ASSESSING PRE-NEWBERRY OCCUPATION BASED ON MORPHOLOGICAL VARIATION AND TEMPORAL-SPATIAL DISTRIBUTION OF DART POINTS IN THE INYO-MONO REGION, CALIFORNIA

A Thesis

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Brian Noel James II

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Brian Noel James II

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Department of Anthropology

Abstract

of

ASSESSING PRE-NEWBERRY OCCUPATION BASED ON MORPHOLOGICAL VARIATION AND TEMPORAL-SPATIAL DISTRIBUTION OF DART POINTS IN THE INYO-MONO REGION, CALIFORNIA

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The Pre-Newberry period in the Inyo-Mono Region has garnered debate in terms of population and land use pattern. Initial thought centered on the abandonment of areas due to climatic fluctuations that prompted population depression. Subsequently, however, the focus turned to the role of different settlement shifts during the middle Holocene and how these changes generated a more ephemeral archaeological record in response to short-term occupation and high mobility. In conjunction with this alternative is the potential for buried deposits to exist under recent Holocene alluvium, and that the visibility of this portion of the record is obscured by taphonomic processes.

In order to assess the viability of these alternative explanations, data on numerous dart points from multiple regional reports and projects, along with new data from the Harry Riddell and Rollin and Grace Enfield collections was compiled. Morphometric analysis was undertaken to address variability in middle Holocene dart forms and obsidian sourcing and hydration data were enumerated and added to new sourcing and hydration data from the Enfield sample. These data were then analyzed across landforms of differing ages within the region. The underrepresentation of points on particular landforms of differing age was addressed and artifact frequencies corrected in an attempt to identify biases.

Known point morphologies remained consistent in many cases adhering to previous conclusions. Identification of a Wide-Stemmed form was established with the possibility that it represents a generalized form related to Pinto points, potentially a preform. Timing of point forms also adhered closely to expected ranges, albeit conditioned by the limitations inherent in obsidian hydration dating (OHD). The perceived gap in pre-Newberry occupation breaks down with the addition of new data, particularly data obtained from the Inyo-White Mountains east of Owens Valley. Occupation of the region appears to gradually increase throughout the middle Holocene with a slight acceleration post 4000 B.P. and a more dramatic pulse during the Late Newberry interval (ca. 2000 B.P.).

_______________________, Committee Chair
Mark E. Basgall, PhD

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Date

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CHAPTER 1

INTRODUCTION

Pre-Newberry (pre-3500 B.P.) occupation in the Owens Valley and adjacent areas within the Inyo-Mono region is not as well understood or represented as preceding or subsequent periods. Owens Valley settlement-subsistence patterns became geographically wide-ranging, logistically organized systems around 2000 years ago, as evidenced by the presence of seasonally occupied dwellings in both northern and southern ends of the valley (Basgall and Delacorte 2012; Basgall and McGuire 1988). Prior to this settlement shift, archaeological patterns are less certain and a “gap” in occupation related to the Middle Holocene Altithermal interval (Antevs) has been long proposed to account for paucity of prehistoric remains during this interval (e.g., Elston 1982; Grayson 1993; Madsen and Berry 1975; Meltzer 1999; Reeves 1969). Alternatively, occupation during the Altithermal was characterized by short-term encampments, reflecting high mobility among adaptively flexible groups (Delacorte 1999; Delacorte et al. 1995). Visibility of pre-Newberry period occupation may also be obscured by taphonomic processes of alluvial progradation, which cover sites over time (Basgall 2009; Basgall and Delacorte 2012; Delacorte 1999; Meyer and Rosenthal 2010; Meyer et al. 2010).

To assess the veracity of these alternative hypotheses and “gap” in human occupation, issues relating to dart point variability, temporal placement, and regional distribution are examined. Statistical analyses of metric attributes, and obsidian hydration dating (OHD) are employed to establish and refine the chronology of regional projectile points. A final analysis explores how projectile point forms of particular age are distributed across landforms of different age to assess potential biases in the archaeological record resulting from late Holocene alluviation. If bias does exist, the disproportionate frequencies of disparate aged projectile points should be less pronounced once landforms of disproportionally younger age are weighted to less abundant surfaces of greater antiquity in the Inyo-Mono region.

The current study benefits from one of the archaeologically best studied areas within the Great Basin, where numerous dissertations, theses, and public projects have been completed. The region harbors a wealth of prehistoric material, spanning the entirety of human occupation. Chronological control in the region is particularly good, given locally available obsidian amenable to obsidian hydration studies, as well as temporally-diagnostic artifacts including beads and projectile points. In fact, a diverse sample of dart points are central to the current study.

The Late Holocene projectile point sequence in the Great Basin is well established on the basis of abundant arrow points (i.e., Rose Spring, Eastgate and Desert series). Dart points used with atlatl immediately prior to the introduction of the bow (i.e., Elko and Humboldt series) are likewise reasonably well dated and understood. But the time span represented by these points is substantially longer than later arrow types, allowing for multiple generations of stylistic change. Early and middle Holocene points forms (i.e., Gatecliff, Pinto, and Great Basin Stemmed) are less common, although they span a considerably greater part of the prehistoric sequence. The increased frequency of points over time is largely a function of population increase, although technological organization (i.e., manufacture, transport, and curation) and settlement-subsistence patterns further structure the archaeological record.

The Inyo-Mono region has a wide range of dart point types, although their definition, dating, and function is often debated (Basgall and Hall 2000; Beck and Jones 1993, 1997; Bettinger 1978; Garfinkel and Yohe 2002; Thomas 1981; Vaughn and Warren 1994). Additionally, points that lack formal definitions have been reported with very general morphology (e.g., wide stemmed varieties [Hall 1989]), or are otherwise untypeable and complicate the dart point record further.

Dart point data in the current sample derive from existing information enumerated in various reports from the region along with data collected from the Harry S. Riddell and Rollin and Grace Enfield collections, containing hundreds of previously unexamined points. The latter data add substantially to the regional projectile point sample, including previously underrepresented types. Measurements from new specimens and data from existing reports serve as the basis for morphometric statistical analyses to refine existing point taxonomies. Existing obsidian source and hydration data were also combined with newly generated source and hydration data from the Enfield collection to examine point chronologies and regional temporal patterns in relation to landforms. Ultimately, these projectile point data furnish a snapshot of pre-Newberry period (pre-3500 B.P.) occupation extending from the Early Holocene up to the mid-point of the Newberry interval (ca. 2000 B.P.), highlighting the potential for buried deposits and changing adaptive strategies during the middle Holocene.

CHAPTER 2

GEOLOGY AND PALEOENVIRONMENT

The Inyo-Mono region of California falls primarily within the hydrologic, geologic, and biotic Great Basin. The southern and eastern portions of the area include the northernmost extent of the Mojave Desert. It is an environmentally diverse region, given variations in elevations and corresponding climate. Mt. Whitney rises to an elevation of 14,505 feet, while the Badwater Basin in Death Valley is situated at 282 feet below sea level. The study locality is bordered by two mountain ranges, the Sierra Nevada on the west and the Inyo-White Mountains on the east. These create a series of north-south trending valleys and uplands that include Long Valley, the Volcanic Tableland, Truman Meadows, and Owens Valley, where most of the studied artifacts are from. Other artifacts derive from the Inyo/White Mountains and Eureka and Rose valleys.

Geologic Context

The geologic structure of the Inyo/Mono region resembles that over much of the Great Basin, with block-faulted valleys flanked by steep mountain fronts. The Inyo-Mono region is distinguished from other parts of the Great Basin, however, by extensive volcanism, which has produced numerous volcanic features. These include the Mono and Inyo Craters, Mammoth Formation (including Devils Post-pile), Long Valley Caldera, Glass Mountain Ridge, Benton Range, Volcanic Tableland, Crater Mountain, and Coso Volcanic Field (Wilkerson et al. 2007), along with numerous hot springs and obsidian flows. No less than eight obsidian sources lie within the study area, including the Bodie

Hills, Mono Craters, Mono Glass Mountain, Truman-Queen, Casa Diablo, Fish Springs, Saline Range, and Coso geochemical types. Changing climatic regimens have also led to the formation of glacial moraines and pluvial lakebed features over much of the region. During the late Pleistocene, Lake Russell (Mono Lake) overflowed into the Owen's River and thence Owens Lake, which overflowed into China Lake, and from there into Searles Lake, Panamint Valley, and eventually Lake Manley (Death Valley [Von Hume et al. 1963]).

Long Valley Caldera

Long Valley lies immediately northwest of the Volcanic Tableland and Owens Valley and was formed by a massive volcanic eruption approximately 760kya (Bailey et al. 1976). Unlike other Inyo-Mono region basins, Long Valley is a caldera roughly 32 kilometers long (east-west) and 18 kilometers wide (north-south). The valley floor lies at an elevation of roughly 6500 feet, its western half comprising a resurgent dome that is believed to have formed approximately 100kya when is rose 450 meters above the surrounding valley floor (Konigsmark 2002). The Owens River drains Long Valley to the south via the Owens River Gorge that cuts through the western edge of the Volcanic Tableland.

Geologically, Long Valley is a mosaic of Pleistocene and Holocene alluvium, terrace gravels of igneous and sedimentary rock, and ryholitic domes and flows. A rhyolitic flow known as the Bishop tuff extends southeast from Long Valley to form the Volcanic Tableland. Other rhyolitic flows associated with the silicic magma chamber under Long

Valley contain obsidian and are abundant in and around the caldera (Harris 1988). The geologically younger, obsidian rich Mono Crater chain lies north of Long Valley and is a product of likely a separate magma chamber under the Mono Crater chain (Lipshie 2001).

The Volcanic Tableland

The Volcanic Tableland is an expansive plateau capped by the Bishop Tuff formation that erupted from the Long Valley caldera and flowed south to within six miles of the modern town of Bishop, California. The surface of the Volcanic Tableland is broken by numerous, discontinuous faults that produce a series of shallow canyons and gullies (Bateman 1965; Jennings 1994). To the east of the Tableland is Chalfant Valley, and to the south Fish Slough, a small, spring-fed fault depression (Bateman 1964; Knopf 1918).

In other respects, the Volcanic Tableland is a homogenous landform of north-south trending fault scarps where slabs of tuff have fractured and been either dropped or upshifted. Erosion of the soft bedrock has produced generally shallow tuffaceous sediments comprised of loose sand mixed with larger cobbles and pebbles. Some areas, in especially the eastern portions of the plateau, contain deeper sediment up to several meters thick, but most prehistoric deposits rarely exceed 50 cm in depth (Giambastiani 2004).

Fish Slough is a depositional setting, where alluvial sediments from adjacent fault scarps and organic deposits have accumulated to locally some depth. It is a small, marshy depression ~12.5 kilometers long and between ~0.25 and 2.5 kilometers wide (Hollett et al. 1991; Danskin 1998). Although no streams flow into the slough, it supports substantial water flows from spring and groundwater discharge. For peoples inhabiting the Volcanic

Tableland, Fish Slough would have constituted the only permanent source of surface water. Thus, existence of Fish Slough had significant implications for prehistoric settlement of the Volcanic Tableland, with numerous sites bordering the area from the early Holocene onward.

Owens Valley

The most prominent of the regional valleys is Owens Valley, a long, block faulted graben that extends from the Volcanic Tableland to just south of Owens Lake. The valley floor is roughly 130 kilometers long and varies between 6 and 16 kilometers wide. It is divided into two structural basins: the Bishop Basin in the north and the Owens Lake Basin in the south. These are separated by east-west trending faults that give rise to the Poverty Hills and Big Pine Volcanic Field (Danskin 1998; Woolfenden 1996). The valley is infilled with late Tertiary and Quaternary alluvium derived from both the Inyo-White and Sierra Nevada ranges, which produce large alluvial fans that extend well onto the valley floor.

In cross-section, Owens Valley is asymmetric consisting of a shallow western bedrock bajada that hugs the base of the Sierra Nevada Mountains and a much deeper, alluvial filled bedrock channel on the eastern side of the valley (Gillespie 1991). Valley fill is particularly thick east of the Alabama Hills near Lone Pine and beneath Owens Lake, where gravity surveys indicate a sediment thickness of nearly two miles.

The primary hydrologic features of the valley are the Owens River and Owens Lake. Historically, numerous Sierran streams and creeks fed the river and the lake filled to a depth of 30 feet with alkaline-charged water. Today, most of the valley’s water is diverted toward Los Angeles by way of an aqueduct system. This has desiccated Owens Lake for much of the past century, save occasional periods of flooding and recently returned Owens River flows that produce a shallow pan of water on portions of the otherwise dry playa.

Truman Meadows

The Truman Meadows is a narrow alluvial flat between two transverse ridges north of Queen Valley, Nevada. This area is substantially higher in elevation than places such as Owens Valley and the Volcanic Tableland, with Montgomery pass situated just below 7,200 feet on the eastern end. Small mountain streams terminate and feed water into Truman Meadows and a spring flows at the very western end of the meadows, where Truman Canyon exits to the west. The ridge formations around Truman Meadows are part of a larger block of tertiary andesite that defines the western Coaldale fault line forming the southern extent of the Mina Deflection (Lee 2009). Truman-Queen, a prominent obsidian source in the region, is comprised of multiple nodular float sources and small obsidian outcrops (Ramos 2000). This source is of particular importance to the current study, as a significant portion of the projectile point sample is manufactured from Truman-Queen glass.

Vegetation

Vegetation in the Inyo-Mono region is characterized by elevationally controlled biotic communities. These can be further divided into three zonal sequence containing two or more plant communities each (Billings 1951; DeDecker 1973; Lloyd and Mitchell 1973;

Munz and Keck 1959; Storer and Usinger 1963). These include the valley lowlands, Inyo-White uplands, and Sierra Nevada uplands.

Valley lowlands harbor limited areas of riparian and wetland vegetation, with trees such as black cottonwood (*Poplus fremontii*), willow (*Salix* sp.), water birch (*Betula occidentalis*), and occasionally black oak (*Quercus kelloggii*). Marsh and wetland plants include sedge (*Carex* sp.), rush (*Juncus* sp.), cattail (*Typha* sp.), and tule (*Scirpus acutus* [Forbes et al. 1988]).

In more arid valley settings is a Desert Scrub community, consisting of allscale (*Atriplex* sp.), sagebrush (*Artemesia* sp.), bursage (*Ambrosia* sp.), ephedra (*Ephedra nevadensis)*, greasewood (*Sarcobutus vermiculatus*), hopsage (*Grayia spinosa*), dropseed (*Sporobolus* sp.), Indian ricegrass (*Achnatherum hymenoides*), arrowweed (*Pluchea sericea)*, rabbitbrush (*Chrysanthemum* sp.), bitterbrush (*Pershia tridentata*), wildrye (*Elymus* sp.), wheatgrass (A*gropyron trachycaulum*), needlegrass (*Achnatherum* sp.), bluegrass (*Poa* sp.), bromegrass (*Bromus* sp.), chia (*Salvia clumbariae*), sunflower (*Helianthus nuttallii*), goosefoot (*Chenopodium* sp.), and blazing star (*Mentzelia albicaulis*) (Cheatham and Haller 1975; DeDecker 1991; Laudenslayer and Boggs 1988; Rowlands 1988).

The Inyo-White Mountain uplands support a Pinyon-Juniper woodland of single-leaf pinyon pine (*Pinus monophylla*), Utah juniper (*Juniperus osteosperma*), and mountain mahogany (*Cercocarpus* sp.). At higher elevations is an upper sagebrush community that separates the Pinyon-Juniper and sub-alpine woodland of bristlecone (*Pinus longaeva*) and limber (*Pinus flexilis*) pine (Verner and Purcell 1988). Finally, at the crest of the range is an alpine tundra community containing Coleville's phlox (*Phlox covillei*), alpine buckwheat (*Eriogonum gracilipes*), dwarf-paintbrush (*Castilleja pilosa*), bluegrass, and blue flax (*Linum lewissii* [Laudenslayer and Boggs 1988, Spira 1991]).

The Sierran uplands consist of a mixed conifer forest of Jeffrey (*Pinus jeffreyi*), lodgepole (*Pinus contorta latifolia*), and ponderosa (*Pinus ponderosa*) pine, along with quaking aspen (*Polpulous tremuloides)*, mountain hemlock (*Tsuga mertensiana*), engelman spruce (*Picea engelmannii*), and sub-alpine (*Abies lasiocarpa*) fir (Bartolome 1988; McBride 1988). Above this woodland are Sierran meadows characterized by Bigelow sneezeweed (*Helenium autumnal*), shooting star (*Dodecatheon* sp.), monkshood (*Aconitum* sp.), meadow paint brush (*Castilleja* sp.), Sierra gentian (*Gentianopsis holopetala*), and meadow mimulus (*Mimulus* sp.). As with the Inyo-White range, the crest of the Sierra Nevada supports an Alpine tundra zone, distinguished by blue grass, cushion cress (*Aubrieta* sp.), mountain sorrel (*Oxyria digyna*), granite buckwheat (*Eriogonum lobbii*), alpine paintbrush (*Castilleja* sp.), alpine locoweed (*Astragalus alpinus*), sky pilot (*Polemonium eximium*), Sierra primrose (*Primula suffrutescens*), whitestem goldenbush (*Ericameria discoidea*), and alpine gold (*Hulsea algida* [Lloyd and Mitchell 1973]). A unique montane assemblage of chaparral and hardwood species occurs in the southern Sierra Nevada, where manzanita (*Arctostaphylos* sp.) and oak (*Quercus* sp.) predominate (McDonald 1988; Risser and Fry 1988).

Climate

The Great Basin is characterized by a continental climate, with pronounced differences between summer and winter temperatures. The northern two thirds of the area has cold winters and hot summers, with the southwestern Great Basin, including the Inyo-Mono region, experiencing less extreme fluctuations in seasonal temperature. Average January temperatures range between 0º and 6º C, with those in July ranging between from 20º and 40º C, depending on latitude. Westerly atmospheric circulation patterns are responsible for most Great Basin precipitation, although Pacific storms lose much of their moisture traversing the Sierra Nevada and Cascade ranges before reaching the Great Basin (Curry 1971; Powell and Kileforth 1991). In addition to this rain shadow effect, the formation of high-pressure over the Great Basin during winter months deflects the jet stream and many inbound storms northward, enhancing the generally arid condition of the region. The Inyo-Mono area is, in many respects, less arid than much of the Great Basin, given the amount of water that drains from the Sierra Nevada into the Owens River system. Most precipitation falls at higher elevations in the mountains as winter snow, with a second pulse of monsoonal summer thunderstorms arriving from the south and unrelated to the larger pacific storms that bring winter precipitation from the Pacific Northwest.

The pronounced relief between valley bottoms and uplands produces marked variations in temperature and seasonal microclimates. Temperatures are highest on the valley bottoms, with an average high in Owens Valley of 25º C in July, and an average low of 2.9º C in January (Powell and Klieforth 1991). Maximum extremes in temperature range from a high of 44.4º C degrees to a low of -21.7º C (Powell and Klieforth 1991; Western Regional Climate Center 1997). Summer temperatures are substantially lower at higher elevation, averaging just 10º C between June and August, with winter extremes reaching -

37.2° C (Powell and Klieforth 1991). On average, temperature drops 2° C for every 1000 foot increase in elevation.

Paleoenvironment

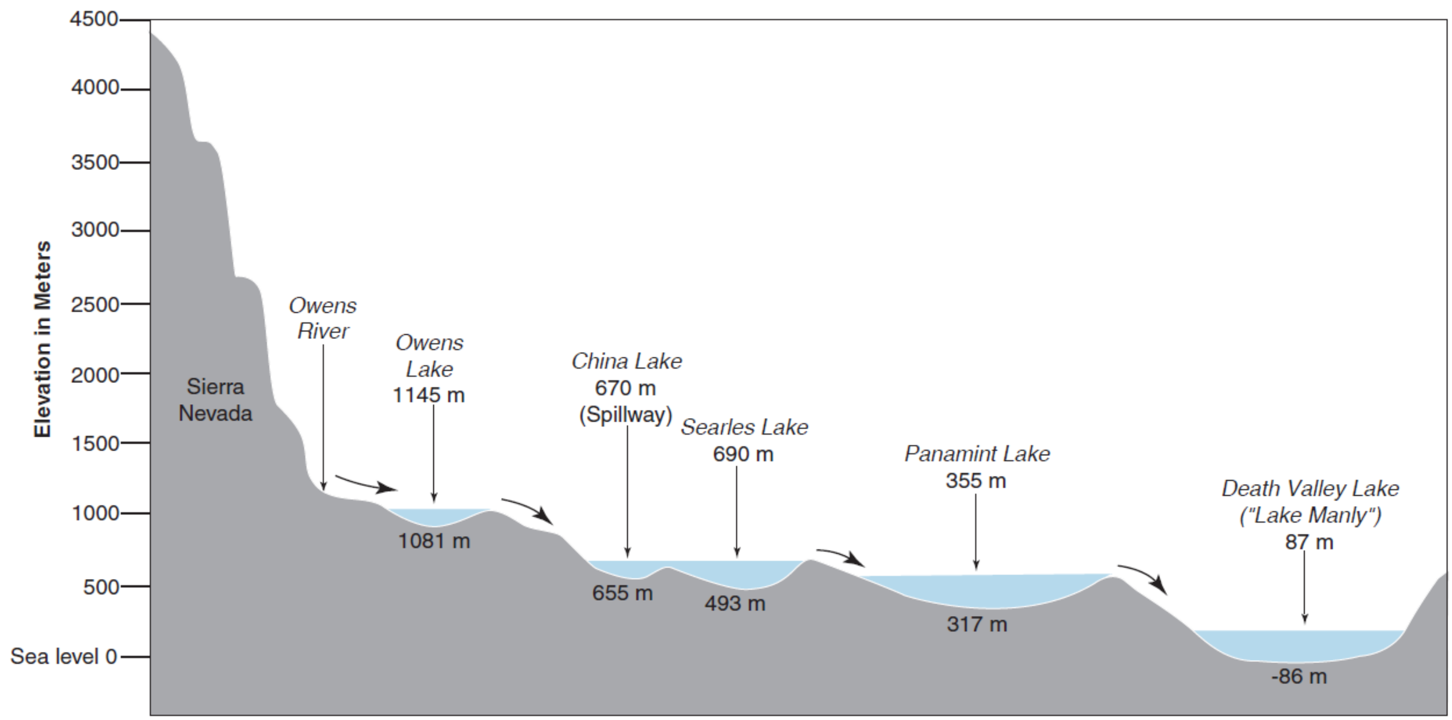
Numerous studies have reconstructed the past climate and environment of the Inyo-Mono region, as summarized below. Data from packrat middens (Halford 1998; Jennings 1989; Jennings and Elliot-Fisk 1993; Koehler and Anderson 1995; Reynolds 1996; Wigand 2002), pollen (Batchelder 1970; Davis et al. 1985; Wigand and Mehringer 1985), tree rings (Graumlich 1993; Hughes and Brown 1992; LaMarche 1973, 1974, 1978; Scuderi 1984, 1987) and lake level fluctuations (Bacon et al. 2006; Benson et al. 1990; Enzel et al. 1992; Stine 1990, 1994, 1995) have been used to reconstruct climate fluctuations during the Holocene. These broadly substantiate Antevs' (1948, 1952) model of Holocene climates, characterizing the early Holocene as cool and moist "Anathermal" (10,000-7000 B.P.), changing to warm-dry conditions during the middle Holocene "Altithermal" (7000-4500 B.P.), and then back to cool-moist "Medithermal" for the last 4500 years.

Overall, the Holocene is marked by warmer conditions than the preceding Pleistocene epoch. Data from packrat midden and lake level studies suggest that the earliest part of the Holocene (10,000-8000 B.P.) was, indeed, cool and moist following the retreat of Pleistocene glaciers that covered much of North America and higher mountain ranges. It has been shown, however, that people arrived in the Americas well before the end of the Pleistocene (Adovasio et al. 1978, 1990; Dillehay 1989) and would have dealt with cold conditions during the Younger Dryas stadial, which saw a late Pleistocene return to full glacial conditions. The moist atmosphere of the early Holocene caused lake levels in Owens Lake to fluctuate and reach their Holocene peak around 7,700 B.P. Owens lake levels were consistently higher prior to the end of the Younger Dryas (~12,900 to 11,700 B.P.), with outflow from the lake draining into the China and Searles lake basins during much of the Late Pleistocene (see Figure 2.1). Researchers posit that Owens Lake may have become a closed basin after its final highstand between 16000 and 15000 years ago (Bacon et al. 2006; see Figure 2.2). Moisture and precipitation decreased dramatically at the end of the Pleistocene, with generally warmer/dryer conditions persisting throughout the human occupation of the region. Climatic fluctuations within the Holocene have been variable in the eastern Sierra, though the existence of expanded marsh habitats during the Holocene in Owens Valley suggest it was one of the most productive environments for human occupation (Pinter et al. 1994; Pinter and Keller 1991).

The middle Holocene was characterized by an extended period of warmer and drier climate, corresponding to the mid-Holocene climatic optimum (~8500-6000 B.P.) or Altithermal (Antevs 1948). Tree ring data point to fluctuating periods of precipitation and drought, with a brief interval of cool/moist conditions around 6000 B.P., followed by a warm/dry climate until 3500 B.P. Sediments in Owens Valley stream cuts indicate that Owens Lake remained shallow or dry for nearly 2500 years between 6,800 and 4,300 B.P., when landforms became unstable as periods of drought caused vegetation communities to shift (Bacon et al. 2006). Treelines in the mountains shifted upward, while episodes of precipitation caused rapid erosion along valley margins and mountain fronts, and progradation of alluvial fans (Meyer et al. 2010). As a more intensive precipitation regime returned to the region toward the end of the Altithermal, unstable landforms denuded of vegetation would have produced a massive movement of sediment onto valley floors. This may have buried many archaeological sites on terraces formed during the early Holocene.

The late Holocene (~4000 B.P. to present) is marked by a shift to cooler/wetter climate that coincides with the Medithermal period proposed by Antevs (1948). This includes a roughly 1º C drop in summer temperature around 3500 B.P., evidenced in tree ring data. Cooling conditions also resulted in a treeline shift 100 meters downslope (LaMarche 1973; see Figure 2.3). Packrat midden, lake level, and other tree ring data support these trends and point to variable conditions throughout the late Holocene. These include a possible drought around 1700 B.P., return to the cool/moist conditions until 1000 B.P., and an unprecedented drought that lasted until 600 B.P.

The latter drought or Medieval Climatic Anomaly (MCA) has been documented in numerous locations around the world, and led to purportedly significant declines in marsh habitat and Owens Lake and river levels in the Inyo-Mono region (Jones et al. 1999; Stine 1998). The MCA coincides with the Haiwee cultural period (1350-650 B.P., see Chapter 3) in Owens Valley, when some researchers have proposed a decline in human occupation of the area. As with the earlier arid period between 7500 and 3500 B.P., the MCA would presumably have engendered many of the same constraints on human population and resources discussed above. Immediately following the MCA was a period of cooling and glacial advance called the “Little Ice Age” (Ladurie 1971; Lamb 1972; Matthes 1939). This cold period lasted from 650 to 150 B.P. and, based on radiocarbon dates on roughly 150 samples of organic material beneath the Baffin Island and Icelandic ice caps, cold summers



Note: Adapted from Smith & Street-Perrott (1983).

Figure 2.1. Owens River drainage system.

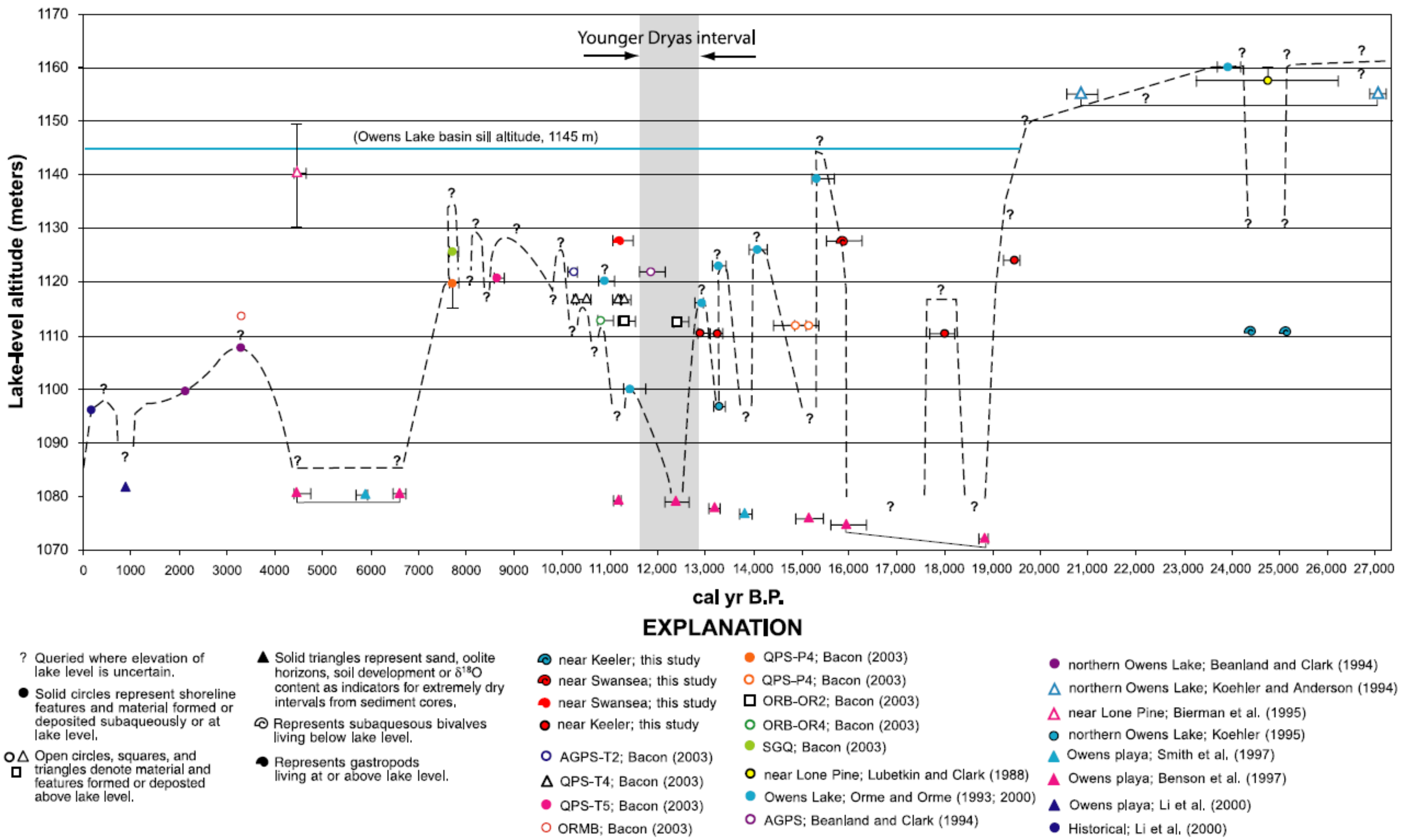


Figure 2.2. Owen Lake levels (from Bacon et al. 2006).

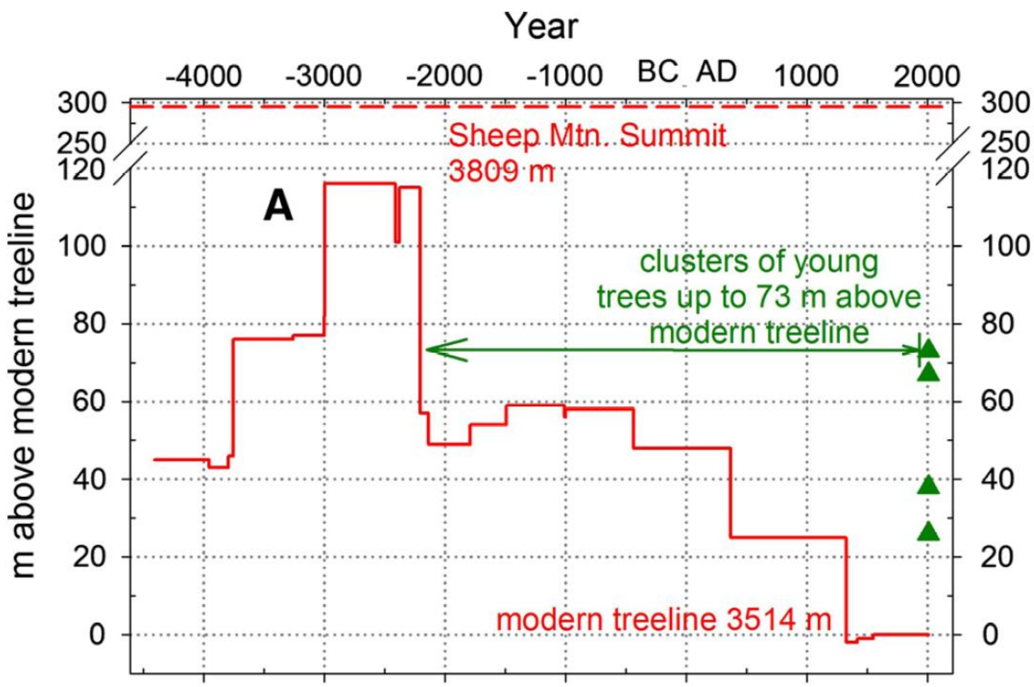


Figure 2.3. White Mountain treeline.

(from Salzer et al. 2014, adapted from La Marche 1973)

and ice growth began abruptly around 650 B.P., followed by a substantial intensification from 520 to 495 B.P. Glacial advance shows little variation, however, from 350 to 150 B.P., with a rapid retreat thereafter (Miller et al. 2012). Finally, conditions from 150 B.P. onward appear to have been fairly mild and stable, consistent with the modern baseline.

Implications for the Pre-Newberry Archaeological Record

Shifts in Holocene climate would have had significant impacts on populations inhabiting the Inyo-Mono region, as manifest in the archaeological record. For example, middle Holocene groups relying on formerly widespread marsh/riparian resources of the early Holocene, may have been forced to shift their focus to other foods and different parts of the landscape. Archaeologically, this interval is poorly represented in the Inyo-Mono and other parts of the Great Basin, when compared to earlier and certainly later times. This “gap” in the record has been explicitly addressed by various researchers (Basgall 2009; Basgall and Delacorte 2011, 2012; Basgall and Hall 2000; Baumhoff and Heizer 1965; Delacorte et al. 1995; Delacorte 1999; Elston 1982; Grayson 1993; Meyer et al. 2010), with several explanations advanced to account for it. Many middle Holocene components north of the Mojave Desert are marked by small accumulations with few time-markers. Assemblages seem to indicate a generalized tool kit, adapted to a highly mobile wide-ranging settlement pattern. In the northern and central Mojave Desert, by contrast, large aggregations of cultural material in resource-rich habitats suggest recurring occupations by possibly large groups.

Archaeological deposits that bracket the middle and late Holocene interval suggest that many of the sites from this period are deeply buried or destroyed (Meyer et al. 2010; Meyer and Rosenthal 2010). Conversely, more abundant early Holocene remains occur in geologic contexts that are not subject to such taphonomic processes. Sites of this age are more visible, not because more people were intensively occupying the region, but because many of the large basins with early Holocene sites retain extensive surfaces of appropriate age (Basgall 1993, 2007; Delacorte 1999; Delacorte et al. 1995; Eerkens et al. 2007; Hall 1990).

Taken together, if shifts in land use and taphonomic processes produce a “gap” in the archaeological record, the frequencies of particular projectile points across landforms of different age may indicate where middle Holocene materials are buried and to what degree these factors influence inferences about human populations. The highly variable morphologies of pre-Newberry period projectile points require, however, that the points themselves be reassessed before their distributions are considered.

CHAPTER 3

PREHISTORIC CONTEXT

The Inyo-Mono region has a well-established culture history based on ethnographic and archaeological data. The region encompasses the southwestern portion of the Great Basin, from which Numic speaking people are believed to have spread across the Intermountain west. The most extensive ethnographic information was collected by Julian Steward in the 1930s (Steward 1930, 1933, 1938), with additional research conducted prior and subsequent to Steward (Coville 1892; Davis-King 2003, 2010; Driver 1937; Kerr 1980; Johnson 2009). The area has been subject to intensive archaeological study as well. Research between the 1940s and 1960s was geared toward understanding the basic chronology and extent of occupation. Early studies focused on documenting the structure and materials in prehistoric sites and investigating the land-use patterns of early occupants (Campbell 1949; Harrington 1957; Lanning 1963; Riddell 1951, 1958; Riddell and Riddell 1956). Numerous archaeological survey and excavation projects have been conducted in Owens Valley and surrounding areas since the early 1970s. These important research efforts have shaped the interpretation of regional prehistory (Basgall and Delacorte 2003, 2012; Basgall et al. 2003; Basgall and Giambastiani 1995; Basgall and McGuire 1988; Bettinger 1975, 1991; Bettinger and Baumhoff 1982, 1983; Delacorte 1990, 1991, 1999, 2001; Delacorte and McGuire 1993; Delacorte et al. 1995; Giambastiani 2004; Gilreath 1995; Hall 1990; Nelson 1999, 2001; Raven 1986; Wickstrom et al. 1993; Zeanah and Leigh 2002).

Previous Archaeological Research

Research over the past few decades is primarily the result of cultural resource management (CRM) studies related to highway and other public development projects. Much of this work focuses on prehistoric subsistence and settlement patterns and documentation of culture change. Prior to the inception of CRM, academic surveys and avocational collecting occurred throughout the region providing the building blocks for understanding regional prehistory. Systematic archaeological investigations within the region began in the late 1930s, 1940s, and 1950s. Important studies early on include Riddell's work at INY-2 (1951) and elsewhere in Owens Valley (Riddell 1958; Riddell and Riddell 1956), Meighan's (1953) excavations at Coville Rockshelter and his 1955 surveys in Mono County, and Harrington's (1957) efforts at the Stahl site near Little Lake. Work done by the Campbells (1935) at the Pinto Basin site in the Mojave Desert also had implications for Inyo-Mono prehistory. All of these efforts and additional ethnographic work (Davis 1963; Heizer 1966; Kelly 1964; Kroeber 1959) established a baseline for archaeology in the region.

Subsequent studies that helped refine regional chronology included Lanning's (1963) efforts at the Rose Spring site (lNY-372), Hunt's (1960) initial surveys in Death Valley, and Davis' (1964) survey and excavations in the Mono Basin and Panamint Valley (Davis 1970). Subsequent developments in the Inyo-Mono region and elsewhere were instrumental in the establishment of a projectile point chronology (Baumhoff and Byrne 1959; Clewlow 1967; Clewlow et al. 1970; O'Connell 1967; Bettinger and Taylor 1974), and the inception of obsidian hydration dating and chemical sourcing methods (Friedman and Smith 1960; Friedman et al. 1966; Jack and Heizer 1968; Stross et al. 1968).

The modern era of Inyo-Mono region archaeology arguably began with Bettinger's Owens Valley, and subsequent Long Valley surveys in the late 1970's. These efforts were directed at the development of site taxonomies and statistical analysis of regional survey data to reconstruct land-use patterns (Bettinger 1978, 1981, 1982). From this point on, the late 1970s and 1980s saw directed efforts involving obsidian source/hydration studies (Hall 1983; Hall and Jackson 1989; Singer and Erickson 1977), and small scale survey and excavation programs (Basgall 1984; Bettinger 1978, 1980; Bettinger et al. 1984b; Bouscaren 1985; Bouscaren et al. 1982; Burton 1986; Jackson 1985; Hall 1986; Wilke 1983).

Significant excavation projects began in the late 1980's with the initial investigations at the Lubkin Creek site (CA-INY-30) in southern Owens Valley (Basgall and McGuire 1988). This multi-component site contained numerous house structures that furnished valuable data on middle and late archaic lifeways, but particularly the late Newberry period (3500-1350 B.P.). Information from the Lubkin Creek site was likewise instrumental in the development of a workable obsidian hydration rate for the Coso geochemical source (Basgall 1990).

Bettinger (1989) excavated three site in the Owens Valley as an extension of the Owens Valley Project begun in 1971 to gather data useful in the development of models of prehistoric settlement and subsistence. The three site chosen were the best representative sites recorded during his initial survey and included a pinyon camp (Pinyon House) and two occupation sites (Two Eagles and Crater Middens). Data from these excavations supported Bettinger's initial observations of shifting land use from riverine to desert scrub over time and the late intensification of pinyon pine nuts coinciding with the diminished importance of large game.

The Alabama Gates project (Delacorte 1999; Delacorte et al. 1995) north of Lone Pine, CA along U.S. 395 was another multi-site excavation that produced one of the richest assemblages of early and middle Holocene material from Owens Valley. Numerous Pinto bifurcate-stemmed projectile points and material of comparable age were recovered, as were additional Newberry and Marana period (650 B.P. – European Contact) remains. This research helped to spur speculation that the regional dearth of middle Holocene archaeology was a product of sedimentation and sampling bias related to landform age. More to the point, the project lies east of the Alabama Hills which act as a barrier to alluvial deposition, preserving ancient land surfaces and a correspondingly early part of the archaeological record east of the hills.

Interest in the Volcanic Tableland was initially centered on the areas abundant rock art in the late 19th and early 20th century (Mallery 1886, 1893; Steward 1929, 1933). The most detailed treatment of the Tableland petroglyphs was conducted by Raven (1986), following early survey work by Meighan (1955) in the vicinity of Chidago Canyon. From the 1960's through the 1980's avocational archaeologists Rollin and Grace Enfield, and Norman Weller, conducted numerous surveys on the Volcanic Tableland, collecting artifact from over 150 sites.

Modern research on the Tableland began in 1987, when six sites were intensively excavated (Basgall and Giambastiani 1992, 1995). Results of this work provided valuable insights on the prehistoric use of the Tablelands environment and identified a new projectile point type, the Fish Slough Side-notched, the implications of which are discussed in Chapter IV. Giambastiani's (2004) dissertation research expanded on previous Tablelands work, conducting additional surveys and excavations. The author also incorporated material from the Enfield collection and was able to show a shift from use of the Fish Slough area early in time to increasing use of drier Tableland areas late in time.

To the south, the Blackrock (Zeanah and Leigh 2002) and Independence-Manzanar projects (Basgall and Delacorte 2003, 2011) investigated numerous sites in central Owens Valley. Data from 26 sites along the U.S. 395 Blackrock project corridor provided important information on the use of Fish Springs obsidian, intensive exploitation of which was confined primarily to the latter part of the sequence. Newberry period mobility patterns were also investigated and found to resemble those identified at the Lubkin Creek site (Basgall and McGuire 1988), not as a sedentary pattern as others have suggested (King et al. 2001).

The Independence-Manzanar project provided substantial data relating to the latter part of the Holocene. This included abundant Haiwee period (1350-650 B.P.) material, including a house floor, and even more Marana age and traces of late Newberry period occupation. As before, use of Fish Springs obsidian was restricted to largely later times, given it presumably interior quality and avoidance during the Newberry period. Data from the project also point to a shift from band-like to household social organization following the period, as other had argued before (Delacorte 1990, 1999).

A final project of note was the Ed Powers data recovery investigation, particularly work at the Birch Creek site (CA-INY-1384/H [Basgall and Delacorte 2012]). As at the Lubkin Creek site (CA-INY-30), excavations at this northern Owens Valley site uncovered thirteen late Newberry and one Marana period house floor. Analysis of these remains supported earlier reconstructions of Newberry period settlement-subsistence patterns as geographically wide-ranging, logistically organized systems. Implications for the transition to the bow and arrow were also provided by two house structures, dating to the Newberry/Haiwee temporal boundary, which contained projectile points consistent with both dart and arrow forms. The following section elaborates on the culture history of the Inyo-Mono region, as reconstructed on the basis of the foregoing and other works in the region.

Culture History

Current nomenclature for the temporal periods employed in this study was initially proposed by Bettinger and Taylor (1974), and later modified by subsequent research (Basgall 2006; Bettinger 1989; Delacorte 1999). The definitions employed here are as follows: Late Pleistocene-Early Holocene (pre-7500 B.P.), Pinto Period (7500-3500 B.P.), Early Newberry (3500-2000 B.P.), Late Newberry (2000-1350 B.P.), Haiwee (1350-650 B.P.), Marana (650 B.P.- European contact ~ A.D. 1850), Ethnographic Period (A.D. 1850-present).

Late Pleistocene - Early Holocene (pre-7500 B.P.)

This period is represented by only a few sites and isolated artifacts scattered throughout the region. These are typically marked by the presence of various fluted and non-fluted, often-edge ground, basally-thinned concave-base projectile points that have been roughly dated between 9000 and 10,000 B.P. on the basis of obsidian hydration. In addition to these are more numerous General Stemmed forms reported from various localities. These include short General Stemmed, often square shouldered “Silver Lake” and long General Stemmed, often weakly shouldered “Lake Mohave” forms (Basgall and McGuire 1988; Borden 1971; Campbell 1949; Davis 1963; Hall 1990; Harrington 1957; Jackson 1985; Jurich et al. 2001; Meighan 1981). Both of the types fall under the broader Great Basin Stemmed series and resemble various forms defined under the Western General Stemmed tradition by Bryan (1980). Points of these styles typically occur with highly formalized flake tools and specialized crescents, the function of which remains unclear.

Studies suggest that early Holocene populations were small, had large ranges, and exploited a diverse range of resources. Site distributions for the period are highly uneven across the region, with places like China Lake containing large accumulations of material (Basgall 2007; see also Basgall 2003, 2004; Davis and Panlaqui 1978), and areas to the north generally fewer sites around ancient lake margins (i.e., Owen Lake), riverine/wetland habitats (Basgall and Giambastiani 1995; Delacorte 1999; Larson 2009), and occasionally upland areas (Basgall 1989; Hall l990; Jurich et al. 2000).

Tool stone diversity at the early sites indicate a pattern of high mobility and a tool kit geared toward a generalized subsistence strategy (Delacorte et al. 1995). Work in the Mojave Desert suggests similarly diverse flaked stone assemblages and comparable mobility patterns (Basgall 1990, 1991, 1993; Douglas et al. 1988; Hall 1992; Warren et al. 1986). Thus, all of the data appear consistent with small groups ranging over large areas, who stopped only briefly at sites, leaving typically sparse accumulations. The diet appears to have been similarly eclectic, including both large and small animals, as opposed to a focus on large game or strictly lacustrine resources. The near lack of ground stone milling tools during this period suggests, however, that plant resources were minimally used in any regular or intensive fashion.

Pinto Period (7500-3500 B.P.)

This Pinto period is represented by the presence of bifurcate-stem projectile points. These include both robust Pinto forms and in some contexts more gracile Gatecliff Split-stem points. The former are of substantially greater antiquity (ca. 8000-4000 B.P.) and found throughout the Mojave Desert and the American southwest, while Gatecliff points are confined to northern portions of the region in primarily Nevada and date to 5500 B.P. and later (Basgall and Hall 2000; Thomas 1981; see Chapter 4). In addition to these are apparently other, less understood point forms dating to this period. These include Fish Slough Side-notched (Basgall et al. 1995) and large robust corner-notched points referred to by some researchers as “thick” Elkos (Gilreath and Hildebrandt 1997). Points of these type and deposits dated to the middle Holocene interval have been documented in both surface and subsurface contexts within the region (e.g., Basgall and McGuire 1988; Delacorte et al. 1995; Jackson 1985). The occurrence of Fish Slough Side-notched points has been linked to exploitation of wetland environments including the Fish Slough locality on the Volcanic Tableland (Basgall and Giambastiani 1992, 1995) and Deep Springs Lake margin (Delacorte 1990) and temporally associated with keeled unifaces in both of these places (Giambastiani et al. 2001).

Aside from the projectile points, assemblages of the Pinto period are similar to the early Holocene, containing numerous formed flake tools. There is an increase, however, in specialized cores and more significantly abundant ground stone milling gear, indicating a greater reliance on plant resources (Basgall and Hal1 1993, 1994; Bouey and Mikkelsen 1989; Delacorte 1999; Delacorte et al. 1995; Hall 1993). Apart from an increase in plant processing, middle Holocene diets appear little changed from those before, making use of both large and small animals (Delacorte et al. 1995). The shift toward increased plant use may be attributed to the apparent warming and drying reported throughout the Great Basin between 8000 and 4000 B.P. (Antevs 1948), which may have effected certain habitats, leading to a wider diet breadth that included low return resources such as seeds (Grayson 1993; also see Warren 1980, 1984).

Unlike earlier sites, some Pinto period accumulations in especially the southern part of the region and Mojave Desert appear to have been substantial residential hubs (Harrington 1957), although the presence of house structures reported at the Stahl site is questionable. Substantial Pinto components have been documented throughout the Mojave Desert at Fort Irwin (Basgall and Hall 1993, 1994; Hall 1993; Jenkins 1987; Jenkins et al. 1984; Laylander and Victorino 2001), Sillurian Valley (Byrd 1998), and Twentynine Palms (Basgall and Giambastiani 2000, Basgall et al. 2003).

Toolstone diversity remains high during this period, connoting continued residential mobility with the dearth of archaeological remains believed by some to signal reduced or limited populations (Elston 1982; Grayson 1993; Kennett et al. 2007). But as mentioned, a more likely scenario is that most Pinto age deposits have been covered or destroyed by alluvial deposition (Basgall 2009). This is supported by the limited occurrence of middle Holocene age landforms that survive in the Inyo-Mono region (Meyer et al. 2010; Meyer and Rosenthal 2010).

Newberry Period (3500-1350 B.P.)

The Newberry period was originally defined as a single cultural period, but more recent research (i.e., Basgall and Delacorte 2012; Basgall and Giambastiani 1992, 1995; Delacorte 1999; Giambastiani 2004; King et al. 2001; Zeanah and Leigh 2002) suggests that the first half of this interval is again, poorly represented and may have more closely resembled the Pinto period than the lifeway characterizing the latter half of the Newberry period. An increase in corner notched Elko series and Humboldt dart points distinguish the Newberry period, the initial (3500-2000 B.P.) part of which saw the continuation of small groups ranging over large territories. As the period progressed it appears that a greater range of resources was exploited and foraging rounds became more regularized. The inception of intensive biface manufacture at major obsidian quarries also developed during this time (e.g., Gilreath and Hildebrandt 1997; Hall 1983; Singer and Ericson 1977) in support of the more regularized settlement pattern.

The Late Newberry period (ca. 2000-1350 B.P.) was an apparent turning point and saw the emergence of even more regularized adaptive strategy that focused on seasonal exploitation of the Owens Valley and adjacent areas (Basgall and Delacorte 2012; Basgall and McGuire 1988; Bettinger 1989, 1991; Delacorte 1990, 1991; Delacorte and McGuire 1993; Delacorte et al. 1995). Projectile points from this time period include the Elko series (corner notched, eared, side-notched and contracting stem), Humboldt series (concave base and basal notched), and Gypsum contracting stem projectile points in areas to the south. Numerous deposits dating to this interval have been excavated, including some in the last decade (Basgall and Delacorte 2012; Basgall and Giambastiani 1995; Basgall and McGuire 1988; Bettinger 1989; Clay and Hall 1988; Delacorte et al. 1995; Gilreath and Nelson 1999; Hall 1990, 1992; Jones & Stokes 2009; Wickstrom et al. 1993; Zeanah and Leigh 2002).

The location and artifact composition of Late Newberry sites suggests they served a variety of functions as temporary camps, residential hubs, and ephemeral hunting and gathering stations. The regularized pattern of settlement is supported by the existence of well-built house structures. The size of which implies dwellings for perhaps extended rather than conjugal families (Basgall and Delacorte 2012; Basgall and McGuire 1988). The existence of such houses and patterned movement of obsidian indicates seasonal migration of groups up and down the Owens Valley and beyond with logistical forays made into Long Valley and the White Mountains to the east. An alternative view holds that Late Newberry period settlement patterns reflect a more sedentary, centralized “village” adaptation (Eerkens et al. 2008; Hildebrandt and King 2002, King et al. 2001), but recent data make this increasingly unlikely (Basgall and Delacorte 2012; Zeanah and Leigh 2002). With increasingly patterned mobility and settlement came apparently intensified resource procurement, much of which was logistically organized, allowing for embedded procurement of obsidian from sources throughout the region.

Haiwee Period (1350-650 B.P.)

The Haiwee period is characterized by many of the trends that began in the Late Newberry period. Increasing settlement patterning, subsistence intensification, and socio-cultural complexity have been assumed to persist. The Haiwee period is marked by the appearance of Rose Spring and Eastgate series projectile points used with the bow and arrow. Reorganization of groups from extended family or band-like to nuclear or conjugal families has been proposed as a result of the introduction of the bow and arrow and privatization of resources during this interval (Bettinger 2015). The Humboldt Basal-notched form appears to persist into the early Haiwee period as a hafted biface not a true projectile point (Bettinger 1978; Garfinkel and Yohe 2002). This artifact type is among the most ubiquitous throughout the Owens Valley and adjacent areas, but was replaced in the later Haiwee period by expedient flake tools instead of the formalized bifaces of Newberry times. Haiwee period ground stone is also less formalized, and less frequently cached than that of the preceding Newberry period, signaling a likely less mobile settlement pattern. In other respects, Haiwee period deposits are represented by numerous sites (Basgall and Delacorte 2003; Byrd and Hale 2003; Delacorte and McGuire 1993; Lanning 1963; Yohe 1992), but many of these occur in markedly different settings than earlier Newberry and subsequent Marana period deposits.

Marana Period (650 B.P. - European contact ~ A.D. 1850)

This period is characterized by still further resource intensification and demonstrably nuclear household structure. Technological shifts include the introduction of the Desert Side-notched and Cottonwood series projectile points, along with the appearance of Owens Valley Brownware pottery. These materials have been attributed to the spread of Numic speaking peoples around 1000 years ago from a purported homeland centered on the Inyo-Mono (Bettinger and Baumhoff 1982, 1983; Delacorte 2008; Lamb 1958). Marine shell beads were brought to the eastern Sierra in increasing quantities during this interval and locally produced steatite beads introduced (Delacorte and Basgall 2012). Marana period components are abundant and widely distributed throughout the region, with numerous house structures excavated in the Owens Valley and the adjacent uplands (Basgall and Delacorte 2011, 2012; Basgall and McGuire 1988; Bettinger 1991; Delacorte 1995). The subsequent protohistoric interval saw the abandonment of alpine settlements that had been used during the Haiwee and Marana periods (Bettinger 1991; Delacorte 1990), and eventual marginalization of native lifeways shortly after Euroamerican settlement in the mid-1800s. Emphasis on the nuclear family and household economy gave way to seemingly more communal settlement on the outskirts of European towns and ranches people and the augmentation of traditional foraging practices by wage labor observed by Steward (1933, 1938, 1970).

Ethnographic Period (A.D. 1850 – Present)

At the time of European contact, Owens Valley was occupied by Mono-speaking

Owens Valley Paiute (Heizer 1966; Steward 1933, 1938). Population estimates placed the native inhabitants at around 1000 individuals (Steward 1933, 1938) an estimate that was later increased to nearly 2000 souls (Wilke and Lawton 1976). Julian Steward was the primary ethnographer to record the traditional lifeway, chronicling various economic tasks and other activities, many of which persisted into the early 20th century.

Flaked and especially ground stone implements persisted in some capacity into the historic interval, though introduction of metal, glass and firearms replaced many traditional tools (Delacorte and McGuire 1993). As nearly as can be reconstructed, protohistoric subsistence relied primarily on plant foods and only secondarily on meat (Bettinger 1999, 2009; Steward 1938, 1955). Large game included antelope, mountain sheep, and deer, which were both individually and communally hunted. Small mammals were more abundant, and jackrabbits of particular importance for both food and a source of skins to make blankets when taken in large numbers by means of communal rabbit drives (Lowie 1939; Wheat 1967). Intensive use of plant resources such as various seeds and pinyon pine nuts was ubiquitous throughout the region and evidence of limited irrigation noted in Owens Valley specifically (Downs 1966; Lawton et al. 1976; Steward 1930, 1955).

The semi-sedentary, district organization of Owens Valley differed from other Paiute groups, where the family band was the highest level of socio-political organization (Steward 1955). Households were often isolated for much of the year as they foraged for resources, although groups of often affinally-related families frequently wintered together (Bettinger 1982; Delacorte 1990; Steward 1938, 1970). Leaders were chosen, as needed, for communal animal drives and festivals, but their position was temporary, unlike Owens Valley headmen.

Reorganization of Owens Valley populations into aggregated "villages" is likely related to the effects of Anglo settlement in the area (Cook 1943; Delacorte and Basgall 2004; Fowler 1989, 1992; Service 1962; Wall 2009). When mining, ranching and a U.S. military presence contributed to violent conflicts between native inhabitants and white settlers (Chalfant 1933; Lawton et al. 1976; Wilke and Lawton 1976). By 1866, peace had been restored, and industries such as mining and ranching were flourishing, prompting the need for wage labor. An influx of people from adjacent regions was driven by these labor opportunities, with the appearance of "villages" likely related to labor induced aggregations situated near farms, ranches and towns (DeDecker 1973; Steward 1970; Walker 2014; Wall 2009; cf. Wells 1983). Taken together, historic and archaeological evidence suggest the prior to the 1860s the Owens Valley Paiute may have looked much different than what Steward described in the early 20th century (cf. Steward 1970). This highlights the potential shortcomings when ethnographic information in conflated with the archaeological record (Ascher 1961; Binford 1979, 1980; Lyman and O'Brien 2001).

There is limited reference to exploitation and habitation of the Volcanic Tableland during the ethnographic period, although Steward (1933) notes that the Bishop Paiute ricegrass, and other seeds in an area extending approximately seven miles west and five miles north of Fish Slough. Additional seed and root gathering areas occurred near Fish Slough and a native cemetery was mapped to the south (Steward 1933). Neighboring groups from Round, Chalfant, Hamil, and Long valleys may have also used the Volcanic

Tablelands, although Steward's accounts are mute on the subject.

The northern periphery of the Mojave Desert, specifically the Coso region was inhabited by the Panamint Shoshone (Coville 1892; Dutcher 1893; Grosscup 1977; Kelly and Fowler 1986; Nelson 1891; Steward 1937, 1938), with village sites reported near Little Lake, Coso Hot Springs, Cold Spring and as far north as Olancha and as far west as Walker pass (Grosscup 1977; Steward 1938).

The Panamint Shoshone were generalized foragers, who spent winters at villages on the valley floor next to streams along the eastern scarp of the Sierra Nevada (Steward 1938). Residence in winter villages was in pit houses, where subsistence relied on stored seeds and nuts, supplemented by rabbits. In spring some families moved to Haiwee Spring to gather greens and later moved to Cold Spring to hunt rabbits, while other families gathered for communal antelope drives. Antelope drives were held at Brown (near the modern town of Inyokern), at the southern end of Owens Lake, at the north end of Saline Valley, creating opportunities for cooperation with neighboring Tubatulabal and other groups. Important supplements to the largely vegetal diet were provided by hunting of bighorn sheep in the Coso range, deer and bighorn in the Sierra Nevada, and fishing in the Owens River and Little Lake (Steward 1938).

CHAPTER 4

RESEARCH ISSUES

The Inyo-Mono region's chronology is one of the best substantiated in the Great Basin, but must be refined if middle Holocene lifeways are to be understood. Sites and components dating to the period between 8000 B.P. and 2000 B.P. are rare in comparison to early and late Holocene deposits (Basgall 2009; Delacorte 1999; Delacorte et al. 1995). The most longstanding approach for constructing the chronological sequence has depended upon time-sensitive projectile points. By examining the spatial and temporal distribution of various point types from landforms of different age, certain gaps in the sequence can be hopefully filled. The research issues considered relate to variability in dart point forms, their distributions and their age.

Variability in Dart Points

Initial attempts to classify projectile points in the western Great Basin were largely intuitive (e.g., Amsden 1937; Campbell and Campbell 1935; Harrington 1957, Heizer and Baumhoff 1961). Today, many researchers rely on their knowledge of local projectile point forms to sort them on the basis of consistent morphological attributes. Nevertheless, many intuitive point classifications encounter difficulties, given their lack of quantitative metric attributes. From the 1980s onward, most Inyo-Mono region projectile points have been analyzed/measured following David Hurst Thomas' approach developed for Monitor Valley, Nevada (Thomas 1978, 1981). Point typing, however, still remains a largely intuitive endeavor, based on the experience of observers. Using a set of predetermined attributes measured directly from points, Thomas grouped various point forms into a replicable taxonomy. His approach has been extrapolated and reproduced throughout much of the western Great Basin. While the Monitor Valley typology is a useful tool for segregating points in the Central Great basin, it is of little utility in the Inyo-Mono region, where point morphologies differ and several disparate types are also found. The following discussion highlights the difference between the Monitor Valley typology and eastern Sierra projectile points, as well as issues pertaining to the spatial and temporal distribution of certain points.

The Pinto Problem

When the Pinto point type was first defined at the Pinto Basin site (RIV-521), Amsden (1935:44) provided only a vague description of the points and little detail regarding their variability, making his classification of limited use:

> "[Pinto points] vary somewhat in detail of form, but through them all one sees the intent... to produce a projectile point with a definite although narrow shoulder and usually an incurving base… The points are thickish, well rounded on each face, as if made from a thick flake…"

Another attempt at classification was made by Rogers (1939:54). His efforts produced more refined morphological categories, wherein different variations were defined:

> "Type 1 has a concave base and sometimes a faintly shouldered effect… Type 2 is broad General Stemmed with weakly developed shoulders… Type 3 has both the base as well as the sides notched… Type 4 points have straight bases and are Side-notched [sic]… Type 5 is a small, slender, leaf-shaped point…"

The most frequently cited classification of the time period is Harrington's (1957) description of the Stahl Site (INY-182) material near Little Lake at the southern end of

Rose Valley. Harrington defines five distinct subtypes of Pinto points including shoulderless, sloping shoulders, square shoulders, barbed shoulders, and single shoulder (Harrington 1957:50-53). All of the aforementioned researchers noted that Pinto points are crudely flaked, resulting in points with typically thick cross sections.

More confusion arose as Lanning (1963) reexamined materials from the Rose Spring site (INY-372) and concluded that the leaf-shaped Pinto points from there were significantly similar to the Stahl site that all could be re-categorized under the term “Little Lake.” Bettinger and Taylor (1974:13) argued against this idea claiming that Little Lake points are “…significantly different in that the Pinto points are thick and percussion flaked, whereas the points of the Little Lake series are long and thin and exhibit extensive pressure flaking as the finishing manufacturing technique.” They suggested that the Pinto designation be reserved for points occurring in the Colorado and Mojave deserts, in keeping with prior researchers who noted the morphological differences between Great Basin and Mojave Pinto points (Layton 1970; O'Connell 1971).

Researchers in other parts of the Great Basin have further confused the matter by proposing numerous names for outwardly similar bifurcate-stem points. Layton (1970) discerned significant morphological differences between the Pinto Basin and Little Lake points, and focused on the geographically widespread range of the series. He believed there was greater affinity between the split-stem points at Silent Snake Springs in northern Nevada than the points found at the Stahl site and coined the term Silent Snake Bifurcate-stem for his projectiles. These had barbed shoulders, a slightly expanding or straight stem, and a basal indentation up to 3.5 mm. Other bifurcate-stem points in Layton’s study area were classified as Bare Creek Eared (O'Connell and Ambro 1968), and differed from Layton's Silent Snake Springs points in their variable shoulder configurations and basal indentation up to 8 mm. Unfortunately, neither of these northern Great Basin categorizations describe the variability in bifurcate-stem points from the Inyo-Mono region, with the northern examples resembling, if anything, the Gatecliff series points defined by Thomas (1981) for central Nevada.

In 1987, Sheila Vaughan and Claude Warren explored the Pinto problem in greater detail. They attempted to categorize Pinto points technologically, stylistically, and morphologically by examining the attributes of 22 Pinto points found at the Awl Site (SBR-4562) in the Mojave Desert, and contrasting them to bifurcate stem points from the central Great Basin. Following Thomas (1981), Vaughn and Warren classified their Pinto points on the basis of metric data (Figure 4.1). Given the small sample size, however, their recognition of six discrete types may be questionable.

Schroth (1994) compared Pinto points from both the Pinto Basin and Stahl sites to determine if they were significantly different. Her statistical t-tests results revealed that only three measurements (thickness, distance to the maximum width from the base, and the ratio of the distance of the maximum width from the base divided by the maximum length) were shared between the two populations. Schroth nevertheless concluded that the two groups of points belonged to the same type on the basis of experimental point manufacturing efforts advocated by Flenniken (1985; Flenniken and Raymond 1986; Flenniken and Wilke 1989). More specifically, Schroth argued that the Pinto points from both sites represented discarded pieces of no further use for hunting and that Pinto points are of no use as time-markers because they persist throughout much of the Holocene. Basgall and Hall (2000) determined that Mojave Desert Pinto points and “little Lake” points are of the same morphology. In fact, the only difference between the points relates to their robustness. This is easily explained by the differences in toolstone material, with most of Inyo-Mono points made of easily worked obsidian and correspondingly thin and most of the Mojave Desert points of less-tractable stone and correspondingly thick. Thus, Basgall and Hall suggest that the term “Little Lake” be abandoned as a distinct point type. Another issue, addressed by Basgall and Hall (2000) was the temporal placement of various bifurcate-stem points. They demonstrated that Gatecliff Split-stem, Pinto, and Elko Eared points are all statistically distinguishable. Elko Eared points are well dated in the Great Basin, although their morphology overlaps that of Pinto points. As such, Basgall and Hall developed metric parameters and a discriminant function to differentiate Elko from Pinto points.

Elko series = BW > 10.0 mm.; 110° < PSA < 150°, or NOA < 80°
Pinto series = BW > 10.0 mm.; PSA < 100°, or NOA > 80°
Type = (SL x 0.1817) + (NOA x 0.0347) - (BW x 0.0941) - 3.6756
(< -1.0 = Elko assignment, > -1.0 = Pinto assignment)

By employing radiocarbon dates and obsidian hydration measurements, they further demonstrated that Gatecliff Split-stem points are significantly younger than the Pinto form, placing the former between ca. 5000 and 3000 B.P. and the latter between 8000 and 4000 B.P.

The Key

1.	Point is unshouldered	out of key
1a.	Point is shouldered	(2)
2.	Point is side-notched	out of key
2a.	Point is stemmed	(3)
3.	Point is small. Neck width $<$ 10.00 mm.	out of key
3a.	Point has neck width $>$ 10.00 mm.	(4)
4.	Point has basal width $<$ 10.00 mm. . . .	out of key
4a.	Point has basal width $\geq$ 10.00 mm.	(5)
5.	Point has BIR $\geq$ 0.98.	out of key
5a.	Point has BIR $<$ 0.98.	(6)
6.	Point has thickness $<$ 6.4 mm.	Elko and Gatecliff series
6a.	Point has thickness $\geq$ 6.4 mm. and WSh $<$ 12.75 mm.	go to 7
6b.	Point has thickness $\leq$ 7.4 mm. and WSh $>$ 12.75 mm.	Elko and Gatecliff series
7.	Point has WSh/MWSh Index $<$ 15 . . .	Group Ic
7a.	Point has WSh/MWSh Index $>$ 15 and $<$ 30	go to 8
7b.	Point has WSh/MWSh Index $>$ 30	go to 9
8.	Point has PSA $\leq$ 100°.	Group IIx
8a.	Point has PSA $>$ 100° and $<$ 110°	Group III
8b.	Point has PSA $\geq$ 110°.	Group Ib
9.	Point has PSA $\leq$ 100°.	Group IIa
9a.	Point has PSA $>$ 100°.	Group Ia

Figure 4.1. Pinto Type key from Vaughan and Warren (1987).

The Pinto problem persists, insofar as various researchers continue to employ different data and have disparate views. What is apparent is that Pinto points are distinct from other bifurcate-stem variants in other parts of the Great Basin. Variability in Pinto forms from the Mojave Desert and Inyo-Mono regions needs to be better resolved through statistical analysis of their morphological overlap and differences. Use of the term “Little Lake” persists in the literature, but given adequate analysis and the benefit of obsidian hydration data, the observations of Basgall and Hall (2000) can probably be confirmed and expanded upon. Metric variability within the Pinto type should, for example, be less pronounced than that between Pinto and other bifurcate-stem types (i.e., Gatecliff), which appear of almost certainly different antiquity.

Another issue that has yet to be clarified is the spatial overlap between different bifurcate-stem points. In the Inyo-Mono region, distributional data on Pinto and Gatecliff points may help to identify their geographical limits. Both types have been identified in the current study sample, with Gatecliff forms of seemingly northern, and Pinto styles seemingly southern distribution, but that has yet to be confirmed.

Thin versus Thick Elko Points

Elko points are the most ubiquitous dart-point type in the Great Basin (Heizer and Baumhoff 1961; Heizer and Clewlow 1968; Heizer and Hester 1978; Holmer 1986; Thomas 1981). Type descriptions for the Elko series have been historically refined and improved as new data are developed, with one of the more recent revelations being the separation of large corner-notched from more gracile Elko forms (Gilreath and Hildebrandt

1997). Of particular significance in this regard is evidence that larger corner-notched points tend to be of appreciably greater age than standard Elko points and may overlap the use of Pinto points. One of the more problematic aspects of this pattern is that all of the thick corner-notched points in Gilreath and Hildebrandt’s (1997) sample are fashioned of Coso obsidian. At the time, sub-source variability in the hydration of Coso obsidian was poorly understood, such that differences in hydration measurements between thick and thin points may have been overestimated (Rogers 2008a, 2008b). Thus, the observed pattern that points of greater than 6.5 mm thickness have, on average, larger hydration readings than thinner variants (12.3µ versus 7.4µ), will need to be confirmed when Coso sub-source differences are taken into account and similar patterns identified for other obsidian sources. If an age difference remains, the definition of the Elko type will clearly need to be revised to reflect the fact that not all large corner-notched points are of the Elko series.

Fish Slough Side-notched

Recent research (Basgall et al. 1995; Basgall and Giambastiani 1995; Giambastiani 2004) has added a new point style to the Inyo-Mono chronology. Fish Slough Side-notched points were first identified on the Volcanic Tableland and named after the type location at Fish Slough. For decades, points of Fish Slough morphology were typically classified as Elko or large side-notched (Delacorte 1990). The most distinctive feature of Fish Slough points is their convex or “rocker” base and broad side notches placed low on the margin. The reason for distinguishing Fish Slough from Elko points is that the Fish Slough form is significantly older being of evidently early-middle Holocene age, overlapping Pinto points.

Two issues need to be resolved with respect to Fish Slough points. First, is to identify erroneously classified Fish Slough points in existing collections and second, is to assemble a larger sample of specimens from different contexts. To date, Fish Slough points have been identified from primarily two places: The Volcanic Tableland (Basgall and Giambastiani 1995; Giambastiani 2004) and Deep Springs Valley (Delacorte 1992). To ascertain whether these occurrences reflect a specialized land-use, sampling, or other pattern, the regional distribution of Fish Slough points needs to be better understood. In order to accomplish this, existing collections will need to be examined for Fish Slough points and their age and associated material determined.

Unshouldered Points

Unshouldered indented-base points within the Inyo-Mono region are usually classified as "Humboldt" save a handful of older Paleoindian artifacts of lanceolate shape with basal thinning. The Humboldt series is divided into two sub-categories, Humboldt Basal-notched and Humboldt Concave-base. The Humboldt series was initially identified by Heizer and Clewlow (1968) at the Humboldt Lakebed Site, (NV-Ch-15). Subsequent studies split the concave base variant into two sub-types, Humboldt Concave-base "A" and Concave-base "B" (Holmer 1978; Roust and Clewlow 1968). These are distinguished by their size, with Concave-base "A" being longer/larger than "B", and the former thought to be older. Humboldt Concave-base points are dated from roughly 6000 to 2200 B.P. (Hester 1973; Warren and Crabtree 1986) in the central and southern Great Basin and from 5000-3000 B.P. in the northwestern Great Basin where they are associated with Gatecliff Split-stem points of similar obsidian hydration age (Clewlow 1967; Delacorte et al. 1995; Layton and Thomas 1979). In the Inyo-Mono region, stratigraphic evidence and obsidian hydration measurements suggest that Humboldt Concave-base points overlap the terminal use of Pinto and initial development of Elko points ca. 4000 to 1350 B.P. (Basgall and McGuire 1988; Delacorte 1999; Delacorte and McGuire 1993; Gilreath and Hildebrandt 1997; Hall 1983; Hall and Jackson 1989; Jackson 1985).

The Humboldt Basal-notched form is a younger, probably hafted, biface that persists well beyond the dart/arrow transition at ca. 1500 to 1350 B.P. (Bettinger 1978; Bettinger et al. 1991; Yohe 1998). In fact, some researchers have posited that the basal-notched variant was of dual purpose over time, switching from an early dart point to a hafted knife later in the sequence (Garfinkel and Yohe 2002).

Another issue with the Humboldt series is its morphological similarity to certain Pinto points. Both are indented base points, where ephemeral shouldering on some reworked Pinto specimens can create confusion. Both Amsden (1935) and Harrington (1957) identified a shoulderless Pinto variant that might be confused with the Humboldt series, although improvements in obsidian hydration and other dating techniques generally allow one to distinguish between them today. In the present study, shoulderless specimens are treated as Humboldt and ephemerally or prominently shouldered pieces as Pinto points.

Other Stemmed Forms

A final, problematical group of points are large stemmed pieces of varying morphology that do not conform to any established type. As long as their number is limited, “sports” of this sort present little problem, but if sufficiently large numbers are encountered their morphological and temporal parameters with respect to existing types needs to be explored. By assembling metric data on unique or unusual large stemmed points, their attributes can be compared to determine if previously unrecognized point types are represented. If so, their temporal placement will need to be assessed on the basis of obsidian hydration and other evidence.

Middle Holocene Gap

The middle Holocene interval is the archaeologically most underrepresented period in the Inyo-Mono region. Between 7500 and 3000 B.P., there are surprisingly few, usually sparse accumulations of material. This perceived “gap” in occupation has been interpreted by various Great Basin researchers to signal limited or reduced population densities that some have attributed to climatic deterioration associated with the Altithermal (e.g., Elston 1982; Grayson 1993). But, some deposits do exist and some appear quite substantial (e.g., Harrington 1957).

Reconstruction of middle Holocene land-use patterns may shed light on the ephemeral nature of the record. As currently perceived, middle Holocene settlement-subsistence patterns were characterized by a highly expansive and fluid, adaptation exploiting a wide range of high-quality resources in a non-intensive fashion (Delacorte 1999; Delacorte et al. 1995). Groups occupying the area were opportunistic foragers with no regularized settlement pattern and a corresponding generalized and flexible toolkit. These patterns indicate that groups were adapted to changing conditions and moved frequently as need required. Population densities were likely low, but more importantly, the occupational signature left behind was typically sparse in nature. Given these patterns, one would expect to see material widely deposited across the landscape, albeit in limited quantities, although the record is mute on this point.

Another likely contributing factor for the scarcity of middle Holocene archaeology is that alluvial sedimentation has destroyed or covered most Pinto age sites (Basgall 2009). Few surface landforms in the Inyo-Mono region date to this interval (Meyer et al. 2010; Meyer and Rosenthal 2010), such that sites from this period are difficult to find. This geomorphological bias is exacerbated by the fact that much of the archaeological work in the region has been conducted on younger, late Holocene land surfaces along U.S. 395. In fact, a recent survey on older land surfaces east of the Owens River encountered dense accumulations of Pinto age material (Basgall 2015, personal communication). Large portions of the Inyo-Mono region remain likewise unsurveyed, including many places with older land surfaces. Thus, by considering the proportion of projectile points and other artifacts in relation to landform age a more accurate assessment of occupational intensity over time can be developed (Meyer and Rosenthal 2010).

CHAPTER 5

METHODS

The current study is a multi-faceted effort with the intent to examine morphological, spatial, and temporal aspects of various prehistoric dart points. To accomplish this, multiple projectile point attributes were collected from numerous archaeological specimens. Data collection was accomplished in three phases. First, point attribute, site provenience, and obsidian source and hydration data were compiled from available published and unpublished sources. Second, projectile points from the Harry S. Riddell Jr. Owens Valley collection, housed at the Phoebe A. Hearst Museum in Berkeley California, were examined and measured using the same metric attributes (Figure 5.1). Finally, metric attributes were generated for a sample of dart points in the Rollin and Grace Enfield collection, on loan to California State University, Sacramento, from the U.S. Forest Service and Bureau of Land Management.

The point measurements were then subjected to statistical analysis in order to group specimens on the basis of similarity. Specimens from the Enfield collection were subject to visual obsidian sourcing and limited obsidian hydration studies. These data were then added to the previously published dataset. The spatial distribution of different point types was determined using GIS software and subsequent analysis of the data conducted by geographic sub-regions. Lastly, point distributions were compared on the basis of frequency on landforms of differing age.

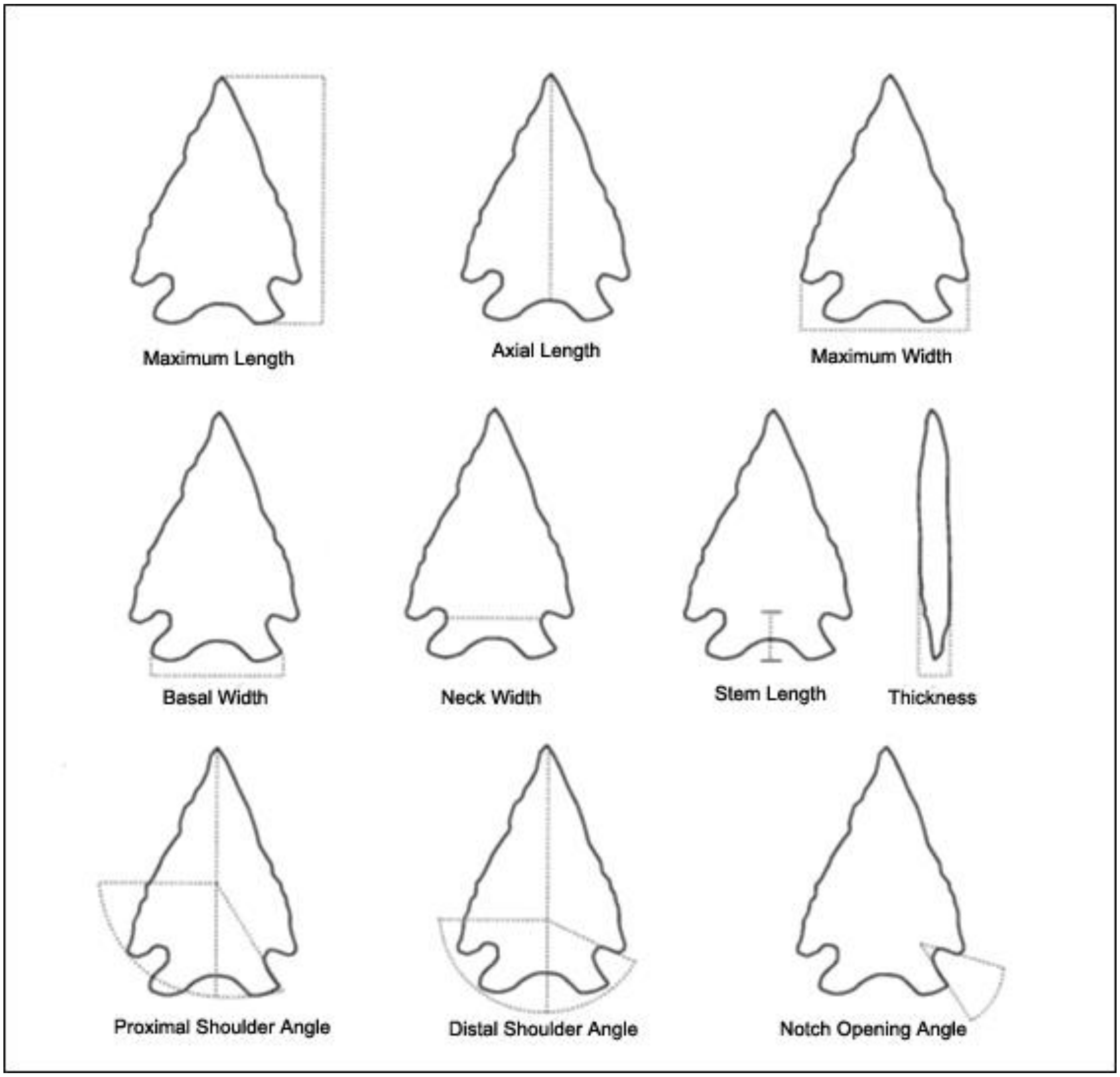


Figure 5.1. Projectile point attributes (from Norton 2009).

Existing Data

The current state of archaeology in the Inyo-Mono region reflects the work of numerous contract-based and academic research projects. Since the implementation of contract archaeology in the 1970s, multiple cultural resource management (CRM) reports have been generated under the auspices of policies and laws protecting cultural resources.

Other studies have been conducted through the lens of academia, tackling a range of archaeological issues. As a primary step toward the research presented here, metric attributes, obsidian hydration, and provenience data on dart points from 38 primary sources were compiled into a single Microsoft Access database (Table 5.1).

Harry S. Riddell Jr. Collection

The Harry S. Riddell Jr. collection is housed at the Phoebe A. Hearst Museum of Anthropology at the University of California, Berkeley. As part of the University of California Archaeological Survey, Riddell collected material from Inyo and Mono counties in the early 1950s. In all, nearly 3000 catalog entries exist from the Inyo-Mono region. The actual number of items is appreciably higher, however, as some tools classes were accessioned in lots. Items in the collection are as varied as they are numerous, including flaked stone implements such as projectile points, bifaces, scrapers, and debitage, pottery, and limited quantities of ground stone.

Inasmuch as dart points are the focus of this study, only they were systematically examined. A total of 381 dart points was examined from 95 different sites. Analysis of the points consisted of drawing the outline of each on a card and measuring the aforementioned attributes (see Figure 5.1) with the data then entered into the Microsoft Access Database.

Rollin and Grace Enfield Collection

The Enfields collected material from numerous archaeological sites in northern Inyo and southern Mono counties between 1960 and 1993. As avocational collectors,

Table 5.1. Projectile Point Data Sources.

	ELKO SERIES					HUMBOLDT SERIES			SPLIT STEM			GBS									
	CN	EE	CS	SN	UN	BN	CB	UN	GC	PN	LL	LM	SL	UN	FSSN	LCN	LSN	WSTM	STM	UNT	TOTAL
NOTHERN MONO COUNTY																					
BIELING 1992	4	5	-	-	4	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	22
HALFORD 1998	3	9	6	-	-	4	1	-	-	3	9	-	-	-	4	-	-	-	-	-	39
LONG VALLEY																					
ARC FIELD SCHOOL1997	3	1	-	-	-	-	-	-	-	3	-	-	1	-	-	-	-	-	-	-	8
BASGALL AND HALL (ORHC)	4	-	-	-	-	-	-	-	-	9	-	-	-	-	5	-	-	-	-	-	18
JACKSON R 1985	13	13	4	-	-	-	-	-	-	1	5	-	8	-	-	-	-	1	-	-	45
ENFIELD COLLECTION	10	15	7	1	-	14	7	-	6	5	-	-	-	-	5	4	2	4	7	4	91
RIDDELL COLLECTION	1	1	1	-	-	3	1	-	-	3	-	-	-	-	1	1	-	-	-	-	12
HALL AND JACKSON 1989	20	26	-	-	14	6	35	-	17	-	9	-	-	-	-	-	6	19	-	-	152
TRUMAN MEADOWS																					
ENFIELD COLLECTION	3	5	10	1	-	9	4	-	7	11	-	3	16	-	2	3	3	11	4	7	99
BENTON RANGE																					
ENFIELD COLLECTION	-	3	1	-	-	1	-	-	1	-	-	-	-	-	-	1	1	-	1	-	9
VOLCANIC TABLELAND																					
BASGALL GIAMBASTIANI 1995	19	23	7	1	-	11	2	-	-	-	12	-	-	-	18	-	-	-	2	-	95
EERKENS KING 2002	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
GIAMBASTIANI 2004	3	5	-	-	54	3	-	-	-	-	1	-	-	-	1	-	-	-	-	-	67
ENFIELD COLLECTION	2	3	-	-	-	1	2	-	3	3	-	-	-	-	6	2	2	-	-	-	24
RIDDELL COLLECTION	-	-	3	-	-	2	-	-	5	-	-	-	1	-	-	-	-	1	3	-	15
N. OWENS VALLEY																					
BASGALL AND DELACORTE 2012	3	18	2	-	2	32	-	1	-	-	-	-	1	-	-	-	-	-	-	-	59

Table 5.1. Projectile Point Data Sources.

	ELKO SERIES					HUMBOLDT SERIES			SPLIT STEM			GBS									
	CN	EE	CS	SN	UN	BN	CB	UN	GC	PN	LL	LM	SL	UN	FSSN	LCN	LSN	WSTM	STM	UNT	TOTAL
BASGALL ET AL 2003	6	21	1	-	-	10	16	-	-	-	-	-	-	-	2	-	-	-	-	-	56
BETTINGER ET AL 1984	1	2	-	-	2	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	6
BOUSCAREN 1985	1	4	-	-	2	2	10	-	-	-	-	-	-	-	-	-	-	-	-	-	19
BURKE ET AL 1995	-	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
DELACORTE AND MCGUIRE 1993	10	5	-	1	-	3	5	-	-	-	-	-	-	-	-	-	-	-	-	-	24
GARFINKEL 1980	-	-	-	-	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	3
JACKSON ET AL 1993	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
JACKSON ET AL 2009	3	4	9	-	-	-	2	-	-	-	2	-	-	-	-	-	-	-	-	-	20
KING ET AL 2001	6	1	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	10
WICKSTROM 1993	-	-	-	-	2	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	5
YORK 1988	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
ZEANAH AND LEIGH 2002	8	-	8	-	2	13	5	-	-	9	-	-	-	-	1	-	-	-	-	-	46
ENFIELD COLLECTION	3	-	1	-	-	-	4	-	1	5	-	-	-	-	2	-	3	1	1	3	24
RIDDELL COLLECTION	31	8	1	-	-	19	10	-	3	12	-	2	1	-	5	2	9	9	1	11	124
S. OWENS VALLEY																					
BASGALL AND DELACORTE 2003	-	-	1	-	1	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	5
BURTON 1996	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
DELACORTE 1999	-	1	-	-	-	-	-	1	-	32	-	-	-	-	-	-	-	-	-	-	34
DELACORTE ET AL 1995	2	3	-	-	-	5	-	-	-	10	-	-	1	1	-	-	-	-	-	-	22
DELACORTE AND MCGUIRE 1993	4	2	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	7
GILREATH AND NELSON 1999	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
ENFIELD COLLECTION	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	2

Table 5.1. Projectile Point Data Sources.

	ELKO SERIES					HUMBOLDT SERIES			SPLIT STEM			GBS									
	CN	EE	CS	SN	UN	BN	CB	UN	GC	PN	LL	LM	SL	UN	FSSN	LCN	LSN	WSTM	STM	UNT	TOTAL
RIDDELL COLLECTION	15	12	1	-	-	4	4	-	-	12	-	-	-	-	-	1	4	1	3	12	69
OWENS LAKE																					
BASGALL AND MCGUIRE 1988	-	4	-	-	4	16	2	-	-	-	7	2	-	1	-	-	-	-	-	-	36
BOUEY 1990	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
DELACORTE AND MCGUIRE 1993	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
EERKENS 2003	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
GILREATH 1995	-	-	-	-	-	2	1	-	-	4	-	3	1	-	-	-	-	-	-	-	11
GILREATH AND HOLANDA 2000	-	-	-	-	-	-	-	-	-	-	-	4	1	-	-	-	-	-	-	-	5
JONES AND STOKES 2002	-	-	-	-	3	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	4
RIDDELL COLLECTION	17	9	1	-	-	19	7	-	3	19	-	-	2	-	4	2	3	5	6	26	123
ROSE VALLEY																					
ENFIELD COLLECTION	-	-	-	-	-	10	1	-	-	1	-	2	2	-	-	-	-	-	-	-	16
RIDDELL COLLECTION	7	3	3	-	-	1	2	-	-	1	-	1	-	-	-	1	-	-	-	1	20
COSO VOLCANIC FIELD																					
GILREATH AND HILDEBRANDT 1995	16	12	-	3	-	7	-	-	-	-	15	19	8	5	-	-	-	-	-	-	85
AYERS ROCK (INY-134)	5	1	-	-	-	-	-	3	-	23	-	-	2	-	-	-	-	-	-	-	34
INYO/WHITE MOUNTAINS																					
ENFIELD COLLECTION	5	18	7	-	-	7	6	-	16	47	-	1	6	-	1	2	3	1	3	2	125
EUREKA VALLEY																					
ENFIELD COLLECTION	4	3	2	-	-	1	-	-	2	-	-	-	-	-	1	3	2	6	11	1	36
TOTAL	232	240	76	20	103	215	132	19	64	215	61	37	51	7	58	22	25	59	42	67	1745

the Enfields worked with archaeologist Emma Lou Davis on several projects, including excavation of Mammoth Creek Cave (Enfield and Enfield 1964). Their initial efforts were focused on the Volcanic Tableland and later expanded to include Long Valley, the Benton Range, Truman Meadows, Mammoth Lakes, Casa Diablo, Eureka, Saline, Deep Springs, and Round valleys, and areas south of Bishop in Owens Valley. With assistance from Norman Weller and various family members, the Enfields recorded over 1000 sites and collected tens of thousands of artifacts. Each site was recorded using a unique number system based on photographs taken at the sites. Site numbers correspond to the film roll and the first picture frame taken at the site. For example, film roll 2-L, frame four would correspond to site 2-L-4. Many of the site records were eventually updated with USGS township, range, and section information, UTM coordinates, site descriptions (e.g., landform, constituents, and vegetation), a sketch map, and often sketches/outlines of artifacts and rock art.

Housed at the U.S. Forrest Service Bishop field office for most of its curatorial history, the Enfield collection was transferred to the Archaeological Research Center, California State University, Sacramento for a formal inventory and cataloging effort. As with the Riddell collection, dart points from the Enfield sites were outlined on cards and measured, yielding a total of 418 mostly obsidian points from 140 sites.

Projectile Point Attributes

The following presents the measurements used to analyze points from both the literature and Riddell and Enfield collections (see Figure 5.1). These duplicate the measurements employed in previous studies to successfully distinguish point types (e.g., Basgall and Hall 2000; Hamilton 2012; Krautkramer 2009; Thomas 1981; Vaughn and Warren 1987). Attributes were measured with digital calipers and a goniometer, with incomplete measurements denoted by the addition of a negative sign (-) before the measurement (see Appendix A).

Weight (WT)

The weight of projectile points was obtained with a digital scale in grams. Whether complete or fragmentary, weights were treated as whole, but during statistical analysis, incomplete specimens were excluded.

Maximum Length (ML)

Maximum length is the linear dimension of the projectile point from the extreme distal to the most proximal end, or the greatest distance from the base to the tip on complete specimens. Broken specimens were measured in similar fashion from the most distal to proximal extent of the piece.

Axial Length (AL)

Axial length refers to the central axis of the point when in plan view. It is the distance between the center points of the distal and proximal parts of the artifact. On fragmentary specimens, the maximum measurement is employed. Thus, a point broken transversally at the distal end can have an axial length greater than that measured along the center-line of the piece.

Stem Length (SL)

Stem length is the distance between the termination of the distal shoulder and the most proximal portion of the projectile point. Unshouldered points, by definition, lack stems.

Maximum Width (MW)

Maximum width is the linear measurement across the widest part of the projectile points. This is often the distance between the distal shoulders, but may, on side-notched or unnotched specimens be the maximum width across the base. On shoulderless points the maximum width is simply the widest measurement across the piece.

Neck Width (NW)

Neck width is the distance between the intersection of the distal and proximal shoulder angles on either side of shouldered projectile points. More specifically, it is the linear measurement of the narrowest point at which the two notches on either side extend into the point.

Basal Width (BW)

Basal width is the maximum distance across the base of the point. On shouldered points it is the maximum width of the point below the proximal shoulder angle. With contracting-stem points, however, the stem element converges inward and that is where the basal width is measured. While this contracting-stem measurement is somewhat subjective, the degree of variation between analysts is likely insignificant. On shoulderless points, the measurement is taken at the termination of the proximal portion of the point.

Maximum Thickness (MTH)

Maximum thickness is the greatest distance between the dorsal and ventral surfaces of the point. Recognition of these surfaces depends, however, on point morphology/condition, such that thickness is taken at the greatest perpendicular measurement to maximum width.

Distal Shoulder Angle (DSA)

The distal shoulder angle is the line defined by the distal most extent of the notch opening as defined by the horizontal plane perpendicular to the maximum length of the point. As a fairly variable measurement, DSA can range from a minimum of 100 to well over 200 degrees.

Proximal Shoulder Angle (PSA)

The proximal shoulder angle is the line defined by the proximal most extent of the notch opening as defined by the horizontal plane that exists perpendicular to the maximum length of the point. Probably the most diagnostic of the angle measurements, PSA ranges from less than 90 to 180 degrees, with much of the variation in projectile point types determined on the basis of proximal shoulder angle.

Notch Opening Angle (NOA)

The notch opening angle is the difference between the distal and the proximal shoulder angles or the opening used to haft points to a shaft. As a product of the DSA and PSA, NOA varies considerably even within a point type, and the same NOA measurement is sometimes found on very different point types. This makes NOA a typically non-diagnostic measurement in itself, but useful for distinguishing between stemmed and notched points.

Basal Indentation (BI)

The basal indentation is the difference between the axial and maximum point length, with a value of zero indicating no indentation.

Basal Width to Maximum Width Ratio (BWR)

This measurement is simply the maximum basal width divided by the maximum width. Its purpose is to examine the overall shape of the projectile point, and is particularly suited for shoulderless points, where it tracks the expansion of the blade from the base.

Projectile Points

Projectile points are probably the most studied artifact in North America, and recognizable to even novice researchers. In mainstream culture, the imagery and meaning of projectile points is synonymous with Native American prehistory in popular thought. This is obviously simplistic, with archaeological interest in points stemming from two things. First is their functional role in hunting and its implications for subsistence and second, is the stylistic variability in points over time, making them useful as temporal markers. In the Great Basin, projectile points are often used for dating and the development of cultural-historical sequences when other chronological controls are lacking. The following is a descriptive overview of established point types in the present analytical sample.

The Elko Series

The Elko series comprises several morphological types that are believed to date around the late-middle Holocene. The most common of these types are the Elko Corner-notched and Elko Eared variants. Less common and, as yet, poorly understood are the Elko Contracting-stem and Elko Side-notched points (Heizer and Baumhoff 1961; Homer 1980). In the Inyo-Mono region, Elko Contracting-stem points are taken to be of similar age to other Elko forms, but in Nevada they are classified as part of the earlier Gatecliff series (Thomas 1981). Elko Side-notched points are comparatively rare and poorly reported and thus their age relative to other Elko forms or older corner-notched and side-notched projectiles is unclear.

Elko Corner-notched and Elko Eared points are medium-to-large dart points, found throughout the Great Basin and parts of California. The Elko series was initially defined by Heizer and Baumhoff (1961) at South Fork Shelter (NV-EL-11), Nevada. The series is a marker of the Newberry period (3500-1350 B.P.) in the Inyo-Mono region, but the most comprehensive definition of the Corner-notched and Eared forms is provided by Thomas (1981) in his treatment of projectile points from Monitor Valley. Based on metric attributes from numerous specimens in Nevada, Thomas produced a typological key for different point forms in central Nevada. This key remains in use today as a useful basis for defining most Great Basin point types. Thomas (1981:21) defines Elko series points as follows:

> “The Elko series consists of large, corner-notched projectile points:
> Large: Basal width greater than 10 mm.
> Corner-notched: Proximal Shoulder Angle between 110° and 150°”

Great Basin archaeologists conventionally distinguish between Elko Eared and Corner-notched varieties, as readably determined by basal indentation:

> “Elko Corner-notched: Basal indention ratio greater than 0.93.
> Elko Eared: Basal indention ratio less than or equal to 0.93.”

Although metrically variable, these attributes have generally withstood the test of time among researchers and are retained for the present study.

Split-stem Types

Two split-stem point types have been identified in the study area: Pinto and Gatecliff Split-stem. While each of these types is fairly distinctive, the range of variation within them produces some overlap and confusion. Thus, further statistical analysis of these types is an important part of the current study, as examples of both occur within the study area.

The Pinto type is a robust dart-point manufactured primarily by percussion flaking, although obsidian specimens may exhibit more refined pressure flaking (see Chapter 4). Gatecliff Split-stem points are also bifurcate-stemmed projectiles, but have typically thin cross-section and extensive pressure flaking. Thomas (1981) defined Gatecliff Split-stem in Monitor Valley, Nevada, but elsewhere points of this type are classified as Bare Creek Eared (O'Connell and Ambro 1968) and Silent Snake Split-stem (Layton 1970). Basgall and Hall (2000) confirmed the relationship between these types and posit that all are of the same morphology and temporal span. A more confusing situation occurs in the southwestern Great Basin where both Gatecliff and Pinto points appear to occur. In fact, Basgall and Hall (2000:268-269) comment on the overlap of these types:

> "Geographic limits of the gracile and robust series remain indistinct, but along the western periphery of the Great Basin a break appears to occur somewhere north of Mono Lake Basin. Bifurcate-General Stemmed points from the southern Walker Basin vicinity, for example, have greater morphological affinities with the Gatecliff series than southern Pinto forms (Hall 1986). There is almost certainly a good deal of north-south overlap to be established through empirical study of individual assemblages and localities, a situation that has already been noted with regard to the eastern Great Basin (cf. Holmer 1986)."

The present study suggests that the overlap between Gatecliff and Pinto types may lie further south, as 47 Gatecliff Split-stem specimens were identified from the Riddell and Enfield collections.

Unshouldered Types

Unshouldered point types include Humboldt Basal-notched and Humboldt

Concave-base. The key issue with these points is to distinguish differences between sub-types (see Chapter 4). Although one of the morphologically simplest point forms, there is variability within and between the types. The Concave-base type was divided by early researchers into "A" and "B" sub-types, with the former being longer and older (Holmer 1978; Roust and Clewlow 1968). Thomas (1981) leaves the Humboldt type as a residual category, given its apparent lack of temporal significance. The Humboldt Basal-notched type has received greater attention in the literature and is defined by a deeply indented basal notch, parallel to slightly concave sides, and fine pressure retouch with often parallel oblique flaking (Bettinger 1978). However, the size of the Basal-notched pieces is extremely variable, leading some researchers to speculate that larger Humboldt points may have served as hafted knives (Bettinger 1978; Garfinkel and Yohe 2002). Given these issues, the present analysis will focus on identifying attributes that can distinguish between various Humboldt forms (e.g., basal width, maximum thickness, basal indentation, and basal width/maximum width ratio).

Fish Slough Side-notched Points

Identified on the Volcanic Tableland and in Deep Springs Valley (Basgall and Giambastiani 1995; Basgall et al. 1995; Delacorte 1992), this type is distinguished by its convex base and typically deep side notching. While these traits cannot be quantified with existing attributes, they are a hallmark of the type, and mat necessitate the future development of new attributes to distinguish them. For the time being, however, the telltale presence or absence of a convex base will suffice to identify the Fish Slough form.

Large Stemmed Types

This category is comprised of the Great Basin Stemmed series (i.e., Silver Lake and Lake Mohave [GBS]), and two additional stemmed point forms, termed here as Wide-stemmed, and General Stemmed. The GBS variants were identified as early Holocene markers around the shore of pluvial Lake Mohave (Amsden 1937). The Lake Mohave type is a large, lanceolate point, with a long stem and weak or ephemeral shouldering. The Silver Lake variety consists of large, short-bladed points with broad shoulders and short, blunt stems.

The Wide-stemmed and General Stemmed points in the current sample differ significantly from the GBS series. These were segregated into their generic descriptive categories based on size and shape. Wide-stemmed points have either a straight, or expanding stem of pronounced width and well-defined shoulders. They are similar to the Silver Lake type, but generally smaller. The General Stemmed form is more generic, with a stem that varies from slightly contracting to slightly expanding. They are typically smaller and narrower, but sill thick in cross section, weighing more than 3.0 grams.

Large Corner-notched

Large Corner-notched points represent a more robust version of the Elko Corner-notched type. It is unclear if the Large Corner-notched pieces identified in the Riddell and Enfield collections correspond to the “thick” Elko points identified by Gilreath and Hildebrandt (1997), but they are large, thick corner-notched points that exceed the metric parameters of classic Elko forms.

Large Side-notched

The Large Side-notched category is somewhat ambiguous, apart from the consistent presence of side-notches. They tend to be large, semi-triangular bifaces, with notches placed at various locations along the blade. Large side-notched dart points occur throughout the Great Basin, the most notable example being the Northern Side-notched type of middle Holocene age in Nevada. These may extend into the Inyo-Mono region, but the eastern Sierran examples lack the unbroken outline and "comma-shaped" notches of Northern Side-notched specimens.

Metrical Analysis

In order to verify the intuitive classification of points, all complete attribute measurements were subjected to various statistical analyses using IBM SPSS ver. 23. As an initial step, macro-groups were established encompassing multiple point types on the basis of one or more morphological constants (Table 5.2), segregated by stem morphology or lack thereof.

The "Corner-notched" group is comprised of Elko Corner-notched, Large Corner-notched, and Elko Eared types. The "Split-Stem" group contains the Gatecliff Split-stem, and Pinto types. The "Side-notched group" contains the Elko Side- notched, Fish Slough Side-notched and more generically Large Side-notched forms. The "Large Stemmed" group includes the Great Basin Stemmed series (Lake Mohave and Silver Lake), Wide-stemmed and General Stemmed points. This group serves as the first test of the Wide-stemmed and General Stemmed types as they relate to existing stemmed point categories.

These types have characteristics that may overlap with multiple point types, requiring comparison with “Corner-notched” and “Split-stem” groups as well. The last macro-group is the “Unshouldered” category consisting of Humboldt Concave-base and Basal-notched points.

Table 5.2. Dart Point Macro-groups.

Macro-group	Point Forms
Corner-notched	Elko Corner notched, Elko Eared, Large Corner notched
Side-notched	Elko Side notched, Large Side notched, Fish slough Side-notched
Split- Stem	Gatecliff Split-stem, Pinto
Large Stemmed	Great Basin Stemmed (Silver Lake, Lake Mohave), Wide-Stemmed, General Stemmed
Unshouldered	Humboldt Concave Base, Humboldt Basal-notched

A subset of specimens in the current sample are reported as Little Lake. Issues regarding this designation and its implication for Split-stem typology are discussed in Chapter 4. The term “Little Lake” conflates specimens that may be attributable to either Pinto or Gatecliff, and require statistical reclassification into one category or the other. For this reason, exclusion from the Split-stem Macro-Group is necessary until metrical distinction between Pinto and Gatecliff points is established. Once this is achieved, Little Lake points will be re-assigned accordingly.

All points were initially classified based on known criteria employed within the Inyo-Mono region and broader Great Basin (Basgall and Giambastiani 1995; Basgall and Hall 2000; Garfinkel and Yohe 2002; Thomas 1981). These types were then subjected to various tests using IBM SPSS version 23 including independent samples t-test and one-way ANOVA (when applicable). These analyses effectively test population means against each other to determine if significant differences exist. The validity of intuitive types or groupings was further assessed using discriminant analysis. This determines how well the initial sample populations, or point types, are differentiated from each other, and predicts group membership of individual specimens. Based on these results, the veracity of existing point types can be assessed, along with the overlap between types within macro-groups. Similarities between non-diagnostic and established point types were also examined to determine if new types may exist or if there are variations within previously identified forms.

Obsidian Sourcing

Obsidian can be assigned to specific geochemical sources using X-ray fluorescence (XRF) or by visually apparent macroscopic hallmarks. The Inyo-Mono region has a well-studied obsidian landscape with major toolstone sources found across the region. Visual obsidian source identification is a cost effective and reliable alternative to XRF, especially in the Inyo-Mono region, where visual identification is fairly accurate (Basgall 1989;

Bettinger et al. 1984a; Brady 2007).

Obsidian specimens from the Enfield collection were visually identified to source by Dr. Michael Delacorte, on the basis of well-established criteria. The intent was to primarily identify four of the most common regional sources: Casa Diablo, Coso Volcanic Field, Fish Springs, and Truman-Queen (Figure 5.2). Each of these sources has a well-established obsidian hydration rate. Secondary sources were also tabulated when identified, and questionably identified specimens avoided for further obsidian hydration dating (OHD). These data were combined with existing source and hydration information reported on points from previous regional projects.

Obsidian Hydration

The dating method employed in the current research is obsidian hydration (OHD), or measurement of the amount of water absorbed into the surface of the glass over time. This technique was first employed in archaeology by Friedman and Smith (1960), and enthusiastically accepted by some (e.g., Friedman and Long 1976; Friedman et al. 1997; Hull 2001; Rogers 2007, 2012), but not other researchers (e.g., Ridings 1995). The rate at which water is absorbed by obsidian is a function of depth over time, measured microscopically in microns (μ) using the standard OHD methodology (see below). Age of an artifact is determined by the derived rate of water absorption raised to an exponent that creates a predictive curve in which depth is equal or near-equal to the square root of time.

Standard OHD is based on the optical measurement of the stress zone within the obsidian matrix caused by the advancement of water. This zone is measured by means of

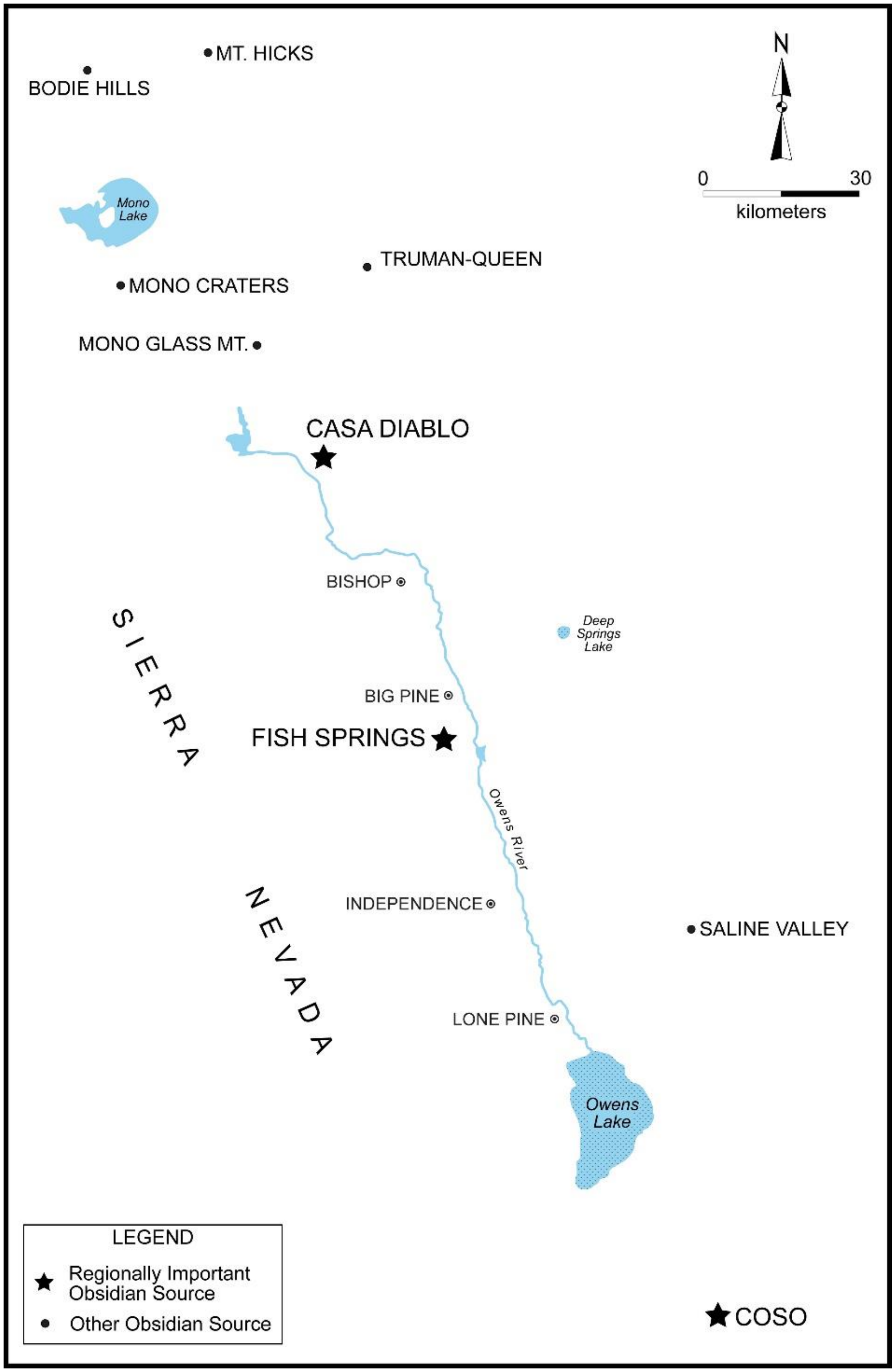


Figure 5.2. Obsidian source map.

microscopy using a polarized microscope with at least 500X magnification. Three regions of the sample need to be considered: the unhydrated area, the hydrated area, and the interface layer between the two. The interface layer, or "hydration front," is a zone of optical contrast when seen under polarized light, due to the phenomenon of "stress birefringence" (Born and Wolf 1980: 703-705; also see Rogers 2012). The layer behind the stress zone, closer to the sample surface, is enlarged due to the absorption of water molecules, while the unhydrated layer is not. This optical phenomenon is similar to that of tempered glass looking mottled when observed through polarized glasses. In tempered glass, zones of less stress are interlaced around high stress sections of glass to prevent large shards of glass when it is shattered, with the leading edge of the stress zone in obsidian being optically similar.

Given the proliferation of standard OHD over the last 40 years (Anovitz et al. 1999; Friedman and Smith 1960; Friedman and Trembour 1983; Liritzis and Stevenson 2012; Meighan 1976, 1983), it has received greater attention in the Great Basin (Basgall 1990; 2002; Basgall and Delacorte 2012; Basgall and Giambastiani 1995; Basgall and Hall 2000; Basgall and McGuire 1988; Duke and Rogers 2011; Hall and Jackson 1989), and is the method employed in the present study to determine the age of artifacts.

Effective Hydration Temperature (EHT) Model

One of the most important factors influencing the hydration process is ambient temperature. Thus, for each study site or location examined, an Effective Hydration Temperature (EHT) scaled to elevation was calculated. Many obsidian specimens in the study were recovered far from the geological source location. Even sites in reasonable proximity to an obsidian source, may be of substantially different temperature, due to differences in elevation. The method employed to compensate for these differences was developed by Alexander "Sandy" Rogers for sites in the Northern Mojave Desert (Rogers 2007), and uses local weather station data to estimate the average annual temperature for a location, the annual temperature variation from January to July, and finally the mean diurnal temperature variation. To operationalize this model for the current study area, different weather stations were used that better represent the Inyo-Mono region. The EHT model uses these calculations from 13 regional weather stations (Table 5.3) of known elevation to establish three corresponding regressions (Figure 5.3-5.5).

Table 5.3 Weather Station Data from the Inyo-Mono Region

Weather Station	Altitude (ft)	Avg Max °F	Avg Min °F	Annual Avg °F	Jul Max °F	Jul Min °F	Jan Max °F	Jan Min °F	Annual Avg (Ta) °C	Annual Var (Va) °C	Diurnal Var (Vd) °C
Trona	1700	80.1	54.0	67.1	102.0	73.6	59.0	36.1	**19.47**	**22.36**	**14.25**
China Lake Armitage	2240	80.5	47.0	63.8	100.6	67.2	59.9	32.3	**17.64**	**21.00**	**16.94**
Inyokern	2440	80.9	47.4	64.2	102.4	65.9	60.5	31.1	**17.86**	**21.31**	**18.31**
Haiwee	3282	73.6	45.1	59.4	95.7	63.8	52.7	29.1	**15.19**	**21.58**	**15.42**
Independence	3940	75.9	45.3	60.6	98.1	64.5	55.3	28.5	**15.89**	**21.89**	**16.78**
Bishop	4110	74.2	37.8	56.0	97.0	55.4	53.5	22.7	**13.33**	**21.17**	**20.11**
Bridgeport	6470	62.6	24.4	43.5	83.1	40.2	42.8	9.4	**6.39**	**19.75**	**21.19**
Lee Vining	6800	61.7	35.2	48.5	82.9	52.3	41.3	20.2	**9.14**	**20.47**	**14.36**
Montgomery Pass	7110	59.6	28.8	44.2	82.9	47.9	39.6	14.9	**6.78**	**21.19**	**16.58**
Mammoth Lakes	7804	57.0	28.6	42.8	77.3	44.5	41.4	18.1	**6.00**	**17.31**	**15.58**
Bodie	8370	56.4	19.4	37.9	76.3	34.6	40.1	6.1	**3.28**	**17.97**	**21.03**
White Mountain	12470	36.8	18.3	27.6	55.1	36.5	24.5	7.0	**-2.47**	**16.69**	**10.03**
Mean	-	66.6	35.9	51.3	87.8	53.9	47.6	21.3	**10.7**	**20.22**	**16.72**
Stdev	-	13.3	12.0	12.3	14.2	13.2	11.0	10.4	**6.9**	**1.89**	**3.19**

Both Annual Average Temperature (Ta, $R^2 = 0.9699$) and Annual Variation (Va, $R^2 = 0.7545$) show a strong correlation with elevation. However, Diurnal Variation (Vd, $R^2 = 0.0926$) displays little relationship to elevation, given likely seasonal temperature disparities at different elevations and latitudinal gradients in daily temperature regimes. This give the following EHT correction: annual average temperature (Ta) at a given site = 22.53-0.0021 x h, where h is elevation in feet, annual variation (Va) at the site = 23.09 - 0.0005 x h, and because of the poor fit with elevation, diurnal variation (Vd) uses the mean value of 16.72 °C as a constant for sites across all elevations (h). Scaled surface

EHT for a given site is based on the equation (Ta) x 0.0062 x ($Va^2 + Vd^2$) after Rogers (2007). This EHT value is used to produce a rim correction factor (RCF) using the equation RCF = exp[-0.060(EHT-EHT_0)] where EHT_0 is the effective hydration

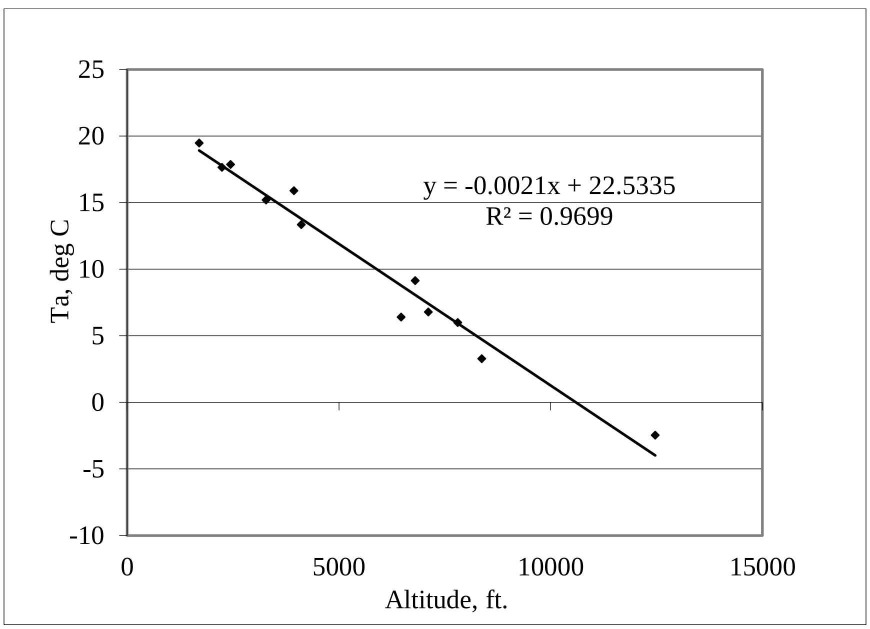


Figure 5.3 Average temperature regression.

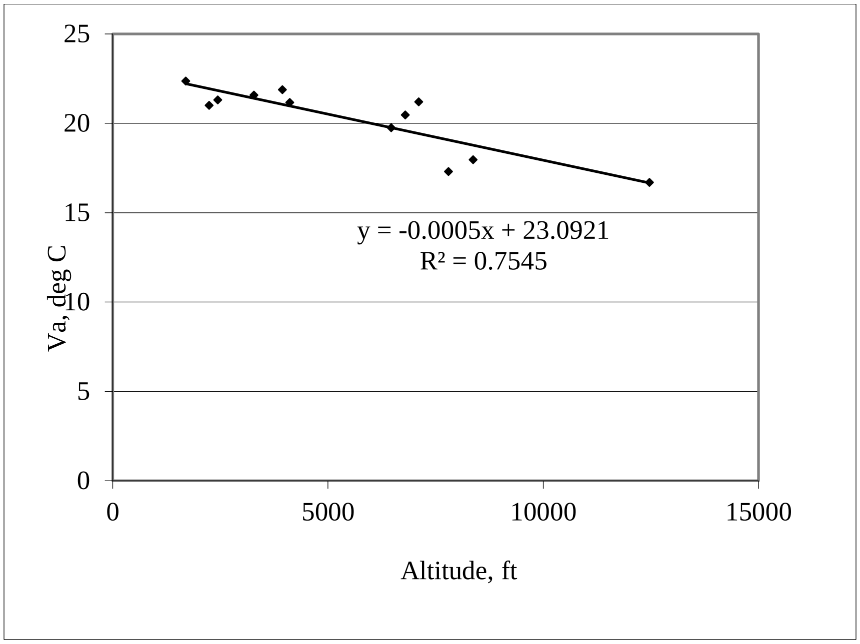


Figure 5.4. Annual variation regression.

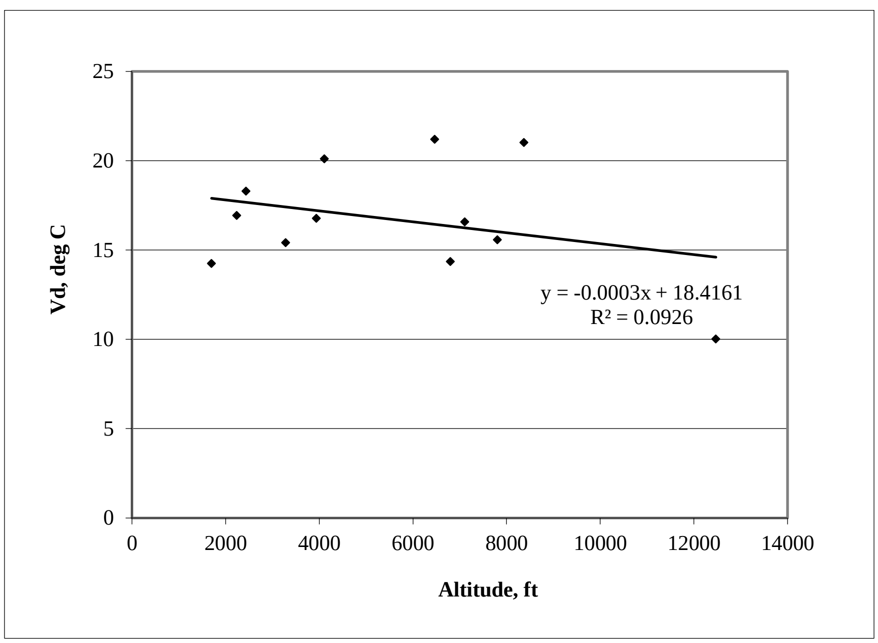


Figure 5.5. Diurnal variation regression.

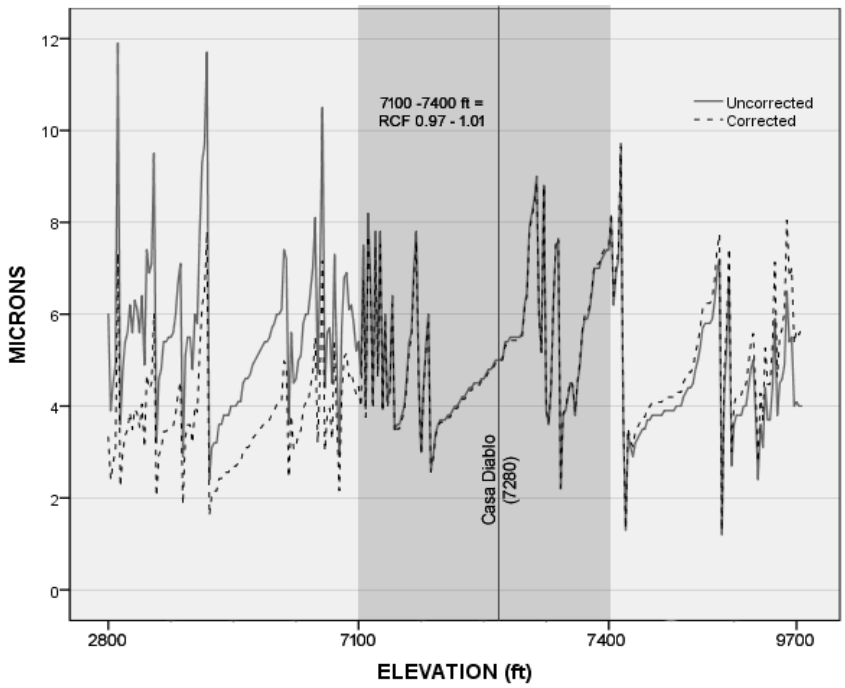


Figure 5.6. Uncorrected versus corrected micron values for Casa Diablo obsidian samples from different elevations.

temperature at the obsidian source or in some cases the geographical region in which the hydration rate for a particular obsidian was developed. This correction factor is multiplied by the observed rim value to produce a corrected rim value before a source specific hydration rate equation is used to calculate a calendrical age estimate.

Using the current Casa Diablo obsidian point sample as an example, Figure 5.6 illustrates the degree to which micron values are effected by differences in elevation. Both corrected and uncorrected lines converge between 7100 and 7400 feet or average elevation of the Casa Diablo source locality (7280 feet). Rim correction factors (RCF) for these elevations bracket 1.00 necessitating little adjustment in micron value. But, as one moves higher or lower in elevation, the EHT model pulls the micron readings either above or below the raw micron value.

Obsidian Hydration Rates

Only four obsidian sources were employed for obsidian hydration dating: Casa Diablo, Truman-Queen, Fish Springs, and the Coso Volcanic Field. Each of these sources has a well-established, empirically verified hydration rate (Table 5.4). These rates were used to calculate calendrical age estimates in years before present (B.P.), or A.D. 1950, for points with hydration readings.

Table 5.4. Obsidian Hydration Rates.

Obsidian Source	Hydration Rate	Region	Citation
Casa Diablo	years B.P. = 129.656 x microns $^{1.826}$	Long Valley	Hall and Jackson 1989
Truman-Queen	years B.P. = 82.74 x microns $^{2.03}$	Volcanic Tablelands	Basgall and Giambastiani 1995
Fish Springs	years B.P. = 96.54 x microns $^{1.90}$	Independence	Basgall 2002
Coso Volcanic Field	years B.P. = 31.62 x microns $^{2.32}$	Lone Pine	Basgall 1990

Coso Volcanic Field (CVF) Sub-source Variability

The CVF hydration rate of longest standing is that developed by Basgall (1990) on the basis of obsidian hydration/radiocarbon pairings from CA-INY-30 (Basgall and McGuire 1988; Basgall 1989, 1990). Coso obsidian hydrates at a faster rate than other regional sources, producing generally larger rim values. The Basgall (1990) rate furnishes effective estimates on material dating back to the middle Holocene, beyond which it produces unrealistically ancient age assignments. This is a function of the late Holocene archaeological data used to develop the rate and a common problem encountered with most empirically generated hydration rate formulations.

More problematic for the CVF is the geochemical variability within the source. Four sub-sources have been identified within the CVF (Sugarloaf Mountain, West Sugarloaf, Joshua Ridge and West Cactus Peak [Ericson 1989; Hughes 1988]), each of which has a different hydration rate. No single rate equation can compensate for the variation in hydration between Coso obsidian sub-sources. Recent studies by Rogers (2008, 2009, 2013), using laboratory induced hydration, have produced four sub-source specific hydration rates (Table 5.5), calibrated to calendar years before A.D. 2000 (cyb2k). These sub-source rates are employed to clarify chronological issues where applicable.

Table 5.5. Coso Sub-Source Hydration Rates (Rogers 2013).

Sub-source	Hydration Rate	Operational Equation
West Sugar Loaf	17.21 μ^2 / 1000 years	cyb2k = 1000 x μ^2 / 17.21
Sugar Loaf Mountain	28.50 μ^2 / 1000 years	cyb2k = 1000 x μ^2 / 28.50
West Cactus Peak	26.76 μ^2 / 1000 years	cyb2k = 1000 x μ^2 / 26.76
Joshua Ridge	22.36 μ^2 / 1000 years	cyb2k = 1000 x μ^2 / 22.36
Coso (Composite)	22.87 μ^2 / 1000 years	cyb2k = 1000 x μ^2 / 22.87

Spatial Analysis

The final component of the study examines the spatial distribution of dart points across landforms of different age within the Inyo-Mono region. Meyer et al. (2010) conducted an expansive geoarchaeological study, assigning Inyo-Mono region landforms to one of thirteen late Pleistocene/Holocene temporal divisions (Table 5.6). Landforms were dated on the basis of archaeological evidence and newly obtained radiocarbon date that were extrapolated across landforms of geographically similar derivation and presumably age. The end result is a GIS database with shapefiles estimating the two-dimensional extent of landforms of differing age. The purpose of the database is to predict the potential for buried archaeological deposits of varying age, given the superposition of

Table 5.6. Landform Ages for the Inyo-Mono Region (Meyer et al. 2010).

Landform Divisions	Date Range
Artificial Cut and Fill	less than150 cal B.P.
Historical and Modern	less than150 cal B.P.
Latest Holocene	2000 - 150 cal B.P.
Latest Holocene Volcanic	2000 - 150 cal B.P.
Late Holocene	4000 - 2000 cal B.P.
Holocene Volcanic (undivided)	11500 - 150 cal B.P.
Middle Holocene	7000 - 4000 cal B.P.
Early Holocene	11500 - 7000 cal B.P.
Early Holocene Volcanic	11500 - 7000 cal B.P.
Latest Pleistocene	15000 - 11500 cal B.P.
Late Pleistocene	25000 - 15000 cal B.P.
Older Pleistocene	1.9 mya - 25000 cal B.P.
Pre-Quaternary	greater than 1.9 mya

alluvial fan deposits emplaced at different times. That said, it is likely that some landforms are less than homogenous, harboring unexpectedly ancient surface deposits in otherwise younger sediment packages. This should not, however, detract from the overall dating and predictive value of the model.

Using ArcGIS 10.3, a proportionality study of different dart points was performed across landforms of different age. The objective of this was to assess the temporal context of various point forms, and to examine how types of differing age co-occur on landforms. More specifically, points of relatively older and younger age should be differentially deposited with respect to the antiquity of landforms. Thus, both older and younger point styles are expected on older landforms, and the converse, in the case of young landforms, where mostly recent point types should be found. Another issue that needs to be considered is the relative proportion of landforms of differing age and how it effects or skews the recovery of points from different periods in the past. This is a largely empirical question regarding the utility of landform age for predicting the recovery of specific artifacts and their meaning with respect to diachronic trends identified in the regional archaeological record.

CHAPTER 6

PROJECTILE POINT ATTRIBUTE ANALYSIS

This chapter presents the results of an analysis of metrical attributes (see Chapter 5) on 1593 projectile points from the Inyo-Mono region. A total of 804 specimens was assembled from 37 archaeological projects throughout the region, together with 789 points analyzed from two avocational collections that span large sections of the eastern Sierra (see Chapter 5, Table 5.1). In addition to these data, 236 Pinto points from Fort Irwin (Basgall 1993; Basgall and Hall 1993, 1994) and 131 Gatecliff Split-stem points from Monitor Valley (Thomas 1981, 1983a, 1983b, 1985, 1988) were incorporated in the study for comparison and to bolster the bifurcate-stem point sample. Statistical tests of population means (i.e., t-tests and One-way ANOVA) and discriminant analysis was performed, when appropriate, on each projectile point macro-group (see Chapter 5, Table 5.3.) to establish a classification. Obsidian specimens from the Enfield collection were visually sourced (n = 224) and a sample (n = 63) subsequently submitted for obsidian hydration analysis. These data, along with obsidian source and hydration results compiled from earlier projects (n = 576), furnish the potential to resolve longstanding issues on dart point classification and chronology.

Corner-notched Macro-Group

The corner-notched group consist of Elko Corner-notched (ECN) and Eared (EE) types as well as Large Corner-notched (LGCN) forms. All specimens were categorized initially following Thomas' (1981) criteria for corner-notched points, i.e., points with a

Proximal Shoulder Angle (PSA) between 110° and 150°. Elko Eared points are further distinguished by a basal indentation ratio (BIR = Axial Length/Maximum Length) of 0.93 or less, with a value greater than this classified as Elko Corner-notched. Large Corner-notched forms were identified in the Enfield and Riddell collections based on their larger size within the Corner-notched macro-group. Of all size attributes examined, neck width (NW) displayed the strongest trend for distinguishing "Large" from other corner-notched points (Figure 6.1). Neck width measurements are also a highly stable attributes, less prone to reworking.

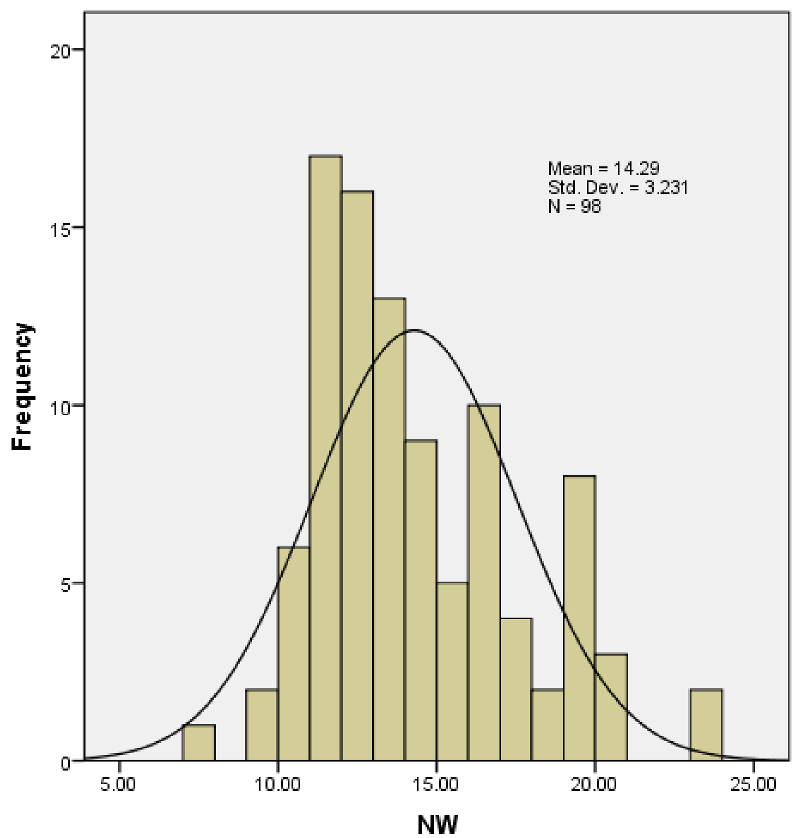


Figure 6.1. Enfield and Riddell Corner-notched neck width distribution.

Two potential breaks in NW distribution can be identified, one at 15mm and a second at 18mm. Discriminant analysis of the maximum thickness, and elements related to stem morphology, i.e., stem length, basal width, basal indentation, distal and proximal shoulder angles, and notch opening angles was performed for points with neck width above or below 15mm. It successfully segregates 84.3% of the points as either Elko or Large Corner-notched forms (Table 6.1).

Table 6.1. Enfield and Riddell Corner-notched 15mm Neck Width Discriminant Results. [a]

		Predicted Group Membership		
	Type	ECN	LGCN	Total
Count	ECN	39	5	44
	LGCN	6	20	26
%	ECN	88.6	11.4	100.0
	LGCN	23.1	76.9	100.0

[a]. 84.3% of original grouped cases correctly classified.

A second discriminant analysis was performed on the same attributes for points with NW above or below 18mm (Table 6.2), wherein 14 specimens previously categorized as Large Corner-notched were reclassified as Elko Corner-notched. Results of this second analysis were more successful than the first, with 88.6% of the cases grouped successfully. Thus, the Large Corner-notched group is better defined using the 18mm NW threshold, with only one (8.3%) seemingly Large Corner-notched specimen being categorized as an Elko point.

Attribute statistics for Elko and Large Corner-notched points identified on the basis

Table 6.2. Enfield and Riddell Corner-notched 18mm Neck Width Discriminant Results. [a]

		Predicted Group Membership		
	Type	ECN	LGCN	Total
Count	ECN	51	7	58
	LGCN	1	11	12
%	ECN	87.9	12.1	100.0
	LGCN	8.3	91.7	100.0

[a.] 88.6% of original grouped cases correctly classified.

Table 6.3. Enfield and Riddell Collection Corner-notched Attribute Statistics.

		WT	ML	AL	SL	MW	BW	NW	MTH	DSA	PSA	NOA	BI
ECN	N	10	13	14	71	46	65	83	84	74	83	72	84
	Mean	4.3	33.5	33.3	9.1	25.5	17.6	13.2	5.9	162.5	122.8	41.2	0.2
	Min	3.1	24.3	22.9	5.2	17.7	9.9	7.4	3.9	120.0	95.0	5.0	0.0
	Max	7.1	46.8	46.8	14.5	33.3	27.7	17.9	12.1	215.0	150.0	100.0	2.4
LGCN	N	3	3	3	13	9	14	15	15	14	15	14	15
	Mean	10.3	40.7	40.7	11.3	32.9	22.8	20.1	7.5	172.1	116.3	56.8	0.2
	Min	4.4	34.3	34.3	6.3	28.5	16.6	18.1	5.3	150.0	90.0	10.0	0.0
	Max	14.8	45.9	45.9	15.9	37.9	26.5	23.7	10.5	200.0	145.0	90.0	2.7

of the 18mm NW threshold, are enumerated in Table 6.3. It shows that Large Corner-notched specimens are, on average, larger, heavier and thicker than the Elko counterparts. Large Corner-notched points have typically wider bases, but the stems are less expanding and a notch opening larger then Elko Corner-notched points.

Applying the 18mm NW definition to Elko Corner-notched identified in regional reports, re-classified five Elko specimens as Large Corner-notched forms (0.04% of the report sample). After combining these with the Enfield and Riddell sample, a two-sample t-test was performed to assess the difference between Elko and Large Corner-notched types (Table 6.4). Results of indicate a strong and pervasive difference between the two types. Shoulder angles are not significantly different, confirming that Elko and Large Corner-notched groups reflect points of fundamentally different size but the same basic shape.

Table 6.4. ECN-LGCN T-test.

	t	df	p
WT	-6.094	29	.000*
ML	-4.346	40	.000*
AL	-4.533	40	.000*
SL	-5.164	159	.000*
MW	-5.454	106	.000*
BW	-5.030	147	.000*
NW	-12.866	185	.000*
MTH	-5.873	185	.000*
DSA	-1.670	160	.101
PSA	1.440	180	.151
NOA	-1.868	158	.064
BI	.898	185	.370

* denotes significantly different samples; significance at 0.05 level

A discriminant analysis using maximum thickness, and elements of stem morphology, i.e., stem length, basal width, basal indentation, distal and proximal shoulder angles, and notch opening angles was also performed. It correctly classified 85.1% of Elko and Large Corner-notched points (Table 6.5). These results suggest that there is, in fact, a distinctly large corner-notched point form within the Inyo-Mono region, albeit, given the significant number of misclassified specimens, this conclusion is tentative.

Table 6.5. Combined Corner-notched Discriminant Analysis Results.[a]

		Predicted Group Membership		
	Type	ECN	LGCN	Total
Count	ECN	85	14	99
	LGCN	4	18	22
%	ECN	85.9	14.1	100.0
	LGCN	18.2	81.8	100.0

[a.] 85.1% of original grouped cases correctly classified.

Table 6.6. Combined Corner-notched Attribute Statistics.

		WT	ML	AL	SL	MW	BW	NW	MTH	DSA	PSA	NOA	BI
ECN	N	24	34	35	137	90	125	160	143	137	155	134	160
	Mean	4.5	36.3	36.1	8.4	25.2	17.6	13	5.7	164.3	124.5	42.1	0.4
	Min	1.6	21.2	21.2	3.2	17	9.9	7.1	3.1	112	82	5	0
	Max	10	56.6	56.6	14.5	36	30.7	17.9	8.4	243	184	104	5.1
LGCN	N	7	8	7	24	18	24	27	27	26	27	26	27
	Mean	10.5	50.7	51.1	10.7	30.9	21.8	19.2	7.6	169.9	119.6	50.6	0.3
	Min	4.4	34.3	34.3	6.3	23.5	11.8	15.2	5.3	145	90	10	0
	Max	14.8	61.4	61.4	15.9	37.9	26.5	24.1	12.1	200	145	90	2.7

Attribute statistics for the complete re-classified samples are presented in Table 6.6. It reveals greater separation in size and weight and slightly more convergence in angles and notch opening than the Enfield and Riddell sample alone as supported by the t-tests. These finding will be further explored in Chapter 7 on the basis of obsidian hydration results. More to the point, if Large Corner-notched points are a truly distinctive type, their temporal occurrence should be markedly different from that of Elko Corner-notched and if not, the two forms may be variations on a single morphological type.

Elko Eared Points

Elko Eared points are distinguished from other corner-notched points by their distinctive basal morphology. That said, it is useful to examine the morphological relationship between Elko Eared and other corner-notched points. Independent-sample t-tests comparing various attributes reveal little similarity between Elko Corner-notched and Eared points (Table 6.7). Apart from thickness, all of the attributes are significantly different between the two types. Large Corner-notched and Elko Eared points are similar

Table 6.7. Elko Eared Comparison T-tests.

	ECN-EE				**LGCN-EE**		
	t	**df**	**p**		**t**	**df**	**p**
WT	-4.323	35	.000*	WT	1.406	29	.170
ML	-3.218	36	.003*	ML	0.225	35	.823
AL	-3.579	29	.001*	AL	0.168	29	.868
SL	-2.500	263	.013*	SL	2.593	150	.010*
MW	-2.601	191	.010*	MW	3.532	119	.001*
BW	-8.086	212	.000*	BW	-0.259	135	.797
NW	-11.365	213	.000*	NW	3.267	192	.002*
MTH	-1.761	304	.079	MTH	5.849	194	.000*
DSA	-7.845	299	.000*	DSA	-4.908	184	.000*
PSA	-4.821	336	.000*	PSA	-3.759	208	.000*
NOA	-5.010	287	.000*	NOA	-1.437	181	.158
BI	-23.125	216	.000*	BI	-19.482	209	.000*

* denotes significantly different samples; significance at 0.05 level

in length and weight, which exceed those of Elko Corner-notched points. Large Corner-notched and Elko Eared specimens share similar basal widths, which probably reflects the basal indentation on Eared specimens that required a larger base to achieve. Results of this comparison confirm the difference between the three point types in the Corner-notched macro-group, and that Elko Eared points are distinct from other corner-notched forms.

Split-Stem Macro-Group

The Split-stem macro group consists of Gatecliff Split-stem and Pinto types. Table 6.8 provides the attribute statistics for both split-stem types and separates the comparative samples from the Central Great Basin and Mojave Desert. On average, Pinto points exhibit thicker cross-sections with obtuse shoulder angles and larger basal morphology. Gatecliff points, are more gracile with acute shouldering and a narrower base. This is consistent for both local and comparative samples for both point types, with no apparent divergences between the mean values.

Split-stem Classification

The distinction between Pinto and Gatecliff Split-stem points has been previously demonstrated by other researchers (Basgall and Hall 2000; Hamilton 2012; Holmer 1986; Schroth 1994; Vaughn and Warren 1987). Gatecliff points tend to be more gracile and have different shoulder and basal configurations. This holds true for the current sample when the Fort Irwin and regional Pinto data are combined (Table 6.9). While there are some similarities in maximum length and width between Pinto and Gatecliff specimens, the former are still generally thicker and have more obtuse notch openings, more expansive bases, and sloping shoulders.

Table 6.8. Attribute Statistics for Split-stem Macro-Group.

		WT	ML	AL	SL	MW	BW	NW	MTH	DSA	PSA	NOA	BI
Gatecliff SS*	N	7	6	7	38	34	35	45	46	46	45	44	44
	Mean	3.4	36.0	30.7	8.9	23.5	12.7	12.8	6.0	176.3	97.2	78.9	3.7
	Std	1.4	7.7	8.9	2.2	4.7	2.2	2.6	1.0	20.4	14.8	22.0	1.4
	Min	1.8	26.3	16.8	4.6	14.9	8.7	8.1	4.4	125.0	60.0	20.0	1.2
	Max	5.4	48.3	44.9	13.2	39.8	19.4	18.9	8.7	255.0	150.0	160.0	6.2
Gatecliff SS	N	48	79	82	117	92	99	128	130	130	130	130	116
(Monitor Valley)	Mean	4.4	43.8	41.3	8.0	21.6	11.5	12.1	5.6	176.9	90.2	86.5	2.8
	Std	1.8	9.8	10.8	1.9	3.7	2.5	2.3	1.1	20.6	9.5	21.0	1.1
	Min	1.6	28.4	20.4	4.6	15.0	6.7	7.5	3.2	120.0	65.0	40.0	1.0
	Max	8.2	71.2	75.7	12.3	29.8	21.3	20.3	9.7	250.0	105.0	155.0	7.0
Pinto	N	59	70	72	159	132	165	169	186	182	196	184	204
	Mean	6.5	36.5	33.4	10.4	22.5	17.8	16.5	7.2	213.6	103.6	109.9	3.7
	Std	3.9	11.1	10.3	2.3	4.8	3.9	3.4	1.7	25.1	12.2	27.1	1.8
	Min	1.1	16.6	13.5	3.8	13	8.8	9.3	3	150	71	40	0
	Max	20.6	68.4	63.4	20.9	36.4	33.9	29.6	15.7	267	153	169	11.5
Pinto	N	93	129	138	201	188	182	220	216	228	231	228	194
(Fort Irwin)	Mean	7.0	40.1	36.6	11.0	23.3	18.6	17.3	7.4	217.4	103.5	113.5	3.3
	Std	3.6	9.7	9.7	2.9	4.0	3.4	3.0	1.6	20.3	15.6	23.7	1.6
	Min	1.1	19.2	16.2	3.8	13.0	8.9	9.3	3.5	158.0	71.0	57.0	0.0
	Max	20.6	68.4	63.4	20.9	35.5	33.9	29.6	14.3	240.0	153.0	169.0	10.2

* specimens from current project database including Enfield Collection, Riddell Collection and 37 regional projects

Table 6.10 present t-test results comparing the combined Pinto and various Gatecliff samples. The results confirm that the length and width of Pinto and Inyo-Mono Gatecliff points are similar, but the types are in other respects quite different. Comparison of the Pinto and Monitor Valley (MV) Gatecliff points shows significant differences in all

Table 6.9. Attribute Statistics for Combined Split-stem Macro-Group.

		WT	ML	AL	SL	MW	BW	NW	MTH	DSA	PSA	NOA	BI
Gatecliff SS	N	7	6	7	38	34	35	45	46	46	45	44	44
	Mean	3.4	36.0	30.7	8.9	23.5	12.7	12.8	6.0	176.3	97.2	78.9	3.7
	Std	1.4	7.7	8.9	2.2	4.7	2.2	2.6	1.0	20.4	14.8	22.0	1.4
	Min	1.8	26.3	16.8	4.6	14.9	8.7	8.1	4.4	125.0	60.0	20.0	1.2
	Max	5.4	48.3	44.9	13.2	39.8	19.4	18.9	8.7	255.0	150.0	160.0	6.2
Gatecliff SS	N	48	79	82	117	92	99	128	130	130	130	130	116
(Monitor Valley)	Mean	4.4	43.8	41.3	8.0	21.6	11.5	12.1	5.6	176.9	90.2	86.5	2.8
	Std	1.8	9.8	10.8	1.9	3.7	2.5	2.3	1.1	20.6	9.5	21.0	1.1
	Min	1.6	28.4	20.4	4.6	15.0	6.7	7.5	3.2	120.0	65.0	40.0	1.0
	Max	8.2	71.2	75.7	12.3	29.8	21.3	20.3	9.7	250.0	105.0	155.0	7.0
Pinto	N	171	227	229	385	356	378	424	442	449	464	449	432
	Mean	6.7	38.8	35.4	10.7	23.3	18.2	17.0	7.3	213.9	103.3	110.5	3.5
	Std	3.6	10.2	9.9	2.8	4.4	3.7	3.2	1.6	23.6	13.8	25.9	1.7
	Min	1.1	16.6	13.5	3.8	13	8.8	9.3	3	150	71	40	0
	Max	20.6	68.4	63.4	20.9	36.4	33.9	29.6	15.7	267	153	169	11.5

Table 6.10. Split-stem Comparative Sample T-test.

Pinto-Inyo/Mono GCSS					Pinto-MV GCSS					Inyo/Mono GCSS-MV GCSS				
	t value	df	p			t value	df	p			t value	df	p	
WT	6.37	201	.000	*	WT	6.26	230	.000	*	WT	-0.50	54	.140	
ML	0.56	232	.575		ML	-3.82	304	.000	*	ML	-1.89	84	.063	
AL	1.04	235	.298		AL	-4.52	309	.000	*	AL	-2.43	88	.017	*
SL	4.35	424	.000	*	SL	12.21	325	.000	*	SL	2.24	156	.027	*
MW	0.08	390	.934		MW	3.36	446	.001	*	MW	2.06	126	.042	*
BW	13.74	410	.000	*	BW	21.45	410	.000	*	BW	2.21	35	.029	*
NW	9.11	470	.000	*	NW	18.67	408	.000	*	NW	1.06	174	.291	
MTH	8.52	450	.000	*	MTH	13.94	430	.000	*	MTH	1.98	177	.049	*
DSA	12.44	503	.000	*	DSA	17.45	440	.000	*	DSA	-0.26	177	.796	
PSA	3.00	510	.003	*	PSA	12.50	462	.000	*	PSA	3.03	175	.004	*
NOA	8.11	494	.000	*	NOA	10.83	455	.000	*	NOA	-2.15	175	.033	*
BI	-0.52	477	.606		BI	4.76	480	.000	*	BI	3.40	177	.001	*

* denotes significantly different samples; significance at 0.05 level

attributes, indicating minimal relationship between the two samples. A more interesting and problematic comparison is between the Inyo-Mono and MV Gatecliff samples.

Despite key similarities in distal shoulder angle and weight, differences between the Gatecliff samples are greater than expected. Although, of similar weight ($p = 0.140$), the difference in point thicknesses approaches the level of significance ($p = 0.049$), with the Inyo-Mono specimens appreciably thicker on average.

In regard to shape, the Inyo-Mono points show deeper basal indentations and longer, slightly expanding stems. These differences are significant from a statistical standpoint, despite their outwardly negligible disparity, which is of greater consequence when distributions cluster tightly around their means. Regional difference in basal morphology and deeper indentation of Inyo-Mono points may relate to increased stability in the haft, necessitated by the use of brittle obsidian instead of cryptocrystalline stone. The deeper indentation would also require a larger base which may account for the difference between the two samples. A t-test comparing the Inyo-Mono and Monitor Valley Gatecliff specimens made only of obsidian, improves the similarity between the samples, with respect to especially thickness (Table 6.11). Differences remain, however, in terms of basal Configuration, with the Monitor Valley sample having narrower stems and shallower basal indentations. The attribute that most distinguishes Gatecliff from Pinto points is the distal shoulder angle, which is nearly identical between Inyo-Mono and Monitor Valley Gatecliff samples regardless of material type. Many of the Inyo-Mono specimens classified as Gatecliff points in the regional literature were probably identified on the basis of their squared-off shoulders and more gracile build than local Pinto points.

Table 6.11. Obsidian Gatecliff T-test.

	t	df	p
WT	-1.997	34	.054
ML	-1.916	59	.060
AL	-2.340	63	.022*
SL	2.248	93	.027*
MW	1.674	75	.098
BW	2.318	74	.023*
NW	0.654	103	.515
MTH	-0.136	104	.892
DSA	-0.047	104	.963
PSA	2.488	102	.016*
NOA	-1.439	102	.153
BI	2.813	106	.006*

* denotes significantly different samples; significance at 0.05 level

Discriminant Analysis

To test whether the two Gatecliff samples represent different morphological populations, a discriminant analysis was performed on more stable attributes minimally impacted by reworking and commonly preserved on fragmentary specimens. These include thickness, stem length, neck and basal width, basal indentation, distal and proximal shoulder angles, and notch opening angles. Results of this analysis revealed considerable overlap between the two samples, with 67.9% of the points correctly classified and 40.0% of the Inyo-Mono specimens classified as Monitor Valley forms and 29.2 % of the Monitor Valley points resembling Inyo-Mono pieces (Table 6.12). This suggests that the two samples grade into each other and could derive from the same population. Given this, it

Table 6.12. Inyo-Mono-Monitor Valley Gatecliff Classification Results.[a]

		Predicted Group Membership		
	Region	Inyo-Mono	Monitor Valley	Total
Count	Inyo-Mono	21	14	35
	Monitor Valley	28	68	96
%	Inyo-Mono	60.0	40.0	100.0
	Monitor Valley	29.2	70.8	100.0

[a.] 67.9% of original grouped cases correctly classified.

seems evident that Inyo-Mono Gatecliff and Pinto points are decidedly different and that the two Gatecliff Split-stem samples are likely one and the same that can be combined and compared together against Pinto forms.

To validate how effectively Pinto and Gatecliff samples can be distinguished, a discriminant analysis was performed. As before, only thickness, and elements of stem morphology (i.e., stem length, neck and basal width, basal indentation, distal and proximal shoulder angles, and notch opening angles) were analyzed. This resulted in function coefficients that successfully classified 92.0% of 435 valid cases (90.1% of 304 Pinto, 96.2% of 131 Gatecliff Split-General Stemmed; Table 6.13).

To identify key attributes driving this result, a stepwise analysis was also performed, to further narrow the variables required to successfully classify different split-stem point types. This identified five attributes of predictive value: basal width, maximum thickness, stem length, distal shoulder angle and basal indentation. By themselves, these attributes classified 92.3% of 442 cases successfully (90.3% of 309 Pinto, 97.0% of 133 Gatecliff Split-Stem; Table 6.14). From these five attributes and their function coefficients an equation is derived that can be used to segregate Pinto from Gatecliff Split-stem:

Type = (BW x 0.200) + (MTH x 0.156) + (SL x 0.055) + (DSA x 0.030) – (BI x 0.161) – 10.464; (< -0.545 = Gatecliff, > -0.545 = Pinto)

Table 6.13. Split-stem Classification Results.[a]

		Predicted Group Membership		
	Point Type	PIN	GCSS	Total
Count	PIN	274	30	304
	GCSS	5	126	131
%	PIN	90.1	9.9	100.0
	GCSS	3.8	96.2	100.0

[a]. 92.0% of original grouped cases correctly classified.

Table 6.14. Stepwise Split-stem Classification Results.[a,]

		Predicted Group Membership		
	Point Type	PIN	GCSS	Total
Count	PIN	279	30	309
	GCSS	4	129	133
%	PIN	90.3	9.7	100.0
	GCSS	3.0	97.0	100.0

[a.] 92.3% of original grouped cases correctly classified.

The Little Lake Problem

The Little Lake type arose from distinguishing split-stem points at the Stahl site at Little Lake (Harrington 1957) from more robust Pinto points in the Mojave Desert (Bettinger and Taylor 1974; Lanning 1963). Many of the Little Lake points were made of obsidian and high-quality cryptocrystalline stone and differentiated from Pinto points given a perceived difference in morphology. This position has been effectively dispelled, however, by metrical data that show little difference between Little Lake and Pinto points, which appear to be one and the same (Basgall and Hall 2000). Use of the term Little Lake is abandoned in the current study, although 52 specimens were classified as such in various regional reports that were consulted. To meaningfully incorporate the “Little Lake” specimens in the current study, and test the consistency with which they were typed, requires that they be reclassified as either Pinto or Gatecliff forms.

To accomplish this, the current sample of Little Lake points was subjected to the previously described discriminant function equation. Of the 52 Little Lake specimens, 30 had the requisite measurements and were classifiable as either Pinto (n = 22) or Gatecliff (n = 8) points. Six of the Gatecliff specimens are from the Volcanic Tableland and the other two from Long Valley. The 22 Pinto examples are primarily from the Coso Volcanic area (n = 14) and, to a lesser extent, the Volcanic Tableland (n = 3), Long Valley (n = 3), Southern Owens Valley (n = 1) and Owens Lake (n = 4). This implies that the southern limits of Gatecliff Split-stem points lies in the vicinity of the Volcanic Tableland and Long Valley, where both Pinto and Gatecliff points co-occur.

Patterns of Split-stem Variability

To assess potential variability in regional split-stem morphology, the Inyo-Mono samples were assessed across three broad geographic areas that encompass smaller sub-regions. The Northern Area is comprised of samples from Long Valley, Truman Meadows, Benton Range, the Volcanic Tableland, and Northern Owens Valley. The Southern Area includes Southern Owens Valley, Owens Lake, Coso Volcanic Field, and Rose Valley specimens. The Eastern Area is represented by points from the Inyo/White Mountains and Eureka Valley (Table 6.15).

Table 6.15. Inyo-Mono Split-stem Comparative Areas.

	Northern Area	Southern Area	Eastern Area	Total
Pinto	77	121	47	245
Gatecliff	29	3	18	50
Total	106	124	65	295

Independent sample t-tests cross-comparing both split-stem samples from Northern, Southern and Eastern parts of the region indicate that the Pinto points are more variable geographically than Gatecliff (Table 6.16). The limited sample size of Gatecliff specimens in the Southern area precludes meaningful comparisons involving this sub-region, but the comparison of Northern and Eastern samples indicates homogeneity among Gatecliff points. Differences in weight and axial length probably result from the limited number of available values, but the convergence in other attributes speaks to the uniformity of regional Gatecliff points.

Table 6.16. Inyo-Mono Comparative Area Independent Samples T-tests.

PIN Northern-Southern					PIN Northern-Eastern					PIN Southern-Eastern				
	t	**df**	**p**			**t**	**df**	**p**			**t**	**df**	**p**	
WT	-3.177	66	.002	*	WT	0.360	29	.722		WT	1.774	49	.082	
ML	0.079	76	.937		ML	1.705	25	.101		ML	1.463	61	.149	
AL	-0.121	79	.904		AL	1.616	30	.117		AL	2.944	60	.011	*
SL	-1.318	145	.189		SL	1.745	91	.084		SL	2.931	122	.004	*
MW	-3.423	126	.001	*	MW	1.352	75	.181		MW	3.490	99	.001	*
BW	-2.280	153	.024	*	BW	0.806	86	.423		BW	2.644	129	.009	*
NW	-2.598	152	.010	*	NW	-0.408	96	.684		NW	1.973	101	.051	
MTH	-2.033	170	.044	*	MTH	-0.205	102	.838		MTH	1.399	142	.164	
DSA	-0.062	167	.951		DSA	-2.666	106	.009	*	DSA	-3.090	143	.002	*
PSA	-1.327	174	.186		PSA	0.450	112	.653		PSA	1.657	154	.100	
NOA	0.470	116	.639		NOA	-2.749	105	.007	*	NOA	-3.891	142	.000	*
BI	-0.089	177	.930		BI	-2.974	118	.004	*	BI	-2.865	159	.005	*

GCSS Northern-Southern					GCSS Northern-Eastern					GCSS Southern-Eastern				
	t	**df**	**p**			**t**	**df**	**p**			**t**	**df**	**p**	
WT	0.564	4	.603		WT	3.670	5	.015	*	WT	3.753	1	.166	
ML	1.500	4	.208		ML	2.248	4	.088		ML	-	-	-	
AL	1.449	4	.221		AL	3.512	5	.017	*	AL	1.089	1	.473	
SL	2.319	24	.029	*	SL	1.114	37	.273		SL	-3.022	15	.009	*
MW	0.752	21	.461		MW	-0.350	31	.729		MW	-0.629	14	.540	
BW	0.250	23	.805		BW	-1.483	34	.147		BW	-1.159	13	.267	
NW	0.333	29	.741		NW	0.651	43	.519		NW	0.043	18	.966	
MTH	-0.277	30	.783		MTH	1.032	44	.308		MTH	0.919	18	.370	
DSA	-3.436	30	.002	*	DSA	-0.227	44	.822		DSA	2.641	18	.017	*
PSA	0.282	28	.780		PSA	-0.820	43	.417		PSA	-0.658	19	.518	
NOA	-3.433	28	.002	*	NOA	0.359	42	.721		NOA	3.039	18	.007	*
BI	-0.309	27	.760		BI	0.255	42	.800		BI	0.420	19	.679	

* denotes significantly different samples; significance at 0.05 level

Comparison of Northern and Southern Pinto samples reveals that southern specimens are thicker, wider, and heavier than those in the north, with larger base and neck attributes. Both areas, however, exhibit points of similar length and shouldering. Different patterns are observed between Southern and Eastern areas, with Pinto points in the east displaying more sloping shoulders and deeper basal indentations, with shorter, narrower stems, although both samples exhibit points of similar weight and thickness. Northern and Eastern comparison show the greatest similarity, with the only significant difference that Eastern Pinto points have more sloping shoulders and deeper basal indentation.

Eastern samples have distinct distal shoulder angles and basal indentations, when compared to other regions. Most of these Eastern specimens were collected in upland hunting areas, that are far removed from their place of manufacture. As such, many of the Eastern points may have been broken and rejuvenated, resulting in points with diminished distal shoulder angles and deeper basal notches. Both these and Northern area specimens comprise a statistically homogenous population of Pinto points.

The southern sample is substantially different from other areas, being more robust than the Northern sample with larger bases than either Northern or Eastern areas. Whether this is a stylistic or functional difference is unknown, but may be in part due to sample size and proximity to tool stone in the southern area. All of these observations would benefit from temporal data to explore changes in point form and distribution over time, using obsidian hydration.

Side-Notched Macro Group

The Side-notched macro-group comprises Large, Fish Slough, and a few previously reported Elko side-notched points subjected to limited analysis. Identification of these styles during the Riddell and Enfield analysis classified all as either Fish Slough or Large

Side-notched. Thomas' (1981) criterion for distinguishing side-from corner-notched points (i.e., PSA>150°) was considered, but rejected because notch position and shape can produce specimens with small PSA measurements that are clearly side-notched. To circumvent this problem, a simple calculation was performed to determine the notch direction angle (NDA), where NDA = NOA/2+PSA, and an NDA of >160° was used to distinguish corner- from side-notched points. Side-notched specimens displayed NDA measurements between 162° and 195°, with a mean of 174°. The Fish Slough Side-notched type is further distinguished by its convex base (Basgall et al. 1995). There are likewise a handful (n = 5) of Elko Side-notched points identified in reports, but these are of no definitive morphology, leaving their designation as "Elko" forms problematic.

Descriptive attribute statistics (Table 6.17) reveal few differences between the Large Side-notched (LGSN) and Elko Side-notched (ESN) points, with subsequent analysis placing the Elko Side-notched specimens in the Large Side-notched category. Fish Slough Side-notched (FSSN) points are in most respects identical in size to the Large Side-notched group, although FSSN have narrower notch openings.

An independent-samples t-test between Large and Fish Slough Side-notched specimens confirms that the only significant attribute difference is the notch opening angle resulting from the lower distal shoulder angle on Fish Slough points (Table 6.18). Unfortunately, samples of both Large and Fish Slough Side-notched points are limited throughout the Eastern Sierra, restricting statistically meaningful analysis. Shifting focus to the Large Side-notched sample, a cluster analysis using a Ward Linkage was performed

Table 6.17. Side Notched Attribute Statistics.

		WT	ML	AL	SL	MW	BW	NW	MTH	DSA	PSA	NOA	BI
LGSN	N	2	5	5	28	14	24	32	33	24	34	24	34
	Mean	7.0	36.4	36.4	10.9	24.3	23.6	16.9	6.2	201.8	153.2	52.3	0.6
	Min	5.4	30.1	30.1	6.6	17.1	14.7	8.9	3.8	164.0	125.0	4.0	0.0
	Max	8.6	47.3	47.3	17.1	33.6	33.6	26.8	9.3	230.0	180.0	100.0	4.5
	Stdv	2.3	6.9	6.9	2.7	5.1	4.9	4.4	1.3	19.2	15.4	27.9	1.1
FSSN	N	4	5	5	48	21	45	45	40	33	54	30	58
	Mean	4.3	35.3	35.3	11.3	26.1	24.2	17.1	6.1	184.9	154.7	33.4	0.0
	Min	2.5	26.3	26.3	7.4	19.2	15.6	8.3	3.7	150.0	120.0	5.0	0.0
	Max	5.3	41.1	41.1	22.1	32.0	31.0	25.0	10.4	225.0	180.0	71.0	0.0
	Stdv	1.2	5.5	5.5	2.5	3.7	3.4	3.7	1.2	18.8	14.0	20.4	0.0
ESN	N	2	2	2	4	5	3	5	5	5	5	5	5
	Mean	6.0	32.2	32.0	11.2	25.9	26.5	17.7	6.6	198.8	149.2	45.6	1.1
	Min	5.2	31.7	31.2	6.4	21.2	20.9	11.6	5.6	173.0	140.0	16.0	0.0
	Max	6.7	32.7	32.7	16.4	32.6	30.2	23.2	7.6	235.0	157.0	90.0	3.8
	Stdv	1.1	0.7	1.1	4.2	4.5	4.9	4.7	0.8	26.0	6.8	28.7	1.6

Table 6.18. FSSN-LGSN T-test.

	t	df	p
WT	-2.18	6	.072
ML	0.02	10	.982
AL	0.05	10	.965
SL	0.71	78	.483
MW	1.05	38	.302
BW	0.21	41	.837
NW	0.13	80	.901
MTH	-0.52	76	.606
DSA	-3.33	60	.002*
PSA	0.66	91	.509
NOA	-2.80	57	.007*
BI	-3.32	90	.002*

* denotes significantly different samples; significance at 0.05 level

to assess whether any morphological patterns exist within the sample (Figure 6.2). Two clusters were identified, comprising 17 specimens in all. Descriptive Statistics for each cluster are enumerated in Table 6.19. The primary segregation between the two clusters appears to be the notch opening angle, with the first cluster having a maximum value of 50°, and the second cluster a minimum value of 55°. This attribute serves to distinguish the two clusters, while other attributes display considerable overlap. The diminished sample size of the clusters makes the results problematic, with the possibility of two distinct point forms defined by nothing but the notch opening angle seemingly unlikely.

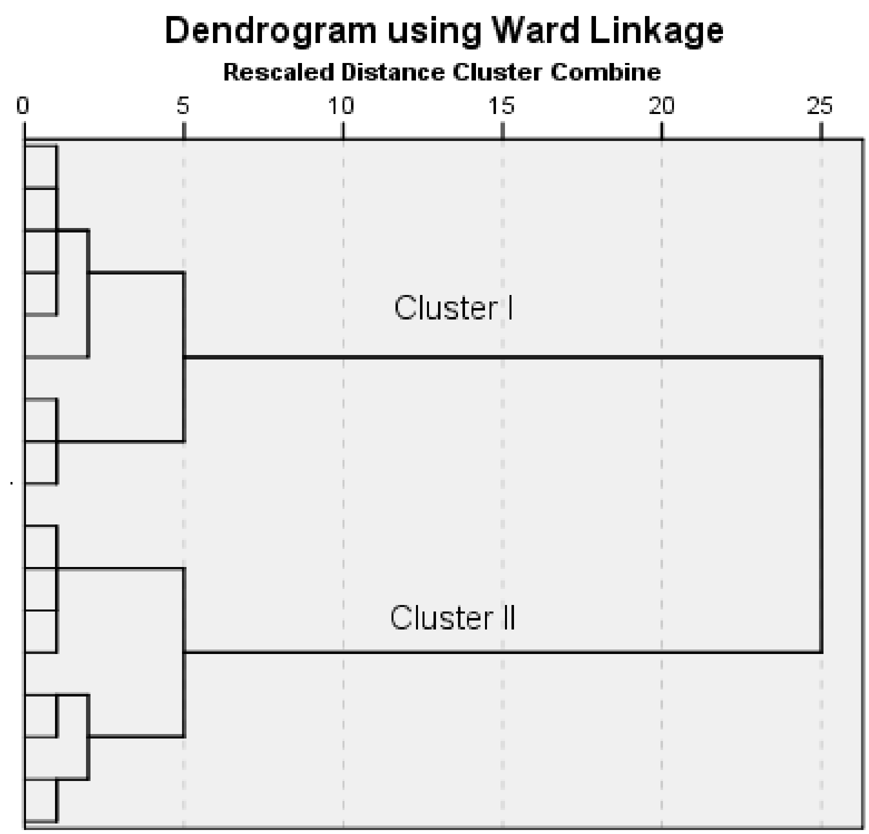


Figure 6.2. Large Side-notched cluster analysis.

Table 6.19. Large Side-notched Cluster Attributes.

		WT	ML	AL	SL	MW	BW	NW	MTH	DSA	PSA	NOA	BI
Cluster I	N	1	2	2	8	3	8	8	8	8	8	8	8
	Mean	8.6	34.0	34.0	9.9	29.6	23.2	15.9	6.4	185.6	156.9	28.8	0.3
	Min	8.6	31.0	31.0	6.8	23.2	15.9	8.9	3.8	170.0	145.0	5.0	0.0
	Max	8.6	37.0	37.0	11.7	33.6	33.6	26.0	8.5	205.0	175.0	50.0	2.6
	Stdv	-	4.2	4.2	1.8	5.6	5.9	5.7	1.7	11.5	9.6	17.7	0.9
Cluster II	N	1	2	2	9	8	9	9	9	9	9	9	9
	Mean	5.4	33.4	33.4	9.4	21.7	20.6	17.5	6.4	216.1	139.4	76.7	0.4
	Min	5.4	30.1	30.1	6.6	17.1	14.7	12.6	5.5	200.0	125.0	55.0	0.0
	Max	5.4	36.6	36.6	11.7	28.0	24.7	22.6	7.4	230.0	170.0	100.0	2.2
	Stdv	-	4.6	4.6	1.7	3.5	3.2	2.8	0.7	11.7	15.9	13.0	0.9

The temporal distribution of the Large Side-notched forms will need to be examined to assess their potential affinities to other regional point series (e.g., Elko), or potentially extra-local types of significantly greater antiquity (e.g., Northern Side-notched).

Large Stemmed Macro-Group

This group includes Lake Mohave (GBS-LM) and Silver Lake (GBS-SL) points subsumed within the broader Great Basin Stemmed (GBS) series, along with two more generalized categories: Wide-Stemmed (WSTM) and General Stemmed (STM) points. Both Wide-Stemmed and General Stemmed forms differ from the Great Basin Stemmed series in size and shape, with both of them being smaller than either GBS type. Wide-Stemmed points have generally a short expanding stem, while General Stemmed points are smaller and narrower than the former. Attribute statistics are enumerated in Table 6.20 and highlight the size and shape differences between the four categories.

Table 6.20. Attribute Statistics for Large Stemmed Macro-Group.

		WT	ML	AL	SL	MW	BW	NW	MTH	DSA	PSA	NOA	BI
WIDE STEMMED	N	14	15	15	32	29	29	34	37	38	38	38	38
	Mean	6.1	38.8	38.5	11.6	25.6	19.9	18.0	7.0	210.1	104.9	105.2	0.1
	Std	2.9	8.7	8.7	2.9	3.7	2.5	2.8	0.9	21.5	8.5	23.1	0.4
	Min	1.7	23.7	22.6	7.1	20.3	16.3	13.3	5.0	145.0	90.0	45.0	.0
	Max	12.2	56.7	56.7	18.3	37.8	24.8	23.1	9.1	245.0	120.0	145.0	1.7
GENERAL STEMMED	N	16	17	17	38	35	36	38	41	41	41	41	41
	Mean	5.6	38.7	38.6	10.4	22.9	12.2	13.6	6.9	198.5	93.0	105.4	0.1
	Std	2.0	8.3	8.3	3.0	3.2	2.2	1.8	1.3	25.8	11.1	26.5	0.3
	Min	3.0	27.7	27.7	5.9	16.6	7.6	9.3	5.2	130.0	65.0	35.0	.0
	Max	10.7	61.1	61.1	21.1	29.2	15.7	17.8	10.1	250.0	120.0	155.0	1.4
SILVER LAKE	N	37	35	35	45	42	44	47	49	50	50	50	51
	Mean	9.6	44.0	43.9	15.3	28.8	18.4	20.4	7.9	204.5	91.1	113.7	0.4
	Std	4.2	9.5	9.7	5.0	5.5	3.7	4.2	1.5	21.4	22.1	20.6	1.0
	Min	3.3	25.9	24.0	8.9	16.7	9.2	7.4	4.0	160.0	70.0	75.0	0.0
	Max	18.2	64.6	64.6	29.7	42.2	26.8	31.5	11.6	250.0	120.0	155.0	5.8
LAKE MOHAVE	N	19	20	20	24	28	16	24	34	19	25	18	37
	Mean	9.7	47.1	46.9	22.0	27.3	16.2	22.1	7.7	219.1	85.0	132.1	1.1
	Std	3.5	9.1	9.1	7.1	3.5	4.1	3.2	1.5	31.5	14.4	27.7	2.9
	Min	6.2	35.0	34.6	12.0	22.1	10.6	15.1	4.8	176.0	55.0	60.0	0.0
	Max	21.3	75.9	75.1	43.0	36.4	23.3	28.2	10.1	255.0	116.0	180.0	13.6

Great Basin Stemmed Series

Lake Mohave and Silver Lake points were initially defined elsewhere (Amsden 1937) and further refinement of the series has clarified and supported the criteria employed for distinguishing these two types (Beck and Jones 1993, 1997; Graf 2001; Holmer 1986; Nelson 1997). Stem configuration is the primary difference between these types with Silver Lake having a shorter, straight stem and squared shoulders and Lake Mohave having a longer, narrower, slightly contracting stem and more ephemeral shouldering. These characteristics were used to differentiate the two types in the current sample and results of a t-test of metric attributes highlights these trends, showing significant divergence in stem length and notch opening angle (Table 6.21). Proximal shoulder angle and neck width also differ between populations, with a p value just above the significance threshold. These results are consistent with previously established definitions for the two types.

Table 6.21 Silver Lake-Lake Mohave T-test

	t value	df	p
WT	-.052	34	.959
ML	-1.088	53	.282
AL	-1.054	53	.297
SL	-4.736	67	.000*
MW	1.318	68	.192
BW	1.763	58	.083
NW	-1.937	69	.057
MTH	.666	81	.507
DSA	-1.734	66	.088
PSA	1.942	73	.056
NOA	-2.628	66	.011*
BI	-.015	86	.988

* denotes significantly different samples; significance at 0.05 level

Wide-Stemmed and General Stemmed Variants

Ambiguous stemmed points were encountered in some frequency Within the

Enfield and Riddell collections. Some of these consisted of fragments too small for formal classification and were excluded from analysis, while the rest (n = 79) were stemmed forms that differed from the GBS series. Two groups were identified on the basis of size differences: Wide-Stemmed (n = 38) and General Stemmed (n = 41). Wide-Stemmed points exhibit larger features overall, but the hallmark of them, is an expanding stem and basal width >16mm. General Stemmed points are narrower with a straighter, smaller stem and base <16mm (see Table 6.20).

Wide-Stemmed and General Stemmed points were initially segregated on the basis of basal width, after univariate analysis revealed slight breaks in attribute frequency (Figure 6.3). While not a strong break in the distribution, a 16mm BW was used as a threshold, and a discriminant analysis was performed using thickness as well as stable attributes related to basal morphology (i.e., stem length, neck width, basal indentation, distal and proximal shoulder angles, and notch opening angles). Results of this analysis classified 92.2% of 64 valid Wide-Stemmed (n = 30) and General Stemmed (n = 34) forms successfully (Table 6.22). This suggests that BW provides a good predictor for the initial classification of these points.

This analysis also revealed that neck width (NW) is a strong discriminant factor, with a function coefficient of 0.948, with the few misclassified cases having narrow neck widths between 14.9 and 16.1mm. Another likely significant reason for misclassifications is the omission of BW in the analysis, which removes one of the methods for tracking expanding, straight and contracting stems within the sample. These issues aside, classification of the stemmed points was sufficiently successful to warrant the initial separation of Wide and General Stemmed categories.

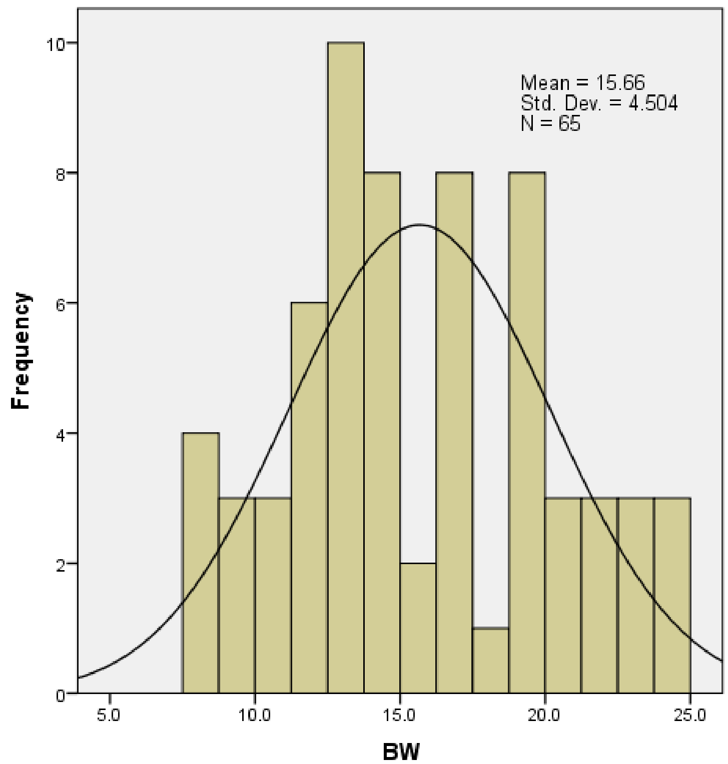


Figure 6.3. Large Stemmed Macro-Group basal width histogram.

A two-sample t-test was performed between Wide-Stemmed and General stemmed samples to ascertain divergent attributes. As expected, significant differences exist in basal and neck widths, and also, maximum width and shoulder angles (Table 6.23). While distinct from Wide-Stemmed specimens, General Stemmed points are a small and variable category of likely one-off or otherwise unique pieces. Some may be manufacturing errors and others potentially unrecognized variants of other stemmed forms. The latter may also be true for the Wide-Stemmed category that potentially share certain traits with split-stem, Large Corner-notched, and Silver Lake samples.

Table 6.22. Wide-Stemmed-General Stemmed Classification Results.[a]

		Predicted Group Membership		
	Point Type	WSTM	STM	Total
Count	WSTM	27	3	30
	STM	2	32	34
%	WSTM	90.0	10.0	100.0
	STM	5.9	94.1	100.0

[a.] 92.2% of original grouped cases correctly classified.

Table 6.23. Wide-Stemmed- General Stemmed T-test.

	t value	df	p
WT	-0.62	28	.535
ML	-0.01	30	.989
AL	0.03	30	.971
SL	-1.56	68	.123
MW	-3.06	62	.003*
BW	-13.31	63	.000*
NW	-7.93	63	.000*
MTH	-0.53	76	.599
DSA	-2.14	77	.036*
PSA	-5.29	77	.000*
NOA	0.02	77	.982
BI	-0.51	77	.613

* denotes significantly different samples; significance at 0.05 level

Point Type Comparisons

Both Wide-Stemmed and General Stemmed forms seem to differ from previously established point types in the Inyo-Mono region. They do, however, overlap with certain shouldered point types. In order to assess whether stemmed specimens might be variants of other point forms, Wide-Stemmed points were compared with Silver Lake types, Split-stem, and Large Corner-notched points, and General Stemmed points were compared to Split-stem forms and a sample of Elko Contracting-stem points that were not part of the larger macro-groupings.

Wide-Stemmed and Silver Lake Comparison

Comparison of Silver Lake and Wide-Stemmed points was important, as they overlap in key attributes. Descriptive statistics for these point categories are enumerated in Table 6.24. Initial analysis consists of an independent-sample t-test (Table 6.25). Significant differences were apparent in weight and thickness, with Silver Lake points appreciably larger. Stem length, maximum width and neck width differ, supporting the fact that Silver Lake points are significantly larger overall. Differences in length are likewise significant, albeit less pronounced, with Silver Lake specimens being longer. Basal width and distal shoulder angle are, by comparison, similar, with both of the points having pronounced shoulders and the Wide-Stemmed examples more sloping shoulders. Similarities in basal width are a product of the Wide-Stemmed from having an expanding stem, as evidenced by the difference in neck width and larger proximal shoulder angle on Wide-Stemmed forms.

Table 6.24. Wide-Stemmed and Silver Lake Attribute Statistics.

		WT	ML	AL	SL	MW	BW	NW	MTH	DSA	PSA	NOA	BI
WIDE STEMMED	N	14	15	15	32	29	29	34	37	38	38	38	38
	Mean	6.1	38.8	38.5	11.6	25.6	19.9	18.0	7.0	210.1	104.9	105.2	0.1
	Std	2.9	8.7	8.7	2.9	3.7	2.5	2.8	0.9	21.5	8.5	23.1	0.4
	Min	1.7	23.7	22.6	7.1	20.3	16.3	13.3	5.0	145	90	45	0.0
	Max	12.2	56.7	56.7	18.3	37.8	24.8	23.1	9.1	245	120	145	1.7
SILVER LAKE	N	37	35	35	45	42	44	47	49	50	50	50	51
	Mean	9.6	44	43.9	15.3	28.8	18.4	20.4	7.9	204.5	91.1	113.7	0.4
	Std	4.2	9.5	9.7	5	5.5	3.7	4.2	1.5	21.4	22.1	20.6	1.0
	Min	3.3	25.9	24.0	8.9	16.7	9.2	7.4	4.0	160	70	75	0.0
	Max	18.2	64.6	64.6	29.7	42.2	26.8	31.5	11.6	250	120	155	5.8

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Table 6.25. Wide-Stemmed-Silver Lake T-test.

	t value	df	p	
WT	-2.38	40	.022	*
ML	-1.90	49	.063	
AL	-1.94	49	.059	
SL	-4.55	74	.000	*
MW	-3.08	72	.003	*
BW	1.68	73	.097	
NW	-3.10	81	.003	*
MTH	-2.71	87	.008	*
DSA	0.26	88	.796	
PSA	3.24	66	.002	*
NOA	-1.38	89	.171	
BI	-1.19	81	.236	

* denotes significantly different samples; significance at 0.05 level

Discriminant Analysis

While differences in the mean value of certain attributes are apparent between Wide-Stemmed and Silver Lake samples, a multivariate discriminant analysis of these categories was performed on elements of stem morphology (i.e., stem length, neck and basal width, basal indentation, distal and proximal shoulder angles, and notch opening angles). Results were limited by the availability of intact measurements, which diminished the sample sizes, although both remain reasonably acceptable. The discriminant analysis successfully classified 80.0% of the sample to their original category with 73.7% (n = 28) of Silver Lake and 88.9% (n = 24) of Wide-Stemmed points correctly assigned (Table 6.26). The greater success rate for Wide-Stemmed points may be partially due to the subjective consistency of the current author who classified all of the Wide-Stemmed points, whereas nearly half (46%) of the Silver Lake projectiles were classified by other researchers.

Table 6.26. Silver Lake-Wide-Stemmed Classification Results.[a]

		Predicted Group Membership		
	Point Type	SL	WSTM	Total
Count	SL	28	10	38
	WSTM	3	24	27
%	SL	73.7	26.3	100.0
	WSTM	11.1	88.9	100.0

[a.] 80.0% of original grouped cases correctly classified.

The primary characteristic distinguishing Wide-Stemmed points are their expanding bases used to classify specimens the Enfield and Riddell collections. Employing a ratio of neck to basal width (NW/BW) for Silver Lake and Wide-Stemmed points, a distribution of ratios that overlap at a value of 1.00 is produced, which is equivalent to a straight stem (Figure 6.4). In an attempt to delineate a potential threshold applicable to points reported in the published data, two discriminant analyses were performed using different values to distinguish Silver Lake from Wide-Stemmed points. The first classifies specimens with a NW/BW ratio greater than 0.95 as Silver Lake, and those below this value as Wide-Stemmed points. The second analysis uses a NW/BW ratio above and below 1.05 to segregate the form. Both analyses excluded the BW and NW measurements to avoid a circular statistical result given the initial segregation method.

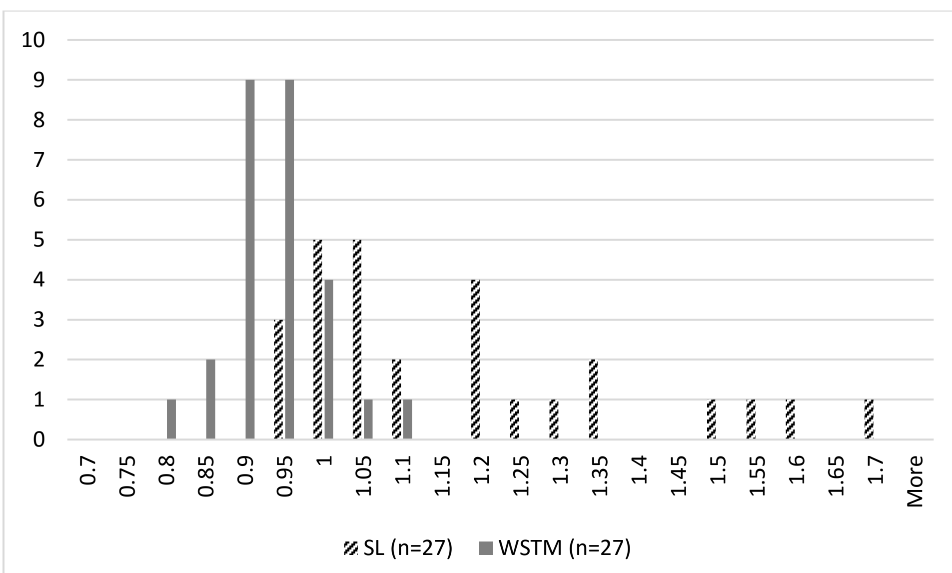

Figure 6.4. Silver Lake and Wide-Stemmed NW/BW ratios.

Result of the first discriminant analysis successfully classified 83.3% of the points, including 23 of 26 (88.5%) Wide-Stemmed and 22 of 28 (78.6%) Silver Lake points (Table 6.27). Classification is improved during the second analysis, with 88.9% of the total valid cases correctly assigned (Table 6.28). Both approaches demonstrate that a minor shift in basal configuration from slightly expanding to slightly contracting has a significant effect on classification, although the contracting stem value of 1.05 NW/BW appears to be a better predictor for segregating these types.

Table 6.27. NW/BW 0.95 Threshold Classification Results.[a]

		Predicted Group Membership		
	Point Type	WSTM	SL	Total
Count	WSTM	23	3	26
	SL	6	22	28
%	WSTM	88.5	11.5	100.0
	SL	21.4	78.6	100.0

[a]. 83.3% of original grouped cases correctly classified.

Table 6.28. NW/BW 1.05 Threshold Classification Results.[a]

		Predicted Group Membership		
	Point Type	WSTM	SL	Total
Count	WSTM	36	4	40
	SL	2	12	14
%	WSTM	90.0	10.0	100.0
	SL	14.3	85.7	100.0

[a.] 88.9% of original grouped cases correctly classified.

Applying the 1.05 NW/BW threshold to the combined set of Wide-Stemmed and Silver Lake points resulted in eight previously published and three Enfield/Riddell collection Silver Lake points reclassified as Wide-Stemmed, and six Enfield/Riddell Wide-Stemmed pieces reclassified as Silver Lake. A discriminant analysis of the regional sample was performed and correctly assigned 86.2% of the points, a similar result to that obtained for the Enfield/Riddell sample (Table 6.29). The consistently poor success classifying Silver Lake points remains problematic, and would probably benefit by incorporating a

Table 6.29. NW/BW 1.05 Threshold Combined sample Classification Results.[a]

		Predicted Group Membership		
	Point Type	WSTM	SL	Total
Count	WSTM	42	5	47
	SL	4	14	18
%	WSTM	89.4	10.6	100.0
	SL	22.2	77.8	100.0

[a.] 86.2% of original grouped cases correctly classified.

comparative sample from the Mojave Desert, where the type was first identified. For the time being, then, the current sample of stemmed points will remain as originally classified. Any further refinement to the classification will depend on temporal data furnished by obsidian hydration. If Wide-Stemmed and Silver Lake points overlap in time, their morphological relationship may reflect the same tradition. If, however, there is a clear separation in time, then their similarities in form may be entirely coincidental.

Large Corner-Notched Comparison

It is possible that Large Corner-notched points share some characteristics with Wide-Stemmed forms. An independent-sample t-test of Wide-Stemmed and Large Corner-notched points shows Wide-Stemmed points overlap substantially with the Large Corner-notched sample in length and stem dimensions, although the latter are wider, thicker and heavier (Table 6.30). Large corner notched examples have likewise smaller distal and larger proximal shoulder angles, resulting in a narrower notch opening than Wide-Stemmed pieces, making it unlikely that the two would be confused.

Table 6.30. Wide-Stemmed/Large Corner-notched T-test.

	t-value	df	p	
WT	-3.33	14	.005	*
ML	-0.81	15	.430	
AL	-0.84	15	.412	
SL	-0.38	52	.705	
MW	-4.99	44	.000	*
BW	-0.89	46	.378	
NW	-0.60	52	.549	
MTH	-2.59	60	.012	*
DSA	8.74	58	.000	*
PSA	-3.62	30	.001	*
NOA	8.22	58	.000	*
BI	-0.77	28	.450	

* denotes significantly different samples; significance at 0.05 level

Discriminant Analysis

Results of the discriminant analysis are more problematic, given the small sample sizes. Nevertheless, 93.0% of the points were correctly classified, with 15 of 16 (93.8%)

Large Corner-notched and 25 of 27 (92.6%) Wide-Stemmed specimens assigned to their respective groups (Table 6.31). This is a conclusive result that the current sample of Large-Corner notched and Wide-stem points do not overlap in any meaningful way.

Table 6.31. Large Corner-notched-Wide-Stemmed Classification Results.[a]

		Predicted Group Membership		
	Point type	LGCN	WSTM	Total
Count	LGCN	15	1	16
	WSTM	2	25	27
%	LGCN	93.8	6.3	100.0
	WSTM	7.4	92.6	100.0

[a.] 93.0% of original grouped cases correctly classified.

Elko Contracting-stem Comparison

Given the variability inherent in the General Stemmed category, the possibility exists that specimens belonging to other types may be included in the sample. One of the more common trends noted in the General Stemmed group is the tendency for the stem element to be contracting. This suggests that some specimens may represent other contracting-stem types. The current sample of dart sized points contains 62 Elko Contracting-stem specimens, which were compared to the General Stemmed points by means of an independent-samples t-test (Table 6.32).

Results of the t-test show that both Elko Contracting-stem and General Stemmed points are similar in size and thickness, but different in most other respects. Elko specimens have significantly shorter, more contracting stems, which results in narrower bases. General Stemmed points are wider and have more sloping distal shoulders, making it unlikely that many of the General Stemmed points could be Elko Contracting-stem pieces. To further assess whether any of the General Stemmed points might fit better in the Elko Contracting-stem category, a discriminant analysis was performed using thickness and

Table 6.32. Elko Contracting-stem-General Stemmed T-test.

	t-value	df	p	
WT	-0.671	24	.509	
ML	-1.774	32	.086	
AL	-2.498	26	.019	*
SL	3.031	82	.003	*
MW	-2.204	73	.031	*
BW	3.938	70	.000	*
NW	3.025	89	.003	*
MTH	1.054	94	.295	
DSA	6.571	98	.000	*
PSA	8.766	97	.000	*
NOA	1.815	98	.073	
BI	-0.324	100	.747	

* denotes significantly different samples; significance at 0.05 level

Table 6.33. General Stemmed-Elko Contracting-stem Classification Results.[a]

		Predicted Group Membership		
	Point type	STM	ECS	Total
Count	STM	32	2	34
	ECS	3	36	39
%	STM	94.1	5.9	100.0
	ECS	7.7	92.3	100.0

[a]. 93.2% of original grouped cases correctly classified.

elements related to basal morphology that are less affected by reworking (i.e., stem length, neck and basal width, basal indentation, distal and proximal shoulder angles, and notch opening angles). Results of the analysis confirm the t-test findings, with 93.2% of the points successfully classified: 32 of 34 (94.1%) General Stemmed, and 36 of 39 (92.3%) Elko Contracting-stem points (Table 6.33). There is no significant overlap between General Stemmed and Elko Contracting-stem points, with the former remaining a likely residual category comprising one-off pieces or remnants of reworked projectiles.

Split-stem Comparison

Comparative analysis of both Wide-Stemmed and General Stemmed forms with the split-stem group was performed by means of a two sample t-test. Relationships were examined first using comparative samples from Fort Irwin (Pinto) and Monitor Valley (Gatecliff) along with Split-stem points from the Inyo-Mono region. Subsequent analysis excluded these extra-local populations, looking only at the regional specimens (Table 6.34).

Comparison of the inclusive and strictly regional sample results shows little significant difference, although there are some shifts in the t-values. When extra-local samples are included, both Pinto and Gatecliff points appear longer than Wide-Stemmed or General Stemmed forms, but when strictly regional samples are compared, Pinto and Gatecliff points are found to be shorter than Wide-Stemmed or General Stemmed points. This is the only observable effect that inclusion of the comparative samples has on the

Table 6.34. Split-stem/General Stemmed Comparative T-tests.

	WSTM-PIN					STM-PIN					WSTM-PIN[a]					STM-PIN[a]			
	t-value	df	p			t-value	df	p			t-value	df	p			t-value	df	p	
WT	-0.65	180	.518		WT	-2.13	185	.043	*	WT	-0.35	87	.730		WT	-1.41	42	.166	
ML	-0.13	226	.898		ML	-0.15	228	.878		ML	0.43	97	.672		ML	0.44	99	.664	
AL	1.13	239	.259		AL	1.25	241	.213		AL	1.67	101	.097		AL	1.82	103	.071	
SL	1.27	415	.206		SL	-0.37	417	.714		SL	1.86	214	.065		SL	0.22	216	.822	
MW	3.31	24	.002	*	MW	-0.75	371	.457		MW	2.96	60	.004	*	MW	-0.67	183	.505	
BW	2.04	397	.042	*	BW	-13.43	390	.000	*	BW	2.99	49	.004	*	BW	-11.30	76	.000	*
NW	1.50	450	.134		NW	-9.14	447	.000	*	NW	1.94	230	.053		NW	-7.28	82	.000	*
MTH	-0.96	425	.340		MTH	-2.98	424	.004	*	MTH	-0.66	74	.512		MTH	-2.54	70	.013	*
DSA	-1.31	477	.192		DSA	-3.87	476	.000	*	DSA	-0.35	249	.724		DSA	-2.61	248	.010	*
PSA	1.58	450	.119		PSA	-5.15	491	.000	*	PSA	1.60	74	.114		PSA	-5.74	260	.000	*
NOA	-1.85	475	.065		NOA	-0.88	474	.381		NOA	-1.10	247	.274		NOA	-0.21	246	.830	
BI	-33.24	473	.000	*	BI	-34.42	471	.000	*	BI	-26.72	266	.000	*	BI	-27.35	269	.000	*

	WSTM-GCSS					STM-GCSS					WSTM-GCSS[a]					STM-GCSS[a]			
	t-value	df	p			t-value	df	p			t-value	df	p			t-value	df	p	
WT	2.34	15	.033	*	WT	2.62	70	.011	*	WT	2.52	20	.021	*	WT	2.80	22	.010	*
ML	-1.64	99	.103		ML	-1.76	101	.081		ML	0.57	20	.573		ML	0.59	22	.562	
AL	-0.66	103	.508		AL	-0.67	105	.506		AL	1.76	21	.093		AL	1.90	23	.071	
SL	6.18	40	.000	*	SL	4.24	41	.000	*	SL	4.45	73	.000	*	SL	2.87	75	.005	*
MW	4.39	158	.000	*	MW	0.81	158	.417		MW	2.24	66	.029	*	MW	-0.54	66	.589	
BW	15.40	165	.000	*	BW	1.06	170	.290		BW	11.40	66	.000	*	BW	-0.46	71	.649	
NW	12.06	209	.000	*	NW	3.26	211	.001	*	NW	8.67	81	.000	*	NW	2.05	83	.043	*
MTH	7.53	216	.000	*	MTH	5.33	216	.000	*	MTH	5.35	86	.000	*	MTH	3.40	86	.001	*
DSA	9.08	217	.000	*	DSA	4.96	48	.000	*	DSA	7.60	87	.000	*	DSA	4.51	69	.000	*
PSA	8.93	79	.000	*	PSA	-0.18	215	.858		PSA	3.56	76	.001	*	PSA	-1.93	85	.057	
NOA	5.00	215	.000	*	NOA	5.75	214	.000	*	NOA	5.21	85	.000	*	NOA	5.47	84	.000	*
BI	-25.95	196	.000	*	BI	-26.74	198	.000	*	BI	-16.77	54	.000	*	BI	-17.01	52	.000	*

[a]excludes comparative Fort Irwin and Monitor Valley samples; *denotes significantly different samples; significance at 0.05

mean values of the different forms. This trend may be due to raw material differences and durability of non-obsidian points comprising the extra-local samples.

Wide-Stemmed and Pinto types share many attributes, but Wide-Stemmed points are typically wider and have broader bases. Another difference is the basal indentation on Pinto, but not Wide-Stemmed or General Stemmed types. General Stemmed points are of similar length, and width to Pinto, but different in other attributes, save their large notch openings. General Stemmed points have likewise narrower bases and a more gracile build. Wide-Stemmed and Gatecliff points share almost nothing but length in common, with the Gatecliff sample being significantly smaller, more gracile, and narrower at the base, with square to slightly tanged shoulders. The General Stemmed sample, however, displays greater morphological similarity to Gatecliff in terms of basal width and proximal shoulder angle. The strongest similarities remain between Wide-Stemmed and Pinto points, which warrants further multivariate analysis to determine how well they segregate.

Discriminant Analysis

Analysis of the points was based on thickness and stem morphology (i.e., stem length, neck and basal width, basal indentation, distal and proximal shoulder angles, and notch opening angle). Results of the classification revealed that Wide-Stemmed forms are easily distinguished from Pinto and Gatecliff points, with all (n = 27) of the Wide-Stemmed points correctly classified (Table 6.35). General Stemmed points were also segregated effectively with 32 of the 34 (94.1%) correctly assigned (Table 6.35). To be sure, Pinto points exhibit some similarity with other forms as nearly a quarter (21.9%) were assigned to other categories, but this may relate to the larger sample of Pinto points and morphological overlap between all dart-sized projectiles.

Table 6.35. Large Stemmed-Split-stem Discriminant Analysis Classification Results.[a]

		Predicted Group Membership				
	Point Type	PIN	GCSS	WSTM	STM	Total
Count	PIN	236	27	20	19	302
	GCSS	5	123	0	3	131
	WSTM	0	0	27	0	27
	STM	0	1	1	32	34
%	PIN	78.1	8.9	6.6	6.3	100.0
	GCSS	3.8	93.9	.0	2.3	100.0
	WSTM	.0	.0	100.0	.0	100.0
	STM	.0	2.9	2.9	94.1	100.0

[a.] 84.6% of original grouped cases correctly classified.

When function coefficients are plotted, the four point types are clearly distinguished, with Wide and General Stemmed samples distinct from both Pinto and Gatecliff (Figure 6.5). There is some overlap between Pinto and other categories, as the discriminant analysis showed, but the primary difference between Wide-Stemmed/General Stemmed and Pinto/Gatecliff groups is the basal indentation on the latter. By definition, both Pinto and Gatecliff points have stems that are bifurcated. It remains possible that some General Stemmed and Wide-Stemmed points represent Pinto or Gatecliff series variants or preforms, such that removing the basal indentation attribute would better reveal the overlap between them.

In order to assess this, the previous discriminant analysis was redone, omitting the basal indentation measurement. The results indicate that there is a greater overlap between the two stemmed and split-stem groups (Table 6.36). While the segregation of Gatecliff points remains reasonably high, with 81.8% correctly assigned, the classification of Pinto

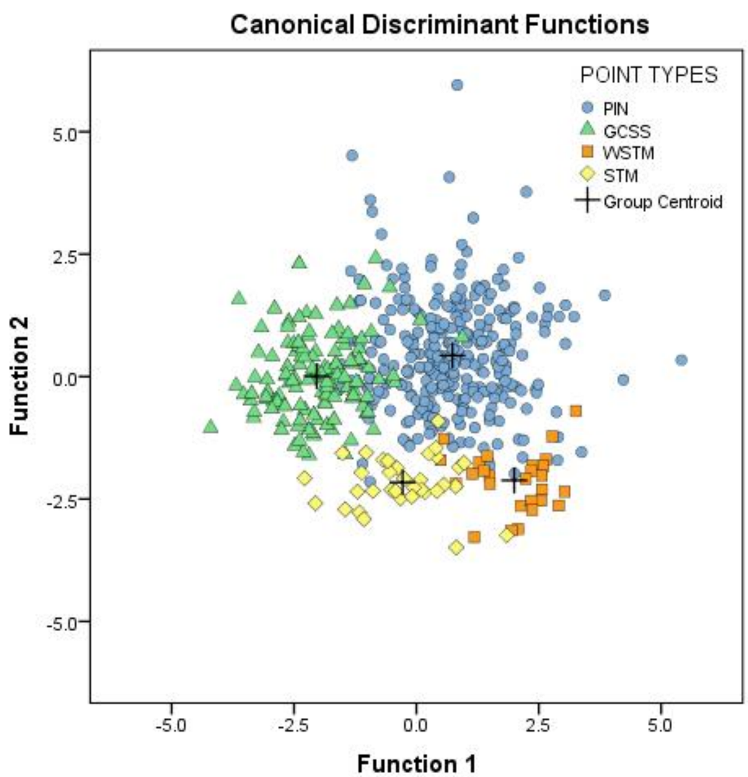

Figure 6.5. Plotted function coefficients.

points decreases to only 47.6%, with many of the Pinto specimens now attributed to Wide-Stemmed forms. Similarly, 25.9% of the Wide-Stemmed points are now classified as Pinto forms. General Stemmed points show greater similarity to Gatecliff than Pinto points, but even 13.6% of the Gatecliff specimens were re-classified as General Stemmed points. The shifts in classification when basal indentation is removed from consideration are graphically apparent when the function coefficients are plotted (Figure 6.6). Instead of four distinct clusters, both Wide-Stemmed and General Stemmed groups are overprinted on the

Table 6.36. Large Stemmed/Split-stem Discriminant Analysis, BI Omitted Classification Results.[a]

		Predicted Group Membership				
	Point Type	PIN	GCSS	WSTM	STM	Total
Count	PIN	164	18	98	33	313
	GCSS	4	108	2	18	132
	WSTM	7	0	20	0	27
	STM	3	6	0	25	34
%	PIN	52.4	5.8	31.3	10.5	100.0
	GCSS	3.0	81.8	1.5	13.6	100.0
	WSTM	25.9	.0	74.1	.0	100.0
	STM	8.8	17.6	.0	73.5	100.0

[a.] 62.6% of original grouped cases correctly classified.

Pinto and Gatecliff clusters, with the greatest overlap of Pinto and Wide-Stemmed points. These results suggest that Wide-Stemmed and Pinto forms may be part of a common morphological series. If true, either the basal notch was a stylistic feature that varied across the region, or Wide-Stemmed points were unfinished preforms. For the preform argument to be true, other things must also be the case. For instance, Wide-Stemmed points must be equal or larger in size on average than the Pinto points as appears generally true (Table 6.37).

Table 6.37. Attribute Statistics for Wide-stemmed and Pinto.

		WT	ML	AL	SL	MW	BW	NW	MTH	DSA	PSA	NOA	BI
WIDE-STEMMED	Num	15	15	15	36	33	33	37	41	42	42	42	42
	Mean	6.4	38.8	38.5	11.5	25.9	19.6	18.1	7.2	203.6	106.9	99.0	0.1
	Std	2.8	8.7	8.8	2.8	4.1	3.4	2.8	1.1	25.4	10.1	26.0	0.4
	Min	2.6	23.7	22.6	7.1	20.3	12.8	13.3	5.0	140.0	90.0	30.0	0.0
	Max	12.2	56.7	56.7	18.3	37.9	25.9	23.1	10.1	245.0	135.0	145.0	1.7
PINTO	Num	59	70	72	159	132	165	169	186	182	196	184	204
	Mean	6.5	36.5	33.4	10.4	22.5	17.8	16.5	7.2	213.6	103.6	109.9	3.7
	Std	3.9	11.1	10.3	2.3	4.8	3.9	3.4	1.7	25.1	12.2	27.1	1.8
	Min	1.1	16.6	13.5	3.8	13	8.8	9.3	3	150	71	40	0
	Max	20.6	68.4	63.4	20.9	36.4	33.9	29.6	15.7	267	153	169	11.5

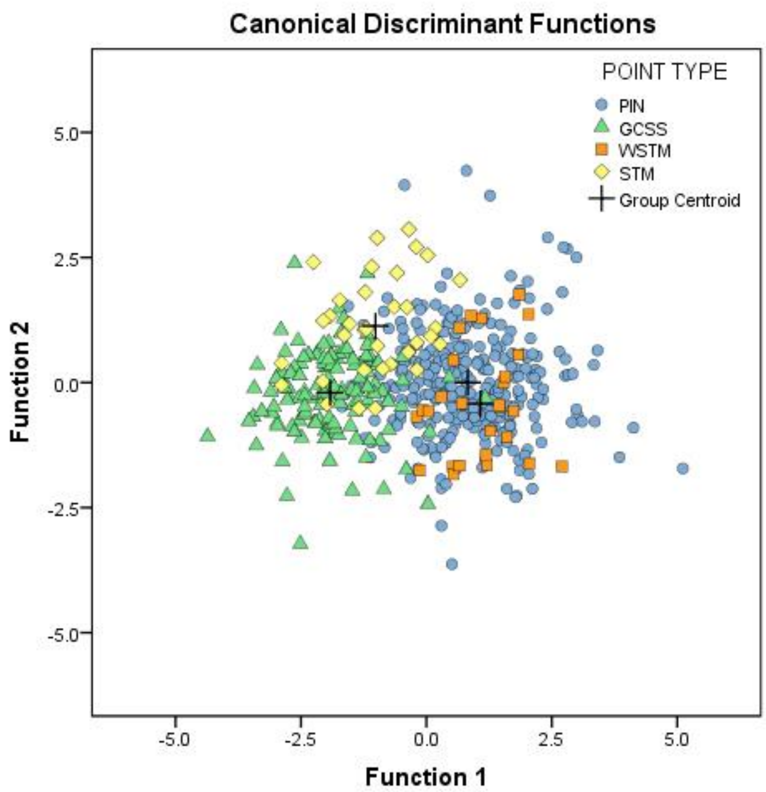

Figure 6.6. Plotted function coefficients: BI omitted.

Wide-Stemmed points have likewise greater stem mass, on average, such that they could have been further reduced into Pinto forms. This is not to suggest that the Wide- Stemmed form represents a pan-Great Basin archetype (cf. Flenniken and Wilke 1989), but, the functional reality of such an implement is worth exploring. The key to this argument, of course, is that Pinto and Wide-Stemmed points must be of comparable age.

Unshouldered Macro-Group

This group includes two distinctly different shoulderless point types: Humboldt Basal-notched and Humboldt Concave Base. Attribute statistics and a two sample t-test (Table 6.38 and 6.39) reveal that the two types are significantly different in every respect, supporting their classification as distinctive types. Humboldt Basal-notched are larger than

Table 6.38. Unshouldered Macro-Group Attributes.

		WT	ML	AL	MW	BW	MTH	BI	BWR
HUMBOLDT BN	Num	38	37	37	98	104	158	159	72
	Mean	9.3	57.2	54.7	24.4	21.8	6.7	6.5	0.91
	Std	5.0	22.0	19.6	4.3	4.6	1.5	2.7	0.11
	Min	1.8	19.0	23.7	14.0	6.0	3.3	0.2	0.53
	Max	22.7	98.7	93.9	36.2	31.8	11.5	17.0	1.10
HUMBOLDT CB	Num	12	11	10	52	70	75	74	39
	Mean	4.7	39.1	39.5	19.2	14.2	6.1	3.0	0.80
	Std	3.3	16.4	14.8	4.3	5.2	1.2	1.7	0.13
	Min	1.8	13.0	17.8	11.7	6.2	3.3	0.0	0.60
	Max	14.2	75.4	73.1	33.4	29.8	11.1	8.8	1.00

Concave Base points, with a deeper basal indentation and a straighter basal blade element. Definition of the Humboldt Basal-notched form has been well established (e.g., Bettinger 1978; Bettinger et al. 1991; Yohe 1998) and warrants no further analysis here.

Humboldt Concave points have a shallow basal indentation and have been segregated into two sub-types: Humboldt Concave-base "A" and Concave-base "B." These were initially distinguished on the basis of length and presumed age, with "Type A" being an older variant greater than three centimeters in length (Holmer 1978; Roust and Clewlow 1968). This distinction is not consistently used, however, as many researchers employ a more general Humboldt Concave base assignment (cf. Hiezer and Hester 1978). Of the 96 Concave base specimens in the present sample only 20 were reported in the literature as being either "Type A" or "Type B."

Table 6.39. Unshouldered T-test.

	t-value	df	p	
WT	2.95	48	.005	*
ML	2.51	46	.016	*
AL	2.28	45	.027	*
MW	7.06	148	.000	*
BW	10.09	172	.000	*
MTH	3.67	179	.000	*
BI	11.91	206	.000	*
BWR	4.67	109	.000	*

* denotes significantly different samples; significance at 0.05 level

Most of the Humboldt concave-base specimens in the current sample are proximal fragments that cannot be typed on the basis of length alone. A cluster analysis of the

Humboldt Concave base specimens was, however, performed using a Ward Linkage of four attributes (basal width, maximum thickness, basal indentation and basal width/maximum width ratio). Three clusters were identified among the 36 valid cases (Figure 6.7). Descriptive statistics for each cluster reveal a clear pattern of size and shape differences (Table 6.40). The third cluster is particularly different from the other two and may reflect specimens approximating the Humboldt Basal-notched type. As such, the four specimens comprising this group may be either misidentified or are simply too fragmentary to reliably classify. All are therefore excluded from further discussion. The two primary clusters are of significantly different size and shape, with one appreciably shorter and

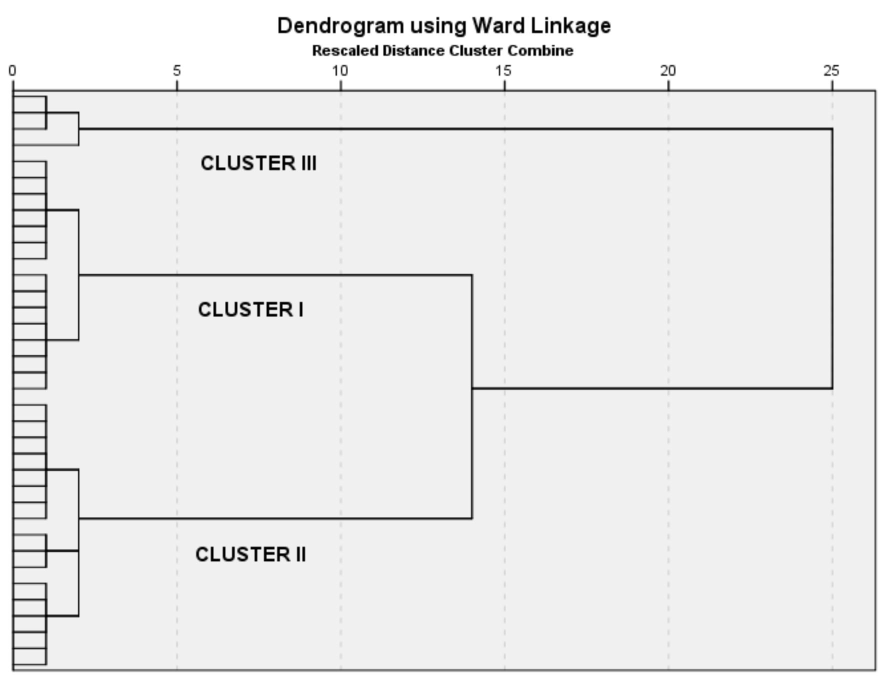

Figure 6.7. Humboldt Concave-base cluster analysis.

narrower than the other and a narrow tapering versus a wider, straighter base. Whether these clusters correspond to earlier "A" and "B" sub-types (Hiezer and Hester 1978) is unclear, but they suggest that Humboldt Concave base is comprised of at least two distinctive sub-types.

Functional differences within the Humboldt series likely correlate to variations in size and shape. The Humboldt basal-notched form, is thought by many to be a hafted biface, given their frequent co-occurrence with more ubiquitous Elko series points and temporal overlap with bow and arrow technology that followed (Bettinger 1978; Garfinkel and Yohe 2002). Characteristically, Humboldt Basal-notched specimens have blade lengths of five centimeters or more, with wide, symmetrically straight blades from the base to midpoint

Table 6.40. Humboldt Concave Base Cluster Analysis Attributes.

		WT	**ML**	**AL**	**MW**	**BW**	**MTH**	**BI**	**BWR**
CLUSTER I	Num	2	2	2	15	15	15	15	15
	Avg	3.0	31.5	28.3	15.8	11.1	6.0	2.9	0.71
	Std	1.6	15.3	14.8	1.8	1.9	1.1	1.5	0.13
CLUSTER II	Num	9	7	7	17	17	17	17	17
	Avg	5.0	44.3	42.3	20.8	17.4	6.5	2.8	0.84
	Std	3.7	15.5	15.5	2.6	1.7	1.1	1.4	0.09
CLUSTER III	Num	0	0	0	4	4	4	4	4
	Avg	-	-	-	29.7	27.2	6.8	4.3	0.92
	Std	-	-	-	2.9	2.5	1.3	3.1	0.12

or farther along the blade margin. The deep indentation of the base further suggests that Humboldt Basal-notched pieces were securely hafted in some fashion. Moreover, the weight of most Basal-notched specimens, which average close to 10 grams, is appreciably greater than other dart-point types. These attributes are more in keeping with an implement intended for heavy use and reworking (i.e., prolonged cutting), as indicated by the high frequency of re-sharpening seen on these implements. Conversely, Humboldt Concave-base points of both sizes are significantly smaller, weighing, on average, a third to half that of the Basal-notched forms. Basal configurations on the smaller Cluster I points show a tendency toward ephemeral shouldering, which suggests a more traditional projectile hafting technology. The larger Cluster II points, although longer, wider, and seemingly straighter edged like the Humboldt Basal-notched form, is still considerably smaller than the Basal-notched sample. This does not preclude the smaller Humboldt points having served perhaps multiple functions as both points and cutting implements, particularly if other dart-point types were present and used during the same interval.

CHAPTER 7

OBSIDIAN SOURCING AND HYDRATION

Four obsidian sources, are the focus of this chapter, given their regional prevalence in the archaeological record and availability of previously established hydration rates: Casa Diablo, Coso Volcanic Field, Fish Springs and Truman-Queen. Data on other obsidian sources present in the projectile point sample can be found in Appendix A. For the sources in question, 660 projectile points have interpretable hydration measurements, 16 have diffuse hydration bands, three have no visible band, and three are too weathered to assess. Source specific hydration values for different points types conform reasonably well to established chronological expectations (Table 7.1). Elko series and Humboldt Basal-notched points have the smallest values, and are the youngest of the regional dart point styles. Humboldt Concave Base points are considerably older, but may overlap the Elko series. Gatecliff Split-stem points precede the Elko series, but are clearly younger than Pinto specimens. The oldest dart-points seem to be the Silver Lake variant of the Great Basin Stemmed series which have larger micron readings than even Lake Mohave specimens. While these patterns seem promising, source-specific analysis of the hydration data and regional distribution of different point types are necessary to establish age estimates for specific point types.

All of the projectile point specimens were subjected to the Effective Hydration Temperature (EHT) regression model presented in Chapter 5. Large coefficients of variation, in all but exceedingly small point samples, reflect likely regional variations in temperature. The rate at which water is absorbed into the glass matrix of obsidian increases

Table 7.1. Dart Point Hydration by Source.

		SOURCE			
		CD	**COSO**	**FS**	**TQ**
Elko CN	n	36	26	20	14
	mean	4.6	8.9	5.7	5.0
	range	2.7-7.4	5.1-20	1.2-8.1	2.2-7.1
	stdv	1.29	3.61	1.81	1.31
	cv	0.28	0.41	0.32	0.26
Elko Eared	n	51	18	7	22
	mean	4.6	8.7	4.9	4.8
	range	2.2-9.5	1.3-8.9	1.6-6.4	2.7-6.8
	stdv	1.17	3.99	1.62	1.09
	cv	0.25	0.46	0.33	0.23
Elko CS	n	22	2	10	8
	mean	4.5	10.8	5.0	5.0
	range	2.4-6.1	7.8-13.7	3.8-7.7	2.8-6.8
	stdv	0.90	4.17	1.35	1.28
	cv	0.20	0.39	0.27	0.25
Elko Unspecified	n	33	8	10	30
	mean	5.0	6.4	5.8	5.6
	range	2.9-7.3	3.4-9.8	2.2-11.8	4.1-7.5
	stdv	1.04	2.17	2.59	0.62
	cv	0.21	0.34	0.45	0.11
Humboldt BN	n	27	25	14	17
	mean	4.4	5.9	5.3	4.0
	range	1.2-6.2	4.6-8.9	1.6-6.9	3.3-5.5
	stdv	1.18	1.05	1.51	0.53
	cv	0.27	0.18	0.29	0.13
Humboldt CB	n	45	4	6	7
	mean	4.8	8.8	6.3	5.8
	range	2.6-8.1	7.5-11.7	5.6-6.7	4.4-6.5
	stdv	1.3027	1.9757	.4457	.6473
	cv	0.27	0.23	0.07	0.11
Humboldt Unspecified	n	1	5	3	-
	mean	4.8	5.3	6.1	-
	range		3.8-7.6	5.7-6.3	-
	stdv	-	1.51	0.32	-
	cv	-	0.28	0.05	-

Table 7.1. Dart Point Hydration by Source.

		SOURCE			
		CD	**COSO**	**FS**	**TQ**
Gatecliff SS	n	2	-	-	3
	mean	6.1	-	-	6.2
	range	5.2-6.9	-	-	3.9-8.4
	stdv	1.20	-	-	2.25
	cv	0.20	-	-	0.36
Fish Slough SN	n	10	-	2	4
	mean	7.9	-	6.7	5.5
	range	3.6-11.7	-	5.8-7.5	2.8-7.6
	stdv	2.45	-	1.20	2.43
	cv	0.31	-	0.18	0.44
Pinto	n	28	32	7	7
	mean	6.6	11.1	8.4	7.1
	range	3.8-11.9	6.1-21.5	3.0-14.6	4.9-8.9
	stdv	1.66	3.85	3.80	1.41
	cv	0.25	0.35	0.45	0.20
Large CN	n	1	3	2	1
	mean	6.2	9.2	5.2	1.7
	range	-	5.1-13.7	3.6-6.8	na
	stdv	-	3.5426	2.2627	-
	cv	-	0.32	0.44	-
Large SN	n	9	3	-	-
	mean	5.1	9.1	-	-
	range	3.8-6.0	8.2-9.6	-	-
	stdv	.8207	.7868	-	-
	cv	0.16	0.09	-	-
General Stemmed	n	2	-	1	1
	mean	6.1	-	3.9	9.3
	range	5.4-6.7	-	-	-
	stdv	0.92	-	-	-
	cv	0.15	-	-	-
Wide-Stemmed	n	19	1	-	6
	mean	6.1	9.3	-	6.8
	range	1.3-8.8	-	-	1.9-16.0
	stdv	1.81	-	-	4.79
	cv	0.30	-	-	0.71

Table 7.1. Dart Point Hydration by Source.

		SOURCE			
		CD	**COSO**	**FS**	**TQ**
Lake Mohave	n	1	18	-	1
	mean	7.6	11.5	-	7.1
	range	-	5.5-17.5	-	-
	stdv	-	2.78	-	-
	cv	-	0.24	-	-
Silver Lake	n	3	9	3	7
	mean	8.4	13.9	6.2	5.8
	range	7.8-9.0	8.6-17.8	5.8-6.6	1.9-9.5
	stdv	0.60	2.67	0.40	2.69
	cv	0.07	0.19	0.06	0.47
GBS Unspecified	n	-	4	-	-
	mean	-	10.9	-	-
	range	-	6.0-14.2	-	-
	stdv	-	3.92	-	-
	cv	-	0.36	-	-

CD = Casa Diablo; CVF = Coso Volcanic Field; FS = Fish Springs; TQ = Truman Queen

with ambient temperature (Friedman et al. 1966; Friedman and Long 1976; Rogers 2007). The most influential determinant of regional temperature is elevation. By correcting hydration readings to reflect temperatures at different elevations within the eastern Sierra, variations in source specific hydration for different point styles, should diminish, as the influence of temperature is eliminated. The resulting micron distributions for different point styles should more accurately reflect their actual age and allow for them to be dated.

Source-Specific Hydration Analysis

Casa Diablo

Descriptive statistics comparing the raw and EHT corrected micron values for points made of Casa Diablo obsidian show that temperature adjusted readings are generally less variable for nearly all point forms (Table 7.2). Exceptions occur where projectile point

Table 7.2. Casa Diablo Hydration Comparison.

	Uncorrected	Corrected	Uncorrected	Corrected	Uncorrected	Corrected
	Elko CN (n = 36)		**Elko Eared (n = 51)**		**Elko CS (n = 22)**	
Mean	4.6	4.3	4.6	3.9	4.5	4.1
Range	2.7-7.4	2.0-7.3	2.2-9.5	2.2-6.0	2.4-6.1	1.6-5.5
Stdv	1.29	1.09	1.18	0.99	0.90	0.80
CV	0.28	0.25	0.26	0.25	0.20	0.19
	Elko UNS (n = 33)		**Humboldt BN (n = 27)**		**Humboldt CB (n = 45)**	
Mean	5.0	3.8	4.4	3.2	4.8	4.5
Range	2.9-7.3	1.9-5.5	1.2-6.2	1.3-5.4	2.6-8.1	2.6-7.8
Stdv	1.01	0.74	1.18	0.88	1.30	1.08
CV	0.20	0.19	0.27	0.27	0.27	0.24
	Humboldt UNS (n = 1)		**Gatecliff SS (n = 2)**		**Pinto (n = 28)**	
Mean	4.8	3.1	6.1	4.7	6.6	6.5
Range	-	-	5.2-6.9	4.3-5.1	3.8-11.9	3.8-9.8
Stdv	-	-	1.20	0.63	1.66	1.46
CV	-	-	0.20	0.13	0.25	0.22
	Fish-slough SN (n = 18)		**Large SN (n = 9)**		**Wide Stemmed (n = 18)**	
Mean	7.9	6.1	4.8	5.1	6.1	6.3
Range	3.6-11.7	2.4-7.8	3.3-6.2	3.8-6.0	1.3-8.8	1.3-8.8
Stdv	2.45	1.48	0.90	.82	1.81	1.66
CV	0.31	0.24	0.18	0.16	0.30	0.26
	Lake Mohave (n = 1)		**Silver Lake (n = 3)**		**General Stemmed (n = 2)**	
Mean	7.6	7.7	8.4	8.3	6.1	5.4
Range	-	-	7.8-9.0	7.5-8.9	5.4-6.7	4.4-6.4
Stdv	-	-	0.60	0.69	0.92	1.38
CV	-	-	0.07	0.08	0.15	0.26
	Large CN (n = 1)					
Mean	6.2	6.3				
Range	-	-				
Stdv	-	-				
CV	-	-				

samples are exceedingly small and in instances where particular point forms are of likely variable age, because specimens were incorrectly classified or the point style was employed over a protracted interval and is a correspondingly poor time-marker.

Temperature corrected box plots (Figure 7.1) for each point form reveals that placement of various point forms generally conforms to regional expectations regarding the relative age of different types. Outliers that fall outside of the 1.5 Interquartile Range of micron distribution are omitted from all source plots. Solitary point specimens exist throughout each source sample and are displayed in the plots, however, they do not contribute meaningfully to temporal patterns. Elko series specimens cluster toward the

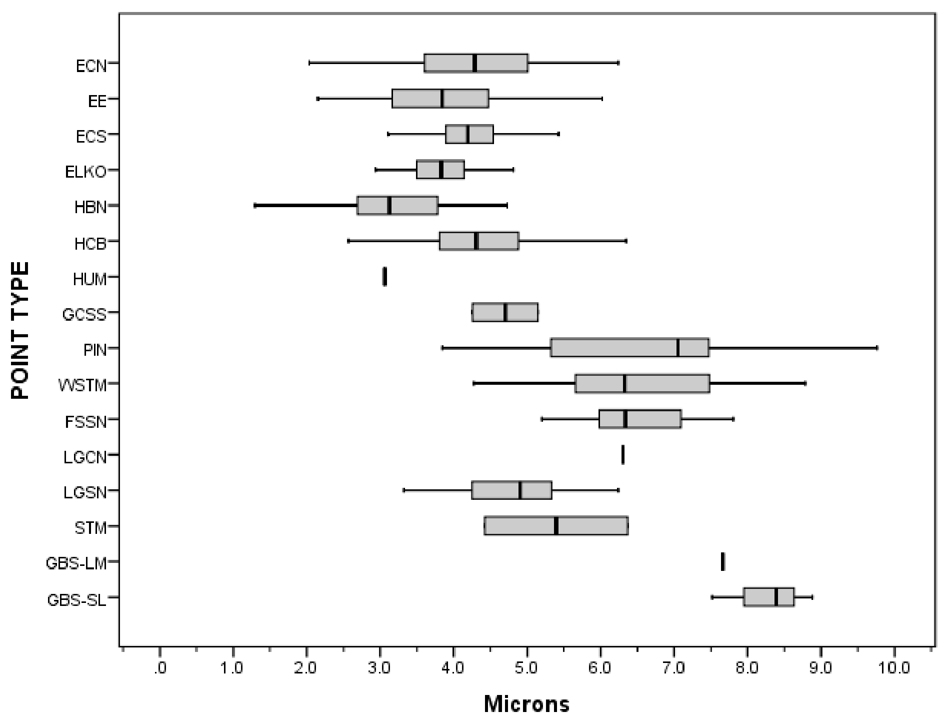

Figure 7.1. Casa Diablo hydration box-plots.

smaller (i.e., younger) end and overlap considerably with the Humboldt series. The Elko Eared form appears slightly younger than the Elko Corner-notched variant, but the seemingly youngest type is Humboldt Basal-notched. This is consistent with the persistence of Humboldt Basal-notched beyond the transition to the bow and arrow. Pinto points are clearly quite old and were produced over an evidently protracted interval in tandem with both Fish Slough Side-notched and Wide-Stemmed points. This is in keeping with previous proposals for the age of Fish Slough points (Basgall et al. 1995), and suggests a strong temporal relationship between Pinto and Wide-Stemmed forms.

Truman-Queen

Points made of Truman-Queen glass are primarily restricted to the northern portion of the study area, with the highest proportion found on the Volcanic Tableland (n = 83; 38.6%). The Truman Meadows area, closest to the obsidian source, has a somewhat lower frequency of Truman-Queen points than either the Volcanic Tableland or northern Owens Valley, but this probably reflects vagaries of sampling in the far from controlled collection of materials. The composition of dart points in the Truman-Queen sample tends to be of later Holocene forms, with substantially fewer early styles.

Specimens were subjected to the same EHT adjustment regression model employed before. Truman-Queen EHT corrections, however, were calculated slightly differently than other obsidian sources. Ideally, artifacts should be corrected to match the temperature present at the parent tool source. The Truman-Queen hydration rate used in the present study was developed, however, with artifacts from the Volcanic Tableland, at lower elevation than the Truman-Queen quarries. Therefore, Truman-Queen temperature corrections were calculated on the basis of a Volcanic Tableland EHT of 17.5° C not the actual Truman-Queen source localities EHT of 14.2° C. More than this, the Truman-Queen obsidian hydration rate formulation is the least refined of the four rates employed in the study (Basgall and Giambastiani 1995).

Results of the Truman-Queen temperature correction are the opposite of that encountered with Casa Diablo, as the variation in hydration actually increases for most point forms (Table 7.3). This may be an unintended result of the method employed for correction, or something as simple as inaccurate temperature data for the Volcanic Tableland. Whatever the case, shifts in micron values are directionally inconsistent, with those for particular point types increasing in some, but declining in other instances, such that Truman-Queen range and standard deviation of hydration value increases for many point categories.

The above notwithstanding, box plots of corrected micron values are generally similar in their relative placement of points to that revealed by Casa Diablo obsidian (Figure 7.2). The Elko and Humboldt series temporal placement for certain categories to that of Casa Diablo, suggesting cluster toward the younger end of the sequence, with Elko Eared specimens being the youngest of the Elko series, and Humboldt Basal-notched points the youngest overall. Pinto points are, again of considerable antiquity and used over an apparently prolonged period.

More problematic is that the sample size for many older point forms is too small to be definitive, while many larger samples have excessively high coefficients of variation.

Given the uncertainties surrounding source specific EHT corrections, aggregated age calculations at the end of this section may be more telling about the temporal placement of individual point forms.

Table 7.3. Truman-Queen Hydration Comparison.

	Uncorrected	Corrected	Uncorrected	Corrected	Uncorrected	Corrected
	Elko CN (n = 14)		**Elko Eared (n = 22)**		**Elko CS (n = 8)**	
Mean	5.0	5.8	4.8	5.3	5.0	5.7
Range	2.2-7.1	2.4-7.7	2.7-6.8	2.6-10.5	2.8-6.8	2.6-7.3
Stdv	1.31	1.59	1.09	1.55	1.28	1.56
CV	0.26	0.28	0.23	0.29	0.25	0.27
	Elko UNS (n = 30)		**Humboldt BN (n = 17)**		**Humboldt CB (n = 7)**	
Mean	5.6	5.3	4.0	3.8	5.8	5.5
Range	4.1-7.5	3.8-6.9	3.3-5.5	3.2-5.2	4.4-6.3	4.3-6.2
Stdv	0.62	0.62	0.53	0.48	0.65	0.62
CV	0.11	0.12	0.13	0.13	0.11	0.11
	Gatecliff SS (n = 3)		**Pinto (n = 7)**		**Wide Stemmed (n = 6)**	
Mean	6.2	7.6	7.1	8.2	6.8	9.9
Range	3.9-8.4	6.2-10.4	4.9-8.9	2.8-14.3	1.9-16.0	3.0-23.4
Stdv	2.25	2.44	1.41	3.69	4.79	6.97
CV	0.36	0.32	0.20	0.45	0.71	0.70
	Fish-slough SN (n = 10)		**Large CN (n = 1)**		**General Stemmed (n = 1)**	
Mean	5.5	6.4	1.7	2.6	9.3	13.6
Range	2.8-7.6	4.1-7.4	-	-	-	-
Stdv	2.43	1.53	-	-	-	-
CV	0.44	0.24	-	-	-	-
	Lake Mohave (n = 1)		**Silver Lake (n = 3)**			
Mean	7.1	10.4	5.8	8.4		
Range	-	-	1.9-9.5	2.8-13.4		
Stdv	-	-	2.69	3.80		
CV	-	-	0.47	0.45		

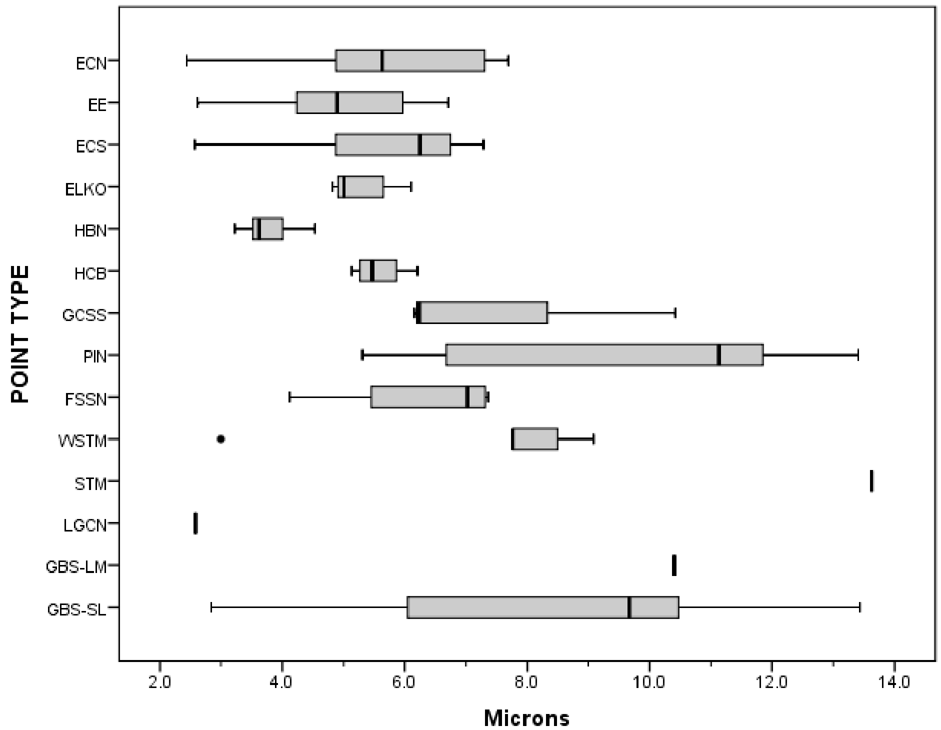

Figure 7.2. Truman-Queen hydration box plots.

Fish Springs

Comparatively few points are made of Fish Springs obsidian, and only 80 of the 125 sourced specimens have reported hydration measurements. The distribution of Fish Springs obsidian is confined primarily to the northern Owens Valley, with a small group of Pinto points made of Fish Springs glass recovered in southern Owens Valley during the Alabama Gates project (Delacorte et al. 1995; Delacorte 1999). Hydration data for these Pinto points, however, were limited due to their weathered condition.

Table 7.4 compares the corrected and uncorrected Fish Springs hydration values for different point types. In keeping with the Casa Diablo result, many point categories display less variability in post EHT hydration values.

Table 7.4. Fish Springs Hydration Comparison.

	Uncorrected	Corrected	Uncorrected	Corrected	Uncorrected	Corrected
	Elko CN (n = 20)		**Elko Eared (n = 7)**		**Elko CS (n = 10)**	
Mean	5.7	5.8	4.9	4.9	5.0	5.0
Range	1.2-8.1	1.2-8.9	1.6-6.4	1.5-6.4	3.8-7.7	3.7-7.7
Stdv	1.81	1.83	1.62	1.63	1.35	1.31
CV	0.32	0.32	0.33	0.33	0.27	0.26
	Elko UNS (n = 10)		**Humboldt BN (n = 14)**		**Humboldt CB (n = 6)**	
Mean	5.8	5.9	5.3	5.2	6.3	6.4
Range	2.2-11.8	2.2-11.6	1.6-6.9	1.6-6.8	5.6-6.7	5.6-6.8
Stdv	2.59	2.61	1.51	1.47	0.45	0.49
CV	0.45	0.44	0.29	0.28	0.07	0.08
	Humboldt UNS (n = 3)		**Pinto (n = 7)**		**Fish-slough SN (n = 2)**	
Mean	6.1	6.0	8.4	8.2	6.7	6.8
Range	5.7-6.3	5.7-6.2	3.0-14.6	2.9-14.3	5.8-7.5	6.2-7.4
Stdv	0.32	0.24	3.80	3.69	1.20	0.81
CV	0.05	0.04	0.45	0.45	0.18	0.12
	Large CN (n = 2)		**General Stemmed (n = 1)**		**Silver Lake (n = 3)**	
Mean	5.2	6.5	3.9	5.7	6.2	9.8
Range	3.6-6.8	5.7-7.3	-	-	5.8-6.6	9.0-10.5
Stdv	2.26	1.10	-	-	0.40	0.74
CV	0.44	0.17	-	-	0.06	0.08

But, variability in the Fish Springs sample is low to begin with. Sample size is likewise limited for most point categories, with the largest sample, that for Elko Corner-notched points (n = 20). Overall, post EHT shifts in Fish Springs micron values are minimal for most points forms, given that many of the specimens derive from northern Owens Valley, close to the Fish Springs source. An exception to this are the ancient Silver Lake points that were recovered far from the Fish Springs quarry.

Box-plots showing the corrected micron distributions for various points show greater overlap than other sources, although their general temporal placement is similar (Figure 7.3). Elko and Humboldt series points are, again, the youngest, on average. Pinto points are consistently older, as observed with other sources, and span a considerable age range. Given the limited sample of Fish Springs points, the observed patterns are less definitive than other sources, but generally conform to the expected temporal sequence.

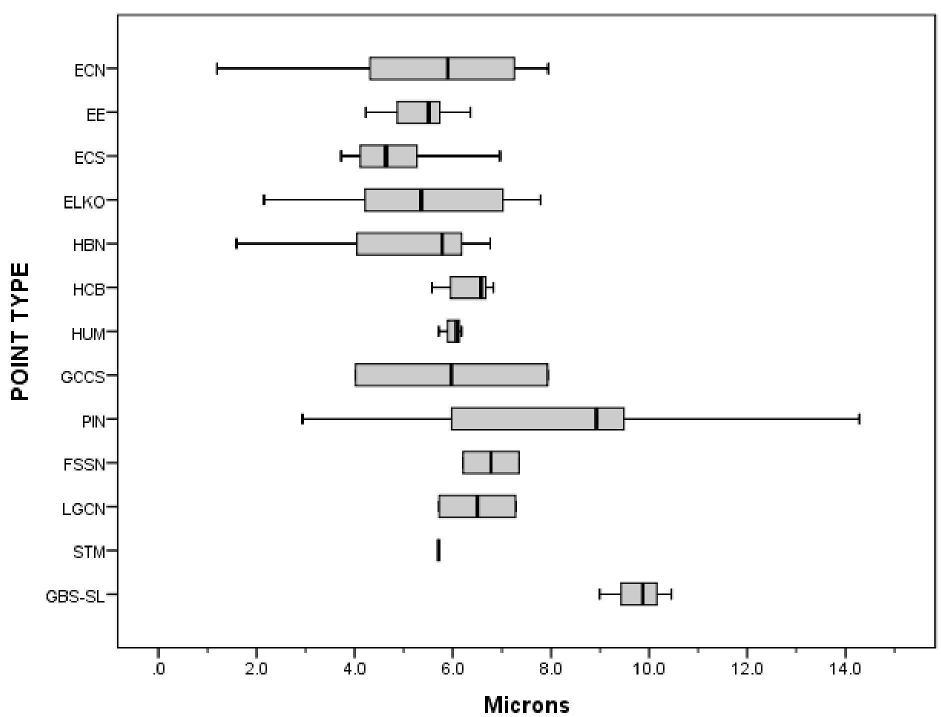

Figure 7.3. Fish Spring hydration box plots.

Coso Volcanic Field

Table 7.5. Coso Volcanic Field Hydration Comparison.

	Uncorrected	Corrected	Uncorrected	Corrected	Uncorrected	Corrected
	Elko CN (n= 24)		**Elko Eared (n = 18)**		**Elko CS (n = 2)**	
Mean	8.9	9.1	8.7	9.1	10.8	10.9
Range	5.1-20.0	5.2-20.8	1.3-18.9	1.3-18.5	7.8-13.7	8.0-13.7
Stdv	3.61	3.6	3.99	4.0	4.17	4.1
CV	0.41	0.40	0.46	0.45	0.39	0.37
	Elko UNS (n = 8)		**Humboldt BN (n = 25)**		**Humboldt CB (n = 4)**	
Mean	6.4	6.4	5.9	5.9	8.8	9.0
Range	3.4-9.8	3.4-9.8	4.6-8.9	4.6-8.9	7.5-11.7	7.5-12.6
Stdv	2.17	2.18	1.05	1.09	1.98	2.42
CV	0.34	0.34	0.18	0.18	0.23	0.27
	Humboldt UNS (n = 5)		**Pinto (n = 32)**		**Wide Stemmed (n = 1)**	
Mean	6.0	5.3	11.1	12.1	9.3	15.1
Range	3.7-9.1	3.8-7.6	6.1-21.5	6.4-20.8	-	-
Stdv	2.21	1.51	3.85	3.62	-	-
CV	0.36	0.28	0.35	0.30	-	-
	Large CN (n = 2)		**Large SN (n = 3)**		**Silver Lake (n = 9)**	
Mean	11.2	15.8	9.1	9.2	13.9	14.7
Range	8.7-13.7	14.6-17.0	8.2-9.6	8.3-10.0	8.6-17.8	10.3-18.8
Stdv	3.54	1.67	0.79	0.82	2.67	2.72
CV	0.32	0.11	0.09	0.09	0.19	0.19
	Lake Mohave (n = 18)					
Mean	11.5	11.6				
Range	5.5-17.5	5.6-18.4				
Stdv	2.78	2.75				
CV	0.24	0.24				

The Coso Volcanic Field source dominates the southern study area and provides the second largest hydration sample. Points made of Coso glass are, however, more wide-spread across the region, as with Casa Diablo obsidian. That said, many of the Coso points in the current sample are from work at China Lake and the Coso Ranges (Gilreath and

Hildebrandt 1997). Many of these sites are situated in the China Lake uplands at elevations from 3150 to 5100 feet. Measurements on Coso specimens are surprisingly variable for some point categories. Application of EHT correction improves this somewhat, for all but the smallest samples (Table 7.5).

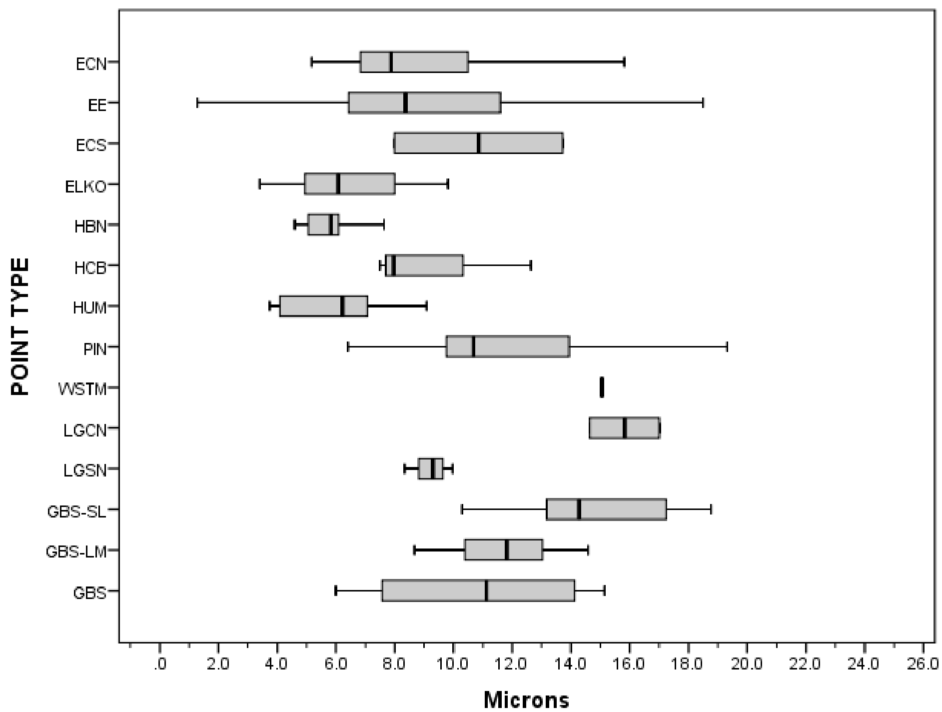

Figure 7.4. Coso hydration box-plot.

Overall patterns in corrected Coso micron distributions are displayed in Figure 7.4. Trends here generally conform to the expected sequencing of points, although the range in values for some types (e.g., Elko Eared) may likely reflect sub-source variability within the Coso Volcanic Field. Four obsidian sub-sources have been identified within the Coso

Volcanic Field: Sugar Loaf Mountain, West Sugar Loaf, Joshua Ridge and West Cactus Peak. Each of these hydrate at a slightly different rate (Ericson 1989; Hughes 1988; Rogers 2008a, 2008b, 2012) and may explain why certain point samples (e.g., Elko and Pinto) display such variable hydration readings. Thus, by examining the hydration of individual sub-sources, the sequencing of points should be improved.

Coso Volcanic Field Sub-Source Hydration (EHT)

Given that Coso sub-source sample sizes ae limited for many point categories, comparison of sub-source hydration is reserved for the more abundant West Sugarloaf and Sugarloaf Mountain sub-groups and point categories with adequate samples (Table 7.6). Micron values falling outside 1.5 times the Inter Quartile Range were treated as outliers and eliminated from the comparison. Variability in points made of Sugarloaf Mountain obsidian is generally lower than West Sugarloaf, with the exception of Pinto points. Mean hydration values are also substantially larger for Sugarloaf Mountain in all point types but Humboldt Basal-notched, however, higher variability in the West Sugarloaf sample is also apparent for this type. This corroborates laboratory induced hydration studies showing that the West Sugar Loaf sub-source hydrates 60% slower than Sugar Loaf Mountain (Rogers 2008).

Hydration Age Estimates

The following presents aggregated age estimates for various projectile points and their relative temporal placement. All hydration readings were subject to age conversions

Table 7.6. Coso Sub-Source Hydration.

		Coso WS	**Coso SL**
ELKO CN	N	11	5
	Mean	9.2	11.9
	Range	6.3-16.4	7.5-11.7
	Stdv	3.4	3.6
	CV	0.37	0.30
ELKO E	N	6	4
	Mean	8.4	10.0
	Range	5.6-14.0	8.4-12.2
	Stdv	3	2.1
	CV	0.36	0.21
HUM BN	N	12	4
	Mean	6.6	5.8
	Range	4.9-9.4	4.9-6.4
	Stdv	1.4	0.7
	CV	0.21	0.12
PINTO	N	14	13
	Mean	10.7	13.1
	Range	7.9-14.4	6.7-19.2
	Stdv	1.5	3.7
	CV	0.14	0.28
GBS LM	N	10	4
	Mean	11.7	11.9
	Range	5.9-19.4	9.1-14.6
	Stdv	3.5	2.3
	CV	0.30	0.19
GBS SL	N	7	2
	Mean	15	16.8
	Range	10.7-19.7	15.5-18.1
	Stdv	3.1	1.9
	CV	0.21	0.11

using the empirical rates outlined in Chapter 5. A seriation frequency of dart points at different time intervals was produced, showing trends that support and expand upon longstanding chronological patterns (Figure 7.5). These data include all Casa Diablo, Truman-Queen and Fish Springs samples, as well as only Coso specimens that could be ascribed to a particular sub source, and excludes unspecified point types that are assigned only to a point series (i.e., Elko, Humboldt, GBS). Similarly, extreme outliers falling outside the 3.0 Inter Quartile Range were excluded from age conversion.

Discussion here centers on conventionally defined point series in lieu of the previously designated macro-groups that were employed for the metric attribute discussion. Other point forms were, however, incorporated when relevant to particular point classes. Where comparisons were previously made, for example, to metric between point groups, the same relationship is explored here to either strengthen or refute the perceived patterns.

Elko Series

Most of the Elko dates fall between 3500 and 1000 B.P., for the entire Elko series (i.e., Corner-notched, Eared and Contracting-stem). Dates on the late end (post 1350 B.P.) are rare, but possibly indicate sustained use of atlatl technology beyond the introduction of the bow and arrow, or may represent misclassified Rose Spring/Eastgate points or transitional atlatl/bow point forms. The introduction of the bow may not, however, have been as rapid as some have suggested (Bettinger 2015). Overlap of atlatl/bow technologies may have occurred for centuries before wholesale adoption of the bow. There is a roughly 700 year lag between the introduction of the bow and intensive plant exploitation and privatization of resources that the bow is believed to have facilitated in the Marana period

(650 B.P. - European contact ~ A.D. 1850 [Bettinger 2015]). It is possible that both weapon systems remained in use through part of the Haiwee period.

Looking at the different Elko point varieties, Corner-notched occurs earlier than either Eared or Contracting-stem types. The Contracting-stem form, however, has a more normal distribution, falling squarely in the Newberry period (3500-1350 B.P.). This suggests that in the Inyo-Mono region contracting-stem dart points are contemporaneous with the Elko not the Gatecliff series as proposed by Thomas (1981) for the central Great Basin.

The few (n = 12) Large Side-notched points with hydration values identified in current study fall within the early portion of the Newberry period. This suggests that an Elko Side-notched point may be a real Newberry point type in the eastern Sierra, albeit a less distinctive marker than other Elko forms. Until more data is brought to bear on Large Side-notched forms, however, the more general category of Large Side-notched should be retained.

The Large Corner-notched specimens lack sufficient hydration data to draw secure conclusions about the form. As a group they date sporadically throughout the Elko interval, although, some exhibit attributes that do not conform to traditional Elko point morphologies (e.g., thickness in excess of 12mm). As previously discussed, Large Corner-notched points may reflect either a real type or extreme size limit of the Elko Corner-notched form. Statistical separation of Elko from Large Corner-notched points was generally successful, although the small samples and morphological overlap between them limits firm conclusions about the veracity of the Large Corner-notched type.

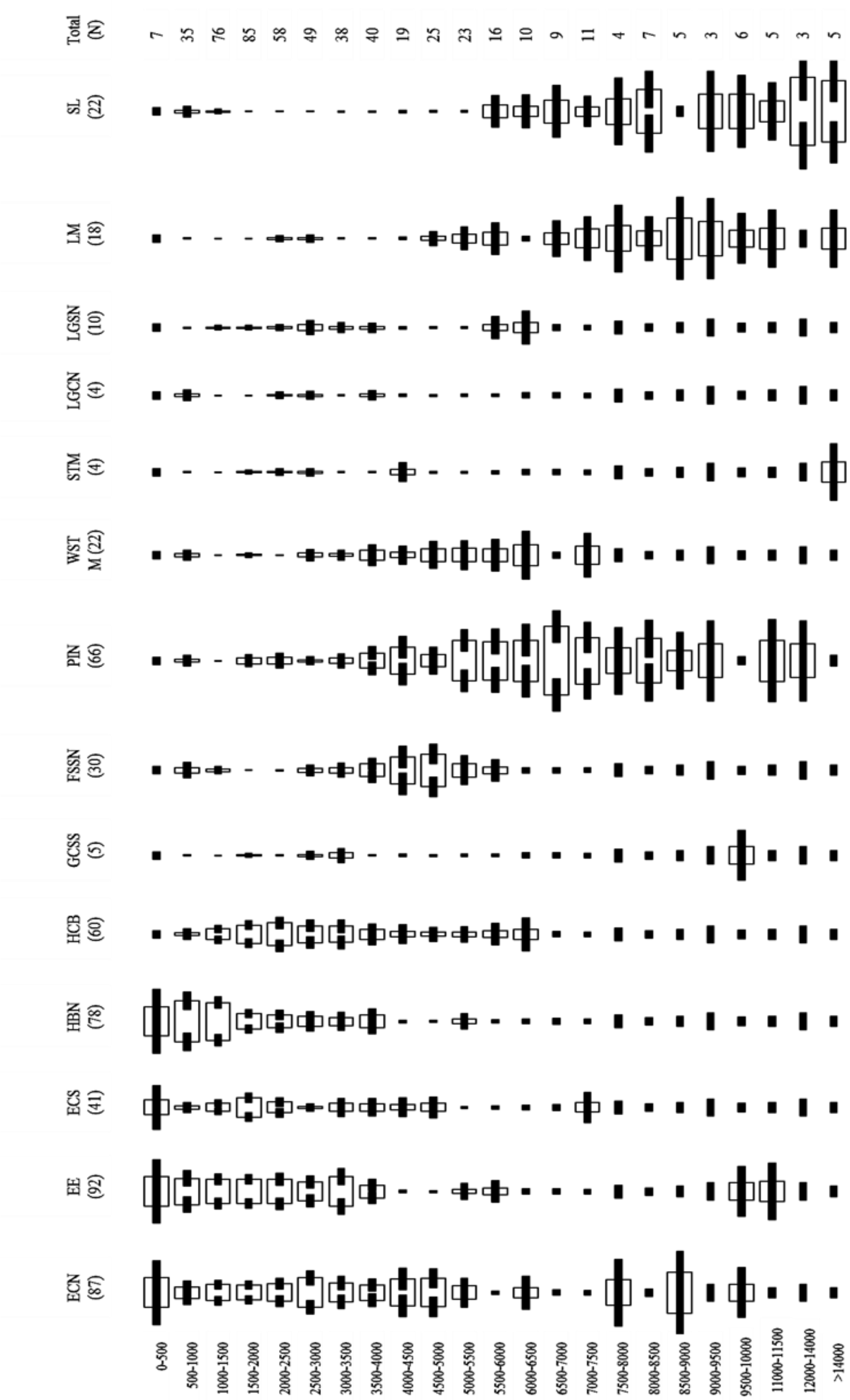

Figure 7.5. Dart point seriation.

Thin versus Thick Elko Points

As initially proposed by Gilreath and Hildebrandt (1997), “Thick” Elko points are an older Elko or larger corner-notched point. Certain corner-notched points from the Coso Volcanic field displayed uncharacteristically thick (>6.5mm) profiles and were of such antiquity, that the authors proposed they were distinct from Elko Corner-notched. Thick examples were on average older, dating to the early-middle Holocene, while thin specimens dated more in line with expectations for the Elko series. Many of the data employed in this study derived from the Gilreath and Hildebrandt (1997) report that first proposed this idea. Thus, any analysis of these specimens will be biased toward the same result. That said, a handful of corner-notched points from the Ayers Rock site (CA-INY-134) are incorporated in the present study, and treatment of the earlier data expanded to temperature correct hydration readings and incorporate recent Coso sub-source specific data.

To explore whether the “Thick” versus “Thin” Elko distinction remains valid, all Elko corner-notched and Eared specimens identified to obsidian sub-source were separated on the basis of the 6.5mm thickness threshold. In all, 32 points (12 thick; 20 thin) produced useful results. The “Thin” population furnished an average age of 3509 cyb2k, and the “Thick” grouped an average age of 9083 cyb2k. This suggests that the initial study was correct, although, a box-plot of the two populations (Figure 7.6) reveals that the “Thick” category varies widely in age and overlaps the “Thin” category in time.

Further examination of the relationship between age and thickness is depicted in a scatter-plot (Figure 7.7). There is a clear, albeit, weak clustering of thick points toward the

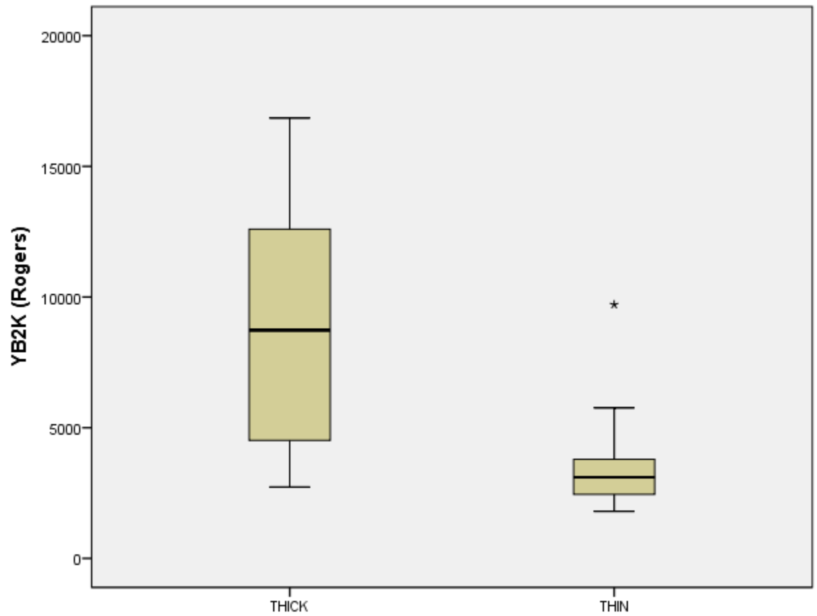

Figure 7.6. Thin versus thick Elko age box-plot.

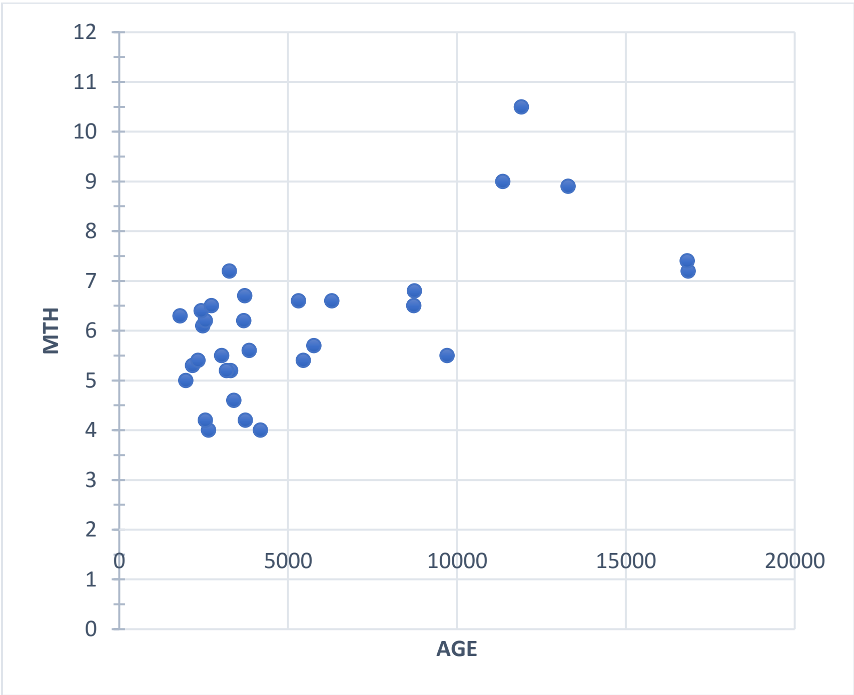

Figure 7.7. Corner-notched thickness versus age.

early end of the sequence, as five of the six specimens thicker than 7.0mm are of substantial antiquity, dating to the Pleistocene-Holocene transition. Most corner-notched points, however, are of varying age thickness throughout the Holocene, with a slight tendency toward thicker points earlier in time. In all, this suggests that a relationship between thickness and age may be valid, although a larger sample is need to verify this pattern.

Split-stem Types

The largest obsidian hydration sample is for Pinto points (n = 73), with few readings on Gatecliff specimens are lacking. Of the 50 Gatecliff specimens, only five have readable micron values. These furnish readings that cluster at the early end of the Newberry period. More intriguing is the sample of Pinto points. These exhibit multiple pulses of use over a large period of time (see Figure 7.5). Pinto points dominate the entirety of the middle Holocene interval, but extend in lesser number back into the early record, where they co-occur with Great Basin Stemmed points.

While most (61.6%) of the Pinto sample falls in the middle Holocene (3500 – 7500 B.P.), further investigation reveals differences in age for particular obsidian sources (Table 7.7). Pinto points made of Coso glass are, on average, the oldest but vary considerably in age (cv = 0.50). Fish Springs Pinto points are of more recent and, again, variable age (cv = 0.60). The Truman-Queen sample, though small, is less varied, with a few specimens that date to the Pinto/Newberry boundary. Casa Diablo specimens include both older and younger points, but are less varied than the Coso sample and younger on average.

Dating of Casa Diablo and Coso Pinto points suggests that those in the northern

Owens Valley are generally younger those in the south. Figure 7.8 plots the age of Pinto points from north to south within Owens Valley.

Table 7.7 Pinto Ages across Obsidian Sources

	Casa Diablo (YB.P.)	**Truman Queen (YB.P.)**	**Fish Springs (YB.P.)**	**Coso (CYB2K)**
n	28	3	7	31
mean	**4109**	**3422**	**4467**	**7525**
min	1591	2450	747	1593
max	9023	3992	7206	12,055
stdev	1744	845	2692	3739
CV	0.42	0.25	0.60	0.50

It shows a weak trend for points to be progressively younger as one moves north. The Coso Volcanic Field yields an average date of 6284 cyb2k/6234 B.P., those in southern Owens Valley an average of 6052 B.P., those in northern Owens Valley a mean of 3425 B.P., and the those from the Volcanic Tableland an age of 3422 B.P. Older points are certainly missing in the north and both early and late examples are found in the south. This suggests that the southern area was more frequently used over time, or the early record is more visible there. The small sample from the north limits the strength of any conclusions, but also highlights the fact that Pinto material is sparse in the north.

Temporal placement of the Pinto form is very ancient in the southwestern Great Basin and Mojave Desert (Basgall and Hall 2000). The present data support that interpretation and further expand the notion that these points persisted throughout the middle Holocene. By the same token, Pinto points appear to be gradually replaced occurring alongside Fish Slough Side-notched, Humboldt Concave-base and Early Elko points. The inception of the Pinto point remains unclear, but it is certainly early in the sequence with a handful of dates that substantially overlap the Great Basin Stemmed series.

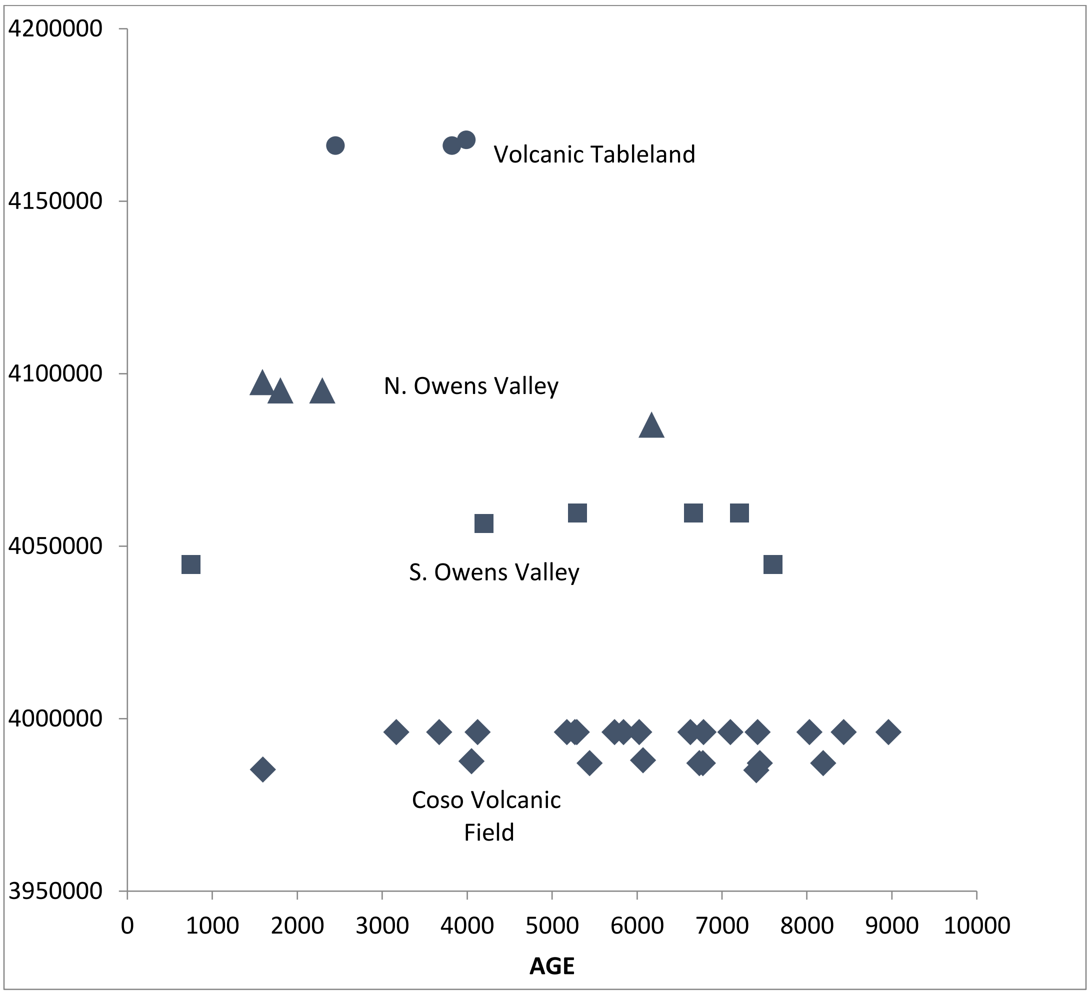

Figure 7.8. Age distribution of Pinto points in Owens Valley.

Humboldt Series

The Humboldt series benefits from one of the largest samples in the current study (n = 177). Both Humboldt Basal-notched and Concave-base points produced obsidian hydration age estimates consistent with previous temporal estimates. Both are late Holocene markers of the Newberry period, with the Basal-notched type of later age. The present data indicate, in fact, that the primary use of the Humboldt Basal-notched post-dates the inception of bow and arrow technology around 1350 B.P. This corroborates the notion that these are actually hafted bifaces rather than true projectiles given their presence in both atlatl and bow and arrow times and hence an altogether different function. Obsidian hydration readings on Humboldt Basal-notched bifaces are tightly clustered in the late Holocene interval, indicating that likely no fragmentary Pinto points were mistakenly included in the category, save possibly one from the Coso area.

Humboldt Concave-base points show an apparent decline in frequency half a millennium earlier than the Basal-notched form, with the Concave-base variety used throughout the entirety of the Newberry period. This temporal distribution slightly predates the Elko series, but does not extend further than the middle Holocene, indicating that no older concave-based forms (e.g., Great Basin Concave-base, Western Fluted) were incorporated in the sample.

Fish Slough Side-notched

Given their distinctive morphology (i.e., convex base) and discrete temporal patterning, the Fish Slough Side-notched is a demonstrably Middle Holocene marker, as previously reported (Basgall et al. 1995; Basgall and Giambastiani 1995; Giambastiani 2004). While only a few new specimens have been dated (n = 7), they are consistent with earlier results. The Fish Slough type appears during the middle Holocene and peaks during the late-middle Holocene, and disappears from the region as Elko and Humboldt points gain popularity. Recognition of Fish Slough points by regional researchers has improved, but additional work is required to fully assess and understand the form.

Wide-Stemmed and General Stemmed Points

These categories were created to categorize points that were variously unique or unlike existing types. The General Stemmed point category is characterized as a narrow, typically gracile, but morphologically variable group of points that are of similarly varying ages. This implies that this is not a real category, but a catchall or residual group of points. Given their variability and morphological distinction from other points, it seems likely that General Stemmed points are probably reworked pieces or production failures.

Wide-Stemmed points are more abundant and display some meaningful temporal patterns. Many date to the middle Holocene alongside Pinto points and disappear rapidly around the time that Elko and Humboldt points are introduced. A few specimens date later in time, but bulk occur as Pinto points are on the decline. What is apparent is that Wide-Stemmed points appear with some frequency in northern areas of the region and are distinct from other earlier stemmed points.

In the previous chapter, it was suggested that Pinto and Wide-Stemmed points may have been part of a single point tradition, with the Wide-Stemmed being a preform for bifurcated points. Although the dating of Wide-Stemmed points does not preclude the earlier hypothesis, they also overlap in age with Elko points. This suggests that the Wide-Stemmed form may have been a preform for multiple types of notched dart points. This is not to argue that Wide-Stemmed points are an archetype for every dart point style (cf. Flenniken and Wilke 1989), but that variability within the type may relate to the eventual form for which they were intended, if they were indeed preforms.

If Wide-Stemmed points are actually preforms, one might expect that they would be most abundant at residential sites and likely whole with no use wear. By the same token, they should be absent at logistical hunting sites, where they would have been fashioned into finished points prior to use. Significantly, Wide-Stemmed forms disappear abruptly when residential patterns shift during late Newberry period. Quarry activity also shifts during this period, with a move to bifacial cores and logistical procurement from seasonally centralized habitation sites. There is a shift as well, from generalized to more specialized toolkits, wherein point forms like Elko Eared display both functional and stylistic properties (Basgall and Delacorte 2012; Basgall and McGuire 1988). Under these conditions, the need for preforms may have diminished, as tool manufacture shifted from quarries to residential sites. In more mobile adaptations, by contrast, finished or near-finished implements were manufactured at the quarry before transport.

Finally, it is clear that the Wide-Stemmed form is unrelated to the Silver Lake type, as the two are of different age with minimal overlap.

Great Basin Stemmed Series

This group is comprised of two point types: Lake Mohave and Silver Lake. Although hydration data are limited, they provide some information on the dating of these forms. First, Lake Mohave appear of erratic age, as only half date to the early Holocene interval and many of these to the later part of the early period. It remains possible that some of the points were misidentified and may be something other than Lake Mohave points. Regardless, just over half of the sample (n = 10) dates to the early Holocene, with one specimen reported from the Pleistocene/Holocene transition. Unfortunately, the hydration sample for Lake Mojave points is too small and problematic to draw any meaningful conclusions.

Silver Lake points are of similarly variable age, but more often early and pre-Holocene antiquity. Two pulses in dates occur at 8000-8500 B.P. and prior to 14,000 B.P.. Given issues with the interpretation of larger Coso hydration rim values, the earlier dates may be suspect, although one of the pre-14,000 B.P. dates derives from a Truman-Queen specimen from Long Valley. In fact, the distribution of age estimates varies between the three sub-regions (i.e., Coso Volcanic Field, Long Valley and Truman Meadows). The Coso region has slightly earlier dates, but this probably relates to the larger sample from there. Terminal dates for Great Basin Stemmed series points have never been definitively established, but appear to persist into the middle Holocene, overlapping Pinto points for at least 2000-3000 years. The youngest dates in the sample are certainly erroneous, falling after the introduction of the bow and arrow. The most definitive pattern in the dating of Great Basin Stemmed series points is that Silver Lake specimens are, on average, older than Lake Mohave points, although morphometric issues surrounding the Silver Lake sample make even this conclusion preliminary.

CHAPTER 8

PROJECTILE POINT DISTRIBUTION AND LANDFORM AGE ANALYSIS

The distribution of various projectile point forms has important implications for diachronic trends in population and land use. The diagnostic properties of projectile points allow for spatial patterns to be observed over time. By examining where certain point forms are found, and in what frequencies, changes in land-use, mobility, resource and toolstone procurement, and occupational intensity can be explored. Moreover, by considering the age of different landforms where points are found, taphanomic biases that may be skewing their recovery can be partially dealt with. Alluvial deposition in lowlands has probably covered up much of the middle Holocene surface record, producing an apparent gap in occupation that may have never existed.

Here, the Inyo-Mono region is divided into seven geographic areas that subsume smaller analytical units employed in previous discussion. These include, the Mono Region (MR) of northern Mono County and Long Valley; Truman (TR), comprising the Truman Meadows and Benton Range; Volcanic Tableland (VT); Northern Owens Valley (NOV); Southern Owens Valley (SOV) which incorporates Owens Lake; Northern Mojave Desert (NMD) including the Coso Volcanic Field and Rose Valley; and Inyo/White Mountains (INWT), which includes Eureka Valley. Raw counts of various points from these areas highlight the differences in point distributions across the region (Table 8.1). Much of this results from the less than random fashion in which the present sample was collected.

Thus, point distributions reflect the intensity of work conducted in different areas as much as a realistic measure of prehistoric occupation. To examine statistical patterns in point distribution between areas, adjusted residuals based on a Chi Square (χ^2) analysis were produced to show where certain points are represented with greater or lesser frequency than expected (Table 8.2).

Table 8.1. Distribution of Projectile Points by Geographic Area.

	MR	**TR**	**VT**	**NOV**	**SOV**	**NMD**	**INWT**	**TOTAL**
Elko Series								
Elko CN	61	3	24	73	38	28	9	236
Elko Eared	59	8	31	64	31	16	21	230
Elko CS	34	11	10	23	3	3	9	93
Elko UNS	15	-	55	19	13	-	-	102
Humboldt Series								
Humboldt BN	27	10	17	84	53	18	8	217
Humboldt CB	44	4	4	54	17	3	6	132
Humboldt UNS	9	-	-	5	2	3	-	19
Split-stemmed								
Gatecliff SS	6	8	11	4	3	-	18	50
Pinto	45	11	13	29	86	40	47	271
Fish Slough SN	15	2	25	10	4	-	2	58
Wide Stemmed	20	11	1	10	6	-	7	55
General Stemmed	7	5	5	2	9	-	14	42
Large CN	5	4	2	2	3	1	5	23
Large SN	10	5	3	13	7	3	5	43
Great Basin Stemmed								
Lake Mohave	-	3	-	2	9	22	1	37
Silver Lake	9	16	1	2	5	12	6	51
Great Basin UNS	-	-	-	-	2	5	-	7
Total	366	101	202	396	291	154	158	1668

Distributional Patterns

Results of the analysis indicate significant variability exists in point distributions and that sampling biases are a factor. For example, Elko series points are heavily skewed toward the northern part of the region, with a greater than expected representation in

Table 8.2. Projectile Point Adjusted Residuals Across Geographic Area.

	MR	TR	VT	NOV	SOV	NMD	INWT
ELK	154	22	65	160	72	47	39
HBN	27	10	17	84	53	18	8
HCB	44	4	4	54	17	3	6
GCSS	6	8	11	4	3	0	18
PIN	45	11	13	29	86	40	47
FSSN	15	2	25	10	4	0	2
WSTM	20	11	1	10	6	0	7
GBS	9	19	1	4	14	34	7
ELK	3.57	-2.88	2.13	2.62	-3.82	-1.37	-2.38
HBN	-3.88	-1.08	-0.93	5.12	2.80	-0.78	-3.08
HCB	3.09	-1.60	-2.67	4.47	-1.53	-3.04	-1.96
GCSS	-1.82	2.90	3.05	-2.81	-2.21	-2.37	6.63
PIN	-2.61	-1.65	-2.95	-5.98	6.70	3.08	5.08
FSSN	0.61	-0.90	8.88	-1.37	-2.20	-2.55	-1.56
WSTM	2.49	4.29	-1.99	-1.17	-1.35	-2.49	0.90
GBS	-2.86	6.13	-2.77	-4.55	-0.46	9.42	-0.44
				Chi-Sq χ^2	**= 533.15**	df	**= 48**

Northern Owens Valley, the Volcanic Tablelands, and Mono Region. Areas to the east and south have similarly fewer Elko points than anticipated, save the northern Mojave Desert, where their occurrence is equivocal in regard to the regional distribution. Given prior evidence that the Elko series, particularly the Eared variant, is a component of a regularized, north to south seasonal round (Basgall and McGuire 1988; Basgall and Delacorte 2012), their diminished occurrence (-3.82) in SOV is questionable apart from a sampling bias. Conversely, Humboldt Basal-notched points are well represented in SOV (2.80), reflecting the same temporal span as Elko series points.

Southern areas produce more negative residuals than northern samples. Of particular note however, is the abundance of Pinto points in both SOV (6.70) and NMD

(3.08). Initially defined in the Mojave Desert (Amsden 1935), it is to be expected that Pinto points would be prevalent in the southern areas, but the SOV sample derives primarily (n = 42, 48%) from a single locale near the Alabama Gates (Delacorte 1999; Delacorte et al. 1995). A natural catchment for Sierran alluvium, the Alabama Hills protect a large swath of land from alluvial deposition, preserving older archaeological deposits. Although an example of sampling bias, Alabama Gates taphonomy is likely not in error or unique.

The Great Basin Stemmed series is well represented in NMD, yielding the highest positive residual of any point category (9.42). As before, stemmed points were first identified (Amsden 1937) in the Mojave Desert and thus, their abundant presence here is to be expected. They are also present in some numbers in the Truman (TR) area (6.13). These northern specimens consist primarily of Silver Lake points from a single Enfield site (2-L-4) that contained multiple Pinto and Wide-Stemmed points as well. In fact, this site accounts for all Wide-Stemmed (n = 11) points in the Truman area (4.29). Previous speculation regarding their relationship to Pinto points cannot be verified, as it appears they do not occur in the same contexts in the same intensity, although, sample size is a limiting factor. Given that pinto points in the south are older, Wide-Stemmed points may be related to younger Pinto points in the north.

The Inyo-White Mountain area has an overrepresentation of both Pinto (5.08) and Gatecliff (6.63) points. These are the only forms that are significantly overrepresented, and they are widely distributed throughout the uplands at nearly 40 different sites. This suggests that Gatecliff points may have arrived from the east, as they are rare in the Owens Valley proper. Other areas where Gatecliff Split-stem points are prevalent include the Truman

Meadows (2.90) and the Volcanic Tablelands (3.05). This too is consistent with the notion that Gatecliff points originated to the east in Nevada and failed to diffuse much beyond the Volcanic Tablelands.

Fish Slough Side-notched points are only prevalent on the Volcanic Tableland (8.88). This is the result of sampling bias, wherein most of the specimens were retrieved from the type site at Fish Slough. Limited identification of these points in the literature poses another problem, but several specimens (n = 11) were identified in the Enfield Collection, though they do not contribute significantly to any geographic area. A large number of Fish Slough points was identified in Deep Springs Valley as well (Delacorte 1990), but are not incorporated in the current study sample.

Projectile Point Distribution by Landform Age

Information on landform age relies on Meyer et al. (2010) which provides an extensive geoarchaeological survey of Inyo-Mono region landforms. A total of 13 dated landform types was identified on the basis of archaeological evidence and newly obtained radiocarbon dates (Table 8.3). For the present purposes, these categories were collapsed into seven landform groups of sequential age (Table 8.4).

The regional landform profile exhibits an obvious bias toward pre-Quaternary (pQ) age surfaces (69.3%), as Meyer et al. (2010) determined that most of the Inyo-White Mountains and Sierra Nevada Range fall into this category. The authors are explicit about the limitations this poses as there are many Holocene-age landforms in these upland areas that are too small and localized to be mapped. Their landform map, therefore, must be used

Table 8.3 Landform Ages for the Inyo-Mono Region (Meyer et al. 2010)

Landform Divisions	**Date Range**
Artificial Cut and Fill	less than150 cal B.P.
Historical and Modern	less than150 cal B.P.
Latest Holocene	2000 - 150 cal B.P.
Latest Holocene Volcanic	2000 - 150 cal B.P.
Late Holocene	4000 - 2000 cal B.P.
Holocene Volcanic (undivided)	11500 - 150 cal B.P.
Middle Holocene	7000 - 4000 cal B.P.
Early Holocene	11500 - 7000 cal B.P.
Early Holocene Volcanic	11500 - 7000 cal B.P.
Latest Pleistocene	15000 - 11500 cal B.P.
Late Pleistocene	25000 - 15000 cal B.P.
Older Pleistocene	1.9 mya - 25000 cal B.P.
Pre-Quaternary	greater than 1.9 mya

with the recognition that it over-generalizes certain aspects. That said, numerous points in the present study derive from these generalized areas subjecting them to this bias. Notable, however, is the large proportion of latest Holocene (LtH) landforms that postdate 2000 B.P, and the scarcity of middle Holocene (MH) aged surfaces. As Meyer et al. (2010) and others (Basgall 2009; Meyer and Rosenthal 2010) have noted, this discrepancy is likely a primary factor reducing the visibility of middle Holocene archaeological deposits.

A portion of the current study data derives from Truman Meadows and White Mountains in Nevada outside the area examined by Meyer et al. (2010), such that landform data are lacking. Instead, USGS geologic maps were consulted and specimens located on

Table 8.4. Inyo-Mono Landform Proportions.

ERA	ACRES	PERCENTAGE	AGE
Historic and Modern (Hm)	141,126.5	1.8%	< 150 years
Latest Holocene (LtH)	1,514,713.6	19.0%	150 - 2000 years
Late Holocene (LH)	232,813.0	2.9%	2000 - 4000 years
Middle Holocene (MH)	89,602.9	1.1%	4000 - 7000 years
Early Holocene (EH)	113,745.8	1.4%	7000-11500 years
Pleistocene (Pl)	351,690.3	4.4%	15000 - 1.9 million years
pre Quaternary (pQ)	5,519,478.7	69.3%	> 1.9 million years

Holocene aged alluvium were ascribed the category Holocene Alluvium (Hal) with a date range of 11,500 to 150 B.P.

A cursory examination of point distribution across specific landforms (Table 8.5) reveals that most point forms were deposited on Late Holocene (LH), Pleistocene (Pl) or pre-Quaternary (pQ) surfaces. Reduced dart point frequencies on the latest Holocene surfaces are likely due to the introduction of the bow and arrow as the primary projectile weapon coinciding with the age of these landforms. Not surprisingly, Historic-Modern surfaces have the fewest dart points, although points of any kind should not be present on such recent surfaces. Historic-Modern surfaces occur primarily next to waterways and active channels, with variable depositional sequences. Moving water can also transport archaeological materials from adjacent surfaces, producing unexpected remains in these areas.

Raw point distributions are heavily influenced by landform. To explore this apparent bias, observed versus expected frequencies of certain point styles were compared

(Table 8.6). This was done for temporally-sensitive types with sufficiently large samples to be reliable.

Table 8.5. Projectile Point Distribution Across Different Aged Landforms.

	***Hal**	**Hm**	**LtH**	**LH**	**MH**	**EH**	**Pl**	**pQ**	**N**
ECN	2	14	29	53	17	27	56	34	232
EE	7	5	18	59	7	15	70	46	227
ECS	6		6	34	4	1	23	18	92
HBN	7	6	17	65	15	23	52	29	214
HCB	4	5	7	25	7	8	58	15	129
GCSS	5	1	1	4			15	24	50
FSSN		2	4	6		3	34	9	58
PIN	7	10	30	32	10	47	36	97	269
LGCN	1	1	4	4	1	2	3	6	22
LGSN	1	3	1	6		1	10	4	26
STM	3	2	3	14	1		10	9	42
WSTM	9	2	3	13		3	12	9	51
GBS-LM	3		9	1	8	1	2	10	34
GBS-SL	11		8	4	7	3	3	15	51
Total	66	51	140	320	77	134	384	325	1497

* Hal = Holocene Alluvium; no higher resolution data available; includes artifacts east of the California/Nevada boundary; Outside of Meyer et al. 2010 study area

Table 8.6. Observed versus Expected Projectile Point Frequencies.

		ECN		**EE**		**HBN**		**HCB**		**PIN**		**GBS**	
Landform	%	Obs	Exp	Obs	Exp	Obs	Exp	Obs	Exp	Obs	Exp	Obs	Exp
LtH	19.0	29	43.7	18	41.8	17	24.5	7	40.7	30	49.8	19	14.8
LH	2.9	53	6.7	59	6.4	65	6.2	25	3.7	32	62.1	5	2.3
MH	1.1	17	2.5	7	2.4	15	2.3	7	1.4	10	2.9	16	0.9
EH	1.4	27	3.2	15	3.1	23	2.9	8	1.8	47	3.7	5	1.1
Pl	4.4	56	10.1	70	9.7	52	9.1	58	5.5	36	11.5	6	3.4
pQ	69.3	34	159.3	46	152.5	29	143.4	15	86.6	97	181.6	27	54.0
LtH	62.0*	29	121.5	18	107.9	17	132.7	7	80	30	102.3	19	31.6
LH	9.5*	53	18.6	59	16.5	65	20.3	25	12.5	32	15.7	5	4.8
MH	3.7*	17	7.2	7	6.4	15	6.6	7	4.1	10	6.1	16	1.9
EH	4.7*	27	9.2	15	8.2	23	8.4	8	5.2	4	7.8	5	2.4
Pl	14.4*	56	28.2	70	25	52	25.6	58	15.8	36	23.8	6	7.3

*pre-Quaternary surfaces excluded

Expected frequencies are predictions of how many points of various types should occur on a particular landform, given its proportional representation in the region and assumption that points are randomly sampled. Thus, middle Holocene age land surfaces represent only 1.1% of the study area, and of the 230 Elko Corner-notched points in the current sample, only 2.5 (1.1%) should be found on any middle Holocene surface. Deviations from the expected frequencies indicate where a particular point type might be over or underrepresented, and if a true landform bias is driving the observed pattern.

Initial analysis shows that all point types are underrepresented on all but the pre-Quaternary and latest Holocene landforms. This result is driven largely by extreme differences in the proportional representation of various landforms, pre-Quaternary surfaces that are too broadly defined to be useful. This reduces the proportional representation of other landforms such that, middle and early Holocene and Pleistocene aged surfaces account in combination for only 7% of all land surface. Thus, the broad scale at which landforms were identified, likely miss much of the surface variability that exists, as acknowledged by the map's authors (Meyer et al. 2010). Another caveat with respect to the present study is the non-random fashion in which the points were originally collected. That said, the study sample is sufficiently large and broad in coverage to assess regional patterns in projectile point distribution.

In spite of the foregoing issues, initial results suggest that older point forms(e.g., Pintos), are more abundant on older landforms, exceeding their expected values by as much as 80.5% on Pleistocene and early-middle Holocene age landforms. Great Basin Stemmed points are seemingly anomalous in their occurrence, save their abundance on pre-

Quaternary surfaces. Given there dating (see Chapter 7) Great Basin Stemmed point should not occur on late landforms, however, observed frequencies are largely opposite of expectations. This highlights the likelihood that landform delineations are potentially problematic. The Elko series and Humboldt Basal-notched points occur in high proportions on late Holocene surfaces, but they are underrepresented in the sample as a whole. To be sure, younger point forms can be expected on any surface of contemporaneous or greater age, but older points on only ancient landforms, making younger points more evenly distributed and regionally visible. Latest Holocene (LtH) surfaces are the second largest in area (19%), and all point forms are overrepresented on them. The limited number of late-dating dart points on latest Holocene surfaces is likely related to the introduction of the bow and arrow and resulting demise of dart points on landforms of every age.

In an attempt to resolve some of the bias in the landform data, a second analysis was performed that removed pre-Quaternary surfaces. In doing so, 325 (22%) of the point specimens are removed from the sample, and the proportional representation of different landforms dramatically altered (see Table 8.7). In this scenario, the latest Holocene landforms dominate the region, with the proportion of other surfaces increasing as well. The only significant shifts in point distributions with this scenario are that Elko Eared points are more or less randomly distributed on middle Holocene surfaces, and Great Basin Stemmed points overrepresented on late and latest Holocene surfaces. Here again, the issue of scale is apparent, with the reality of landform age probably falling somewhere between the first and second scenarios. What is apparent is that older point forms are regionally underrepresented. Pinto points occur in some numbers in many older contexts, but their representation is diminished when landform area is taken into account. This suggests that abundant middle Holocene material is buried under more recent Holocene alluvium that produces fewer dart points than older Holocene landforms. Greater control on the variability within landforms will be crucial for understanding these and other distributional trends.

Applying weighted mean corrections to the sample based on landform acreage, density corrected projectile point frequencies were calculated for time-sensitive types (Figure 8.1). It suggests a steady increase in occupation from Pinto times onward. The

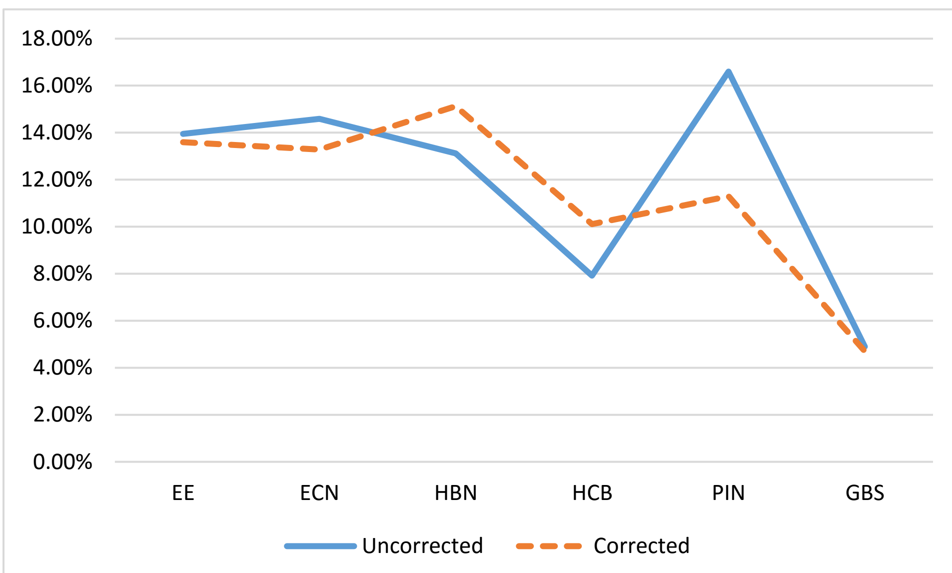

Figure 8.1. Combined point series proportions.

diminished Pinto frequency in the corrected profile reflects numerous Pinto points recovered from pre-Quaternary (pQ) landforms (n = 97) that were omitted in the corrected version. In fact, this is the highest frequency of any point type on a particular landform. The opposite effect occurs with the Humboldt Basal-notched sample, the frequency of which increases due to the abundance (n = 65) of Humboldt Basal-notched pieces on smaller late Holocene (LH) landforms.

On balance, correcting for the differential density of points does little to alter the relative proportions of different types, because the greatest number of points come from smaller landforms. In the case of older points, their underrepresentation on the smaller surfaces (i.e., MH and EH) is offset by their overrepresentation on larger landforms (i.e., pQ). Finally, corrections of this type are subject themselves to inherent sampling biases, as none of the landforms were randomly sampled in proportion to their regional occurrence.

Distribution of Obsidian Hydration Derived Dates

Dates derived from 575 obsidian projectile points were also divided into 500 year increments with respect to regional temporal periods. Their distributions within and across landforms are discussed, and weighted mean adjustments applied to create a corrected regional age profile to explore occupational intensity over time.

Dates are heavily biased toward the later part of the sequence, with the majority (65.4 %) of the age estimates falling after 3500 B.P. at the inception of the Newberry period. Pinto period ages are less than half (25.7%) as abundant and older dates even less common (8.9%). The distribution of ages across landforms (Table 8.7) show a pronounced clustering of dates on older surfaces (i.e., Pl and pQ) prior to 1500 B.P. whereas dates after this point occur mostly on late Holocene (LH) landforms. Late Holocene and Pleistocene

Table 8.7. Distribution of Obsidian Hydration Ages Across Landforms.

Period	YB.P.	*Hal	Hm	LtH	LH	MH	EH	Pl	pQ	N
Marana	0-500	12.5%			**37.5%**	25.0%	12.5%	12.5%	0.0%	8
	500-1000	8.6%	2.9%	2.9%	**51.4%**	2.9%	5.7%	22.9%	2.9%	35
Haiwee	1000-1500	1.5%	1.5%	12.3%	**64.6%**	9.2%	3.1%	4.6%	3.1%	65
	1500-2000		3.4%	2.2%	38.2%	2.2%	1.1%	**46.1%**	6.7%	89
Late Newberry	2000-2500	1.2%	1.2%	22.2%	23.5%		2.5%	**35.8%**	13.6%	81
Early	2500-3000			8.6%	25.9%	8.6%	6.9%	**36.2%**	13.8%	58
Newberry	3000-3500	2.5%	2.5%	10.0%	32.5%	5.0%	2.5%	32.5%	12.5%	40
	3500-4000	2.5%	2.5%	10.0%	10.0%	2.5%	15.0%	**35.0%**	22.5%	40
	4000-4500	5.0%		5.0%	20.0%	5.0%	5.0%	**35.0%**	25.0%	20
	4500-5000	4.5%		9.1%	9.1%	4.5%	4.5%	**54.5%**	13.6%	22
	5000-5500	14.3%		4.8%		9.5%	4.8%	28.6%	**38.1%**	21
	5500-6000	18.8%	6.3%	12.5%	6.3%	6.3%		**31.3%**	18.8%	16
	6000-6500	10.0%		20.0%	30.0%				**40.0%**	10
	6500-7000			11.1%		22.2%	11.1%	11.1%	**44.4%**	9
Pinto	7000-7500	10.0%		**30.0%**	10.0%	20.0%	10.0%		20.0%	10
	7500-8000			50.0%				50.0%		2
	8000-8500	25.0%		12.5%		25.0%			**37.5%**	8
	8500-9000			20.0%				20.0%	**60.0%**	5
	9000-9500	33.3%				33.3%			33.3%	3
	9500-10000	**50.0%**				16.7%		16.7%	16.7%	6
	10000-10500				100.0%					1
	10500-11000									
Early Holocene	11000-11500	20.0%		20.0%	20.0%	20.0%			20.0%	5
	11500-12000					50.0%			50.0%	2
	12000-12500								**100.0%**	1
Pleistocene	>14000	11.1%			5.6%	5.6%		11.1%	**66.7%**	18
	Total	4.7%	1.6%	10.1%	28.2%	6.1%	4.2%	28.9%	16.3%	575

* Hal = Holocene Alluvium; no higher resolution data available; includes artifacts east of the California/Nevada boundary; Outside of Meyer et al. 2010 study area

landforms have the largest proportion of dates, a trend that expectedly mimics the pattern observed in raw point counts. Thus, temporal pattering in relation to landform appears consistent. Most dates on late Holocene surfaces postdate 4000 B.P., the greatest proportion of which post-date 2000 B.P. after the landforms were established. Similarly, early Holocene landforms only have occupation after 7500 B.P. after they became stable.

A notable anachronism to the above are the numerous early Holocene dates found on latest Holocene (LtH) surfaces. Part of this may be explained by the lack of resolution in the definition of various landforms, wherein remnants of older surfaces may survive unrecognized within later contexts. Generally speaking, later Holocene landforms should have fewer dart points of typically younger derivation given the recent age of the sediment. But younger landforms are also widespread and of probably greater temporal variability then earlier surfaces. Holocene Alluvium (Hal) east of the California/Nevada border is, for example, of pan-Holocene age, and has dates reflecting multiple periods, albeit a limited sample from just a few areas.

Other landforms display similar temporal discrepancies, particularly where sample sizes are negligible. Where sample sizes are better, there is a general trend for older surfaces to produce older dates, and younger surfaces appropriately recent dates. What is still unclear is the variability within Early and Middle Holocene sediment packages, as no Early Holocene ages were identified on Early Holocene surfaces, and numerous older dates were found on the Middle Holocene surfaces. As previously stated, better resolution of the variation between landforms needs to be obtained. It seems apparent, for example, that the geographic extent of some landforms may be too limited to properly assess the temporal placement of materials.

Regional age profiles displaying corrected and uncorrected data (Figure 8.2) show a general trend toward increased occupation that began gradually throughout the Pinto period and increased dramatically at the end of the Pinto and subsequent early Newberry period. From 2000 B.P. onward, occupation spiked sharply prior to the introduction of the bow and arrow, when dart points were abandoned. The implications here are for a steady increase in occupation beginning at the early Holocene-Pinto boundary, with no indication of population decline during the middle Holocene. That late Newberry occupation may have corresponded with a population surge after 2000 B.P. may relate to the embedded

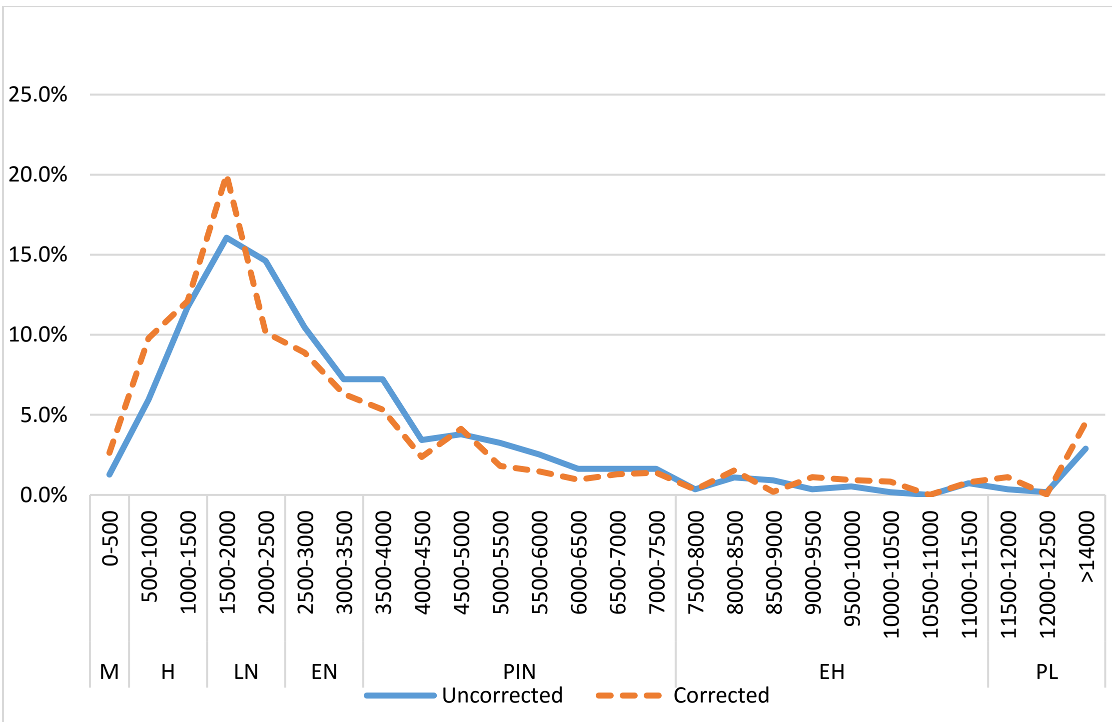

Figure 8.2. Regional projectile point age distribution.

procurement of toolstone within the seasonal round of late Newberry period groups, allowing for increased manufacture of projectile points. This is when the use of projectile points becomes potentially problematic for estimating population or occupational intensity, as the organization of technology appears to have changed at this time. The small pulse of Pleistocene dates prior to 14,000 B.P. were obtained exclusively on Coso obsidian specimens. All are older point forms (GBS and Pinto) dating to between roughly 14,000 and 17,000 B.P., so it is unlikely that they represent any true occupation during this interval, although, the possibility cannot be entirely dismissed.

Middle Holocene Gap

Revisiting the central theme and research issue of the current study, it is apparent that no middle Holocene “gap” exists and that material of this age is actually more prevalent than previously assumed. The increased Pinto presence in the current data set reflects a near-doubling of the regional Pinto point sample extracted from various reports and monographs (n = 143) and from the Riddell and Enfield collections (n = 121). Collections like these should be examined when possible, as they may contain significant portions of the archaeological record that are rarely encountered. In fact, these data were instrumental in identifying the trend of increasing occupation during the middle Holocene. Although the initial increase in occupation occurs as the Altithermal period (Antevs 1948) waned toward the end of the middle Holocene, climatic conditions may have had an effect on population growth, but never to the point of population decline. A more plausible effect of climatic conditions may have been re-organization of land-use during the middle Holocene era, as people shifted toward higher latitudes in the region or increasingly exploited the upland habitats more intensively. A final thought on the subject is, as always, that more data are needed to continually asses and update the archaeological record.

CHAPTER 9

SUMMARY AND CONCLUSIONS

The current study analyzed morphological, temporal and spatial patterns of prehistoric Great Basin dart points in separate, but sequential fashion. Together, these analyses were employed to examine occupational intensity prior to the introduction of the bow and arrow as well as shifts in land use. The morphology of projectile points in the current sample is generally consistent with previous typologies, although the small samples for some types limit the conclusions that can be drawn. Dating by means of obsidian hydration generally confirms the existing point sequence, but new insights into the age of certain existing and new point forms is also provided. Differences in geographic distributions and dating of points were also explored. A final analysis of point form and age across landforms of different antiquity was further explored to correct for taphonomic biases in the archaeological record. Results for each of these endeavors are briefly summarized below, along with possibilities for further research.

Patterns of Morphology and Temporal Placement

Chapters 6 and 7 present results of analyses to better define changes in point morphology over time. Definition of distinct point forms was necessary to characterize the often daunting variability in dart point form before the age of various types could be assessed by employing obsidian hydration and other approaches.

Metric analysis of 1593 dart points on the basis of 13 attribute measurements was used initially to confirm existing or establish new point types (see Basgall et al. 1995;

Basgall and Hall 2000; Thomas 1981). Entirely new categories were proposed for specimens that differed from previously established types. Points were also grouped, on the basis of broader morphology into larger macro-groups (i.e., Corner-notched, Side-notched, Split-Stem, Large Stemmed, and Unshouldered) for comparative statistical analysis.

Results of these initial analyses help to reify existing typologies and highlight the variability in dart points, within even the same type. This was particularly true for large stemmed points. Absent a well-established type collection like that available and employed for the split-stem points, Silver Lake and Lake Mohave stemmed points were difficult to segregate in the sample. As such, they were left as previously classified, with the caveat that their taxonomies were inconclusive. Further study of Great Basin Stemmed points, possibly employing data from the Mojave Desert, could help to establish a baseline for the timing of regional early Holocene occupation.

Sample size was in many instances a limitation (e.g., side-notched and Great Basin Stemmed), but even larger samples (e.g., split-stem forms) suffered from extensive variation. Attribute measurements within and between point forms often displayed large ranges, negating the use of univariate thresholds for successful classification. Segregation of point forms using multivariate discriminant analyses was more successful. This approach considers the way in which different attributes interact, and supported, more often than not, the initial type calls.

In all, 18 point categories were subjected to obsidian hydration analysis, with some representing well established types, and others newly defined categories of unknown age.

Dating of well-established types generally conformed to previously established age estimates for groups like the Elko and Humboldt series. Other categories however, were of either variable age or of such limited number that the results were inconclusive. Pinto points for instance, were evidently made and used for millennia and appear of disparate antiquity in different places. Temporal data are lacking for regional Gatecliff samples, such that no conclusive age assignment could be offered, save that most of the specimens are younger than Pinto and older than Elko points. The more compelling argument in regard to Pinto and Gatecliff points is that their eastern Sierra spatial overlap is limited to the Inyo-White Mountains and basins east of Owens Valley. Moreover, Gatecliff points do not appear to exist further south or west than the Volcanic Tablelands. This suggests that the Inyo-Mono region had a pre-Newberry period population that differed from that in the central Great Basin where Gatecliff points are ubiquitous.

The Wide-Stemmed point category provides one of the more interesting temporal patterns when compared to Pinto points. The idea that these Wide-Stemmed points are Pinto preforms was suggested, but temporal data indicate that some Wide-Stemmed specimens could as easily have been Elko series preforms. Larger corner notched specimens may also fit this preform function, as obsidian hydration data suggest contemporaneity with the Elko series, and some overlap in size with Wide-Stemmed forms. Large, generalized preforms may have been common in toolkits until the late Newberry period (ca. pre-2000 B.P.) when large highly formalized bifaces come to dominate flaked stone assemblages (Delacorte et al. 1995). This, in turn, may have related to changes in settlement-subsistence patterns between middle and late Holocene time, when purportedly hyper-arid conditions ameliorated. The advantage of preformed points over large bifacial blanks (cores) relates to the amount of material transport required. Late Newberry period bifaces were easily transported back to a central place for further reduction. Prior to the Newberry settlement shift to such seasonally centralized sites, however, dart points may have been nearly finished implements at quarries to ensure maximum reliability and utility.

Pinto Settlement, Mobility and Timing: Future Research

Variability in the age and geographically expansive occurrence of Pinto points required greater analysis than other point forms. In Chapter 7, it was shown that there was an emerging trend for Pinto points to be, on average, younger in more northern areas. Further analysis revealed, however, that Long Valley, Truman Meadows and Inyo-White Mountains had substantial samples of Pinto points. The present hydration sample lacks specimens from the Inyo-White Mountain area, but Long Valley and Truman Meadows produced some Pinto point hydration dates. These areas provide seemingly older Pinto hydration values than the Volcanic Tablelands or Owens Valley, with the caveat that sample sizes and composition are far from comparable between areas. (Figure 9.1). While there is no fixed trend in the age of Pinto points, they do decrease in age from the Coso Volcanic Field to the Volcanic Tablelands.

Despite less than perfect data, an argument can be made regarding the of a pre-Newberry settlement shift. Using the Coso Volcanic Field and Long Valley sub-samples, there is an apparent shift in occupational intensity between the two areas (Figure 9.2). The moving average trend line for each of the samples intersect just after 7500 B.P., coinciding

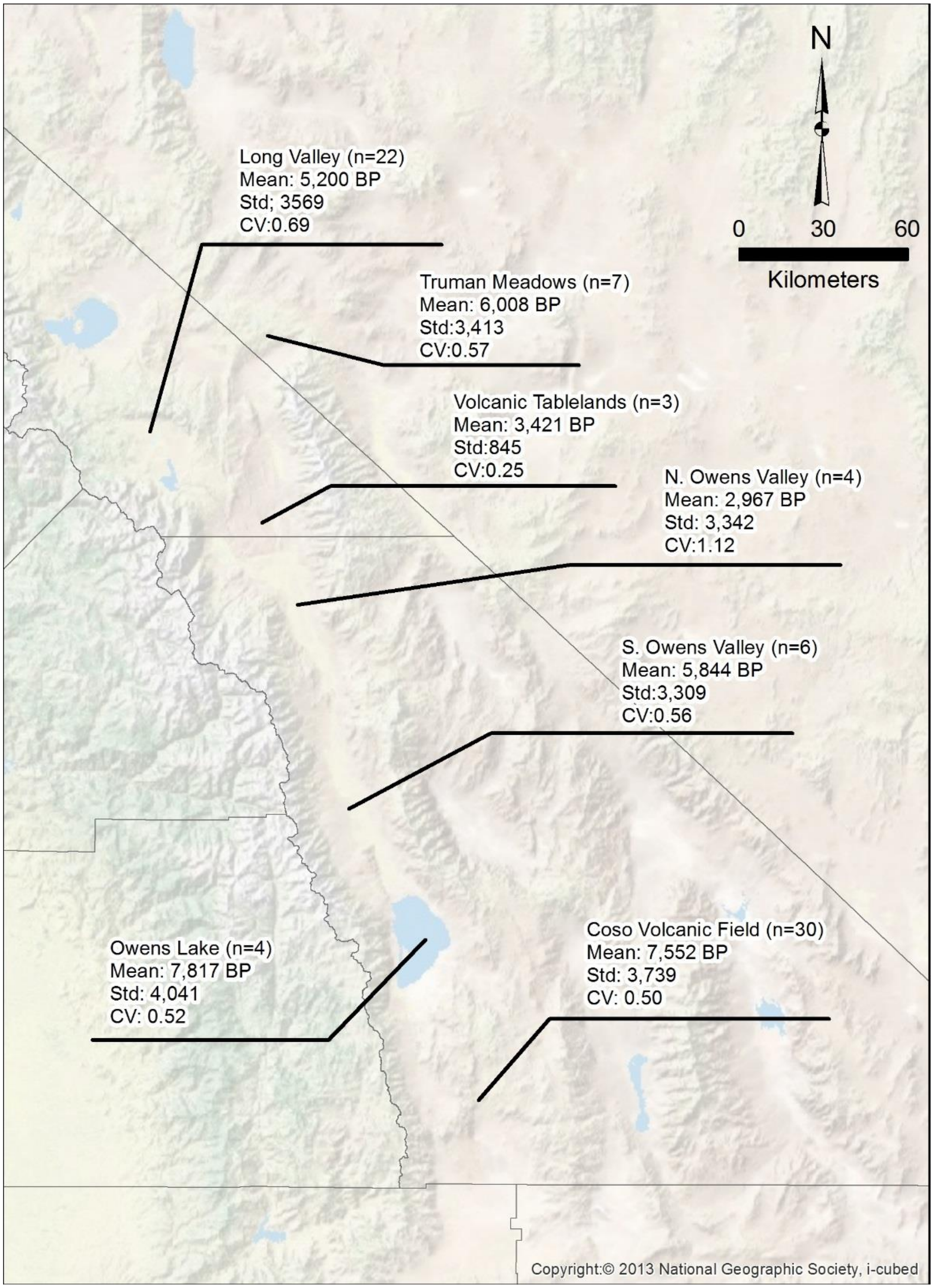

Figure 9.1. Pinto age distribution map.

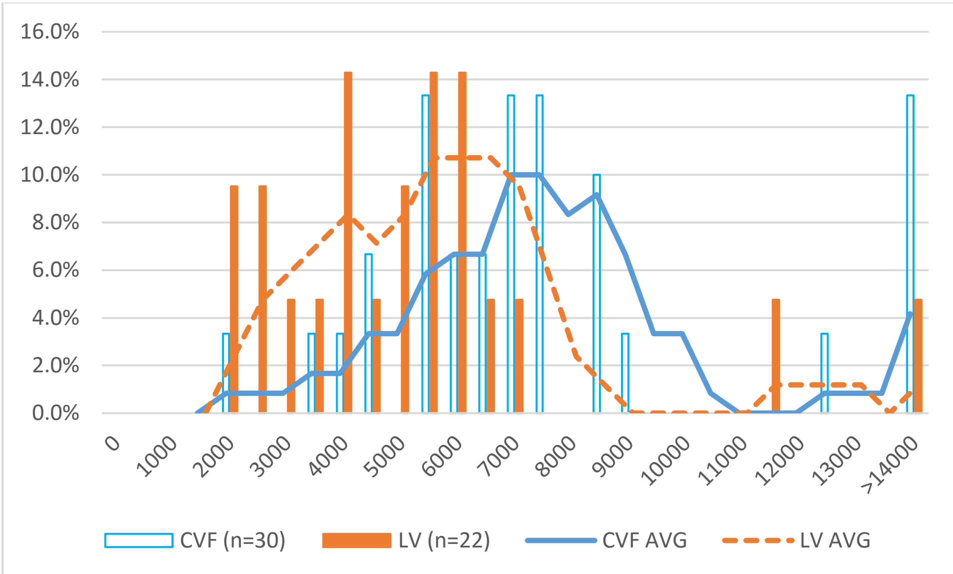

Figure 9.2 CVF and LV Pinto age comparison.

with the onset of the Altithermal period.

It is proposed, here, that early groups benefitted from wetter climatic conditions and had more stable occupation, near reliable water and tool stone sources, accounting for the larger accumulations of Pinto material at sites in southern areas (e.g., Stahl Site [Harrington 1957] and Pinto Basin [Campbell and Campbell 1935]). But, as conditions grew warmer and drier, there was a gradual movement northward and shift to greater mobility as resources declined, a similar pattern as that proposed by Baumhoff and Hiezer (1965). An ephemeral middle Holocene record of expansive, short term habitation has been posited elsewhere (Delacorte 1999; Delacorte et al. 1995).

This preliminary assessment of Pinto point temporal and spatial patterning would needs to be examined further by incorporating obsidian hydration data from the numerous specimens identified in the Inyo-White Mountains. As observed in Chapter 8, numerous Pinto points were collected by the Enfields in the uplands east of Owens Valley. Further refinement and obsidian hydration dates of the Inyo-White Mountain points and better resolution of upland landform ages, may resolve where and how extensively groups traveled during the middle Holocene. Lowland areas suffer from poor hydration samples on Pinto points with those that do exist exhibiting some variability in age toward the younger end. Where substantial numbers of pre-Newberry period points have been found (e.g., Alabama Gates [Delacorte 1999]), weathering and diffuse hydration readings have limited their temporal resolution. The paucity of data and degree of landform bias within the region leave the "Pinto problem" far from resolved, though it is clear that there was no middle Holocene abandonment of the area and that evidence of pre-Newberry period occupation is more abundant than once thought.

APPENDIX A:

Projectile Point Attribute Catalog

(SEE ENCLOSED DISC)

APPENDIX B:

Obsidian Sourcing and Hydration Catalog

(SEE ENCLOSED DISC)

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