. and 1,350 B.P. (Thin Elko, Humboldt Basal-notched), reaching 19 per 1000 years. The upward trend continues into the 1,350 B.P.–650 B.P. interval (153 Rose Spring/Saratoga Spring points per 1,000 years), but decreases after 650 B.P., where the frequency of Desert series points drops to 62 per 1,000 years.

This finding runs counter to the results of archaeological surveys conducted in other pinyon zones in the western Great Basin, where projectile points reach maximum frequencies during the Marana period (post-650 B.P.; see Bettinger 1975; Delacorte 1990). Increased frequencies of Marana period points in the pinyon zone have been interpreted as reflecting the continuing intensification in the use of upland resources (particularly pinyon nuts). This trend is thought to have culminated in the ethnographic patterns observed by Steward (1933, 1938), with the exploitation of pinyon representing a major component of the overall subsistence-settlement system. The relatively low frequency of Desert series points in the Coso Target Range (roughly half the number of Rose Spring/Saratoga Spring points) is difficult to understand given the contrasting patterns outlined above. It is possible, however, that it could reflect a late-period depletion of local game populations within this relatively small island of upland habitat. This issue will be addressed in more detail below.

PREHISTORIC SITE TYPES

Following the lead of Bettinger (1975, 1979) and Delacorte (1990), prehistoric sites were divided into three basic

Table 4

ARTIFACT ASSEMBLAGES BY SITE TYPE.

	Pinyon Camp with Rock Rings (n=26)		Pinyon Camp without Rock Rings (n=59)		Temporary Camp (n=90)		Pinyon Cache (n=39)		Total
	Number	Mean per site	Number	Mean per site	Number	Mean per site	Number	Mean per site	Number
Flaked Stone									
Projectile Point	101	3.9	223	3.8	156	1.7	21	0.5	501
Biface	168	6.5	313	5.3	178	2.0	34	0.9	693
Drill	6	0.2	7	0.1	3	<0.1	-	-	16
Uniface	-	-	2	<0.1	1	<0.1	-	-	3
Groundstone									
Handstone	53	2.0	63	1.1	–	–	–	–	116
Millingslab	116	4.5	115	1.9	–	–	–	–	231
Milling Slick	64	2.5	55	0.9	–	–	–	–	119
Bowl Mortar	–	–	2	<0.1	–	–	–	–	2
Incipient Mortar Cup	6	0.2	2	<0.1	–	–	–	–	8
Bedrock Mortar	3	0.1	7	0.1	–	–	–	–	10
Other									
Pottery	42	1.6	10	0.2	–	–	–	–	52
Glass Bead	–	–	–	–	–	–	1	<0.1	1
Steatite Bead	–	–	1	<0.1	–	–	–	–	1
Pinyon Pole	1	<0.1	–	–	–	–	–	–	1
Bow	2	0.1	–	–	–	–	–	–	2
Features									
Rock Shelter	3	0.1	2	<0.1	1	<0.1	1	<0.1	7
Hunting Blind	7	0.3	11	0.2	4	<0.1	–	–	22
Rock Ring	46	1.8	–	–	–	–	44	1.1	90
Rock Art Element	1017	39.1	640	10.8	784	8.7	47	1.2	2488
Total	1635	N/A	1453	N/A	1127	N/A	148	N/A	4363

Note: N/A – Not applicable.

settlement categories: Pinyon Camps, Temporary Camps, and Pinyon Caches. Pinyon Camps are habitation areas characterized by the presence of milling gear and often rock ring features, as well as by a variety of implements such as projectile points, bifaces, and unifaces. They are further divided into two subgroups, those with rock rings and those without rock rings. Rock rings represent pinyon caches or residential structures, and can sometimes be distinguished from one another by size, substrate, and formality of construction (i.e., caches tend to be smaller, are located on rocky/gravelly substrate, and have a less organized placement of the rocks). No attempt was made to differentiate between the two feature types during the survey, but this is not considered to be a significant problem as both indicate intensive use of the pinyon zone.

Temporary Camps lack milling gear and rock rings, and usually have a rather limited artifact assemblage characterized by tools used to hunt and process large game (i.e., projectile points, bifaces, and flake tools). Pinyon Caches are sites with rock rings and no milling gear, and can occur as isolated features, or with a very limited assemblage of flaked stone tools and debitage. The following discussion uses data obtained from both the random and target survey units.

Twenty-six Pinyon Camps with rock rings were identified during the project (Table 4). All artifact classes reach maximum densities at these sites, and include the full range of tools one would associate with residential activities. Flaked stone tools include projectile points, bifaces, drills, and unifaces (simple flake tools were not recorded during the survey), while the ground stone assemblage is composed of handstones, millingstones, milling slicks, and a variety of mortars. Uncommon artifacts include ceramic sherds, pinyon poles, and wooden bows, while uncommon features include rock shelters and hunting blinds.

Pinyon Camps without rock rings were more common, and were encountered at 59 sites (Table 4). The frequency of rock art drops significantly within this site type, while artifact frequencies are also slightly lower for all classes. Nevertheless, the range of implements observed is quite similar to that at Pinyon Camps with rock rings, clearly documenting the residential nature of these sites.

Ninety Temporary Camps were recorded (Table 4). Lacking milling gear, these sites have rather narrow assemblages consisting almost entirely of projectile points and bifaces (three drills and one uniface constitute the only other tools observed at the 90 sites; see Table 4). These findings suggest that Temporary Camps were associated with hunting activities, and probably include camp sites, hunting/stalking areas, and places where animals were butchered.

Thirty-nine Pinyon Caches were recorded, nine as formal archaeological sites and 30 as isolated features (Table 4). They are characterized by the presence of at least one rock ring, and contain little or no additional artifactual debris. Milling gear (by definition) is absent, while low frequencies of projectile points, bifaces, and debitage are sometimes encountered, probably representing fortuitous rather than functional associations. Rock art is also quite rare, found at only two sites.

CHRONOLOGICAL CHANGES IN LAND-USE

The nearly 270 temporally diagnostic projectile points recovered from over 200 archaeological components makes it possible to evaluate how the prehistoric use of the Coso Target Range changed over time. The cross-tabulation of time-sensitive projectile points against functionally distinct artifact assemblages produces several interesting results, some of which conform to existing models of prehistoric land-use and some that do not. The following discussion addresses a variety of issues related to past land-use patterns, beginning with an analysis of site distributions across vegetative zones, both atemporally and chronologically. Attention then turns to the initiation of intensive pinyon harvesting and its possible relationship to the decline of large game populations in the area.

TABLE 5

DISTRIBUTION OF SITE TYPES ACROSS VEGETATIVE ZONES.

	Pinyon Camp with Rock Rings	Pinyon Camp without Rock Rings	Temporary Camp	Pinyon Cache	Total
Pinyon (894.7 acres)					
Sites	9	7	24	25	65
Sites per 100 acres	1.0	0.8	2.7	2.8	7.3
Pinyon/Sage (668.5 acres)					
Sites	15	37	44	14	110
Sites per 100 acres	2.2	5.5	6.6	2.1	16.5
Sage (934.4 acres)					
Sites	2	15	22	-	39
Sites per 100 acres	0.2	1.6	2.4	-	4.2
Total (2497.5 acres)					
Sites	26	59	90	39	214
Sites per 100 acres	1.0	2.4	3.6	1.6	8.6

Vegetation and Its Influence on the Distribution of Prehistoric Sites

The survey area essentially consists of three vegetative zones: pinyon woodland, pinyon woodland-sagebrush ecotone, and open sagebrush flats. For this study, pinyon woodland is defined by the areas shaded green on 7.5' USGS topographic maps, with unshaded areas classified as open sagebrush. The pinyon-sagebrush ecotone includes a 50 m.-wide zone along the pinyon-sage boundary (i.e., 25 m. of each zone). To measure the density of sites across these areas, the number of acres surveyed within each vegetative zone was measured, and then compared to the frequency of archaeological sites discovered within each zone.

Table 5 summarizes the distribution of the four prehistoric site types across the three vegetative zones. These data show that Pinyon Camps with rock rings are found in low/moderate densities within the pinyon zone, reach maximum densities in the pinyon/sage zone, and drop to only trace amounts in open sage. This basic pattern is more pronounced among Pinyon Camps without rock rings, as site densities are over three times greater in the pinyon/sage zone than in either the pinyon or open sage zones; Temporary Camps also follow the same trend. Pinyon Caches, however, are found in maximum densities within the pinyon zone, slightly lower densities in the pinyon/sage zone, and are completely absent in the open sage. The relatively high density of these generally isolated rock ring features in the pinyon zone thus supports their use as green pine cone caches. Similarly, Pinyon Camps with rock rings are also found in the pinyon zone at a proportionally higher rate than sites lacking rock ring features.

The distribution of time-sensitive projectile points across these vegetative zones adds an interesting chronological dimension to these relationships (Table 6). Like the distribution of archaeological sites, all projectile point types are found in highest absolute and relative densities within the pinyon/sage zone. Major differences occur, however, when the frequency of time-sensitive points within the pinyon zone are compared to those found in open sagebrush settings. Desert Side-notched/Cottonwood and Rose Spring/Saratoga Spring points are found in much higher frequencies in the pinyon zone (25.0% and 31.1%, respectively) than in the sagebrush (10.7% and 12.3%, respectively), while the distribution is relatively even among Thin Elko/Humboldt Basal-notched (23.1% versus 21.5%). Older points occur more often in sagebrush than in pinyon, as indicated by Pinto/Humboldt Concave-base (28.6% versus 10.7%) and early Holocene markers (22.21% versus 11.1%). Analysis of these three groups in a two-by-three contingency table produces a chi-square value of 10.4, which is significant at the 0.01 level. These data clearly indicate that arrow points are found in pinyon woodland settings at a higher rate than earlier, particularly early/middle Holocene, forms.

Table 6

DISTRIBUTION OF TIME SENSITIVE PROJECTILE POINTS ACROSS VEGETATIVE ZONES.

	Pinyon	Pinyon/Sage	Sage	Total
DSN/Cottonwood	14	36	6	56
Rose Spring/Saratoga	38	69	15	122
Thin Elko/Humboldt Basal-notched	15	36	14	65
Pinto/Humboldt Concave-base	3	17	8	28
Early Holocene[a]	1	6	2	9
Total	71	164	45	280
Acres Surveyed	894.7	668.6	934.4	2,497.7
Points per Acre	0.08	0.25	0.05	0.11
Arrow Points	52	-	21	73
Thin Elko/Humboldt Basal-notched	15	-	14	29
Other Dart Points	4	-	10	14
Total	71	-	45	116
				X^2 = 10.4

Note: DSN – Desert Side-notched. [a]Early Holocene - includes Pinto, Lake Mohave, Silver Lake, and Fish Slough Side-notched points.

Initiation of Intensive Pinyon Processing

As previously discussed, archaeological surveys conducted in the Inyo-White Mountains by Bettinger (1975, 1989) and Delacorte (1990) indicate that use of the pinyon zone during the Newberry period (ca. 4,000 B.P.–1,350 B.P.) was largely focused on hunting large game, with little emphasis placed on the harvesting of pinyon nuts (particularly green-cone harvesting). Their conclusions were supported by the abundant presence of temporary hunting camps associated with Elko series projectile points, and the absence of Elko series points at pinyon camps (i.e., sites with milling gear and/or rock rings), where Rose Spring (1,350 B.P.–650 B.P.) and Desert series points (post-650 B.P.) were primarily recovered. These findings are largely consistent with diet breadth and transport models which indicate that brown cone pinyon would be included in the diet early in prehistory, and harvested and moved to lowland residential sites with a minimal signature in the archaeological record. Due to the higher cost of green cone harvesting, the onset of this subsistence pursuit would have been delayed until later in time, and may have triggered a higher degree of residential activity within the pinyon uplands (Barlow and Metcalfe 1996; Jones and Madsen 1989; Rhode 1990; Zeanah and Simms 1999).

Reynolds (1997), in contrast, found that Elko points were frequently associated with milling equipment and rock rings, leading her to conclude that intensive, green-cone pinyon harvesting was initiated during the Newberry period, perhaps 2,000 years earlier than proposed by Bettinger (1975, 1989) and Delacorte (1990).

Table 7

RELATIVE FREQUENCY OF TIME SENSITIVE PROJECTILE POINTS AGAINST PREHISTORIC SITE TYPES.

		Pinyon Camps									
		with rock rings		without rock rings		Temporary Camps		Pinyon Caches			
		Number	Sites	Number	Sites	Number	Sites	Number	Sites	Isolates	Total
Desert Side-notched		5	4	5	4	3	3	3	2	1	17
Cottonwood		12	5	21	10	4	4	2	2	–	39
	subtotal	**17**	**9**	**26**	**14**	**7**	**7**	**5**	**4**	**1**	**56**
Rose Spring		34	8	22	15	35	23	3	2	12	106
Saratoga Spring		5	3	6	6	5	4	-	-	-	16
	subtotal	**39**	**11**	**28**	**21**	**40**	**27**	**3**	**2**	**12**	**122**
Humboldt Basal-notched		6	6	4	4	6	6	–	–	9	25
Elko		8	6	21	15	6	5	–	–	4	39
	subtotal	**14**	**12**	**25**	**19**	**12**	**11**	**–**	**–**	**13**	**64**
Humboldt Concave-base		2	2	6	4	1	1	–	–	2	11
Pinto		4	3	7	6	3	3	–	–	4	18
	subtotal	**6**	**5**	**13**	**10**	**4**	**4**	**–**	**–**	**6**	**29**
Silver Lake		–	–	2	2	–	–	–	–	–	2
Lake Mojave		–	–	2	2	–	–	–	–	–	2
Fish Slough Side-notched		1	1	2	2	–	–	–	–	1	4
	subtotal	**1**	**1**	**6**	**6**	**–**	**–**	**–**	**–**	**1**	**8**
Total		77		98		63		8		33	279

Note: Sites = number of sites with projectile point type.

Although not specifically addressed by Reynolds (1997), these findings, if correct, have major implications for subsistence-settlement pattern models currently applied to the region.

First, the high costs associated with green cone harvesting makes it seem unlikely that this activity would have occurred during short-term logistical forays to the uplands (though it should be emphasized that we still lack quantitative data as to what these costs actually are). Second, the early use of green cone harvesting is at odds with prevailing ideas about resource intensification, rising human population densities, and the expansion of Numic-speaking peoples throughout the Great Basin (Bettinger 1994; Bettinger and Baumhoff 1982).

Traditionally, archaeologists identify green-cone pinyon exploitation activities based on the presence of both rock rings and milling gear. As will be demonstrated below, however, these artifact classes do not appear to be equally linked to the green-cone processing of pinyon nuts. For the purpose of this study, rock rings and milling gear are cross-tabulated separately against temporally diagnostic projectile points (Table 7). The analysis begins by comparing sites that have rock rings (i.e., Pinyon Caches and Pinyon Camps with rock rings) to those that do not (i.e., Temporary Camps and Pinyon Camps without rock rings). These data show that few early/middle Holocene projectile points (23.3%) are associated with sites having rock rings; this is also the case for Thin Elko and Humboldt Basal-notched points, where only 27.5% of these artifacts are associated with rock ring sites. However, beginning with Rose Spring and Saratoga Springs points, the frequency of association increases to 38.2%, and increases thereafter to 40.0% among Desert series points.

Table 8

RELATIVE FREQUENCY OF TIME SENSITIVE PROJECTILE POINTS AT SITES WITH OR WITHOUT ROCK RINGS.

	Sites with Rock Rings	Sites without Rock Rings	Total
Desert Side-notched/Cottonwood	22	33	55
Rose Spring/Saratoga	42	68	110
Elko/Humboldt Basal-notched	14	37	51
Middle/Early Holocene[a]	7	23	30
Total	85	161	246
Arrow points	64	101	165
Dart points	21	60	81
Total	85	161	246
			$X^2 = 4.1$
Ceramics	42	4	46
Pinyon Pole/Bows	3	–	3
Total	45	4	49

Note: [a]includes Humboldt Concave-base, Pinto, Silverlake, Lake Mohave, and Fish Slough Side-notched points.

Table 9

RELATIVE FREQUENCY OF TIME SENSITIVE PROJECTILE POINTS AT PINYON AND TEMPORARY CAMPS.

	Pinyon Camps (with milling gear)	Temporary Camps (without milling gear)	Total
Desert Side-notched/Cottonwood	43	7	50
Rose Spring/Saratoga	67	40	107
Elko/Humboldt Basal-notched	39	12	51
Middle/Early Holocene[a]	26	4	30
Total	175	63	238
Arrow points	110	47	157
Dart points	65	16	81
Total	175	63	238
			$X^2 = 2.9$

Note: [a]includes Humboldt Concave-base, Pinto, Silverlake, Lake Mohave, and Fish Slough Side-notched points.

This relationship is best illustrated by comparing arrow points to earlier dart forms (Table 8). These data show a 25.9% association with rock rings among the earlier points, and a 38.8% association among the later, arrow point forms. An application of a chi-square test to these findings produces a value of 4.1, significant at the 0.05 level, indicating that rock rings are more highly associated with post-1,350 B.P. materials.

Other late period indicators include ceramic sherds (post-650 B.P.), wooden bows (which post-date 300 B.P. based on a radiocarbon assay obtained by Hildebrandt and Ruby [2004]) and—in all probability—wooden pinyon poles (Table 8). Nearly all sherds (91.3%) and all wooden implements are found at sites with rock rings, which lends additional support to the relatively recent age of these features.

Milling equipment follows a different pattern. A comparison of all Pinyon Camps (which include milling gear) to Temporary Camps (which do not) reveals a much more even distribution of temporally diagnostic projectile points (Table 9). Over 86% of the early/middle Holocene projectile points are found at sites with milling gear; this frequency drops only slightly among the Thin Elko/Humboldt Basal-notched (76.5%) and Rose Spring/Saratoga (62.6%) groups, and increases again to 86.0% within the Desert series. A chi-square test of this relationship, comparing arrow to dart points, produces a value of 2.9, which is not significant at the 0.05 level.

These data indicate that milling equipment was used throughout the entire sequence, but the regular use of rock rings is a late phenomenon (sometime after 1,350 B.P.; see also Basgall and Giambastiani 1995). If green-cone processing is directly linked to the use of rock rings, but rock rings and milling gear are not obviously always linked to one another, it follows that milling gear was probably also used for resources other than green cone pinyon nuts—most importantly the highly ranked brown cone pinyon nuts. Ethnographic accounts indicate that even after the brown cones have ripened and the nuts are readily available, handstones and millingstones were often used to process the nuts. Wheat (1984), for example, notes that the Paiute of western Nevada knocked down the ripened nuts with long poles, collected them in burden baskets, and carried them back to camp. The unhulled nuts were cleaned of clinging debris, placed into a winnowing tray with hot coals, and then bounced and turned to protect the basket from burning. After the nuts began to hiss and pop, they were placed on a flat rock and quickly cracked, using a handstone, and hulled. Excess hulls were removed using the winnowing basket, and the nuts were roasted again with hot coals, using a similar technique. After the second roasting, the hard, brittle nuts were then ground into a fine powder that could be made into a thin porridge that was eaten hot or cold.

Based on these findings, it appears that prior to 1,350 B.P., a much wider range of subsistence activities occurred in the pinyon zone than originally hypothesized by Bettinger (1975, 1989) and Delacorte (1990). Rather than focusing entirely on hunting, it appears that plant collecting and processing also occurred on at least an occasional basis. The relatively high frequency of milling gear found at sites where Thin Elko/Humboldt Basal-notched and middle/early Holocene projectile points occur probably indicates that brown cone pinyon nuts were harvested during forays into the pinyon zone. Such a finding is fully consistent with the high caloric value of this resource (Simms 1985a, 1987).

Whether plant food collection and processing occurred in support of hunting forays into upland areas, or were independent events focused solely on the collection of pinyon nuts or other important plant foods, is an open question. Based on current thinking, however, the latter alternative seems more likely—men probably made logistical hunting forays into the mountains from lowland settlements at various times of the year, while larger groups of men and women went to the pinyon zone during the fall to collect and transport pinyon nuts back to the lowland settlements for winter use. This conclusion is also consistent with transport studies conducted elsewhere in the Great Basin (see Barlow and Metcalfe 1996; Jones and Madsen 1989; Rhode and Madsen 1998; Zeanah and Simms 1999).

Given the rarer co-occurrence between rock rings and these early projectile point forms, it seems likely that intensive green-cone production did not occur until later in time (post-1,350 B.P.), when a much larger proportion of the overall crop was harvested, processed, and stored through the use of more labor intensive activities like green cone removal with pinyon hooks, the establishment of multiple caches, and the roasting of the unripened cones. The increased cost of these activities also appears to be linked to a shift in settlement patterns, given that pinyon zones throughout the southwest Great Basin saw a higher degree of residential activity late in time (Bettinger 1991).

Changing Projectile Point Frequencies: Implications for the Depletion of Large Game

Changes in the frequency of temporally diagnostic projectile points have been commonly used as a proxy measure for changes in regional human population densities. Many researchers, for example, have observed that late period (post-650 B.P.) points are the most abundant forms in upland habitats, and much of this trend is particularly prevalent in the pinyon zone. The peak frequency of Marana period projectile points (i.e., Cottonwood and Desert Side-notched), combined with their common association with rock rings and milling gear, has been attributed to a more intensive use of the pinyon zone, and a greater use of the green-cone harvesting strategy (Bettinger 1975; Delacorte 1990). Although the sample from the Coso Target Range also shows steep increases in point types through time (see Table 3), the frequency peaks during the Haiwee period (1,350 B.P.–650 B.P.) and drops by approximately 60% in the following period (153 to 62 per 1,000 years).

The lower frequency of Marana period points might reflect a decrease in hunting due to a depletion of local game populations, particularly bighorn sheep. As outlined above, the Coso Range supports a small island of pinyon with multiple springs, and is surrounded by a sea of arid lands. Such an area would have supported a relatively small population of large game particularly susceptible to severe impacts from hunting. If use of the pinyon zone reached maximum intensity during the Haiwee and Marana periods, it stands to reason that hunting pressure would have also increased during these intervals, and could have lowered the overall productivity of the local game population. Bighorn sheep would have been particularly susceptible to depletion within this island setting, as they tend to occupy relatively small home ranges and are known to be non-aggressive colonizers of new habitats. Such a process of over-exploitation would be consistent with the Grant et al. (1968) hypothesized correlation between the decimation of sheep and prehistoric declines in the production of sheep petroglyphs in the Coso region. It also finds some support in the local historic record, as sheep are not mentioned in the hunting stories included in the diary of an early charcoal producer who occupied the area in the early 1870s (see Hildebrandt and Ruby 1999).

Table 10

PRESENCE/ABSENCE OF ROCK RINGS AND MILLING GEAR AT SINGLE COMPONENT SITES IN THE PAPOOSE FLAT AREA[a].

	Rock Rings	No Rock Rings	Total	Milling Gear	No Milling Gear	Total
Single Component Sites						
Desert Series	16	2	18	10	8	18
Rose Spring	10	5	15	7	8	15
Elko/Humboldt	8	12	20	11	9	20
Pinto	–	1	1	–	1	1
Total	34	20	54	28	26	54
Arrow Points	26	7	33	17	16	33
Dart Points	8	13	21	11	10	21
Total	34	20	54	28	26	54
			$X^2 = 9.0$			$X^2 = 0.004$

Note: [a]Data derived from Reynolds (1996:88–89).

DISCUSSION

Previous research in southeastern California by Bettinger (1976, 1989) and Delacorte (1990) indicated that prior to 1,350 B.P., the pinyon-juniper woodland was used primarily for hunting, with only casual harvest of brown cone pinyon nuts. After 1,350 B.P., the use of pinyon nuts intensified, as the green-cone harvesting technique became a dominant component of the subsistence economy. This conclusion was based on survey data showing an association between post-1,350 B.P. projectile points (Rose Spring, Desert series) and "domestic facilities" (i.e., rock rings and/or milling gear), and the absence of this association with projectile forms pre-dating 1,350 B.P. (e.g., Elko, Humboldt, and Pinto series).

A large-scale archaeological survey within the Coso pinyon zone supports the suggestion that there was an increase in the green-cone harvesting technique during the late period. This conclusion is not based on the presence of milling gear, however, as these tools and features appear to occur throughout the entire occupational sequence. Milling gear, contrary to the earlier work of Bettinger (1976, 1989) and Delacorte (1990), is commonly found in the Coso pinyon zone at sites that also contain Elko and Humboldt Basal-notched projectile points, as well as point forms dating to the middle and early Holocene (e.g., Pinto and Fish Slough Side-notched). It appears that milling gear has been incorrectly defined as domestic implements or facilities strictly associated with green-cone production. Instead, late period pinyon harvest intensification appears to be evidenced by the increased use of rock rings caches after 1,350 B.P.

The importance of distinguishing between rock ring caches and milling gear is also documented by Reynold's (1996) work in the Inyo Mountains. By considering milling gear and rock rings as domestic facilities indicative of intensive, green-cone processing, she concluded that the "more intensive and more productive green cone method" was initiated during the Newberry Period and "not after ca. 1,350 B.P." (Reynolds 1996:155). While this conclusion is perfectly reasonable given the original definition and interpretation of domestic facilities, separation of milling gear and rock rings produces a significantly different picture, one that is quite similar to that found in the Coso pinyon zone (Table 10). Using data from Reynolds' (1996) single component sites (i.e., those producing only one type of projectile point), the frequency of sites having rock rings increases over time relative to those that do not; that is, only 38.1% of sites with darts (pre-1,350 B.P.) contain rock rings, while this frequency increases to 78.8% among sites with only arrow points (post-1,350 B.P.). Application of a chi-square test to these findings produces a value of 9.0, significant at the 0.005 level. Milling equipment, in contrast, is present in nearly identical frequencies at sites with arrow points (51.5%) and at sites containing only dart points (52.4%; Table 10).

Although there is a clear increase in the use of rock rings after 1,350 B.P., they are still present at sites containing earlier projectile point forms. This latter association could indicate that green cone processing was initiated before 1,350 B.P., and intensified thereafter (i.e., providing some support for Reynolds' position).

It should be emphasized, however, that archaeological materials are often quite congested within pinyon environments (one site per 12.7 acres at Coso), resulting in significant chronological overlap at any given archaeological site. Given the coarse-grained nature of artifact association reported here (i.e., co-occurrences at a single site), exact dating of green cone processing is not possible. To achieve a higher level of resolution requires formal excavation, where true associations between archaeological materials can be determined. Where such excavations have occurred in the uplands of the southwestern Great Basin, none have reported residential occupations or intensive pinyon processing prior to 1,000 B.P. (e.g., Bettinger 1989; Eerkens and King 2002).

These findings suggest that while the original green-cone hypothesis stands, Bettinger (1976, 1989) and Delacorte (1990) may have underestimated the importance of pinyon use during earlier time periods. Dietary analyses by Simms (1985a, 1985b) indicate that pinyon nuts, when harvested using the brown-cone technique, are one of the highest ranked subsistence resources available to Great Basin peoples. Moreover, several researchers argue that due to their high nutritional returns, it makes economic sense to transport them great distances—distances greater than the 15 km. between the floor of Owens Valley (ca. 4,000 ft) and the surrounding pinyon-juniper woodland (ca. 7,000–9,000 feet; see also Barlow and Metcalfe 1996; Jones and Madsen 1989; Rhode 1990; Zeanah 2002; Zeanah and Simms 1999). The high return rate of pinyon nuts, combined with the fact that they are abundantly present in Newberry period residential bases on the valley floor (e.g., Basgall and McGuire 1988), surely indicates that they were more than a casual resource prior to 1,350 B.P.

Given the high degree of logistical organization associated with the Newberry period (Basgall and McGuire 1988; Bettinger 1999; Delacorte 1990; Hildebrandt and McGuire 2002; McGuire and Hildebrandt 2005), forays from the valley floor to the pinyon zone to collect brown-cone pinyon is entirely consistent with the overall adaptation. As mentioned above, one of the best Newberry period lowland residential bases excavated to date (INY-30), produced a plant macrofossil assemblage dominated by pinyon nuts—in addition to other upland resources like marmot and mountain sheep (Basgall and McGuire 1988). The logistical hunting of animal resources could have occurred for most of the year without incurring scheduling conflicts with pinyon. During the fall, however, such conflicts would have occurred (i.e., the presence of large groups of people collecting nuts is not conducive to stalking game), requiring some difficult decisions regarding the costs and benefits of the two activities. Although it is difficult to know exactly how these decisions played out during the Newberry period, it seems clear that the scale shifted in favor of pinyon sometime during the Haiwee period (1,350 B.P.–650 B.P.), perhaps due to the over-exploitation of large game populations (see Madsen 1986). Such a conclusion may be supported by a late prehistoric reduction of large mammal bone in regional faunal assemblages (Holanda and Delacorte 1999; Basgall and Giambastiani 1995; Hildebrandt and McGuire 2002), and over-exploitation may have contributed to a decrease in the frequency of hunting implements (i.e., projectile points) after 650 B.P. in the Coso pinyon zone.

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